

UNIVERSITY OF GHANA



EXTREME VALUE MODELLING OF THE WATER LEVELS OF
THE AKOSOMBO DAM

BY

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DECLARATION

I hereby declare this submission is my own work, except where otherwise stated, under the supervision of Dr. E. N. N Nortey and Dr. K Doku-Amponsah.

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ABSTRACT

The Akosombo dam is Ghana's main source of energy. Considering the current increase in the demand for electricity in the country, where an increase in demand implies more pressure on the dam, it is therefore very important to investigate the tail behaviour of the water levels of the dam. This is necessary because the level of water in the dam determines the amount of electricity generated. The study investigated this problem using Univariate Extreme Value Theory. Both the Generalized Extreme Value distribution and the Generalized Pareto distribution were fitted to the Akosombo data. The Generalized Extreme Value distribution performed better than the Generalized Pareto distribution. Maximum likelihood estimation method was employed in the estimation of the model parameters. The study indicated that the water levels cannot fall below 226.00ft., which is the critical water level of the Akosombo dam. However, there is evidence of the dam attaining water levels below the minimum head operation level. We therefore recommended that, other forms of power generation should be explored to reduce the dependence on the Akosombo dam due to the fact that the dam can attain water levels below the minimum head operation. We also recommended that to prevent flooding during periods of excess water and abundant inflow, the high of the reservoir should be extended to retain the excess water which is spilled out.

DEDICATION

To God almighty who protects and grants me breath and grace.

And

To my parents, Mr and Mrs Johnson Ocran and brothers who love and supported me.

And

To my Lectures and Colleagues who enriched my knowledge.

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CHAPTER ONE

GENERAL INTRODUCTION

1.1 Introduction

The classical statistical theory is often concerned with the behavior of the mean, which is described through the expected value $E(X)$ of the underlying distribution. On the basis of the law of large numbers, the sample mean is used as a consistent estimator of $E(X)$. The central limit theorem yields the asymptotic behavior of the sample mean. This result can be used to provide a confidence interval for $E(X)$ in case the sample size is sufficiently large, a necessary condition when invoking the central limit theorem. Now what happens if the second moment, $E(X^2)$ or even the mean, $E(X)$ is not finite? Then the central limit theorem cannot be applied and so is the classical statistical theory, or what if one wants to estimate $p = P(X > x)$ for $x > x_{n,n}$ where $x_{n,n}$ is the largest order statistic in n sample and the estimate \hat{p} defined above yields the value 0? We cannot simply assume that such x -values are impossible. However, the traditional technique based on the empirical distribution function, does not yield any useful information concerning this type of questions. This shows that there is the need to develop special techniques that focuses on the extreme values of a sample, on extremely high quantiles or on small tail probabilities. In real life situations, these extreme values are often of key interest (Extracted from Beirlant *et al.* (2004)).

Extreme Value Theory (EVT) is an area of statistics, which deals with the statistical techniques for modeling and the estimation of extreme (rare) events. By definition, Extreme Values are scarce, meaning that estimates are often required for levels of a process that are much greater (or less) than have already been observed, which implies an extrapolation from observed levels to

unobserved levels and EVT provides a class of models to enable such extrapolation, (Coles, 2001).

EVT is unique as a Statistical discipline in that, it develops techniques and models for describing the unusual rather than the usual since it provides a framework in which an estimate of anticipated forces could be made using historical data, (Coles, 2001).

The distinguishing feature of an extreme value analysis is the objective to quantify the stochastic behavior of a process at unusually large or small levels, which usually requires estimation of the probability of events that are more (or less) extreme than any that have already been observed, (Coles, 2001). In this thesis, we shall focus on extreme high and low levels of the water levels of a dam.

1.2 Background of the Akosombo Dam

The construction of the Akosombo dam started in 1961 and was commissioned into operation by Dr. Kwame Nkrumah, Ghana's First president in January 1965.

The Akosombo dam, also known as the Akosombo Hydroelectric Project, is a hydroelectric dam on the Volta River in the Southeastern Ghana in the Akosombo gorge. The construction of the dam flooded part of the Volta River Basin and the subsequent creation of the Lake Volta. Lake Volta is the World's largest man-made Lake, covering 8,502 square kilometers, which is 3.6% of Ghana's land area.

On the east side of the dam are two adjacent spillways that can discharge approximately 34,000 square meters per second ($1,200,000\text{cu ft/s}$) of water. The dam power plant contains six 170MW Francis turbines. Each turbine is supplied with water via 112 – 116 meters (367 – 381ft)

long and 7.2 meters (24ft) diameter penstock with a maximum of 68.8 meters (226ft) of hydraulic afforded.

The dam provides electricity to Ghana and some neighboring West African Countries including Togo and Benin.

Power demands, along with unforeseen environmental trends, have resulted in rolling blackouts and major power outages. An overall trend of lower lake levels has been observed, sometimes below the minimum requirement for the operation of the dam. There have also been records of lake levels very close to the maximum requirement for the operation of the dam. Lower water levels are accompanied with load shedding of electricity and the high water levels result in the opening of the floodgates to protect the dam from collapsing, which result in flooding in the Communities downstream. The dam operates between a minimum level of 240ft and a maximum level of 278ft. The lowest ever water level was recorded for the period under study is 234.00ft., this was recorded in 1966 and the highest (277.54ft) ever water level was recorded in 2010. The critical level of the dam is 226ft and at this level, all the turbines must be shut down.

1.3 Problem Statement

The Ghana Energy Commission, in their 2014 energy supply and demand outlook for Ghana reported that, as at December 2013, 1,580MW (53.80%) of Ghana's energy security depends on hydro power plants and out of this, the Akosombo dam alone contribute 1,020MW (34.70%). For hydro power plants, the water level at a particular time is a major factor in determining the power output from the plant. Water levels below the requirement for operation result in low power output from the plant since not all turbines can function at such minimal level. This may

result in major power outages leading to power rationing in many parts of the country, which affect households, business, economic and social activities. In the 2014 energy supply and demand report by Ghana Energy Commission, it was reported that, the Nation's real Gross Domestic Product (GDP) growth in 2013 reduced from 8.8% in 2012 to 7.1%. This was attributed to negative growth in the manufacturing Subsector and the services sector, which was largely due to the inadequate grid power supplied which led to nationwide load shedding for most part of the year. During the early part of 2007, there was a reduction in electricity supply from the Akosombo dam due to low water levels of the dam and this had an adverse effect on the country's economy. However, when there are abundant rain and increased inflow of water, the dam approaches the maximum operation head level of 278ft., which leads to water discharge to safeguard the integrity of the dam structure. In the later part of 2010 for instance, the dam approached its maximum operation head level and due to that, water was discharged for several weeks which resulted in flooding downstream, (VRA, 2010). This led to loss of properties and evacuation of communities which also has an adverse effect on the Country's economy. Therefore, an extreme water level of the dam at any giving time directly affects power supply, lives and properties of people along the Volta Lake. This is the reason why this study sort to study the extremes of the dam.

1.4 Objectives of the Study

This study seeks to use EVT to analyze the water levels of the dam to enable us determine:

- (i) The lowest water level and the highest water level that the Akosombo dam can attain.
- (ii) The exceedance probabilities for very low water levels and very high water levels of the Akosombo dam.
- (iii) The return periods (recurrence interval) and their corresponding return levels for the Akosombo dam.

1.5 Rationale of the Study

This study can help the Authorities in charge of the dam, have a fair idea as to when, the water level can fall below the minimum operating level and also when it can rise above the maximum operating level and the chances of these events happening, so that they can put in place contingency plans.

This study will also add to the existing literature on the application of EVT in hydrology, specifically to dams, since not much work has been done to this effect. This will enrich the knowledge in this field of statistics.

1.6 Scope of the study

The data consist of daily water readings of the Akosombo dam between the periods; January 1, 1966 and December 31, 2013.

1.7 Limitations of the study

The data at hand did not enable us to consider other factors which may influence the water levels of the Akosombo dam. Factors such as rainfall, inflow of water from other sources, water spillage from the dam and evaporation. This study considered only the water levels of the dam.

CHAPTER TWO

LITERATURE REVIEW

2.1 Historical Review (the Birth of Extreme Value Theory)

Historically, work on extreme value problems may be traced back to as early as 1709, when Nicolas Bernoulli discussed the mean largest distance from the origin given n points lying randomly on a straight line of a fixed length t (Kotz and Saralees, 2000). Systematic development of the general theory may be regarded as having started with the paper by Von Bortkiewicz (1922), which dealt with the distribution of range in random samples from a normal distribution. The importance of the paper by Bortkiewicz is inherent in the fact that the concept of distribution of largest value was clearly introduced in it for the first time (Kotz and Saralees, 2000).

The key result obtained by Fisher and Tippet in 1928 on the possible limit laws of the sample maximum seemingly created the idea that EVT was something rather special, very different from classical central limit theory (Beirlant *et al.*, 2004).

In 1943, Gnedenko presented a rigorous foundation for the Extreme Value Theory (EVT) and provided necessary and sufficient conditions for the weak convergence of the extreme order statistics (Kotz and Saralees, 2000). Gnedenko (1943) unified and formalized the ideas into the fundamental assumption in EVT known as the Extreme Value Condition (Kotz and Saralees, 2000). The Extreme Value Condition provides a Semi-parametric model solely for the tails of the distribution function.

The doctoral dissertation by Haan in 1970, on Regular Variation and its Application to the Weak Convergence of Sample Extremes, is an important contribution to the theoretical development of EVT (Beirlant *et al.*, 2004).

Theoretical developments of the 1920s and 1930s were followed in the late 1930s and 1940s by a number of papers dealing with practical applications of extreme value statistics in distributions of human lifetimes, Radioactive emission (Gumbel, 1937a, b), strength of materials (Weibull, 1939), flood analysis (Gumbel, 1941, 1944, 1945, 1949a) and rainfall analysis (Potter, 1949), as summarized by Kotz and Saralees (2000).

2.2 Some Application of Extreme Value Theory

Application of Extreme Value Theory has become one of the most important statistical discipline for the applied Sciences over the years. The statistical analysis of extreme values is employed in numerous disciplines; including hydrology, meteorology, engineering, finance, economics, reinsurance, and telecommunication, sport science and demography. The environmental sciences are a rich source of extreme value problems; for example, in predicting unusually strong wind, high waves and the excessive river levels.

Gilli and Kellezi (2006) used Extreme Value Theory to compute tail risk measures and their related confidence intervals and also applied it to several major stock market indices.

Jockovic (2012) used Extreme Value Theory (the Generalized Pareto Distributions) in finance, to estimate Value-at-Risk (VaR).

Marimoutou *et al.*(2009) modeled VaR for long and short trading position in oil market by applying Extreme Value Theory models to forecast the Value-at-Risk (VaR).

Gencay and Faruk (2004) employed Extreme Value Theory to generate Value-at-Risk estimates; their results indicated that, EVT-based Value –at – Risk estimates are more accurate at higher quantiles.

Cotter (2005) measured Extreme risk in futures of contracts traded on the London International Financial Futures Exchange via Extreme Value Theory.

Coles (2001) applied EVT in sport science to study the fastest annual race time for the women's 1500 meter event over the period 1972 – 1992.

Adam and Tawn (2012) employed models of extreme value theory to model the times of gold medalist's Swimmers in the Olympic 400m freestyle from 1924 - 2004.

Chan and Nadarajah (2015) explained the temporal changes in the extremes of the returns of electricity demand in the UK with the generalized Pareto distribution.

Blanchet *et al.* (2009) analyzed snowfall data from the Swiss Alpine region, using EVT based on a “peaks-over-threshold” approach and a Poisson point process representation, in which they found out that, a significant number of the stations do not follow the Gumbel distribution. They also found out that low altitude stations in the Swiss plateau are heavy tailed because of rare extraordinary snowfall events.

Watts *et al.* (2013) used extreme value models to quantify the upper tail of the distribution of human lifespans.

2.3 Extreme Value Analysis Models

The Classical extreme value theory assumes independence and constant distribution through time. The Classical theorem applies only to sequences of Independent and Identically Distributed (IID) random variables, however, it also holds when the hypotheses are relaxed moderately; for instance, when there exists a relatively weak statistical dependence between the random variables (Méndez and Menéndez, 2006). According to Méndez and Menéndez (2006), the theorem can be employed in practice, if every year can be conceived to be composed of many small “sampling” intervals (e.g. hours), such that successive values of the process are appropriately identically distributed and show “relatively weak” statistical dependence.

Hawkes *et al.* (2008) stated that, standard methodologies employed in extreme value analysis should consist of adopting asymptotic models to describe the stochastic variations of the process.

D’Onofrio *et al.* (1999) employed the Generalized Extreme Value (GEV) distribution to estimate the return periods of extreme water levels.

Huang *et al.* (2008) employed the GEV model to analyze annual maximum water levels on the coast of the United States.

Xu and Huang (2010) employed the GEV model to estimate extreme water level at Wusong station near Shanghai.

What all these studies have in common is that, all the authors assumed independence and constant distribution through time, but in the context of environmental processes, the assumption of constant distribution through time restrict the findings in the form of the data used in the study. The moment there is a change in the characteristics of the data over time; such findings will no longer be valid. Environmental processes are usually non-stationary; non-stationary

processes have characteristics that change systematically through time. Non-stationarity is often apparent in environmental processes because of seasonal effects, perhaps due to different climate patterns in different months or in a form of trends, possibly due to long-term climate changes (Coles, 2001). In modeling extreme non-stationary processes, the general assumptions of independence and constant distribution through time cannot be applied. For the non-stationary approach, the parameters of the distribution functions are replaced with time-dependent parameters, so that the results of the extreme value analysis also vary with time (Coles (2001); Katz *et al.* (2002); El Adlouni *et al.* (2007); Hundecha *et al.* (2008); Mudersbach and Jensen (2010); Khaliq *et al.* (2006)).

According to Mudersbach and Jensen (2010), the non-stationary problem can be solved by detrending the data, in order to apply the classical extreme value analysis, however, the non-stationary approach has the benefit of enabling the extrapolation of the results up to future time horizons.

Northrop and Jonathan (2010) mentioned that, in the application of EVT to environmental data, it is common for extremes of variables of interest to be non-stationary, which changes systematically in space, time or with the values of covariates.

Coles (2001) studied the annual maximum sea-level data at Fremantle where the location parameter was modeled as a linear time-dependent model.

Jensen and Mudersbach (2010), applied the non-stationary statistical model to annual maximum water levels from 1849 - 2007 at the German North sea gauge at Cuxharen using linear and exponential time models for the location and scale parameters of the GEV. The results were

compared with stationary methods and it was found that, the non-stationary GEV approach is suitable for determining coastal design water levels.

Katz *et al.* (2002) employed a non-stationary GEV model and recommended a linear model for the location and a log-transformed model for the scale parameter but with fixed shape parameter.

El Adlouni *et al.* (2007) studied the conditional distribution of the annual maximal precipitation according to the SOI index at the Randsburg station in California using the classical model, GEV0, linear trend model, GEV1 and quadratic dependence structure model, GEV2. The comparison of these models by the deviance statistic indicated that, the GEV2 model more adequately represents the data variance. El Adlouni *et al.* (2007) also compared GEV1 and GEV11 and concluded that, GEV11 is more adequate to represent the data.

El Adlouni *et al.* (2007) stated that, empirical studies of non-stationary models indicate that, it's preferable to represent the non-stationarity in both the location and the scale parameters.

Hundecha *et al.* (2008) implemented a non-stationary extreme value analysis to estimate quantiles of extreme wind speed and their changes against time. It was applied to 10-m wind speed data from the North American Regional Reanalysis (NARR) data set and data from some selected stations of environment of Canada.

Zhang *et al.* (2004b) compared different methods of detecting trends in extreme values and concluded that methods based on modeling trends in the parameter of the distribution of the extremes are powerful methods of detecting statistically significant trends in the extremes (as cited by Hundecha *et al.* (2008)).

Tramblay *et al.* (2013) analyzed heavy rainfall events from the Southern France using both the Non-stationary model and the classical stationary model and concluded that the non-stationary model is better.

Watts *et al.* (2013) employed the non-stationary Generalized Extreme Value and Generalized Pareto distributions in modeling life span data.

Bezak *et al.* (2014) compared the Peak-Over-Threshold method and the Annual maxima method and concluded that, the Peak-Over-Threshold method yields better results than the Annual maxima method.

2.4 Parameter Estimation

In every statistical modeling, parameter estimation is of great importance, since a wrong choice in the estimation procedure weakens the inference drawn from the study, thus a wrong choice affects the quality of the work. Several estimation techniques have been exploited and their strengths and weaknesses discussed in details by different authors, such as; Coles (2001), Hawkes *et al.* (2008), Beirlant *et al.* (2004), Katz *et al.* (2002), Ribereau *et al.* (2008), Mendez and Menendez (2006) and Bezak *et al.* (2014).

Ribereau *et al.* (2008) compared to the maximum likelihood (ML) method, the Generalized Probability Weighted Moment (GPWM) method and found out that the GPWM method performs better and is computationally easy but cannot obtain confidence interval. The GPWM can only have a non-stationary location parameter, whereas, with the ML method the three parameters of the GEV distribution can be non-stationary. Ribereau *et al.* (2008) also found that, when the

Independent and Identically Distributed (IID) assumption is not satisfied, the ML method offers an elegant way to handle non-stationarities by letting the GEV parameters be time dependent.

Katz *et al.* (2002) stated that the probability weighted moments (PWM) or L-moment due to their computational simplicity and also their better performance for small samples, are more common in the applications of hydrologic extremes than the ML estimation method.

According to Katz *et al.* (2002) and Scarf and Laycock (1996) due to the ML estimation's adaptability to model changes, it makes it easy to handle more complex situations that involve covariate but the PWM cannot easily incorporate covariates.

Bezak *et al.* (2014) compared the annual maxima approach and the POT approach using L-moment, the conventional moments and the ML estimation techniques and concluded the L-moment performance better than the other two techniques.

ML estimation is widely used in extreme value modeling since it provides asymptotically unbiased parameter estimators and also from all unbiased estimators, it has the least mean square error Hawkes *et al.* (2008). The authors also said that the ML estimation approach is the best if we have large sample.

El Adlouni *et al.* (2007) extended the Generalized Maximum Likelihood (GML) method introduced by Martins and Stedinger (2001), for the estimation of parameters to the non-stationary case. They compared the ML and GML estimation methods, with a simulation experiment. It was shown that GML method produces the best results with respect to bias and root-mean-square error (RMSE). The GML method is a particular case of the Bayesian approach based on the maximum likelihood method with additional prior information.

According to Castillo and Hadi (1997), the Method of moments and the Probability-Weighted Moments can yield estimates which are inconsistent with the observed data. They also stated that, for large sample, ML estimation is to be preferred due to its efficiency in the case of large samples. Castillo and Hadi further indicated that, the PWM provides better results for small samples.

Northrop and Jonathan (2010) proposed a method for setting a covariate-dependent threshold in which they employed quantile regression to select the appropriate threshold to model non-stationary exceedances of high threshold.

CHAPTER THREE

THE EXTREME VALUE THEORY (EVT)

METHODOLOGY

3.1 Introduction

Consider a random sample $\{X_i, 1 \leq i \leq n\}$ from a distribution F , where X_i is a random value of the daily flow at a dam site for day i with a distribution function F . The behaviour of the mean has often been the focus of classical statistical theory. The discussion of the classical statistical theory of the mean is based on the Central Limit Theorem (CLT) and it often approximates to the normal distribution as a basis for statistical inference. The classical CLT states that the distribution of

$$T_n = \sqrt{n} \frac{\left(\sum_{i=1}^n x_i - E(\mathbf{X}) \right)}{\sqrt{\text{var}(\mathbf{X})}} \quad (3.1.1)$$

approximates to the standard normal for sufficiently large n (i.e. as $n \rightarrow \infty$)

In general, the Central limit problem considers the sum $s_n = \sum_{i=1}^n x_i$ and manipulate it to find constants $a_n > 0$ and b_n such that

$$Y_n = \frac{s_n - b_n}{a_n} \quad (3.1.2)$$

converges in distribution to a non-degenerate distribution.

Then from the limiting distribution of the quantity Y_n , the distribution of Y_n can be determined. The normal distribution is attained as a limit for the sum (or average) of independent and identically distributed random variables, except when the underlying distribution F possesses a

heavy tail. The extremes produced by such sample will distort the averages so that an asymptotic behaviour, which is different from the normal behaviour is obtained. Extreme Value Theory (EVT) is concerned with probabilistic and statistical questions related to very high or very low values in sequences of random variables and in stochastic processes. Extreme Value Theory is the theory of modeling the behaviour of sample extremes and measuring events which occur with very small probability. The behaviour of such order statistics may be achieved through their exact distribution function or through their limiting distribution function.

Let $X_{n,n} = \max\{X_1, X_2, \dots, X_n\}$ denote the Sample maximum, where X_1, \dots, X_n is a sequence of independent random variables having a common distribution function F .

Theoretically, the distribution of $X_{n,n}$ can be derived exactly for all values of n :

$$P\{X_{n,n} \leq x\} = P\{X_1 \leq x, X_2 \leq x, \dots, X_n \leq x\} = \prod_{i=1}^n P\{X_i \leq x\} = \{F(x)\}^n \quad (3.1.3)$$

But this approach has two flaws associated with it; the first is $F(x) < 1$, so

$F(x)^n \rightarrow 0$, as $n \rightarrow \infty$ and the other is the distribution of F may not be known.

The purpose of EVT is finding the behaviour of the Sample extremes for n sufficiently large

3.2 The Data

The Volta River Authority (VRA) measures the daily elevation (in feet) of the Akosombo dam and keeps records on these elevations. That data was obtained from the Engineering Services Department of the VRA, the Akuse office. The data covers 1965 to 2013, however the 1965 data has some irregularities so it will be excluded from the analysis. The highest ever water level recorded from 1966 to 2013 is 278.54ft., which was recorded on the 8th and 9th of November, 2010. The lowest ever is 234.00ft recorded on 28th June, 1966.

Two approaches would be considered for the analysis. One approach would make use of monthly maximum and minimum water levels. Therefore, these extrema will be extracted and use in the analysis. The other approach will set two thresholds; one for the selection of maximum water levels and the other for the selection of minimum water levels. Any water level which fall above the threshold for the maximum is considered an extreme and those that fall below the threshold for the minimum is also considered an extreme.

3.3 Domain of Attraction

Definition 3.3.1

Let X_1, X_2, \dots, X_n be independent and identically distributed random variables with common distribution function F . We say F belong to the domain of attraction of a distribution V , if there exists norming constants $a_n > 0$ and centering constants b_n such that as $n \rightarrow \infty$

$$\lim_{n \rightarrow \infty} P\left(\frac{s_n - b_n}{a_n}\right) \rightarrow V(x)$$

at all continuity points x of V .

Definition 3.3.2

The random variable $X_{n,n}$ belongs to the maximum domain of attraction of a non-degenerate distribution H , if for a suitable Sequence $\{a_n > 0, n \geq 1\}$ and $\{b_n, n \geq 1\}$ such that at all continuity point x of the distribution function, H

$$\lim_{n \rightarrow \infty} P\left(\frac{X_{n,n} - b_n}{a_n} \leq x\right) = \lim_{n \rightarrow \infty} \left\{F(a_n x + b_n)^n\right\} \rightarrow H(x) \quad (3.3.1)$$

3.4 Extreme Value Distribution (EVD); Extremal Type Theorem (Maxima)

Theorem 3.4.1

If there exist sequences of constants $\{a_n > 0\}$ and $\{b_n\}$ such that

$$P\left(\frac{X_{n,n} - b_n}{a_n} \leq x\right) \rightarrow H(x) \text{ as } n \rightarrow \infty$$

where H is a non-degenerate distribution function, then $H(x)$ belongs to one of the following families:

$$\text{I: } H(x) = \exp\left\{-\exp\left[-\left(\frac{x-b}{a}\right)\right]\right\} \quad -\infty < x < \infty$$

$$\text{II: } H(x) = \begin{cases} 0, & x \leq b \\ \exp\left\{-\left(\frac{x-b}{a}\right)^{-\alpha}\right\}, & x < b \end{cases}$$

$$\text{III: } H(x) = \begin{cases} \exp \left\{ - \left[- \left(\frac{x-b}{a} \right)^\alpha \right] \right\}, & x < b \\ 1, & x \geq b \end{cases}$$

for parameters $a > 0, b$ and in the case of families II and III $\alpha > 0$.

In simple language, Theorem 3.4.1 states that the rescaled Sample maxima $(X_{n,n} - b_n) / a_n$ converges in distribution to a variable having a distribution within one of the families labeled I, II and III, with types I, II and III known as Gumbel, Fréchet and Weibull families respectively.

Each family has a location and scale parameter b and a respectively; but the Fréchet and Weibull families have a shape parameter α in addition. These three types of extreme value distributions (EVD) are the only possible limits for the distribution of $X_{n,n}$ irrespective of the distribution of F for the population (Coles, 2001; Beirlant *et al.*, 2004)

Theorem 3.4.1 provides an extreme value analog of the Central Limit Theorem. The proof of the Theorem can be found in Beirlant *et al.* (2004).

3.5 The Generalized Extreme Value (GEV) Distribution

The Gumbel, Fréchet and the Weibull distributions have distinct forms of behaviour, corresponding to different forms of tail behaviour for the distribution function F of the X_i . This can be made precise by considering the behaviour of the limit distribution H at its upper endpoint. For the Weibull the upper endpoint is finite, while the Fréchet and the Gumbel have an infinite upper endpoint. The density of H decays exponentially for the Gumbel distribution and polynomially for the Fréchet distribution. The Fréchet family contains distributions that are

heavy tailed. The infinite endpoint of the distribution function implies some moment do not exist for this class of distribution. The Weibull family contains distributions that have a lighter tail than the exponential.

The three different families give different representations of extreme value behaviour in application. In the early applications of EVT, one of the families was usually adopted and then used to estimate the relevant parameters of the distribution, but two weaknesses are associated with this;

- a. A technique is required to choose the most appropriate distribution from the three families for the data in question and;
- b. The moment a choice is made; all inferences assume the choice to be correct and do not allow for uncertainty of the choice made, even though this uncertainty may be substantial.

A better approach was offered by a reformulation of the models, which was independently proposed by Von Mises (1954) and Jenkinson (1955) (Coles, 2001). The Gumbel, Fréchet and Weibul families can be combined into a single family of models having the distribution function of the form (Coles, 2001);

$$H(x) = \begin{cases} \exp \left\{ - \left[1 + \gamma \left(\frac{x - \mu}{\sigma} \right) \right]^{-1/\gamma} \right\}, \gamma \neq 0 \\ \exp \left\{ - \exp \left[- \left(\frac{x - \mu}{\sigma} \right) \right] \right\}, \gamma = 0 \end{cases} \quad (3.5.1)$$

defined on the set $\left\{x: 1 + \gamma \left(\frac{x - \mu}{\sigma}\right)\right\}$, where the parameters satisfy $-\infty < \mu < \infty, \sigma > 0$ and $-\infty < \gamma < \infty$.

This is known as the Generalized Extreme Value family of distributions. The model has three parameters: a location parameter, μ ; a scale parameter, σ ; and a shape parameter, γ . The shape parameter, $\gamma < 0$ if the underlying distribution has a finite upper endpoint, $\gamma = 0$ if the underlying distribution decreases exponentially and $\gamma > 0$ if the tail decreases polynomially. Thus, $\gamma = 0$ corresponds to the Gumbel distribution, $\gamma > 0$ corresponds to the Fréchet distribution with $\alpha = 1/\gamma$ and $\gamma < 0$ corresponds to the Weibull distribution with $\alpha = -1/\gamma$.

The unification of the original three families of the extreme value distribution into a single family was a breakthrough for statistical implementation. From inference on γ , the data at hand determines the most appropriate type of tail behaviour and therefore, it is no more necessary to make subjective priori judgments about which individual extreme value distribution would be appropriate for the data (Coles, 2001). The uncertainty in the inferred value of γ measures the lack of certainty as to which of the original three types is most appropriate for a given data set (Coles, 2001). The GEV provides a model for the distribution of block maxima. Its application consists of blocking the data into blocks of equal length and fitting the GEV to the set of block maxima. But in implementing this model for any particular data sets, the choice of block size can be critical. The choice amounts to a trade-off between bias and variance; blocks that are too small mean that approximation by the GEV is likely to be poor, leading to bias in estimation and extrapolation.

3.6 Asymptotic Models for Minima

There are some applications of EVT which require models for extremely small observations. For instance, in the study of the water levels of a dam, it will be of interest to study the tail behaviour of the minimum water levels since the level of the water determines how much hydro-electric power is generated.

Let $X_{1,n} = \text{Min}\{X_1, X_2, \dots, X_n\}$, where the X_i denote the individual daily water levels. Assume the X_1, X_2, \dots, X_n to be independent and identically distributed, similar arguments apply to $X_{1,n}$ as was applied to $X_{n,n}$, leading to a limiting distribution of a suitable re-scaled variable. Let $Y_i = -X_i$, for $i = 1, 2, \dots, n$, this implies that small values of X_i corresponds to large values of Y_i .

So if $X_{1,n} = \text{min}\{X_1, \dots, X_n\}$ then

$$Y_{n,n} = \text{max}\{Y_1, Y_2, \dots, Y_n\} = \text{max}\{-X_1, -X_2, \dots, -X_n\}$$

$$X_{1,n} = -\text{max}\{-X_1, -X_2, \dots, -X_n\}$$

This implies $X_{1,n} = -Y_n$

Hence for large n

$$\begin{aligned} P\{X_{1,n} \leq x\} &= P\{-Y_n \leq x\} = P\{Y_n \geq -x\} = 1 - P\{Y_n \leq -x\} = 1 - H(-x) \\ &= 1 - \exp\left\{-\left[1 + \gamma\left(\frac{-x - \mu}{\sigma}\right)\right]^{-1/\gamma}\right\} \\ &= 1 - \exp\left\{-\left[1 - \gamma\left(\frac{x - \hat{\mu}}{\sigma}\right)\right]^{-1/\gamma}\right\} \end{aligned}$$

Therefore, the GEV distribution for minima is defined as

$$H^*(x) = \begin{cases} 1 - \exp \left\{ - \left[1 - \gamma \left(\frac{x - \hat{\mu}}{\sigma} \right) \right]^{-1/\gamma} \right\}, \gamma \neq 0 \\ 1 - \exp \left\{ - \exp \left(\frac{x - \hat{\mu}}{\sigma} \right) \right\}, \gamma = 0 \end{cases} \quad (3.5.1)$$

on $\left\{ x: 1 - \frac{\gamma(x - \hat{\mu})}{\sigma} > 0 \right\}$ and where $\hat{\mu} = -\mu$, $-\infty < \hat{\mu} < \infty$, $\sigma > 0$ and $-\infty < \gamma < \infty$.

In situations where a model for the block minima is required, the GEV distribution for the minima can directly be applied.

Another method is to make use of the duality between the distribution for maxima and minima. Given the data x_1, x_2, \dots, x_n that are realization from the GEV distribution for minima, with parameters $(\hat{\mu}, \sigma, \gamma)$, implies fitting the GEV distribution for maxima to the data $-x_1, -x_2, \dots, -x_n$. The maximum likelihood estimate of the parameters of this distribution corresponds exactly to that of the required GEV distribution for minima apart from the sign correction $\hat{\mu} = -\mu$.

3.7 The Generalized Pareto Distribution (GPD)

The GEV method is very useful when only block maxima (or minima) data are available, but when other extremes (higher or lower water levels) data are available it's wasteful. For instance, two or three very high water levels may occur within one year (or month), yet only one of these levels is included in the estimation. This may possibly lead to underestimation of the frequency of occurrence of such levels. Therefore, if hourly, daily, weekly or monthly observations are available, the data can be put to better use by avoiding the blocking method.

Let $X_1, X_2, X_3, \dots, X_n$ be a sequence of independent and identically distributed random variables, with common distribution function F . X_i is considered as extreme event if it exceed some threshold u . If X denote; an arbitrary term in X_i , then, the stochastic behaviour of extreme events is given by the conditional probability (Coles, 2001),

$$P(X > u + y / X > u) = \frac{1 - F(u + y)}{1 - F(u)}, y > 0 \quad (3.7.1)$$

With the parent distribution F known, the distribution of threshold exceedances in equation (3.7.1) can be derived, however, in practice the parent distribution is usually not known, hence we sought to approximation that is applicable for high values of threshold.

Theorem 3.7.1

Let $X_1, X_2, X_3, \dots, X_n$ be a sequence of independent and identically distributed random variables with distribution function F and let $X_{n,n} = \max\{X_1, \dots, X_n\}$. Let X denote an arbitrary term in the X_i sequence and assume that F satisfies the GEV conditions, so that for n sufficiently large,

$$P(X_{n,n} \leq x) \approx H(x),$$

where H is as defined in equation (3.3.1).

Then, for sufficiently large u , the distribution function of $(X - u)$ conditional on $X > u$ is approximately (Coles, 2001);

$$H(y) = 1 - \left(1 + \frac{\gamma y}{\sigma}\right)^{-1/\gamma} \quad (3.7.2)$$

defined on $\{y: y > 0 \text{ and } (1 + \frac{\gamma y}{\sigma}) > 0\}$, and where

The family of distributions defined by equation (3.7.2) is known as the Generalized Pareto Distribution (GPD).

Theorem 3.7.1 implies that, if block maxima have approximating distribution H , then threshold excesses have corresponding approximate within the generalized Pareto family.

The rigorous connection of the Pareto distribution with classical extreme value theory was established by Pickands (1975) (Coles, 2001).

The parameters of the GP distribution of threshold excesses are uniquely determined by that of the associated GEV distribution of the block maxima. The shape parameter, γ of the GEV distribution is the same as the corresponding GP distribution parameter. There is a close parallel between limit results for sample maxima and limit results of exceedance over thresholds. According to Coles (2001), also for the GP distribution, if $\gamma < 0$, the distribution of excesses have an upper bound of $u - \sigma/\gamma$; if $\gamma > 0$ the distribution has no upper limit and if $\gamma = 0$, the distribution is unbounded, which we may take the limit as $\gamma \rightarrow 0$ to get

$$H(y) = 1 - \exp\left(-\frac{y}{\sigma}\right), y > 0 \quad (3.7.3)$$

which is exponential distribution with mean σ .

3.8 Parameter Estimation

The estimation of the Extreme Value Index (EVI) is of key interest in extreme value analysis since it determines the tail behaviour of the underlying distribution F . Once the EVIs are known; other equally important estimators for statistical inferences can then be obtained. Some of these important estimators are the extreme quantiles, exceedance probabilities and the return periods.

3.8.1 Block Maxima (or Minima) Approach

The block maxima (or minima) method consist of dividing the sample into, say m non-overlapping blocks. The blocks are usually equal in length and the block sizes are usually selected naturally. The maximum (or minimum) of each block is selected as m independent sample maxima (or minima) from the observed data and then fitted to the GEV distribution. The choice of block size is very important and it is a trade-off between bias and variance. Blocks of small size are likely to yield poor approximation by the GEV distribution and blocks of larger size produce few block maxima (or minima), which might lead to large variance. Though, block size may not refer to months, in this study, the block size would be monthly. Thus monthly maxima and monthly minima water levels of the Akosombo dam would be used, instead of the usual annual extremes. Though, the block sizes in this case may differ because the months do not have the same number of days, but we do not expect this to affect the result significantly. We use monthly extremes due to the scarcity of data and also, for us to consider more than one datum per year.

According to Mendez and Menendez (2006), to reduce the problem of data scarcity, it is necessary to employ monthly maxima method, peak-over-threshold method or r -largest order statistics in order to consider more than one extreme datum per year. According to them,

monthly random variables of an extreme event can be expected to be more homogeneous than within years.

3.8.2 Maximum Likelihood (ML) Estimation Method

The parameters of the GEV distribution may be estimated by Maximum Likelihood (ML), Probability Weighted Moments (PWM) or the L-moments method. The advantage of the ML over the other techniques of parameter estimation is its adaptability to changes in model structure. That is, although the estimating equations change if a model is modified, the underlying methodology is essentially unchanged. The ML also has a convenient set of “off-the-shelf” large sample inference properties (Coles, 2001).

Considering the assumption that X_1, X_2, \dots, X_n are independent, then the likelihood function of the GEV is given as;

$$L(\omega) = \prod_{i=1}^n g(x_i; \mu, \sigma, \gamma), \omega = (\mu, \sigma, \lambda),$$

where $g(x_i; \mu, \sigma, \gamma)$ denotes the GEV density function with parameters μ , σ and γ evaluated at x_i . If $\gamma \neq 0$, the log-likelihood is;

$$l(\omega) = -n \log \sigma - (1 + 1/\gamma) \sum_{i=1}^n \log \left[1 + \gamma \left(\frac{x_i - \mu}{\sigma} \right) \right] - \sum_{i=1}^n \left[1 + \gamma \left(\frac{x_i - \mu}{\sigma} \right) \right]^{-1/\gamma}$$

provided that $1 + \gamma \left(\frac{x_i - \mu}{\sigma} \right) > 0$ for $i = 1, \dots, n$.

If $\gamma = 0$, the log-likelihood reduces to;

$$l(\omega) = -n \log \sigma - \sum_{i=1}^n \left(\frac{x_i - \mu}{\sigma} \right) - \sum_{i=1}^n \exp \left\{ - \left(\frac{x_i - \mu}{\sigma} \right) \right\}$$

The estimates of the parameters (μ, σ, γ) are obtained by maximizing the log-likelihood function. Beirlant *et al.* (2004) and Coles (2001) stated that, since the support of the GEV depends on unknown parameter values, the usual regularity conditions underlying the asymptotic properties of ML estimators are not automatically applicable. Smith (1985) studied this problem in detailed and his findings are summarized in Coles (2001) as:

- When $\gamma > -0.5$, maximum likelihood estimators are regular, and hence have the usual asymptotic properties.
- When $-1 < \gamma < -0.5$, maximum likelihood estimators do not have the usual asymptotic properties, but it is obtainable.
- When $\gamma < -1$, maximum likelihood estimators are not likely obtainable.

3.8.3 Extreme quantiles and other parameters

When the estimates of μ, σ and γ of the GEV distribution have been obtained, other equally important extreme events of any extreme value analysis are extreme quantiles, exceedance probabilities, and return levels and their corresponding periods. An important objective of extreme value modeling is the estimation of an extreme quantile which correspond to a given return period, q , or the maximum value observed in q years (Jonathan and Ewans, 2013)

The extreme quantile of the GEV can be estimated by inverting the GEV distribution function in (3.5.1);

$$q_{x,p} = \begin{cases} \hat{\mu} - \frac{\hat{\sigma}}{\hat{\gamma}} \left[1 - \{-\log(1-p)\}^{\hat{\gamma}} \right], \hat{\gamma} \neq 0 \\ \hat{\mu} - \hat{\sigma} \log[-\log(1-p)], \hat{\gamma} = 0 \end{cases} \quad (3.8.1)$$

where $H(q_{x,p}) = 1 - p$ and $0 \leq p \leq 1$

The parameters $\hat{\mu}$, $\hat{\sigma}$ and $\hat{\gamma}$ are corresponding ML estimates of μ , σ and γ respectively.

In simple language, $q_{x,p}$ is the return level associated with the return period $1/p$.

Usually long return periods which correspond to small value of p , are of key interest in practice.

For $\gamma < 0$, an inference can be made on the upper endpoint of the distribution. This is the return period for the infinite observation which corresponds to $q_{x,p}$ with $p = 0$ and the ML estimate is

$$q_{x,0} = \hat{\mu} - \hat{\sigma}/\hat{\gamma}.$$

3.8.4 Confidence Interval Estimations

The estimator ML is asymptotically normal and hence normal confidence interval can be derived for the GEV parameters (μ , σ and γ). If θ is any one of the parameters, then the $100(1 - \alpha)\%$ confidence interval for θ is (Beirlant *et al.*, 2004);

$$\hat{\theta} \pm \phi^{-1}(1 - \alpha/2) \sqrt{\frac{\hat{V}_{ii}}{m}},$$

where $\hat{\theta}$ is the ML estimates of θ and $\hat{V}_{i,i}$ denotes the diagonal element of the variance covariance matrix of ML estimator and m is the number of sample maxima (or minima) available.

Similarly, inference concerning the GEV quantiles can be based on the normal limiting behaviour. A straightforward application of the delta method produces

$$\sqrt{m}(\hat{q}_{x,p} - q_{x,p}) \xrightarrow{D} N(0, \varepsilon' V \varepsilon), \text{ as } m \rightarrow \infty,$$

where $\hat{q}_{x,p}$ denotes the estimator for $q_{x,p}$ which is obtained by substituting the ML estimator into (3.8.1) and where V is a covariance matrix of ML estimator and

$$\varepsilon' = \left[\frac{\partial q_{x,p}}{\partial \sigma}, \frac{\partial q_{x,p}}{\partial \gamma}, \frac{\partial q_{x,p}}{\partial \mu} \right]$$

According to Beirlant *et al.* (2004), inference based on the normal limit results may be misleading as the normal approximation to the true sampling distribution of the respective estimators may be poor; however, the profile likelihood function provides better confidence intervals than the normal interval. The profile likelihood function of γ is given by (Beirlant *et al.*, 2004)

$$L_p(\gamma) = \max_{\mu, \sigma/\gamma} L(\mu, \sigma, \gamma)$$

Therefore, the profile likelihood ratio statistic

$$\Lambda = \frac{L_p(\gamma_0)}{L_p(\hat{\gamma})}$$

equals the classical likelihood ratio statistic for testing the hypothesis

$$H_0 : \gamma = \gamma_0 \text{ vrs } H_1 : \gamma \neq \gamma_0$$

and hence for $m \rightarrow \infty$, $-2 \log \Lambda \xrightarrow{D} \chi_1^2$.

At significance level α , H_0 is rejected if $-2 \log \Lambda > \chi_1^2(1 - \alpha)$, the profile likelihood-based

100(1 - α)% confidence interval for γ is given by

$$CI_\gamma = \left\{ \gamma : -2 \log \frac{L_p(\gamma)}{L_p(\hat{\gamma})} \leq \chi_1^2(1 - \alpha) \right\} = \left\{ \gamma : \log L_p(\gamma) \geq \log L_p(\hat{\gamma}) - \frac{\chi_1^2(1 - \alpha)}{2} \right\} ..$$

Similarly, profile likelihood- based confidence intervals for the other GEV parameters can be constructed.

3. 8.5 Model Verification for the Generalized Extreme Value Distribution

Coles (2001) stated that, it is impossible to verify the validity of an extrapolation from a GEV model, but some assessment can be made with reference to the observed data. The probability plot, quantile plot and a density plot are good graphical tools for assessing the goodness-of-fit of a GEV model (Coles, 2001). A probability plot and quantile plot involves the comparison of the empirical and a fitted distribution.

Let $x_{(1)} \leq x_{(2)} \leq \dots \leq x_{(k)}$, then the empirical distribution function evaluated at $x_{(i)}$ is defined

as $\tilde{F}(x_{(i)}) = i/k + 1$ (Coles, 2001).

When the estimated parameters is substituted into (3.5.1), the resulting model-based estimates are

$$\hat{F}(x_{(i)}) = \exp \left\{ - \left[1 + \hat{\gamma} \left(\frac{x_{(i)} - \hat{\mu}}{\hat{\sigma}} \right) \right]^{-1/\hat{\gamma}} \right\}$$

If the GEV model is appropriate, $\tilde{F}(x_{(i)}) \approx \hat{F}(x_{(i)}); i = 1, 2, \dots, k$ (Coles, 2001).

Hence a probability plot will consist of the points (Coles, 2001)

$$\left\{ \left(\tilde{F}(x_{(i)}), \hat{F}(x_{(i)}) \right); i = 1, 2, \dots, k \right\}$$

and should yield a straight one-to-one line of points, any deviation from linearity is an indication of failure of the GEV model.

Additionally, the quantile plot consist of points (Coles, 2001)

$$\left\{ \left(\hat{F}^{-1}(i/k + 1), x_{(i)} \right); i = 1, 2, \dots, k \right\}$$

Hence from (3.8.1) we have (Coles, 2001)

$$\hat{G}^{-1}\left(\frac{1}{k+1}\right) = \hat{\mu} - \frac{\hat{\sigma}}{\hat{\gamma}} \left[1 - \left\{ -\log\left(\frac{1}{k+1}\right) \right\}^{-\hat{\gamma}} \right]$$

The quantile plot should also yield a straight one-to-one line of points. Any deviation from linearity in the plot indicates failure of the model.

3.8.6 Peak-over threshold approach: threshold selection

An event is considered extreme if it exceeds a high threshold u , that is, if it is defined as $\{x_i: x_i > u; i = 1, 2, \dots, n\}$. Where the x_i 's are a random sample of size n from the random variable X having a distribution function F . We however have to select an appropriate threshold such that it is enough to justify the GP distribution assumption. The selection of threshold is similar to the choice of block size in the block maxima approach; it is a balance between bias and variance. In

this case, too low a threshold is likely to violate the asymptotic basis for the model, leading to bias and too high a threshold will increase the variance since it will generate few excesses. Two procedures will be used to aid in the selection of an appropriate threshold for the GP model. One of the procedures consists of an exploratory technique which is carried out prior to the estimation of the model and the other procedure involves an assessment of the stability of parameter estimates, which is based on fitting the model across a range of different thresholds (Coles, 2001).

The Mean Residual Life Plot

This procedure depends on the mean of the GP distribution, let Y have a GP distribution with parameters σ and γ , thus scale and shape respectively, then

$$E(Y) = \frac{\sigma}{1-\gamma}, \text{ for } \gamma < 1 \quad (3.8.2)$$

Suppose the GP distribution is a valid model for the excess of a threshold u_0 produced by a series X_1, \dots, X_n , then by (3.8.2), we have

$$E(X - u / X > u_0) = \frac{\sigma_{u_0}}{1-\gamma}, \text{ for } \gamma < 1$$

where X is an arbitrary term of the series and σ_{u_0} denotes the scale parameter corresponding to excesses of the threshold u_0 . Now if the GP distribution is valid for the excesses of u_0 , then it should equally be for all thresholds $u > u_0$. This is subject to an appropriate change of the scale parameter to σ_u .

Now for $u > u_0$ and from equation (3.7.3)

$$E(X - u / X > u) = \frac{\sigma_u}{1 - \gamma} = \frac{\sigma_{u_0} + \gamma u}{1 - \gamma} \quad (3.8.3)$$

For $u > u_0$, $E(X - u / X > u)$ is a linear function of the threshold u . The estimates by (3.8.3) are expected to change linearly with u and for values of u for which the GP model is appropriate.

This leads to the locus of points

$$\left\{ \left(u, \frac{1}{n_u} \sum_{i=1}^{n_u} (x_{(i)} - u) \right) : u < x_{\max} \right\}$$

where $x_{(1)}, \dots, x_{(n_u)}$ consist of the n_u observations that exceeds u and x_{\max} is the maximum of the X_i , this is known as the mean residual life plot or mean excess plot. For values above the threshold u_0 , for which the GP distribution yields a valid approximation for the excess distribution, the mean residual life plot should be approximately linear.

The mean residual life plot can also be used to assess the domain of attraction of the underlying distribution (Beirlant *et al.*, 2004). According to Beirlant *et al.* (2004), when the distribution of a random variable, say X , has a tail heavier than the exponential (HTE), then the mean residual life function increases and decreases for tails lighter than the exponential distribution (LTE). Therefore, the shape of the mean residual life function provides important information on the tails of the distribution in question.

Gosh and Resnick (2010), the mean excess plot is a graphical tool which is widely used in the study of extreme values for the verification of a GP model for the excess distribution.

The Threshold Stability Plot

According to Coles (2001), if a GP distribution is an appropriate model for excess of a threshold u_0 , then excesses of a higher threshold u should also follow a GP distribution and the shape parameters of the two distributions are identical.

Let σ_u denote the value of the GP scale parameter for a threshold of $u > u_0$, then from equation (3.7.1)

$$\sigma_u = \sigma_{u_0} + \gamma(u - u_0) \quad (3.8.4)$$

When $\gamma = 0$, the scale parameter is unchanged.

This problem is corrected by reparameterizing the GP scale parameter as

$$\sigma^* = \sigma_u - \gamma u, \text{ which is fixed with respect to } u \text{ by (3.8.4)}$$

Now if u_0 is a valid threshold for excesses to follow the GP distribution, then the estimates of both σ^* and γ should be stable above u_0 . The estimates of these quantities will not exactly be constant, due to sampling variability but they should be stable after allowance for their sampling errors (Coles, 2001).

3.8.7 Maximum likelihood Estimation of the GP model

After a suitable threshold has been determined, the parameters of the GP distribution can be estimated by maximum likelihood.

Let y_1, y_2, \dots, y_m be the m excesses over a threshold u . The log-likelihood function if $\gamma \neq 0$ is given by

$$l(\sigma, \gamma) = -m \log \sigma - (1 + 1/\gamma) \sum_{i=1}^m \left\{ \log \left[1 + \frac{\gamma}{\sigma} y_i \right] \right\},$$

provided $1 + \frac{\gamma}{\sigma} y_i > 0, i = 1, 2, \dots, m$

If $\gamma = 0$, the log-likelihood function reduces to

$$l(\sigma) = -m \log \sigma - \frac{1}{\sigma} \sum_{i=1}^m y_i$$

3.8.8 Extreme Quantiles and Other Parameters

Extreme quantiles of the GP distribution can be obtained by inverting the GP distribution function to yield (Beirlant *et al.*, 2004)

$$x_r = \begin{cases} \frac{\hat{\sigma}}{\hat{\gamma}} (p^{-\hat{\gamma}} - 1), \hat{\gamma} \neq 0 \\ -\hat{\gamma} \log p, \hat{\gamma} = 0 \end{cases} \quad (3.8.5)$$

where the parameters $(\hat{\sigma}, \hat{\gamma})$ are ML estimates of (σ, γ) respectively.

If $\gamma < 0$, the right endpoint of the GP distribution is finite and is given by

$$x_+ = \frac{\hat{\sigma}}{|\hat{\gamma}|}, p \rightarrow 0 \text{ in (3.8.5)}$$

If the data are not exact GP distributed, (3.7.1) implies that

$$\bar{F}_u(y) = \frac{\bar{F}(u+y)}{\bar{F}(u)} \sim \left(1 + \frac{\gamma}{\sigma} y \right)^{-1/\gamma}$$

Where $\bar{F}(u+y) = 1 - F(u+y)$ and $\bar{F}(u) = 1 - F(u)$

When $x = u + y$

$$\bar{F}(x) \sim \bar{F}(u) \left[1 + \frac{y}{\sigma} \right]^{-\frac{1}{\gamma}}$$

Estimating $\bar{F}(u)$ by the proportion of exceedances over the threshold u , m/n and replacing σ and γ by their corresponding estimates yields

$$\bar{F}(u) = \frac{m}{n} \left[1 + \frac{\hat{\gamma}}{\hat{\sigma}} (x - u) \right]^{-\frac{1}{\hat{\gamma}}} \quad (3.8.6)$$

The POT estimator for extreme quantiles can now be obtained from inverting the right-hand side of (3.8.6).

In the case where $\gamma \neq 0$, we obtain the extreme quantile estimator as

$$x_r = u + \frac{\hat{\sigma}}{\hat{\gamma}} \left[\left(\frac{np}{m} \right)^{-\hat{\gamma}} - 1 \right] \quad (3.8.7)$$

\hat{x}_r is the r observation return level and yield an upper end-point

$$\hat{x}_+ = u - \frac{\hat{\sigma}}{\hat{\gamma}}, \text{ as } p \rightarrow 0 \text{ in (3.8.7)}$$

3.8.9 Confidence Interval Estimation for the GP distribution Estimates

As in the case of the GEV distribution, $100(1 - \alpha)\%$ confidence interval for the parameters γ and σ of the GP distribution can be derived. Let ψ denote any of the parameters of the GP distribution, then a $100(1 - \alpha)\%$ confidence interval of ψ is given by, Beirlant *et al.* (2004)

$$\hat{\psi} \pm \phi^{-1}(1 - \alpha/2) \sqrt{\frac{\hat{V}_{ii}}{m}}$$

Where $\hat{\psi}$ is the ML estimator of any of the parameters (σ, γ) and \hat{V}_{ii} denotes the diagonal elements of the variance covariance matrix of the ML estimates.

Inference about return levels x_r can be drawn in a similar way. Straightforward application of the delta method gives

$$\sqrt{m}(\hat{x}_r - x_r) \xrightarrow{D} N(0, w'Vw)$$

Where V is a covariance matrix of ML estimator and

$$w' = \left[\frac{\partial x_r}{\partial \sigma}, \frac{\partial x_r}{\partial \gamma} \right]$$

Therefore, a $100(1 - \alpha)\%$ confidence interval for x_r is given by

$$\hat{x}_r \pm \phi^{-1}(1 - \alpha/2) \sqrt{\frac{w'Vw}{m}}$$

Beirlant *et al.* (2004) again proposed that, better confidence intervals can be constructed on the basis of the profile likelihood ratio test statistic. By similar arguments as in the case of the GEV distribution, the $100(1 - \alpha)\%$ profile likelihood confidence interval for the parameter γ can be obtained as

$$CI_{\gamma} = \left\{ \gamma : \log L_p(\hat{\gamma}) \geq \log L_p(\hat{\gamma}) - \frac{\chi_1^2(1 - \alpha)}{2} \right\}$$

The profile likelihood confidence intervals for the other GP parameters can be obtained through similar arguments.

3.8.10 Model Verification for the Generalized Pareto Distribution

Quantile plots, probability plots and density plots are very good graphical tools for assessing the validity of a fitted GP model (Coles, 2001).

Suppose there exist, a threshold u , threshold excesses $y_{(1)}, y_{(2)}, \dots, y_{(r)}$ and an estimated model \hat{F} .

Then its probability plot consists of the pairs (Coles, 2001)

$$\left\{ \left(\frac{i}{r+1}, \hat{F}(y_{(i)}) \right) : i = 1, \dots, r \right\}$$

$$\text{Where } \hat{F}(y) = \begin{cases} 1 - \left(1 + \frac{\hat{\gamma}y}{\hat{\sigma}} \right)^{-1/\hat{\gamma}}, & \hat{\gamma} \neq 0 \\ 1 - \exp\left(-\frac{y}{\hat{\sigma}} \right), & \hat{\gamma} = 0 \end{cases}$$

And the quantile plot is defined as (Coles, 2001)

$$\left\{ \left(\hat{F}^{-1}(i/(r+1)), y_{(i)} \right) : i = 1, \dots, r \right\}$$

$$\text{Where } \hat{F}^{-1}(y) = u + \frac{\hat{\sigma}}{\hat{\gamma}} (y^{-\hat{\gamma}} - 1), \text{ for } \hat{\gamma} \neq 0$$

If the GP distribution is a valid model for the excesses of u , then both the probability plot and the quantile plot are expected to be approximately linear.

A histogram of the threshold exceedances is overlay with the density of the GP model and also compared to see if the GP is a valid model for the data of interest.

3.9 Extremes of Dependent (Stationary Series) Sequence

The extreme value models described in the previous sections have been derived under the assumption that, the underlying processes consist of sequences of independent and identically distributed random variables. But in practice, the types of data to which extreme value models are commonly applied to are usually not independent in nature. For example, considering the Akosombo water levels, which consist of daily records. Intuitively, we expect dependence from one day to the next and such dependence is likely to be present in the extremes of the process. In threshold exceedances analysis we are likely to include all daily observations and these extreme water levels are also very likely to depend on one another from one day to the next. This observation is common to the extremes of most environmental time series and such temporal dependence violates the basic assumption of classical extreme value modeling; the assumption of independence of the sequence of extremes.

The most natural generalization of a sequence of independent random variables is to a stationary series, which is a more realistic assumption for many physical processes (Coles, 2001). Stationarity implies that, given any subset of variables, the joint distribution of the same subset viewed n times point later remains unchanged. Thus, if X_1, X_2, X_3, \dots , is a stationary process, then X_1 must have the same distribution as X_{100} and the joint distribution of (X_1, X_2, \dots, X_k) must be identical to that of $(X_{k+1}, X_{k+2}, \dots, X_n)$. Stationarity does not prevent X_i being dependent on previous values, rather, trends, seasonality and other deterministic cycles are excluded by an assumption of stationarity.

It worth noting that, under some conditions on the dependence structure, the asymptotic distributions of the maximum of a stationary stochastic process can be related with the maximum of an associated independent sequence of random variables with the same distribution function of the dependent one (Freitas and Freitas, 2008).

3.9.1 Maxima (or Minima) of Stationary Series

A very important result mostly used to formulate a condition that makes the notion of extreme events near independent is “Ledbetter’s $D(u_n)$ condition”, which makes sure long-range dependence is sufficiently weak so as not to affect the asymptotics of an extreme value analysis.

Definition 3.9.2 (Ledbetter’s $D(u_n)$ condition),

A stationary series X_1, X_2, X_3, \dots is said to satisfy the $D(u_n)$ condition if, for all

$$i_1 < \dots < i_p < j_1 < \dots < j_q \text{ with } j_1 - i_p > l$$

$$\left| P\{X_{i_1} \leq u_n, \dots, X_{i_p} \leq u_n, X_{j_1} \leq u_n, \dots, X_{j_q} \leq u_n\} - P\{X_{i_1} \leq u_n, \dots, X_{i_p} \leq u_n\} P\{X_{j_1} \leq u_n, \dots, X_{j_q} \leq u_n\} \right| \leq \alpha(n, l) \quad (3.9.1)$$

Where $\alpha(n, l) \rightarrow 0$ for some sequence l_n such that $l_n/n \rightarrow 0$ as $n \rightarrow \infty$.

For sequence of independent variables the difference in probabilities expressed in (3.9.1) is exactly zero for any sequence u_n . More generally, we will require that the $D(u_n)$ condition holds only for a specific sequence of threshold u_n that increases with n . For such a sequence, the $D(u_n)$ condition ensures that, for sets of variables that are far enough apart, the difference in

probabilities expressed in (3.9.1) if not zero, is sufficiently close to zero to have no effect on the limit laws of extremes.

Theorem 3.9.2

Let X_1, X_2, X_3, \dots be a stationary process and let $X_{nn} = \max\{X_1, \dots, X_n\}$. Then if $\{a_n > 0\}$ and $\{b_n\}$ are sequences of constant such that $P\{(X_{nn} - b_n)/a_n \leq x\} \rightarrow H(x)$, where H is a non-degenerate distribution function and the $D(u_n)$ condition is satisfied with $u_n = a_n x + b_n \forall x \in \mathbb{R}$, then H is a member of the generalized extreme value family of distributions.

Theorem 3.9.3 (Extreme of dependent Sequences)

Let $X_1^*, X_2^*, X_3^*, \dots$ be a stationary series satisfying Leadbetter's $D(u_n)$ condition and let $X_{nn}^* = \max\{X_1^*, \dots, X_n^*\}$. Let X_1, X_2, X_3, \dots be an independent series with X having the same distribution as X^* and let $X_{nn} = \max\{X_1, \dots, X_n\}$. Then if X_{nn} has a non-degenerate limit law given by

$P\{(X_{n,n} - b_n)/a_n \leq x\} \rightarrow H(x)$, it follows that;

$$P\{(X_{n,n}^* - b_n)/a_n \leq x\} \rightarrow H^\theta(x) \quad (3.9.2)$$

for some constant θ such that $0 < \theta \leq 1$.

The parameter θ is known as the Extremal index and quantifies the extent of Extremal dependence; $\theta = 1$ for a complete independent process and $\theta \rightarrow 0$ with increasing level of Extremal dependence. Since H in Theorem 3.8.3 is necessarily an extreme value distribution and due to the max-stability property, then the distribution of maxima in processes displaying short-range temporal dependence (characterized by Extremal index θ) is also a GEV distribution; the

powering of the limit distribution by θ only affects the location and the scale parameters of the distribution.

Theorem 3.9.3 implies that if maxima of a stationary series converge, which by theorem 3.9.2, they will do, then provided an appropriate $D(u_n)$ condition is satisfied, then its limiting distribution is related to the limiting distribution of an independent series. The effect of the dependence as seen in expression (3.9.2) is just a replacement of H as the limit distribution with H^θ . More precisely, if H corresponds to the GEV distribution with parameters (μ, σ, γ) and $\gamma \neq 0$ then, Coles (2001)

$$H^\theta(x) = \exp \left\{ - \left[1 + \gamma \left(\frac{x - \mu}{\sigma} \right) \right]^{-1/\gamma} \right\}^\theta = \exp \left\{ - \left[1 + \gamma \left(\frac{x - \mu^*}{\sigma} \right) \right]^{-1/\gamma} \right\}$$

Where $\mu^* = \mu - \frac{\sigma}{\gamma}(1 - \theta^{-\gamma})$ and $\sigma^* = \sigma\theta^\gamma$

Thus if the distribution of X_{nn} is GEV with parameters (μ, σ, γ) , then that of X_{nn}^* is also GEV with parameters $(\mu^*, \sigma^*, \gamma)$. Note that the EVI remains unchanged.

3.9.2 Models for Block Maximum (or Minimum)

If long-range dependence at extreme levels is weak, so that the data can be reasonably assumed as a process satisfying the $D(u_n)$ condition, the distribution of the block maximum falls within the same family of distribution as would be appropriate if the series were truly independent. Although the parameters would be different from those that would suppose the series is actually independent but since the parameters needs to be estimated, this is not that important (Coles,

2001). Therefore, dependence in data can be ignored when modeling block maxima (Coles, 2001).

3.9.3 Modeling threshold Exceedances

Though the modeling procedures for fitting the GEV for the set of block maxima remains unchanged for stationary series, but for the threshold exceedance method, some modification is needed, since extremes may have the tendency to cluster in a stationary series (Coles, 2001).

For a stationary series, the usual asymptotic argument means that marginal distribution of the excesses of a high threshold is a Generalized Pareto, but does not specify the joint distribution of neighbouring excesses. There is no general theory to provide an alternative likelihood that incorporates the dependence in observations (Coles, 2001).

According to Coles (2001), there are various suggestions, which offer a way of dealing with the problem of dependent exceedances in the threshold exceedance approach. These include:

- (i) The Declustering method
- (ii) Fitting the GP distribution to all exceedances, ignoring dependence, but then appropriately adjusting the inference (usually an inflation of the standard error) to account for reduction in information
- (iii) Explicitly modeling the temporal dependence in the process (but this approach makes use of multivariate EVT)

The most widely-used method is the declustering, which corresponds to a filtering of the dependent observations to obtain a set of threshold excesses that are approximately independent.

This works by going through the following steps:

- (i) Choose an auxiliary declustering parameter, say k .
- (ii) A cluster of threshold excesses is then considered to have ended as soon as at least k consecutive observations fall below the threshold.
- (iii) Go through the entire series identifying clusters in this manner.
- (iv) The maximum (or peak) observation from each cluster is then extracted and the GP distribution is fitted to the set of cluster peak excesses.

This method is simple, but has its limitations. Results can be sensitive to the arbitrary choices made in cluster determination and there is arguably wastage of information in discarding all data except the cluster maxima.

3.9.4 Estimation of Extreme Quantile for a Stationary GP model

The rate at which clusters occur, rather than the rate of individual exceedances must be considered when finding an m -observation return level (Coles, 2001). Therefore, the m -observation return level is defined by

$$\hat{x}_m = u + \frac{\hat{\sigma}}{\hat{\gamma}} \left[\left(m\hat{\tau}\hat{\theta} \right)^{-\hat{\gamma}} - 1 \right]$$

where σ and γ are the GP distribution parameters, τ is the probability of an exceedance of the threshold u , θ is the Extremal index.

Letting n_u denote the number of exceedances of the threshold u , n_c the number of clusters obtained above u and n the sample size,

$$\hat{\tau} = \frac{n_u}{n} \quad \text{and} \quad \hat{\theta} = \frac{n_c}{n_u}$$

According to Coles (2001), inference on return levels is robust to the choice of the threshold u and the declustering parameter k . Also instability in the Extremal index estimate does not impact on the estimation of return levels excessively (Coles, 2001).

3.10 Extremes of Non-stationary Sequences

Non-stationary processes have characteristics that change systematically through time. Non-stationarity is common in environmental processes and this may be due to seasonal effects and climate changes for different periods of time. In modeling extremes of non-stationary processes, the general assumption of independence and constant distribution through time cannot be applied. In the case of non-stationarity, the parameters of the distribution function are replaced by time-dependent parameters, so that the result of the extreme value analysis also varies with time. For the non-stationary approach, the parameters of the distribution are modelled as a covariate of time. Based on the observed trend in the time series model, the parameters can be modeled accordingly, thus as a linear function, a quadratic function, cubic function or an exponential function.

3.10.1 The Structure of the GEV Model under non-stationarity

Let $GEV(\mu, \sigma, \gamma)$ denote the GEV distribution with parameters μ, σ and γ , a suitable model for X_t , the annual (or monthly) maximum water level at time t , becomes

$X_t \sim GEV(\mu(t), \sigma(t), \gamma(t))$. This implies that, the location parameter, the scale parameter and shape parameter are time dependent. Due to the difficulty in estimating the shape parameter with precision, the shape parameter is usually kept constant (Coles, 2001). Also, in order to ensure the

positivity of the scale parameter for all values of t , an exponential model is usually used for the scale parameter (Coles, 2001). The variations through time in the observed process can be modeled as a polynomial or an exponential trend in the location parameter, based on the kind of trend observed in the process.

Therefore, the models for the parameters may be;

$$\mu(t) = \beta_0 + \beta_1 t$$

$$\sigma(t) = \exp(\alpha_0 + \alpha_1 t)$$

$$\gamma(t) = \gamma$$

Or

$$\mu(t) = \beta_0 + \beta_1 t + \beta_2 t^2$$

$$\sigma(t) = \exp(\alpha_0 + \alpha_1 t)$$

$$\gamma(t) = \gamma$$

The parameters β_0 , β_1 , β_2 , α_0 , α_1 and γ are estimated from the observed data. It should be noted that, more complex models than what has been stated above can be obtained.

The GEV distribution then becomes;

$$G(x,t) = \begin{cases} \exp \left\{ - \left[1 + \gamma \left(\frac{x - \mu(t)}{\sigma(t)} \right) \right]^{-1/\gamma} \right\}, \gamma \neq 0 \\ \exp \left\{ - \exp \left[- \left(\frac{x - \mu(t)}{\sigma(t)} \right) \right] \right\}, \gamma = 0 \end{cases} \quad (3.10.1)$$

where x is the independent water level, $\mu(t)$ the time-dependent location parameter, $\sigma(t)$ the time-dependent scale parameter and γ the constant shape parameter.

3.10.2 The Structure of GP Model under non-stationarity

Using the notation $GP(\sigma, \gamma)$ to denote the GP distribution with parameters σ and γ , the time-dependent model for threshold exceedances can be expressed as

$$(X_t - u(t)/X_t > u(t)) \sim GP(\sigma(t), \gamma),$$

where $(\sigma(t), \gamma)$ are the time-dependent GP distribution parameters and $u(t)$ is a time-dependent threshold. Just as in the GEV case, the shape parameter, γ would be kept constant and the scale parameter modeled as in the case of the GEV distribution.

The GP distribution is now defined as;

$$H(y) = \begin{cases} 1 - \left[1 + \frac{\gamma}{\sigma(t)} y_t \right]^{-1/\gamma}, & \gamma \neq 0 \\ 1 - \exp\left(-\frac{y_t}{\sigma(t)}\right), & \gamma = 0 \end{cases} \quad (3.10.2)$$

Where $y_t = X_t - u(t)$ and X_t are the time series of daily observation X_1, X_2, \dots, X_n of the Akosombo water levels at a given time t .

3.10.3 Model Choice

Due to the possibility of modeling any combination of the extreme value model parameters as a function of time, there is a large catalogue of models to select from and selecting an appropriate model becomes an important issue. The basic principle is parsimony, obtaining the simplest model possible, which explains as much variation in the data as possible (Coles, 2001).

The model is needed as a description of the process that generated the data and not for the data themselves, so it is necessary to assess the strength of evidence for the more complex model structure (Coles, 2001). If the evidence is not particularly strong, the simpler model should be selected in preference.

Maximum likelihood estimation of nested models leads to a simple test procedure of one model against the other. With models $M_0 \subset M_1$, the deviance statistic is defined as

$$D = 2\{l_1(M_1) - l_0(M_0)\}$$

Where $l_0(M_0)$ and $l_1(M_1)$ are the maximized log-likelihood under models M_0 and M_1 respectively. Large values of D indicates that model M_1 explains substantially more of the variation in the data than M_0 while small values of D suggest that the increase in model size does not bring any improvements in the model's capacity to explain the data. The asymptotic distribution of the deviance function is used to determine how large D should be before model M_1 is preferred to model M_0 . M_0 is rejected by a test at the α – level of significance if

$D > C_\alpha$, where C_α is the $(1 - \alpha)$ quantile of the χ_k^2 distribution and k is the difference in the dimensionality of M_1 and M_0 .

3.11 Parameter Estimation for Non-stationary model

Now we consider how to estimate the Extreme Value Index, which is very key in extreme value analysis and other equally important extreme events.

3.11.1 Maximum Likelihood (ML) Estimation Method for the GEV distribution

The parameters of the GEV distribution may be estimated by Maximum Likelihood (ML) estimation technique.

Let $x_t \sim GEV(\mu(t), \sigma(t), \gamma)$, a non-stationary GEV model to describe the distribution of x_t for $t = 1, \dots, m$, where each of $\mu(t)$, $\sigma(t)$ and γ have an expression in terms of a parameter vector. The likelihood function of the non-stationary GEV is then given;

$$L(\omega) = \prod_{t=1}^m g(x_t, \mu(t), \sigma(t), \gamma) , \quad \omega = (\mu(t), \sigma(t), \gamma)$$

Where $g(x_t; \mu(t), \sigma(t), \gamma)$ denotes the GEV density function with parameters $\mu(t)$, $\sigma(t)$ and γ evaluated at x_t . If $\gamma \neq 0$, the log-likelihood is;

$$l(\omega) = - \sum_{t=1}^m \left\{ \log \sigma(t) + (1 + 1/\gamma) \log \left[1 + \gamma \left(\frac{x_t - \mu(t)}{\sigma(t)} \right) \right] + \left[1 + \gamma \left(\frac{x_t - \mu(t)}{\sigma(t)} \right) \right]^{-1/\gamma} \right\}$$

provided that $1 + \gamma \left(\frac{x_t - \mu(t)}{\sigma(t)} \right) > 0$ for $t = 1, \dots, m$.

If $\gamma = 0$, the log-likelihood reduces to;

$$l(\omega) = - \sum_{t=1}^m \left\{ \log \sigma(t) + \left(\frac{x_t - \mu(t)}{\sigma(t)} \right) + \exp \left[- \left(\frac{x_t - \mu(t)}{\sigma(t)} \right) \right] \right\}$$

The estimates of the parameters $(\mu(t), \sigma(t), \gamma)$ are obtained by maximizing the log-likelihood function.

3.11.2 Extreme quantiles Estimation for the non-stationary GEV distribution

When the estimators of $\mu(t), \sigma(t)$ and γ of the GEV distribution have been obtained, the other most important parameters of any extreme value analysis is to be able to estimate extreme quantiles, exceedance probabilities and return periods.

The extreme quantile of the GEV can be estimated by inverting the GEV distribution function in (3.10.1);

$$q_{x,p} = \begin{cases} \mu(t) - \frac{\sigma(t)}{\gamma} \left[1 - \{-\log(1-p)\}^{-\gamma} \right], \gamma \neq 0 \\ \mu(t) - \sigma(t) \log[-\log(1-p)], \gamma = 0 \end{cases} \quad (3.11.1)$$

for $0 \leq p \leq 1$.

The parameters $\mu(t), \sigma(t)$ and γ are replaced with their corresponding ML estimates.

3.11.3 Peak-over threshold approach: threshold selection

In extremes of non-stationary sequences, the assumption of constant threshold of exceedances is not the best, since the characteristics of the process change systematically through time. Hence a temporally changing threshold is required, one way of determining such a threshold is by the use of quantile regression. However, an appropriate quantile should be chosen such that, the value of the threshold is enough to justify the GPD assumption. The choice of a threshold is a balance between bias and variance as described in the previous sections.

3.11.4 Quantile Regression

Since we wish to set a non-constant threshold, we employ quantile regression which is used to quantify how a given conditional quantile (or quantiles) of a response variable Y depends on the observed values of covariates (Koenker and Hallock, 2001). The quantile regression model condition quantiles as function of predictors. The quantile regression model is an extension of the linear regression model. While the linear regression model specifies the changes in the conditional mean of the dependent variable associated with a change in the covariates, the quantile regression model specifies changes in the conditional quantile. Any predetermined position of the distribution can be modeled since quantiles are used. Quantile regression is used to quantify how a conditional quantile of a response variable depends on the observed values of covariates

Let y_τ denote the conditional τ^{th} quantile of Y , satisfying $P(Y \leq y_\tau) = \tau$ for $\tau \in (0,1)$ and $y_\tau \in \mathbb{R}$.

According to Koenker and Bassett (1978), the regression parameters are estimated by minimizing

$$\hat{Q}_Y(\tau) = \arg \min_{\delta \in \mathbb{R}^n, y_\tau \in \mathbb{R}} \left\{ \sum_{i \in \{i|Y_i \geq y_\tau\}} \tau(Y_i - y_\tau) + \sum_{i \in \{i|Y_i < y_\tau\}} (1-\tau)(Y_i - y_\tau) \right\}$$

With respect to $\boldsymbol{\delta} = (\delta_0, \delta_1, \dots, \delta_n)'$, where $Y_i = \boldsymbol{\delta}X_i + \boldsymbol{\varepsilon}$.

The R package `quantreg` (Koenker, 2015) can be employed to estimate δ . If the probability of threshold exceedance is quadratic (or cubic), then the form of the GP model fitted implies that particular form of the quantile regression model be used to set the threshold. Therefore, for a given GP model, we know which quantile model to fit.

3.11.5 Maximum likelihood Estimation for the GP distribution

After a suitable threshold has been determined, the parameters of the GP distribution can be estimated by maximum likelihood.

Let y_1, y_2, \dots, y_m be the m excesses over a threshold $u(t)$. The log-likelihood function if $\gamma \neq 0$ is given by

$$l(\sigma(t), \gamma) = -\sum_{t=1}^m \left\{ \log \sigma(t) + (1 + 1/\gamma) \log \left[1 + \frac{\gamma}{\sigma(t)} y_t \right] \right\}$$

provided $1 + \frac{\gamma}{\sigma(t)} y_t > 0, t = 1, 2, \dots, m$

If $\gamma = 0$, the log-likelihood function reduces to

$$l(\sigma(t)) = -\sum_{t=1}^m \left\{ \log \sigma(t) + \frac{y_t}{\sigma(t)} \right\}$$

3.11.6 Extreme Quantiles Estimation for the non-stationary GP distribution

Extreme quantiles of the GP distribution can be obtained by inverting the GP distribution function in (3.9.2) to yield

$$x_{y,p} = \begin{cases} \frac{\sigma(t)}{\gamma} (p^{-\gamma} - 1), \gamma \neq 0 \\ \sigma(t) \log p, \gamma = 0 \end{cases} \quad (3.11.2)$$

where the parameters $(\sigma(t), \gamma)$ are substituted with their corresponding ML estimates.

3.12 Model Verification

After the estimates of various parameters of possible model have been determined, we need to verify the appropriateness of the adopted model. For the non-stationary case, the lack of homogeneity in the distributional assumptions for each observation calls for some modification in the diagnostic plots discussed for the independent and identical distribution. It is generally only possible to use such diagnostic plots on standardized version of the data, given the fitted parameter values (Coles, 2001). For instance, based on the estimated model

$$X_t \sim GEV(\hat{\mu}(t), \hat{\sigma}(t), \hat{\gamma}),$$

the standardized variables \tilde{X}_t , is defined by (Coles, 2001)

$$\tilde{X}_t = \frac{1}{\hat{\gamma}} \log \left\{ 1 + \hat{\gamma} \left(x_t - \frac{\hat{\mu}(t)}{\hat{\sigma}(t)} \right) \right\} \quad (3.12.1)$$

and each of the standardized variables \tilde{X}_t have the standard Gumbel distribution, with probability density function

$$P\{\tilde{X}_t \leq x\} = \exp\{-\exp(-x)\} \quad x \in \mathbb{R} \quad (3.12.2)$$

The probability and the quantile plots of the observed \tilde{x}_t are constructed with reference to the Gumbel distribution (Coles, 2001). Letting $\tilde{x}_{(1)}, \dots, \tilde{x}_{(m)}$ denote the ordered values of \tilde{x}_t , the probability plots consists of the pairs (Coles, 2001);

$$\left\{ \left(\frac{i}{m+1}, \exp\left(-\exp(-\tilde{x}_{(i)})\right) \right) : i = 1, \dots, m \right\}$$

and the quantile plot consists of the pair (Coles, 2001);

$$\left\{ \left(\tilde{x}_{(i)}, -\log(i/(m+1)) \right) : i = 1, \dots, m \right\}$$

According to Coles (2001), the probability plot is invariant to the Gumbel distribution as a reference distribution but the quantile plot is not and so any choice other than the Gumbel would produce a different plot.

Similar techniques can be adopted for the GP distribution. For the GP distribution, a set of temporally varying thresholds $u(t)$, which yield threshold excesses y_{t_1}, \dots, y_{t_k} is considered. The estimated model is then defined as $Y_t \sim GP(\hat{\sigma}(t), \hat{\gamma})$.

In this case, since the exponential distribution is a special case of the GP family with $\gamma \rightarrow 0$, the exponential distribution would be used as the reference distribution (Coles, 2001).

$\tilde{Y}_t = \frac{1}{\hat{\gamma}} \left(\frac{Y_t - u_t}{\hat{\sigma}(t)} \right)$ is the standardized variables for the GP distribution.

Letting $\tilde{y}_{(1)}, \dots, \tilde{y}_{(k)}$ denote the ordered values of the observed \tilde{Y}_t , the probability plot consist of the pairs (Coles, 2001),

$$\left\{ \left(i/(k+1), 1 - \exp(-\tilde{y}_{(i)}) \right) : i = 1, \dots, k \right\}$$

and the quantile plot consist of pairs (Coles, 2001),

$$\left\{ \left(\tilde{y}_{(i)}, -\log \left(1 - \frac{i}{k+1} \right) \right) : i = 1, \dots, k \right\}$$

Just as in the case the GEV distribution, the probability plot is invariant to the choice of reference distribution but the quantile plot is specific to the choice of exponential scale (Coles, 2001).

CHAPTER FOUR

ESTIMATION AND INTERPRETATION OF THE EXTREME VALUE MODELS

4.1 Introduction

This chapter presents the extreme value analysis of the water levels of the Akosombo dam and discussion of the result obtained based on some of the methodologies described in chapter three. The chapter is subdivided into four main sections, excluding the introductory section. First and foremost, section 4.2 describes the basic characteristics of the data under study. Secondly, section 4.3 describes the Generalized Extreme Value Model. In this section, both the Block Maxima and the Block Minima models are applied to the data. Thirdly, in section 4.4, the Threshold Exceedances model methodologies are applied to the data. In this section, we study the Left and Right Tails of the Generalized Pareto Distribution via the data just as in the case of the GEV distribution.

4.2 Data and Preliminary Analysis

Data used for the analysis were the daily water levels of the Akosombo dam. The data consisted 17,525 data points, which spanned January 1, 1966 to December 31, 2013.

Table 4.1: Descriptive Statistics of the Akosombo dam

Minimum	1 st Quartile	3 rd Quartile	Mean	Skewness	Maximum
234.00	248.06	265.73	256.67	-0.124	277.54

In 1966, thus a year after the commissioning of the dam, the water levels were generally low. The lowest ever water level for the period under study is 234.00 ft., this was recorded on June 28, 1966. The electricity demand during that time was at a minimal level, so the electricity generated by such low water levels was not a problem. However, with the nation's current increasing demand for electricity, any water level below 240ft. is a disaster and will lead to nationwide load shedding.

In the year 2010, the water levels were generally high, especially in the month of November, peaking 277.54ft. The water levels in the month of November came very close to the maximum capacity (278ft.) of the dam and therefore resulted in the opening of the spill gate of the dam. This led to flooding in the Southern part of Ghana.

The Skewness value indicates the distribution is asymmetric and therefore has a tail much lighter than that of the normal distribution. This observation is also supported by the histogram in figure 4.1.

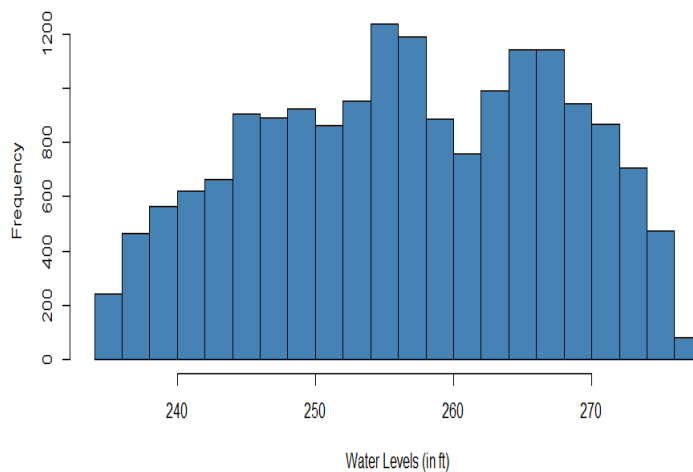


Figure 4.1: Akosombo dam Water Level

4.3 Fitting the Generalized Extreme Value Model to the Monthly extremes

The Generalized Extreme Value analysis consists of the Block Maxima and the Block Minima methods discussed in chapter three. With the blocking method, we considered the monthly maximum and minimum water levels as our sample. This resulted in 576 data points in each case. Though, the block sizes differ since months have unequal number of days, but we do not expect this to have significant influence on our analysis.

4.3.1 Test of Stationarity

In order to investigate the stationarity or non-stationarity of the monthly extreme, we employed the Phillips-Person unit root (PP) test, wherein the alternative hypothesis states that, the data is stationary. According to the analysis carried out, the PP test of Stationarity for monthly maximum water levels of the Akosombo dam resulted in a Dickey – Fuller test value of -36.3012 and a truncation lag parameter of 6 with a p-value less than 0.01. Additionally, the PP test of Stationarity for monthly minimum water levels of the Akosombo dam resulted in a Dickey – Fuller test value -35.0714 and truncation parameter 6 with a p-value less than 0.01. Therefore, both samples are stationary at 1% significant levels. Since the P-value observed in both cases is less than 0.01, we then reject the null hypothesis and conclude that, the two samples are stationary.

4.3.2 The Blocking Method; Generalized Extreme Value Model

Since the samples are stationary, we build stationary models for the extremes. Although, stationarity does not imply independence but since the blocking method weakens the dependence in the data, we can assume that the data are independent and then use the classical EVT to model the stationary sequence as independent sequence. This concept is well explained in chapter three.

In modeling the minimum, we employ the duality between maximum and minimum and so, we converted the minimum into a maximum problem by using the negated forms of the minimum. The maximum likelihood estimate of the parameters of this distribution corresponds exactly to that of the required GEV distribution for minima apart from the sign correction $\hat{\mu} = -\mu$. $\hat{\mu}$ is the estimate of the location parameter of the minima distribution and μ is that of the transformed distribution.

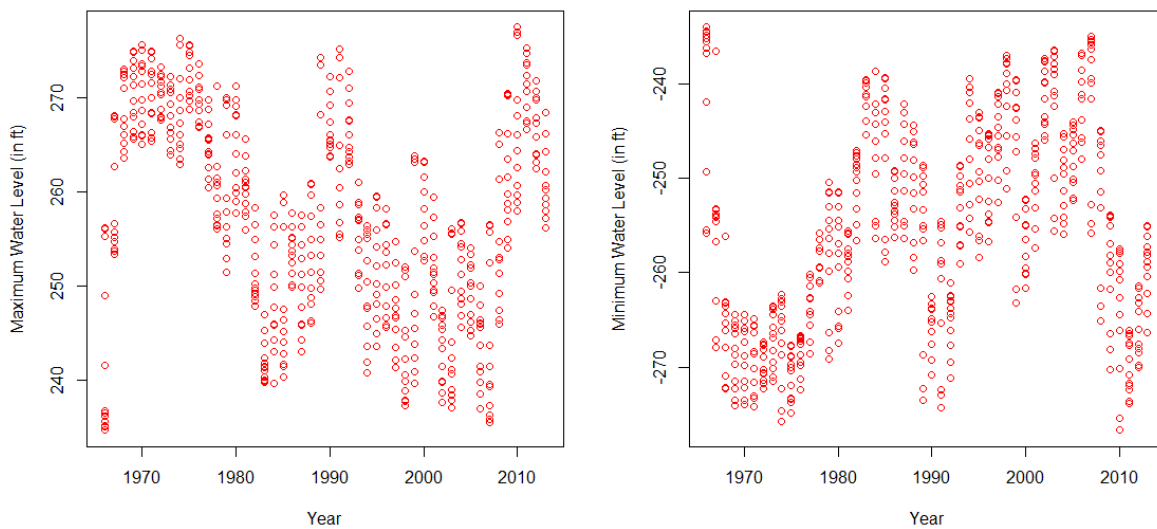


Figure 4.2: Monthly Maximum Water Levels, left panel; Monthly Minimum Water levels, right panel.

Figure 4.2 shows the time series plots of the sample maxima and minima water levels for the monthly blocks. From Figure 4.2, it can be seen that, the maximum and minimum plots are similar in terms of variations and trends.

Figure 4.3 shows the exponential Quantile – Quantile (Q-Q) plots for the maximum and minimum water levels. The Quantile – Quantile (Q-Q) plot can be used to assess the fit of any statistical model Beirlant *et al.* (2004). The exponential QQ-plot can be used to pictorially determine the domain of attraction of the underlying distribution. The downward curvature (which means decreasing slope) of the QQ-plots in both cases indicates that the distribution has a tail lighter than the exponential. This implies the distribution belongs to the Weibull domain of attraction.

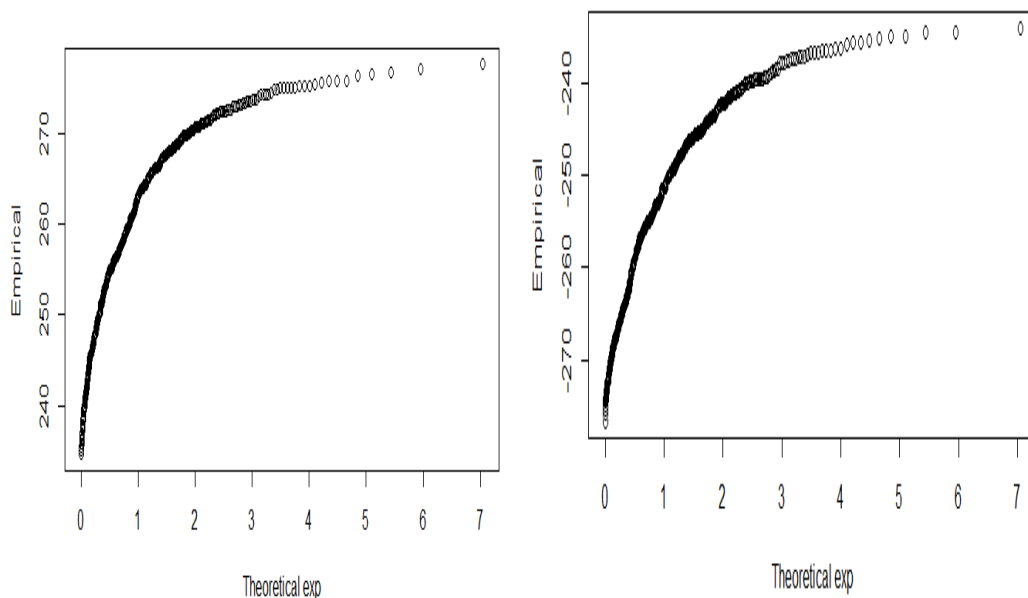


Figure 4.3: Exponential QQ-plot for Maximum water levels, left panel; Exponential QQ-plot for Minimum water levels, right panel.

The GEV models for both monthly maximum and minimum water levels were fitted using maximum likelihood. Table 4.2a and 4.2b; present the parameter estimates and their corresponding standard errors (in parentheses) for the maximum water levels and minimum water levels respectively. The Extreme Value Index (EVI), thus shape parameter, is negative in both cases and this suggests that the underlying distribution belongs to the Weibull domain of attraction. The Wald confidence intervals for the parameters are also presented in these tables. According to Beirlant *et al.* (2004), greater accuracy for the confidence intervals is attained by the profile log-likelihood. The confidence intervals for the profile log-likelihood are presented in Table 4.3. The profile log-likelihood and the Wald confidence intervals for the left tail are similar but that of the right differs. The lower profile log-likelihood for the shape parameter is not obtainable in the case of the right tail.

Table 4.2a: Parameter estimates of the GEV distribution for the right tail of the Akosombo dam water levels and their corresponding standard errors (in parentheses).

Parameter	Estimates	Lower CI (95%)	Upper CI (95%)
Location ($\hat{\mu}$)	254.90 (0.53)	253.87	255.94
Scale ($\hat{\sigma}$)	11.42 (0.42)	10.59	12.24
Shape ($\hat{\gamma}$)	-0.47(0.034)	-0.54	-0.41

Table 4.2b: Parameter estimates of the GEV distribution for the left tail of the Akosombo dam water levels and their corresponding standard errors (in parentheses).

Parameter	Estimates	Lower CI (95%)	Upper CI (95%)
Location ($\hat{\mu}$)	-259.10 (0.52)	-260.11	-258.08
Scale ($\hat{\sigma}$)	10.69 (0.40)	9.91	11.47
Shape ($\hat{\gamma}$)	-0.33 (0.04)	-0.41	-0.25

Table 4.3: Profile log-likelihood of the parameters of the fitted GEV

Left tail (95%)			Right tail (95%)		
Parameter	Lower	Upper	Parameter	Lower	Upper
Location (μ)	-260.11	-258.08	Location (μ)	253.40	256.37
Scale (σ)	9.96	11.53	Scale (σ)	10.35	12.72
Shape (γ)	-0.407	-0.246	Shape (γ)	NA	-0.37

We further use diagnostic plots to assess the fitted GEV models for the monthly maximum and minimum water levels. The plots are the QQ-plot (a), PP-plot (b) and a histogram overlay with the density curves of the fitted GEV (c). The plots are presented by Figure 4.4. For the QQ-plot and the PP-plot, a good fit should yield a straight one-to-one line of points. Generally, the QQ-plot is preferred to the probability plot. The linearity of the QQ-plot and the PP-plot indicates that, the model is a valid model. Thus the GEV model fit the data very well. From the histogram,

the density also appears to be consistent with the data points. We therefore conclude that the diagnostic plots are in favour of the fitted model.

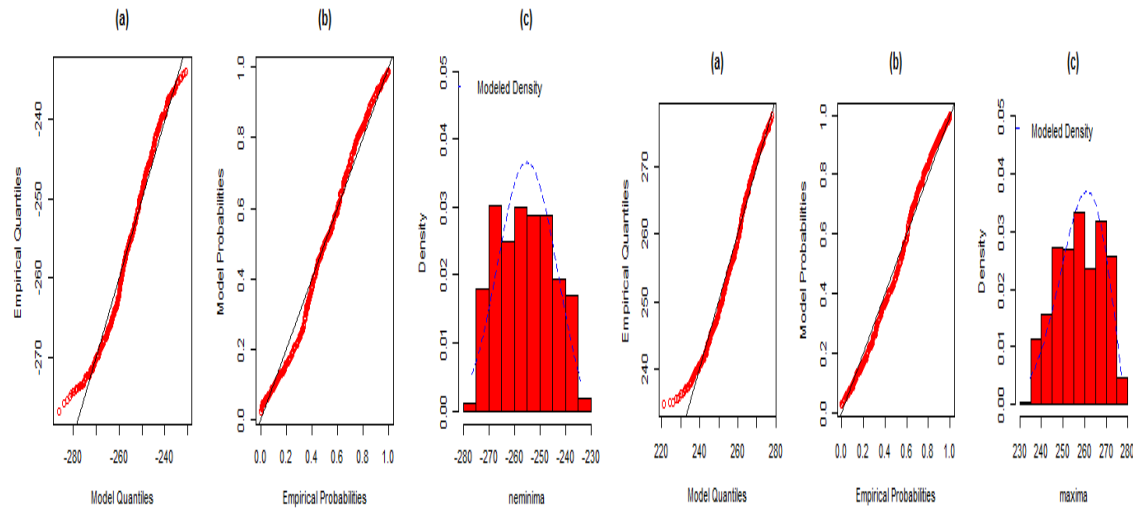


Figure 4.4: Diagnostic plots for the fitted GEV model for the monthly minimum water levels, left panel; monthly maximum water levels, right panel.

Now that there is no doubt the GEV model belongs to the Weibull domain of attraction, we then estimate the upper endpoint of the distribution. If $\gamma < 0$, $\mu - \sigma/\gamma$ is the upper endpoint of the distribution and a lower endpoint when $\gamma > 0$, (Coles, 2001). From the analysis, the upper bound for the left tail is 226.69ft, which is way below the lowest water level ever recorded for the period under study, but very close to the critical level of the dam and that of the right tail is 279.07ft, which is above the maximum water capacity (278ft.) of the Akosombo dam.

Now we consider the estimation of return periods and exceedance probabilities for the tails of the distribution. Table 4.4 presents the probabilities of exceedances for some selected water levels of the dam. We observed that, in the case of the right tail, higher water levels are associated with lower exceedance probabilities. Additionally, any level greater than the maximum capacity of the dam has exceedance probability zero, which implies, it is impossible to observe a level higher than what the dam can actually contain. Since there is a ceiling (278ft.) on the amount of water the dam is allowed to contain, any level close to it leads to spillage of water from the dam to save the dam from collapsing, therefore it is impossible for the dam to attain a level higher than 278ft. The exceedance probabilities for the left tail is interpreted as, probability that, water levels fall below the absolute value of the water level. Also in the case of the left tail, lower water levels are associated with lower exceedance probabilities. The exceedance probabilities for water levels below 230ft are all zeros. Very low probabilities imply that, the chances of observing such water levels are rare, but not impossible and the zero probabilities imply that it is impossible to observe the water level less than 230ft.

Table 4.4: Exceedance Probabilities estimates using the GEV model

Right Tail							
Water level (in ft.)	270	272	275	277	278	279	280
Exceedance Probabilities	0.118	0.071	0.023	0.006	0.001	0.0000	0.0000
Left Tail							
Water level (in ft.)	-240*	-238*	-235*	-230*	-225*	-220*	-210*
Exceedance Probabilities	0.065	0.040	0.016	0.001	0.000	0.000	0.000

(*) Negative values are interpreted in absolute value terms

Table 4.5 presents the return periods for various water levels of the dam. The return period's measures how long, it is expected for a given water level to be exceeded, on average, once for a specified period (Salas and Fernandez, 1999). The return periods for the GEV model are in years, though monthly extremes were used in the analysis. A 100-year return period implies that, on average, the water level is expected to exceed 276.40ft. once every 100 years. The return periods for the left tail are interpreted in absolute terms. However, for the left tail, it is the expected time for the water to fall below that water level. For instance, the 100-year return period for the left tail means that, on average it is expected for the water level to fall below 233.80ft once every 100 years.

Table 4.5: Return Periods estimates for the GEV model

Right Tail					
Return period	5-year	10-year	20-year	50-year	100-year
Water level (ft.)	267.19	270.76	273.18	275.32	276.40
Left Tail					
Return period	5-year	10-year	20-year	50-year	100- year
Water level (ft.)	-246.45*	-242.12*	-238.86*	-235.64*	- 233.80*

(*) Negative values are interpreted in absolute value terms

4.4 Fitting the Generalized Pareto Model to the daily water levels of the Akosombo dam

The daily water levels of the Akosombo dam are considered as realization of a random variable having a distribution function F . As we described in chapter three, the peak-over threshold method considers an event as extreme (here daily water level) if it exceeds a high threshold u . The excesses over the threshold u are approximated with the Generalized Pareto (GP) distribution. The choice of u as was discussed in chapter three is a very important issue for this method. It is a trade-off between a low u with minimal variance and a high u with a minimal bias. In order to know whether to model the daily water levels as stationary or non-stationary, we have to perform a stationarity or non-stationarity test to confirm the nature of the series.

4.4.1 Test of stationarity for the daily water levels

In order to investigate the stationarity of the daily water levels, we employed the Augmented Dickey-Fuller (ADF) test, for which the alternative hypothesis states that, the data is stationary. The ADF test of Stationarity of the daily water levels of the Akosombo dam resulted in a Dickey-Fuller test value of -6.7334 and a lag order of 25 with a p-value less than 0.01. We therefore, conclude that the daily water levels are stationary at 1% significant levels.

4.4.2 The Peak-Over Threshold Method; Threshold Selection

The mean residual life plot also known as mean excess plot and a threshold stability plot was used to aid in the selection of an appropriate threshold. For the mean excess plot, we select u as the point to the right of which a linear pattern is observed. The second approach is to estimate the model at a range of thresholds and above a threshold u_0 at which the asymptotic properties for the GP model is valid; the parameter estimates should be approximately stable, thus approximately constant, Coles (2001). From Figure 4.5 (right panel), we can conclude, there is some sort of linearity above $u = 273.00ft$ for the maximum daily water levels of the Akosombo dam. It can also be observed from figure 4.6a that, the parameter estimates appear stable around $u = 273.00ft$. Since both procedures support $u = 273.00ft$, we selected $u = 273.00ft$ as our threshold for the right tail. From the left panel of figure 4.5, we selected our threshold to be $u = -236.00ft$. (236.00ft.), since there is evidence of linearity above $u = -236.00ft$. Also the threshold stability plot presented by figure 4.6b, shows stability of the parameter estimates around $u = -236.00ft$.

Additionally, the shape of the mean excess plot provides important information about the tail of the distribution at hand (Beirlant *et al.*, 2004). The mean excess plot has a positive slope if the

distribution has a tail heavier than the exponential distribution (HTE) and a negative slope if the distribution has a lighter tail (LTE) (Beirlant *et al.*, 2004). Therefore the decreasing nature in both cases indicates that, they both have a tail lighter than the exponential distribution. Thus, they both belong to the GP distribution with Weibull domain of attraction.

If the mean excess plot is close to linearity for high threshold values, then the data conform to a GP distribution (Ghosh and Reinck (2011); Das and Ghosh (2013)). The mean excess plot is a pictorial way of checking if a data conform to a GP distribution (Ghosh and Reinck, 2010).

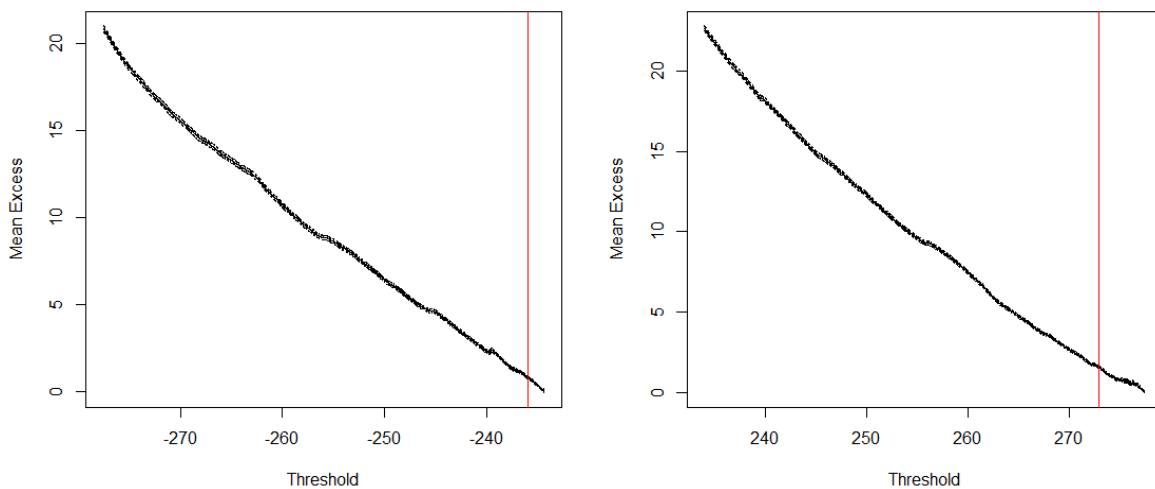


Figure 4.5: Mean residual life plot for daily minimum water level (left panel) and daily maximum water level (right panel) of the Akosombo dam

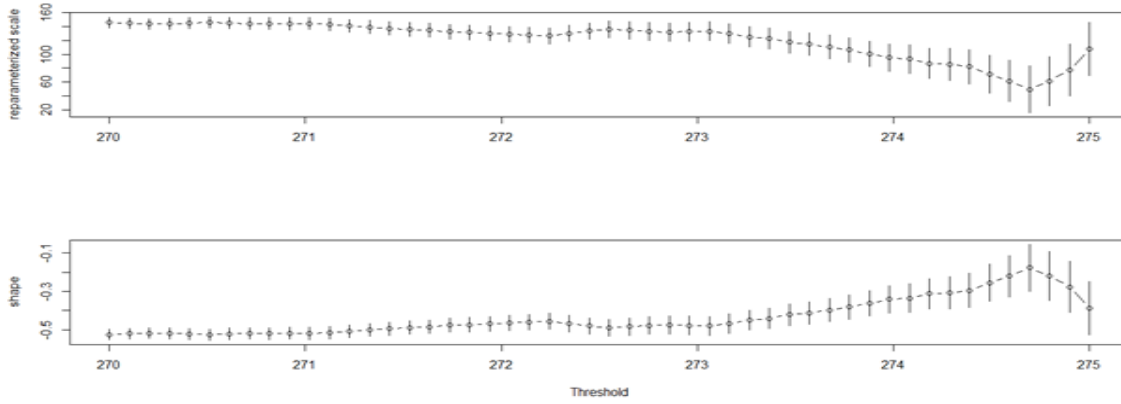


Figure 4.6a: Parameter estimates against threshold for daily maximum water levels

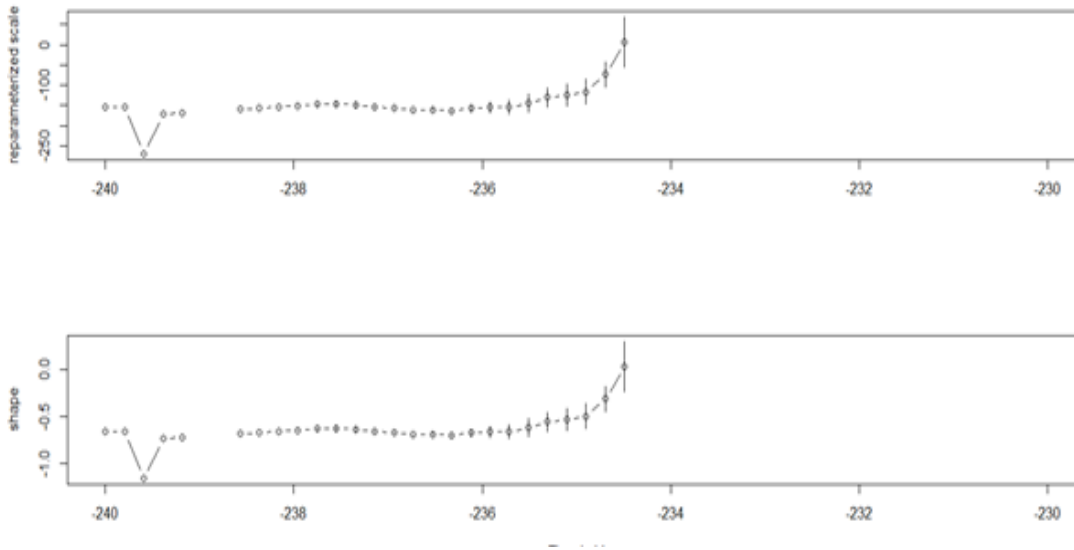


Figure 4.6b: Parameter estimates against threshold for daily minimum water levels

The threshold choice of 273.00ft for the right tail yielded a sample of size of 831 (4.74%) excess maximum daily water levels and a choice -236.00ft (236.00ft.) for the left tail yielded 239 (1.36%) excess minimum daily water levels.

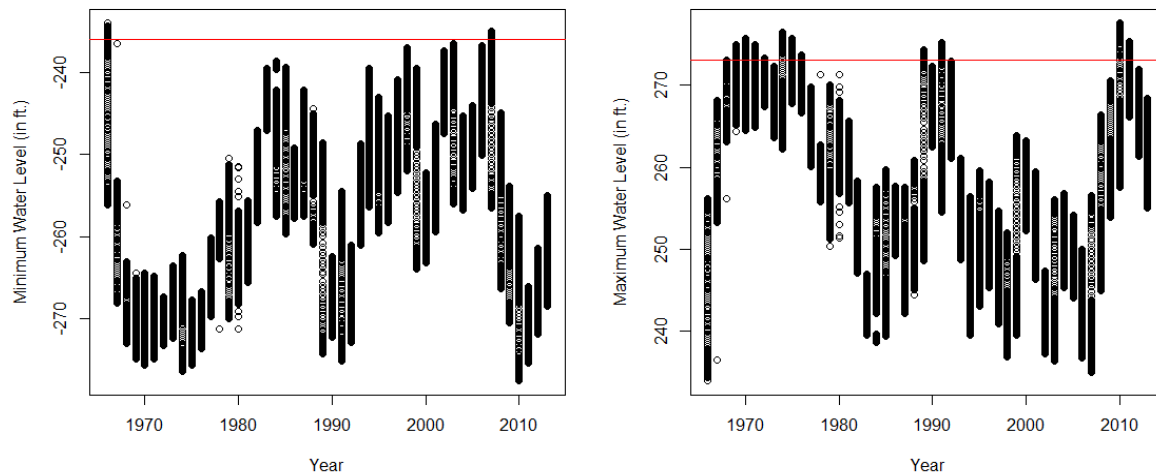


Figure 4.7: Plot of exceedances for daily minimum water levels, left panel, and daily maximum water levels, right panel.

As discussed in chapter three, Coles (2001) offered three approaches to handle dependent exceedances for the Peak-Over threshold method. We employed the first two procedures discussed, in this study. The third procedure was not used because it employs Multivariate Extreme Value Theory, which is beyond the scope of this study.

Fitting the GP distribution using the declustering procedures

An Extremal Index (θ) of 0.012 was obtained for the right tail. The Extremal Index measures the degree of dependence of the exceedances, the closer the value to zero, the stronger the dependence and the closer the value to one the weaker the dependence (Coles (2001); Ferro and Segers (2003)). The Extremal Index (θ) is bounded below by zero and above by one, thus $0 < \theta \leq 1$ (Coles (2001); Ferro and Segers (2003)). Since $\theta = 0.012$, the exceedances of the daily water levels for the right tail are highly dependent. Table 4.6 presents the estimates obtained via the declustering method. This procedure resulted in 10 clusters with a clustering

interval of 5, which means only 10 out of the 831 exceedances was used to fit the GP distribution. A shape parameter estimate of -0.9925 was obtained under the declustering approach, a value of -0.9925 implies that, the usual asymptotic properties are not met, (Smith, 1985, as cited by Coles, 2001). The negativity of the shape indicates that, the GP distribution has a tail lighter than the exponential distribution, thus, the GP distribution belongs to the Weibull domain of attraction. The profile log-likelihood confidence intervals are (4.5091, 4.5177) for the scale parameter and (-0.9942, -0.9925) for the EVI. There is no much difference between the two types of confidence intervals.

Table 4.6: Parameter Estimates of GP model for right tail (cluster maxima) and their corresponding standard errors (in parentheses).

Parameter	Estimates	Lower CI (95%)	Upper CI (95%)
Scale (σ)	4.5091(0.0345)	4.4415	4.5767
Shape (γ)	-0.9928($2 * 10^{-6}$)	-0.9928	-0.9927

An Extremal Index of 0.0084 was obtained for the left tail. This is an indication of high dependence among the exceedances of the daily minimum water levels. The declustering resulted in a cluster interval of 3 and 2 clusters. The parameter estimates obtained using the cluster maxima approach for the left tail is summarized as follows; estimate of the shape(γ) is -1.014; this value implies that the usual asymptotic properties have not been met and also the ML estimators are not obtainable. Hence the standard errors for the estimates were not obtainable.

Again, since $\gamma < 0$, the GP distribution belongs to the Weibull domain of attraction. The estimate of the scale (σ) parameter is 2.030.

Figure 4.8 presents diagnostic plots for the fitted GP model using cluster maxima. Clearly, the left tail (left panel) is very poor. Though, the fitted model for the right tail (right panel) also does a poor work, but it's better than that of the left tail distribution. In both the quantile and the probability plots for the right tail, we observed deviation from linearity at the extremes and this implies that the fitted model fails at the extremes.

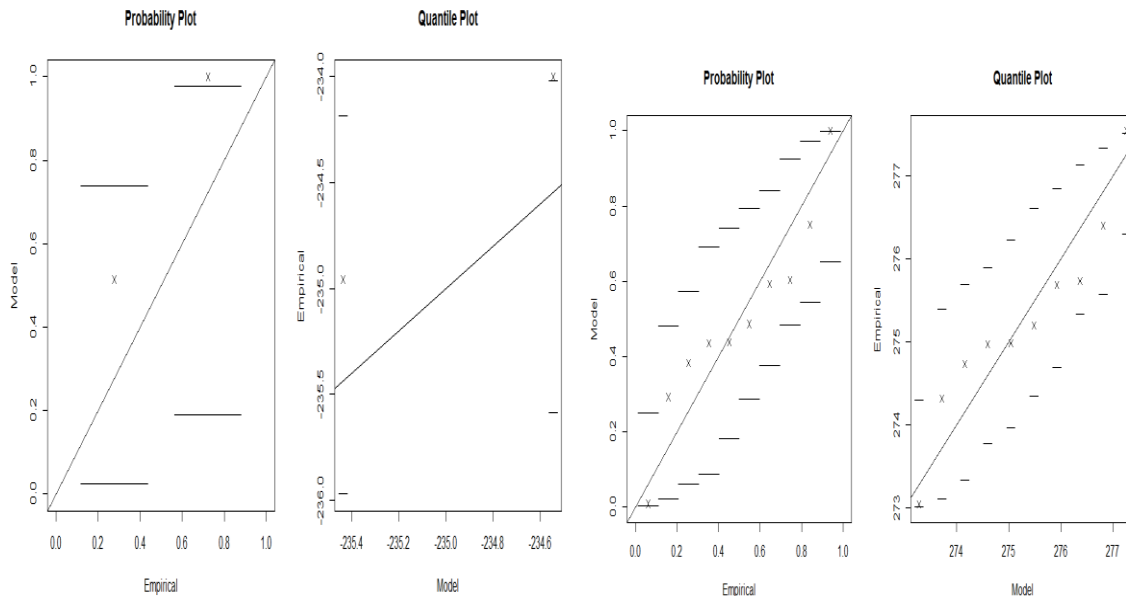


Figure 4.8: Diagnostic plots for fitted GP model using cluster maxima, left tail (left panel) and right tail (right panel).

Now that we know the GP distribution belong to the Weibull domain of attraction, we then estimate the upper endpoint of the Weibull distribution. The upper endpoints for the right and the

left tail distributions for the fitted GP model for the cluster maxima are 277.54ft and 234.00ft respectively. That of the right tail is equal to the maximum water level for the period under study. That of the left tail is also equal to the minimum water level for the period under study.

Table 4.7 presents the return level estimates using the GP model for the cluster maxima. The 100-year return level (right tail) is 277.78ft., this implies that, this water level can be observed on average once in every 100 years and that of the left tail is 234.02ft.

Table 4.7: Return period estimates and their corresponding return levels for the fitted GP model (cluster maxima)

Right tail					
Return period	5-year	10-year	20-year	50-year	100-year
Water level (ft.)	277.53	277.51	277.49	277.41	277.28
Left tail					
Return period	5-year	10-year	20-year	50-year	100-year
Water level (ft.)	-234.00*	-234.00*	-234.00*	-234.01*	-234.02*

(*) Values are interpreted in absolute terms

Fitting GP distribution to all Exceedances (whiles ignoring dependence among the exceedances)

Table 4.8 presents the estimates for the right tail obtained using the second procedure suggested by Coles (2001). With this procedure, we ignored the dependence and fit the GP distribution to all exceedances and adjusted the inference by inflating the standard error. From Table 4.10, since $\gamma > -0.5$, it implies the usual asymptotic properties are met and the ML estimators are regular. We inflated the standard error of the scale parameter by a factor of 1.04 and that of the shape by 3.27. Therefore, the adjusted standard errors are 0.094 and 0.082 respectively. These factors were determined by using simulation to find the best fit. We then compared the standard errors of the actual model and the simulated model to obtain the factors. The result of the simulated model can be found in the appendix I by Table 1-A, Figure 1-A, Table 1-B and Figure 1-B.

Table 4.8: Parameter Estimates for the GP model for all exceedances ignoring dependence, right tail.

Parameter	Estimates	Lower CI (95%)	Upper CI (95%)
Scale (σ)	2.3014 (0.090)	2.124	2.479
Shape (γ)	-0.486 (0.025)	-0.535	-0.437

We ignored the dependence among the exceedances and fitted the GP distribution to all the 239 exceedances. After which we inflated the standard errors. The factors used to inflate the standard errors were obtained in a similar manner as that of the right tail. The adjusted standard errors for the scale and shape parameter estimates are 0.066 and 0.086 respectively. An estimate of -0.678

was obtained for the shape parameter of the GP distribution. We observed that $\gamma < -0.5$, this implies the ML estimators are not regular but obtainable. Table 4.9 presents the estimates for the left tail obtained by modeling the exceedances as independent random variable.

Table 4.9: Parameter Estimates for the GP model for all exceedances ignoring dependence, left tail.

Parameter	Estimates	Lower CI (95%)	Upper CI (95%)
Scale (σ)	1.362 (0.047)	1.269	1.454
Shape (γ)	-0.678 (0.022)	-0.720	-0.635

Table 4.10 presents the profile log-likelihood of the GP distribution parameter. The lower limit of the shape parameter for the left tail is not obtainable. The Wald confidence interval for the scale parameter and the profile log-likelihood are similar for the left and right tails. However, that of the shape parameters differs.

Table 4.10: Profile log-likelihood of the GP distribution parameters

Left tail (95%)			Right tail (95%)		
Parameter	Lower	Upper	Parameter	Lower	Upper
Scale (σ)	1.18	1.58	Scale (σ)	2.13	2.49
Shape (γ)	NA	-0.59	Shape (γ)	-0.54	-0.44

We now assess the fitted GP distribution using diagnostic plots; these are shown in Figure 4.9. The diagnostic plots for the right tail are those on the left panel and that of the left tail are those on the right panel (please note that, these diagnostic plots are for the models in which the dependence was ignored). Both the Q-Q plots and the P-P plots are close to linearity, it therefore indicates that, the GP distribution fits the data. Though the diagnostic plots are not highly convincing, but there is less doubt about the quality of the fit.

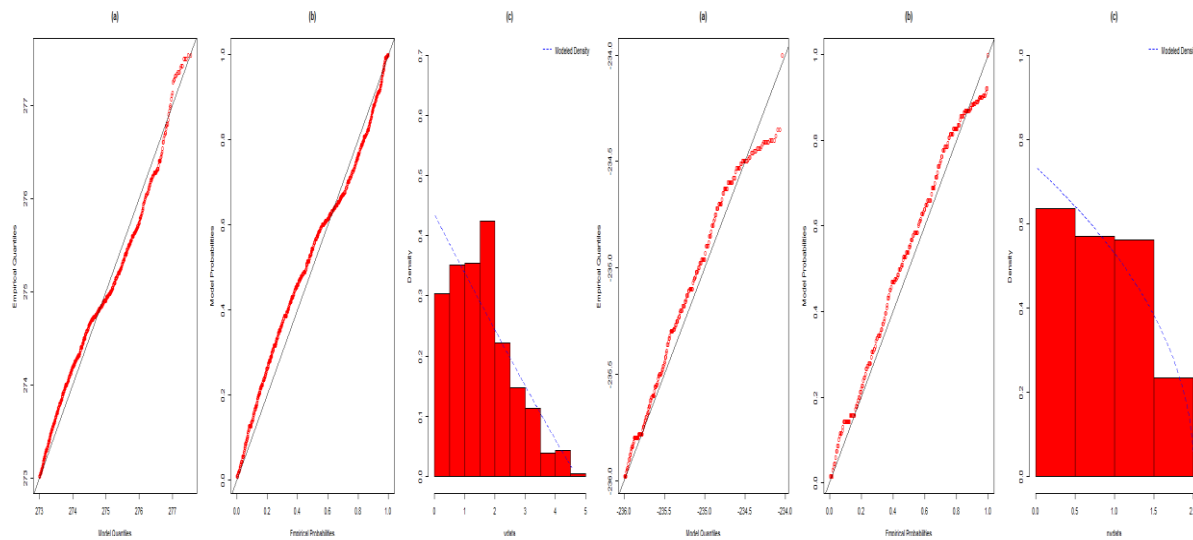


Figure 4.9: Diagnostic plots for the fitted GP model, right tail (left panel) and left tail (right panel)

Since there is no doubt that the GP distribution belongs to the Weibull domain of attraction, we can estimate the upper endpoint of the GP distribution. The estimates of the upper endpoints for the fitted GP model for all exceedances as independent random variables is 233.ft for the left tail and 277.73ft for the right tail. The estimates are very close to the minimum and the maximum water levels recorded for the period under study.

We now turn our attention to the estimation of exceedance probabilities and return periods. These extreme events are shown in Tables 4.11 and 4.12 respectively. We observed that the water levels of the dam cannot reach 278ft. or higher, since the exceedance probability is zero for water level of 278ft. or higher. It was also observed that, the Akosombo dam cannot attain a water level of 233.50ft or lesser, since their exceedance probabilities are zero.

Table 4.11: Estimated exceedance probabilities for the fitted GP distribution

Right Tail						
Water level (ft.)	274.0	275.0	276.0	277.0	278.0	279.0
Exceedance probability	0.6138	0.3233	0.1267	0.0216	0.0000	0.0000
Left Tail						
Water level (ft.)	-235.0*	-234.5*	-234.0*	-233.5*	-233.0*	-232.0*
Exceedance probability	0.3620	0.1319	0.0004	0.0000	0.0000	0.0000

(*) Values are interpreted in absolute terms

A 100-year return period for the right tail has a return level of 277.46ft., which means this water level can be observed on average once in every 100 years. This water level is very close to the maximum water level ever recorded for the past 50 years that the dam has been in existence. The 100-year return period for the left tail is 234.03ft, though this is not the lowest ever recorded in

the past 50 years of the dam's existence, but it is very close to the minimum water level for the 47 years under study.

Table 4.12: Return period estimates for the fitted GP distribution

Right Tail					
Return Periods	5-year	10-year	20-year	50-year	100-year
Water level (ft.)	276.58	276.91	277.14	277.36	277.46
Left Tail					
Return Periods	5-year	10-year	20-year	50-year	100-year
Water level (ft.)	-243.27*	-234.17*	-234.10	-234.05	-234.03

(*) Values are interpreted in absolute terms

CHAPTER FIVE

DISCUSSION, CONCLUSION AND RECCOMENDATION

5.1 Discussion and Conclusions

This study sets out to investigate the extremes of the water levels of the Akosombo dam using Extreme Value Theory. We had three main objectives. This section of the chapter discusses the findings of the analysis and the answers, our findings provide to the objectives of the study and also the conclusion drawn from the study.

Two methods were considered in the analysis; these are the Block Maxima (BM) method and the Peak-Over Threshold method (POT). Parameter estimates of the various models were estimated via the ML estimation method. The study considered both the left and right tail distributions of the Akosombo water levels.

The Extreme Value Index (EVI) for the tails were obtained via the maxima blocks method and the peak-over-threshold method. The EVI determines the tail behaviour of the underlying distribution and the domain of attraction of the underlying distribution. Though, the EVIs were different for the tails, all were negative. The negativity of the EVI indicated that, the tail distribution of the Akosombo water levels belongs to the Weibull domain of attraction. In absolute terms the EVIs yielded by the maxima block method were smaller than that of the peak-over-threshold method. The EVI yielded by the maxima block method were all greater than -0.5, which meant, the usual asymptotic properties were satisfied by the model while those of the POT method were not all less than -0.5, an indication of failure of the model to meet the usual asymptotic properties in some cases. The parameter estimates for the models are provided in Tables 4.2a, 4.2b, 4.6, 4.8 and 4.9.

The diagnostic plots also indicated that, the model of the maxima block method, thus the GEV model, performs better than that of the POT, thus the GP model.

High dependence was observed within the exceedances, so we employed two different procedures proposed by Coles (2001) to handle the dependence in the exceedances. First the data were declustered and the maximum of each cluster was used to fit the GP distribution. This was done to weaken the dependence in the exceedances, so that the data would be relatively independent. With the second procedure, we ignored the dependence in the exceedances and assumed the data to be independent and then fitted the GP distribution to all the exceedances to obtain the estimates of the parameters. The standard errors for the parameter estimates obtained by this procedure were inflated to account for the reduction in information. The model of the latter procedure turns out to perform better than that of the former. Their diagnostic plots are shown by Figures 4.8 and 4.9.

The EVI also determines the upper bound for the tail distributions. The upper bound for the tail distribution is how high (in the case of the right) or how low (in the case of the left tail) the value of a random variable under investigation can attain. Inferring from the results obtained from the analyses carried out, the water level is bounded below by 226.69ft and bounded above by 279.07ft. This is the response to the first objective of the study

In addition, exceedance probabilities were estimated for some low water levels and high water levels of the Akosombo dam. The EVI is also a key determinant in the estimation of these probabilities. These probabilities provided information on the chances of the water levels falling below a certain minimum or rising above a certain maximum water level. It is impossible for the water levels to fall below the critical water level (226.00ft.) of the dam, since the probability of

observing such an extreme event is zero. The answer to the second objective of the study is provided by Tables 4.4 and 4.11.

Finally, we considered the extreme quantiles; the EVI again determines the extent of these extreme events. We expect the water level to fall below 233.80ft once every 100 years and also rise above 276.00ft once every 100 years. Tables 4.5 and 4.12 provided the answer to the third objective of the study.

We conclude by emphasizing that, the GEV distribution fitted the Akosombo water levels better than the GP distribution; this is evident from their diagnostic plots and their Extreme Value Index (EVI).

5.2 Recommendations

- Considering how easy, the water levels of the dam can drop below the minimum operating level, dependence on the dam for electricity supply should be reduced.
- Also, considering the fact that during certain periods, the water levels of the dam approach the maximum head operation level, the dam's reservoir should be extended to retain the excess water which is spilled out.
- Multivariate Extreme Value Analysis, which should include other factors which may influence the water levels of the dam, should be employed to further investigate this problem.
- We also propose Semi-parametric models or the Bayesian approach to carry out further investigation into this problem.

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APPENDICES

APPENDIX I

Computations

Introduction

All computations and graphics presented in this thesis were performed using the R statistical programming language. This section will provide information on the packages in R which were used and some R functions used. This section also contains information on the simulated result used to inflate the standard errors of the GP models.

Below is a brief description of some of the R functions used for modeling the data for either the block maxima method or threshold-over-exceedance method. This includes;

A. Packages used

Name of Package	Version
fBasics	3011.87
tseries	0.10-34
evd	2.3-0
evir	1.7-3
extRemes	2.0-4

B. A list of Some of the R functions used

pp.test: a function for finding the Phillips-Perron test for the null hypothesis that the data has a unit root. The alternative hypothesis for this test is that the data is stationary

adf.test: a function for finding the Augmented Dickey-Fuller test for the hypothesis that the data has a unit root test. The alternative hypothesis for this test is that the data is stationary.

mrlplot: a function for creating the mean residual life plot over increasing threshold.

gplot: a function for creating a QQ-plot for threshold data against the exponential distribution or the generalized Pareto distribution.

thresrange.plot: a function for finding an appropriate threshold for GP model by fitting it to a sequence of thresholds in order to find the lowest threshold that yields roughly the same parameter estimates as any higher threshold.

fevd: a function for fitting a univariate extreme value distribution functions (e.g. GEV, GP, PP, Gumbel or Exponential) to a data. It allows covariate models for the parameters. This function uses MLE, GMLE, Bayesian or L-moments methods for parameter estimation, however, the default method is the MLE. Its output can also be used as an input for the ***plot*** function to create diagnostic plots such as; qq-plot, pp-plot, density plot or return level plot of a fitted model.

fpot: a function for finding maximum likelihood estimators of the generalized Pareto distribution. The exceedances over threshold (if *cmax* is *FALSE*) or the maxima of the clusters of exceedances (if *cmax* is *TRUE*) are fitted to a GP distribution (if *model*=*"gpd"*). It allows any of the parameters to be held constant if desired.

pextRemes: a function for calculating probabilities from fitted extreme value distributions or draw random sample from them. It takes as input the output of the function ***fevd*** to calculate the probabilities.

rlevd: a function for finding the return levels for fitted extreme value distributions.

Confint: a function for computing confidence intervals for one or more parameters in a fitted model. The input object should be a fitted model (e.g GEV, GP, profile likelihood, etc).

profile: a function for finding the profile likelihood of parameters of a fitted model. The input object should be a fitted model.

Simulation Result

The negativity of the EVI indicates that, the distribution belongs to the Weibull domain of attraction.

Table 1-A: Parameter estimates of the simulated GP distribution; right tail

Parameter	Estimate	Standard error
Scale	0.8566	0.0945
shape	-0.5386	0.0819

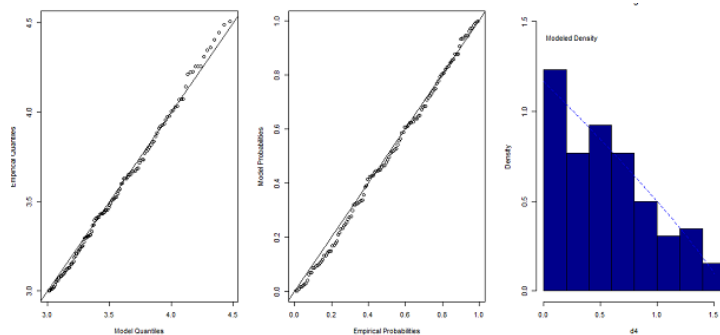


Figure 1-A: Diagnostic plots for the simulated GP distribution; right tail

Table 1-B: Parameter estimates of the simulated GP distribution; left tail

Parameter	Estimate	Standard error
Scale	0.3007	0.0334
shape	-0.6156	0.0851

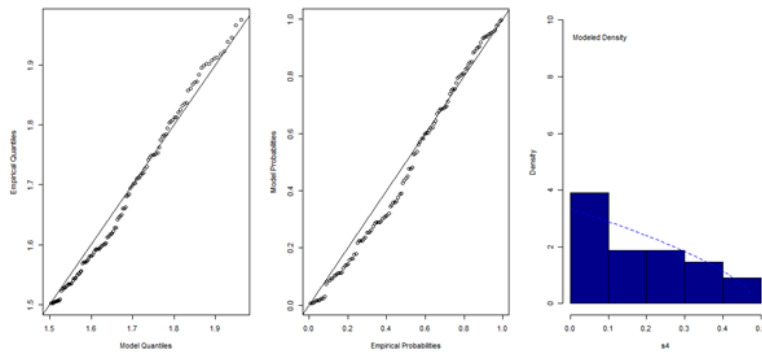


Figure 1-B: A diagnostic plot for the simulated GP distribution; left tail

APPENDIX II**Data****DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1966**

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	236.70	236.17	235.55	235.02	234.60	234.40	235.18	236.70	241.90	249.28	255.45	256.14
2	236.70	236.17	235.51	234.98	234.60	234.41	235.20	236.78	242.19	249.54	255.55	256.14
3	236.69	236.16	235.51	235.00	234.65	234.41	235.25	236.78	242.49	249.76	255.62	256.13
4	236.68	236.16	235.50	235.02	234.63	234.41	235.27	236.88	242.78	250.03	255.68	256.12
5	236.68	236.13	235.42	234.85	234.60	234.44	235.29	236.90	242.98	250.29	255.74	256.12
6	236.65	236.10	235.32	234.90	234.63	234.44	235.29	236.98	243.24	250.50	255.80	256.10
7	236.63	236.10	235.35	234.88	234.63	234.45	235.30	237.00	243.58	250.72	255.86	256.10
8	236.61	236.00	235.33	234.83	234.60	234.43	235.40	237.05	243.82	250.98	255.86	256.10
9	236.60	235.98	235.30	234.90	234.58	234.41	235.45	237.10	244.04	251.28	255.90	256.10
10	236.69	235.98	235.30	234.85	234.58	234.41	235.48	237.16	244.30	251.46	255.97	256.10
11	236.59	235.98	235.30	234.90	234.55	234.46	235.49	237.23	244.58	251.70	256.02	256.10
12	236.53	235.95	235.29	234.85	234.53	234.48	235.50	237.30	244.80	251.95	256.10	256.10
13	236.52	235.90	235.25	234.80	234.53	234.44	235.50	237.80	245.02	252.16	256.14	256.10
14	236.52	235.85	235.25	234.80	234.50	234.42	235.65	237.46	245.22	252.40	256.16	256.08
15	236.51	235.83	235.23	234.75	234.50	234.45	235.69	237.58	245.50	252.63	256.16	256.08
16	236.46	235.80	235.23	234.78	234.51	234.45	235.70	237.70	245.62	252.85	256.16	256.08
17	236.42	235.80	235.20	234.75	234.51	234.44	235.80	237.84	245.83	253.10	256.16	256.04
18	236.42	235.80	235.20	234.72	234.50	234.46	235.84	237.94	246.09	253.30	256.14	256.02
19	236.42	235.75	235.18	234.70	234.49	234.53	235.84	238.08	246.38	253.50	256.14	256.00
20	236.41	235.75	235.18	234.70	234.50	234.70	236.00	238.35	246.54	253.68	256.14	256.00
21	236.41	235.72	235.16	234.70	234.50	234.70	236.00	238.58	246.75	253.90	256.14	256.00
22	236.37	235.65	235.13	234.65	234.50	234.68	236.05	238.84	246.92	254.15	256.14	256.00
23	236.35	235.62	235.13	234.63	234.53	234.72	236.15	239.10	247.30	254.35	256.14	256.00
24	236.30	235.60	235.11	234.63	234.48	234.72	236.20	239.40	247.52	254.45	256.14	256.00
25	236.30	235.60	235.11	234.60	234.46	234.77	236.24	239.68	247.79	254.62	256.14	255.98
26	236.27	235.60	235.10	234.60	234.40	234.80	236.30	240.02	248.02	254.78	256.14	255.98
27	236.26	235.56	235.10	234.58	234.38	234.93	236.35	240.33	248.34	254.90	256.14	255.93
28	236.24	235.55	235.10	234.53	234.35	234.00	236.42	240.68	248.54	255.00	256.14	255.90
29	236.22		234.96	234.50	234.35	235.06	236.45	240.96	248.80	255.15	256.14	255.87
30	236.22		234.90	234.60	234.40	235.10	236.50	241.20	249.02	255.26	256.14	255.88
31	236.20		235.05		234.40		236.50	241.58		255.35		255.82

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1967

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	255.80	255.22	254.57	254.70	253.75	253.30	253.35	253.98	256.78	263.01	268.00	267.78
2	255.79	255.20	254.72	254.30	253.75	253.30	253.38	254.02	256.70	263.30	268.00	267.80
3	255.78	255.18	254.70	254.15	253.70	253.32	253.40	254.05	257.06	263.60	268.00	267.74
4	255.78	255.18	254.60	254.16	253.70	253.28	253.40	254.05	257.21	263.88	268.05	267.78
5	255.75	255.14	254.52	254.00	253.70	253.25	253.42	254.10	257.34	264.13	268.06	267.75
6	255.73	255.12	254.50	254.00	253.72	253.20	253.45	254.15	257.48	264.38	268.08	267.70
7	255.70	255.10	254.48	254.00	253.67	253.20	253.45	254.20	257.60	264.60	268.08	267.68
8	255.68	255.08	254.40	253.98	253.60	253.25	253.50	254.20	257.72	264.88	268.10	267.68
9	255.65	255.05	254.40	253.94	253.60	253.28	253.55	254.30	257.85	265.08	268.10	267.66
10	255.63	255.02	254.40	253.90	253.55	253.30	253.58	254.35	258.00	265.30	268.12	267.64
11	255.60	255.00	254.40	253.90	253.50	253.30	253.55	254.38	258.14	265.50	268.12	267.57
12	236.53	255.00	254.31	253.85	253.50	253.32	253.58	254.42	258.32	265.74	268.13	267.59
13	255.60	255.00	254.30	253.83	253.50	253.35	253.66	254.45	258.48	265.96	268.14	267.52
14	255.58	254.90	254.25	253.80	253.48	253.30	253.63	254.49	258.63	266.18	268.14	267.58
15	255.58	254.90	254.27	253.80	253.48	253.30	253.64	254.56	258.83	266.38	268.12	267.52
16	255.56	254.90	254.27	253.76	253.48	253.30	253.66	254.62	259.19	266.60	268.12	267.50
17	255.56	254.90	254.20	253.74	253.46	253.32	253.68	254.70	259.50	266.78	268.10	267.46
18	255.54	254.90	254.15	253.76	253.48	253.30	253.68	254.80	259.82	266.90	268.08	267.40
19	255.52	254.86	254.20	253.76	253.50	253.28	253.78	254.98	260.05	267.06	268.04	267.42
20	255.52	254.82	254.24	253.78	253.50	253.28	253.85	255.10	260.25	267.23	268.00	267.40
21	255.50	254.78	254.20	253.78	253.48	253.28	253.95	255.22	260.48	267.31	268.00	267.42
22	255.48	254.74	254.25	253.80	253.46	253.30	253.90	255.35	260.72	267.43	267.98	267.44
23	255.45	254.74	254.20	253.80	253.48	253.30	253.90	255.48	260.98	267.52	267.98	267.43
24	255.42	254.70	254.20	253.80	253.44	253.32	253.90	255.60	261.18	267.58	267.94	267.38
25	255.40	254.65	254.20	253.82	253.45	253.32	253.92	255.77	261.38	267.62	267.90	267.29
26	255.40	254.60	254.20	253.78	253.45	253.35	253.90	255.88	261.56	267.65	267.88	267.24
27	255.39	254.58	254.20	253.80	253.40	253.35	253.90	256.08	261.80	267.70	267.88	267.22
28	255.35	254.57	254.15	253.78	253.42	253.35	253.93	256.18	262.10	267.80	267.88	267.19
29	255.32		254.25	253.78	253.45	253.35	253.94	256.35	262.40	267.86	267.85	267.20
30	255.28		254.20	253.78	253.40	253.33	253.93	256.48	262.71	267.90	267.85	267.11
31	255.26		254.70		253.35		253.95	256.63		267.98		267.08

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1968

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	267.05	266.10	265.20	264.25	263.68	263.28	264.37	267.95	271.10	272.23	272.53	272.90
2	267.04	266.05	265.15	264.25	263.58	263.30	264.37	268.05	271.06	272.30	272.58	272.90
3	267.02	266.00	265.10	264.20	263.52	263.25	264.37	268.20	271.14	272.30	272.62	272.87
4	267.00	265.97	265.05	264.10	263.50	263.30	264.44	268.34	271.00	272.38	272.70	272.82
5	267.00	265.92	265.03	264.05	263.52	263.28	264.50	268.52	270.97	272.50	272.74	272.82
6	267.00	265.92	265.02	264.05	263.52	263.28	264.62	268.66	270.95	272.50	272.80	272.80
7	266.96	265.90	265.00	264.03	263.45	263.24	264.68	268.85	271.10	272.45	272.75	272.80
8	266.92	265.87	265.00	264.04	263.40	263.24	264.75	268.95	271.10	272.48	272.80	272.82
9	266.88	265.85	265.00	264.06	263.40	263.28	264.82	269.10	271.12	272.48	272.82	272.81
10	266.85	265.82	264.92	264.02	263.30	263.30	264.95	269.17	271.26	272.44	272.86	272.76
11	266.73	265.82	264.88	264.00	263.30	263.36	265.02	269.30	271.28	272.39	272.86	272.75
12	266.72	265.78	264.82	264.00	263.38	263.40	265.12	269.38	271.30	272.46	272.88	272.73
13	266.64	265.72	264.84	263.94	263.38	263.38	265.20	269.49	271.36	272.42	272.90	272.73
14	266.64	265.70	264.80	263.90	263.30	263.41	265.26	269.57	271.36	272.46	272.86	272.70
15	266.62	265.66	264.72	264.00	263.30	263.45	265.35	269.57	271.38	272.38	272.90	272.69
16	266.63	265.62	264.70	264.00	263.32	263.60	265.39	269.65	271.50	272.34	272.90	272.62
17	266.60	265.55	264.60	263.97	263.32	263.80	265.44	269.66	271.53	272.40	272.95	272.64
18	266.60	265.54	264.56	263.97	263.28	263.74	265.50	269.68	271.58	272.36	272.97	272.64
19	266.50	265.50	264.50	263.98	263.24	263.78	265.58	269.78	271.64	272.46	272.97	272.58
20	266.48	265.53	264.50	263.85	263.20	263.82	265.65	269.78	271.76	272.38	272.95	272.56
21	266.43	265.50	264.48	263.78	263.13	263.82	265.80	269.82	271.76	272.32	272.85	272.55
22	266.38	265.45	264.50	263.73	263.13	263.86	265.98	270.05	271.80	272.30	273.04	272.55
23	266.32	265.42	264.49	263.68	263.20	263.92	266.10	270.20	271.80	272.25	273.04	272.56
24	266.26	265.40	264.43	263.63	263.18	263.98	266.23	270.34	271.84	272.25	273.00	272.52
25	266.26	265.36	264.40	263.70	263.18	264.05	266.43	270.50	271.84	272.20	273.00	272.50
26	266.25	265.33	264.35	263.63	263.20	264.10	266.66	270.62	271.92	272.27	273.00	272.49
27	266.25	265.30	264.35	263.68	263.20	264.12	266.83	270.75	271.97	272.30	272.98	272.45
28	266.20	265.30	264.35	263.62	263.22	264.12	267.05	270.87	272.02	272.30	273.00	272.45
29	266.17	265.28	264.32	263.58	263.20	264.20	267.23	270.90	272.06	272.36	272.96	272.44
30	266.13		264.30	263.66	263.20	264.28	267.45	270.90	272.15	272.33	256.14	272.35
31	266.10		264.28		263.22		267.77	271.03		272.43		272.30

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1969

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	272.32	271.45	269.70	268.00	266.45	265.60	265.13	265.86	268.65	273.48	274.72	274.00
2	272.35	271.45	269.70	267.92	266.40	265.60	265.22	265.86	268.70	273.60	274.76	274.00
3	272.30	271.40	269.70	267.92	266.34	265.58	265.27	265.86	268.80	273.72	274.80	274.00
4	272.28	271.35	269.60	267.90	266.30	265.55	265.23	265.86	268.90	273.96	274.84	273.90
5	272.22	271.35	269.58	267.90	266.30	265.53	265.15	265.86	269.08	274.08	274.85	273.88
6	272.17	271.32	269.63	267.92	266.30	265.50	265.12	265.89	269.14	274.29	274.88	273.83
7	272.17	271.20	269.56	267.92	266.30	265.50	265.12	265.94	269.20	274.45	274.88	273.80
8	272.17	271.18	269.46	267.90	266.25	265.50	265.10	266.00	269.30	274.58	274.90	273.77
9	272.16	271.18	269.50	267.70	266.05	265.47	265.15	266.05	269.47	274.70	274.88	273.72
10	272.00	271.15	269.50	267.60	266.08	265.47	265.18	266.09	269.62	274.70	274.84	273.68
11	272.08	271.06	269.50	267.60	266.00	265.48	265.18	266.19	269.72	274.75	274.82	273.63
12	272.05	270.93	269.45	267.50	265.95	265.48	265.20	266.28	269.87	274.76	274.85	273.60
13	272.05	270.78	269.33	267.40	265.93	265.44	265.23	266.32	270.05	274.86	274.80	273.58
14	271.96	270.78	269.25	267.40	265.90	265.40	265.25	266.32	270.15	274.88	274.75	273.53
15	271.96	270.70	269.14	267.40	265.90	265.40	265.28	266.44	270.30	274.92	274.70	273.49
16	271.92	270.70	269.10	267.32	265.94	265.34	265.38	266.52	270.45	274.97	274.64	273.44
17	271.88	270.60	268.98	267.20	265.90	265.28	265.42	266.60	270.63	274.94	274.59	273.40
18	271.83	270.58	268.94	267.10	265.90	265.28	265.42	266.77	270.70	274.89	274.46	273.34
19	271.83	270.38	268.81	267.15	265.90	265.28	264.40	266.88	270.91	274.82	274.38	273.26
20	271.83	270.28	268.70	267.10	265.95	265.25	265.43	266.98	271.12	274.85	274.32	273.22
21	271.82	270.22	268.62	267.04	265.88	265.25	265.48	267.08	271.30	274.82	274.26	273.14
22	271.78	270.13	268.58	267.00	265.80	265.25	265.50	267.16	271.45	274.80	274.26	273.12
23	271.75	269.99	268.50	266.94	265.80	265.20	265.53	267.30	271.61	274.78	274.26	273.07
24	271.70	269.86	268.44	266.88	265.84	265.18	265.58	267.45	272.00	274.74	274.22	273.02
25	271.68	269.75	268.45	266.80	265.74	265.24	265.52	267.60	272.28	274.72	274.20	272.99
26	271.64	269.80	268.35	266.78	265.76	265.20	265.68	267.74	272.42	274.72	274.19	272.96
27	271.62	269.70	268.30	266.78	265.74	265.20	265.75	267.88	272.65	274.76	274.15	272.95
28	271.60	269.72	268.28	266.80	265.70	265.15	265.73	268.10	272.86	274.84	274.10	272.95
29	271.57		268.25	266.58	265.62	265.12	265.76	268.12	273.04	274.77	274.07	272.92
30	271.54		268.15	266.50	265.62	265.09	265.80	268.30	273.20	274.76	274.03	272.90
31	271.50		268.05		265.60		265.86	268.50		274.75		272.30

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1970

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	272.84	271.47	269.85	268.73	267.20	265.90	265.05	264.48	266.22	273.98	275.10	273.40
2	272.84	271.40	269.78	268.67	267.15	265.92	265.05	264.45	266.36	274.20	275.10	273.38
3	272.80	271.34	269.75	268.63	267.05	265.90	265.05	264.45	266.54	274.40	274.88	273.38
4	272.75	271.30	269.70	268.54	266.98	265.90	265.02	264.45	266.70	274.65	274.80	273.35
5	272.70	271.20	269.68	268.46	266.93	265.90	265.00	264.45	266.90	274.80	274.73	273.30
6	272.62	271.18	269.68	268.43	266.90	265.83	264.96	264.45	267.12	274.98	274.73	272.20
7	272.56	271.10	269.63	268.43	266.88	265.83	264.94	264.48	267.22	275.08	274.68	273.18
8	272.52	271.05	269.60	268.40	266.88	265.96	264.92	264.52	267.45	275.25	274.60	273.13
9	272.50	271.00	269.60	268.33	266.85	265.70	264.94	264.52	267.58	275.35	274.55	273.13
10	272.47	270.96	269.54	268.22	266.76	265.70	264.94	264.55	267.80	275.45	274.50	273.13
11	272.47	270.88	269.54	268.17	266.70	265.65	264.94	264.60	268.00	275.52	274.44	273.10
12	272.38	270.80	269.54	268.12	266.60	265.65	264.92	264.64	268.22	275.60	274.40	273.10
13	272.35	270.76	269.50	268.08	266.57	265.63	264.90	264.70	268.55	275.65	274.32	273.07
14	272.29	270.73	269.46	268.04	266.57	265.55	264.87	264.75	268.84	275.73	274.26	273.04
15	272.20	270.66	269.40	267.98	266.48	265.58	264.87	264.82	269.10	275.73	274.18	273.00
16	272.16	270.58	269.32	267.86	266.44	265.55	264.87	264.90	269.35	275.73	274.10	272.97
17	272.12	270.53	269.30	267.86	266.40	265.48	264.83	265.00	269.55	275.70	274.07	272.92
18	272.09	270.49	269.27	267.85	266.37	265.44	264.78	265.04	269.85	275.65	274.02	272.90
19	272.07	270.47	269.22	267.80	266.32	265.40	264.76	265.10	270.18	275.54	273.98	272.90
20	272.03	270.42	269.20	267.75	266.29	265.40	264.73	265.20	270.46	275.50	273.83	272.87
21	272.00	270.40	269.14	267.66	266.20	265.40	264.73	265.32	270.93	275.48	273.80	272.85
22	271.92	270.28	269.14	267.65	266.18	265.38	264.70	265.38	271.20	275.40	273.78	272.80
23	271.86	270.20	269.18	267.60	266.23	265.32	264.68	265.40	271.40	275.38	273.70	272.77
24	271.78	270.15	269.14	267.60	266.23	265.28	264.65	265.45	271.68	275.34	273.70	272.72
25	271.82	270.06	269.08	267.45	266.23	265.20	264.60	265.50	272.10	275.32	273.67	272.68
26	271.73	269.98	269.04	267.45	266.20	265.20	264.58	265.53	272.45	275.30	273.62	272.68
27	271.68	269.90	269.04	267.45	266.18	265.16	264.55	265.60	272.85	275.30	273.58	272.64
28	271.55	269.83	268.98	267.40	266.10	265.16	264.55	265.74	273.08	275.33	273.58	272.60
29	271.60		268.94	267.36	266.05	265.14	264.50	265.84	273.40	275.30	273.56	272.54
30	271.50		268.84	267.30	266.00	265.10	264.48	266.00	273.62	275.24	273.5	272.54
31	271.48		268.76		265.90		264.44	266.10		275.18		272.52

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1971

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	272.50	271.57	270.04	268.35	266.32	265.38	264.89	265.70	268.52	273.00	274.94	274.20
2	272.50	271.54	270.10	268.35	266.28	265.38	264.97	265.75	268.60	273.16	274.94	274.17
3	272.48	271.54	270.10	268.27	266.16	265.40	264.92	265.80	268.68	273.33	274.92	274.13
4	272.48	271.44	270.02	268.20	266.16	265.35	264.95	265.88	268.72	273.42	274.90	274.10
5	272.44	271.38	270.02	268.10	266.14	265.35	265.00	265.93	268.77	273.54	274.90	274.10
6	272.44	271.34	270.00	267.95	266.10	265.35	265.00	266.00	268.87	273.70	274.90	274.04
7	272.42	271.22	269.97	267.88	266.04	265.30	265.00	266.14	268.95	273.80	274.86	274.04
8	272.40	271.14	269.87	267.78	266.00	265.26	265.00	266.20	269.02	273.90	274.82	274.00
9	272.36	271.08	269.87	267.66	266.00	265.22	265.00	266.27	269.14	274.00	274.82	273.98
10	272.36	271.04	269.80	267.60	266.00	265.22	265.05	266.33	269.30	274.12	274.78	273.93
11	272.24	271.02	269.80	267.55	266.00	265.16	265.10	266.44	269.48	274.22	274.72	273.90
12	272.22	270.97	269.77	267.50	265.96	265.16	265.10	266.53	269.75	274.38	274.70	273.90
13	272.18	270.97	269.77	267.42	265.96	265.20	265.10	266.60	269.98	274.46	274.67	273.88
14	272.12	270.90	269.74	267.35	265.96	265.15	265.10	266.68	270.15	274.52	274.67	273.88
15	272.12	270.84	269.60	267.28	265.92	265.10	265.05	266.75	270.30	274.55	274.62	273.88
16	272.12	270.84	269.54	267.20	265.88	265.10	265.05	266.80	270.50	274.55	274.60	273.85
17	272.07	270.78	269.44	267.06	265.85	265.05	265.09	267.00	270.72	274.63	274.57	273.83
18	272.00	270.70	269.36	266.95	265.85	265.00	265.18	267.20	270.96	274.68	274.54	273.80
19	272.00	270.58	269.28	266.87	265.85	264.98	265.25	267.42	271.10	274.78	274.50	273.76
20	271.98	270.48	269.25	266.80	265.75	264.94	265.30	267.55	271.26	274.83	274.50	273.73
21	271.94	270.35	269.12	266.70	265.75	264.92	265.36	267.75	271.40	274.85	274.50	273.65
22	271.88	270.28	269.05	266.62	265.72	264.92	265.40	267.94	271.60	274.85	274.45	273.65
23	271.88	270.18	269.00	266.50	265.72	264.96	265.44	268.05	271.84	274.90	274.42	273.60
24	271.88	270.18	268.92	266.50	265.72	265.02	265.50	268.12	271.92	274.95	274.40	273.60
25	271.83	270.15	268.80	266.50	265.70	265.02	265.50	268.25	272.10	274.95	274.34	273.55
26	271.78	270.20	268.73	266.45	265.64	265.00	265.50	268.30	272.30	274.95	274.30	273.53
27	271.74	270.26	268.60	266.45	265.64	265.05	265.56	268.30	272.42	274.98	274.27	273.50
28	271.72	270.22	268.56	266.45	265.58	265.00	265.56	268.35	272.60	274.98	274.28	273.46
29	271.67		268.56	266.42	265.55	264.95	265.62	268.35	272.78	274.98	274.28	273.40
30	271.63		268.50	266.38	265.52	264.93	265.68	268.40	272.90	274.98	274.23	273.34
31	271.63		268.40				265.75	268.45		274.98		273.30

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1972

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	273.30	272.30	271.28	270.35	268.84	267.80	267.55	267.70	268.08	270.68	272.50	271.76
2	273.30	272.27	271.28	270.35	268.70	267.85	267.50	267.67	268.10	270.72	272.48	271.74
3	273.23	272.27	271.28	270.35	268.62	267.85	267.50	267.65	268.17	270.76	272.44	271.68
4	273.20	272.22	271.28	270.35	268.30	267.85	267.64	267.65	268.33	270.78	272.40	271.62
5	273.12	272.20	271.22	270.35	268.30	267.90	267.43	267.67	268.35	270.88	272.38	271.55
6	273.05	272.16	271.18	270.37	268.30	267.90	267.43	267.65	268.38	270.92	272.38	271.55
7	273.05	272.10	270.98	270.37	268.26	267.85	267.40	267.67	268.48	270.94	272.38	271.50
8	273.05	272.10	270.98	270.37	268.16	267.85	267.37	267.67	268.60	271.02	272.38	271.48
9	273.02	272.08	270.98	270.30	268.10	267.80	267.40	267.67	268.80	271.10	272.40	271.40
10	273.00	272.00	270.98	270.25	268.00	267.80	267.40	267.67	268.90	271.20	272.40	271.40
11	273.00	271.96	270.95	270.16	268.00	267.80	267.45	267.70	268.93	271.25	272.30	271.38
12	272.96	271.94	270.90	270.06	267.88	267.80	267.45	267.68	269.05	271.33	272.30	271.34
13	272.90	271.90	270.90	269.97	267.82	267.80	267.45	267.68	269.16	271.40	272.30	271.32
14	272.90	271.90	270.87	269.91	267.78	267.82	267.40	267.64	269.33	271.50	272.28	271.28
15	272.87	271.84	270.84	269.84	267.78	267.80	267.40	267.64	269.42	271.54	272.23	271.22
16	272.84	271.80	270.82	269.80	267.78	267.77	267.44	267.55	269.52	271.60	272.20	271.17
17	272.84	271.77	270.72	269.80	267.80	267.77	267.44	267.58	269.62	271.70	272.15	271.12
18	272.80	271.75	270.72	269.76	267.80	267.80	267.44	267.58	269.68	271.84	272.13	271.07
19	272.77	271.75	270.70	269.70	267.70	267.75	267.47	267.60	269.80	271.84	272.10	271.00
20	272.75	271.67	270.70	269.64	267.70	267.65	267.47	267.55	270.05	271.95	272.10	270.90
21	272.75	271.62	270.70	269.55	267.67	267.65	267.44	267.55	270.13	272.00	272.05	270.84
22	272.70	271.58	270.64	269.50	267.70	267.68	267.44	267.60	270.20	272.04	272.05	270.84
23	272.65	271.52	270.52	269.40	267.70	267.68	267.44	267.64	270.30	272.13	272.02	270.84
24	272.58	271.50	270.50	269.28	267.74	267.70	267.52	267.64	270.33	272.16	272.00	270.80
25	272.52	271.50	270.50	269.14	267.64	267.65	267.50	267.70	270.35	272.20	271.92	270.75
26	272.50	271.45	270.46	269.02	267.70	267.65	267.54	267.75	270.40	272.30	271.88	270.75
27	272.50	271.45	270.46	269.00	267.70	267.65	267.54	267.80	270.48	272.40	271.85	270.75
28	272.45	271.35	270.40	268.92	267.75	267.62	267.62	267.90	270.55	272.42	271.82	270.72
29	272.40		270.35	268.92	267.78	267.60	267.67	268.00	270.57	272.42	271.82	270.68
30	272.36		270.30	268.88	267.84	267.58	267.70	268.00	270.65	272.48	271.76	270.62
31	272.30		270.30		267.84		267.70	268.05		272.50		270.60

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1973

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	270.60	269.35	268.10	266.90	265.70	264.42	263.94	263.60	266.50	271.02	272.35	271.45
2	270.55	269.28	268.10	266.90	265.60	264.42	263.98	263.60	266.64	271.10	272.35	271.40
3	270.50	269.22	268.05	266.76	265.60	264.42	263.98	263.60	266.80	271.20	272.35	271.30
4	270.50	269.20	268.00	266.70	265.60	264.40	263.98	263.65	267.00	271.40	272.32	271.27
5	270.48	269.14	268.00	266.58	265.55	264.40	263.94	263.68	267.24	271.52	272.30	270.20
6	270.40	269.09	268.00	266.58	265.55	264.40	263.94	263.80	267.34	271.62	272.30	271.15
7	270.34	269.07	268.00	266.50	265.50	264.40	263.94	263.93	267.55	271.75	272.25	271.12
8	270.34	269.04	267.90	266.50	265.35	264.40	263.90	264.10	267.70	271.82	272.22	271.08
9	270.34	269.04	267.85	266.50	265.35	264.30	263.90	264.20	267.88	271.86	272.20	271.05
10	270.30	268.98	267.78	266.46	265.25	264.30	263.86	264.32	268.08	272.00	272.20	271.00
11	270.27	268.92	267.70	266.40	265.25	264.30	263.86	264.40	268.15	272.12	272.17	270.94
12	270.27	268.86	267.65	266.30	265.20	264.28	263.84	264.46	268.32	272.22	272.13	270.90
13	270.20	268.83	267.58	266.30	265.15	264.28	263.88	264.50	268.50	272.28	272.10	270.90
14	270.14	268.75	267.45	266.20	265.10	264.25	263.88	264.60	268.70	272.32	272.05	270.85
15	270.08	268.70	267.40	266.20	265.07	264.25	263.90	264.70	268.90	272.32	272.00	270.82
16	270.05	268.66	267.40	266.16	265.05	264.25	263.90	264.82	269.08	272.32	272.00	270.80
17	270.00	268.63	267.40	266.16	265.00	264.20	263.90	264.86	269.20	272.32	271.95	270.70
18	270.00	268.60	267.30	266.10	265.00	264.12	263.86	264.90	269.40	272.32	271.90	270.66
19	269.92	268.60	267.25	266.10	265.00	264.10	263.86	264.95	269.50	272.32	271.87	270.60
20	269.90	268.57	267.25	266.10	264.90	264.00	263.84	265.15	269.58	272.30	271.84	270.57
21	269.80	268.52	267.15	266.00	264.85	264.00	263.75	265.18	269.70	272.25	271.80	270.50
22	269.79	268.48	267.15	265.95	264.83	263.92	263.75	265.28	269.88	272.25	271.74	270.44
23	269.75	268.48	267.10	265.95	264.83	263.92	263.63	265.50	270.10	272.30	271.70	270.39
24	269.70	268.42	267.10	265.95	264.83	263.90	263.70	265.58	270.20	272.30	271.65	270.36
25	269.64	268.35	267.10	265.90	264.78	263.90	263.67	265.70	270.30	272.30	271.65	270.32
26	269.60	268.32	267.08	265.86	264.72	263.90	263.67	265.85	270.42	272.30	271.65	270.30
27	269.59	268.25	267.08	265.84	264.70	263.90	263.65	265.97	270.50	272.35	271.60	270.26
28	269.52	268.19	267.00	265.80	264.60	263.90	263.58	266.10	270.64	272.35	271.60	270.20
29	269.49		267.00	265.80	264.55	263.90	263.58	266.22	270.84	272.32	271.50	270.17
30	269.45		267.00	265.80	264.50	263.94	263.60	266.30	270.95	272.35	271.5	270.17
31	269.42		266.90		264.45		263.55	266.35		272.35		270.12

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1974

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	270.10	268.17	267.34	266.10	264.64	263.46	262.65	263.03	265.15	272.28	276.40	275.66
2	270.07	268.65	267.30	266.05	264.60	263.44	262.60	263.09	265.28	272.58	276.40	275.64
3	270.00	268.60	267.28	266.00	264.57	263.40	262.53	263.18	265.50	272.80	276.32	275.60
4	269.96	268.56	267.24	265.90	264.52	263.37	262.49	263.22	265.62	273.10	276.32	275.60
5	269.92	268.50	267.16	265.80	264.49	263.35	262.45	263.30	265.78	273.36	276.32	275.56
6	269.85	268.46	267.08	265.69	264.49	263.35	262.43	263.33	266.04	273.55	276.28	275.50
7	269.83	268.42	267.02	265.69	264.49	263.35	262.40	263.36	266.20	273.80	276.30	275.45
8	269.83	268.37	266.98	265.67	264.49	263.35	262.40	263.43	266.58	274.00	276.24	275.42
9	269.78	268.30	266.90	265.63	264.47	263.32	262.37	263.46	266.88	274.20	276.22	275.35
10	269.75	268.27	266.84	265.58	264.47	263.30	262.37	263.46	267.06	274.40	276.20	275.35
11	269.72	268.25	266.80	265.50	264.47	263.30	262.34	263.50	267.32	274.70	276.20	275.27
12	269.68	268.22	266.78	265.50	264.40	263.27	262.30	263.58	267.65	274.90	276.20	275.24
13	269.60	268.22	266.78	265.55	264.33	263.20	262.26	263.65	267.92	275.05	276.17	275.20
14	269.54	268.17	266.72	265.47	264.29	263.10	262.26	263.69	268.20	275.18	276.14	275.16
15	269.50	268.08	266.70	265.42	264.23	263.10	262.30	263.76	268.45	275.38	276.12	275.10
16	269.47	268.00	266.70	265.30	264.19	263.05	262.35	263.84	268.65	275.54	276.10	275.04
17	269.40	267.90	266.66	265.25	264.11	263.05	262.39	263.89	268.90	275.70	276.10	275.02
18	269.33	267.88	266.60	265.18	264.02	263.05	262.39	264.00	269.10	275.80	276.06	275.00
19	269.22	267.88	266.52	265.18	263.98	263.05	262.45	264.08	269.40	275.84	276.04	274.95
20	269.18	267.88	266.48	265.10	263.98	263.00	262.50	264.12	269.60	275.84	276.04	274.90
21	269.16	267.80	266.42	265.12	263.95	263.00	262.57	264.18	269.90	275.95	276.00	274.86
22	269.13	267.70	266.40	265.08	263.95	262.98	262.59	264.30	270.08	276.03	275.98	274.84
23	269.10	267.65	266.36	265.00	263.95	262.95	262.63	264.35	270.42	276.06	275.96	274.82
24	269.08	267.63	266.34	264.96	263.93	262.88	262.63	264.40	270.58	276.08	275.95	274.79
25	269.02	267.63	266.30	264.89	263.87	262.88	262.63	264.47	270.80	276.24	275.90	274.74
26	269.00	267.54	266.28	264.81	263.85	262.84	262.60	264.53	271.05	276.28	275.87	274.72
27	268.95	267.48	266.25	264.78	263.78	262.78	262.68	264.60	270.25	276.30	275.85	274.69
28	269.90	267.40	266.20	264.75	263.75	262.75	262.74	264.70	271.48	276.28	275.81	274.65
29	268.84		266.19	264.73	263.66	262.75	262.87	264.85	271.75	276.28	275.79	274.65
30	268.77		266.15	264.68	263.55	262.70	262.92	264.95	272.05	276.28	275.75	274.58
31	268.70		266.12		263.48		262.98	265.10		276.28		

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1975

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	273.70	272.38	271.15	269.78	268.70	267.50	267.50	266.94	266.90	267.03	269.52	271.00
2	273.65	272.32	271.10	269.80	268.66	267.50	267.43	266.90	266.80	267.20	269.65	270.98
3	273.55	272.28	271.03	269.70	268.58	267.50	267.40	266.90	266.80	267.38	269.80	270.90
4	273.53	272.22	270.95	269.62	268.52	267.48	267.40	266.85	266.80	268.40	269.85	270.84
5	273.53	272.15	270.90	269.60	268.52	267.42	267.38	266.82	266.74	267.42	269.95	270.80
6	273.49	272.10	270.87	269.50	268.50	267.42	267.32	266.80	266.80	267.45	270.10	270.76
7	273.49	272.10	270.84	269.48	268.50	267.35	267.28	266.78	266.85	267.45	270.25	270.70
8	273.43	272.08	270.82	269.40	268.47	267.30	267.24	266.75	266.85	267.50	270.40	270.66
9	273.40	272.02	270.74	269.34	268.40	267.25	267.14	266.75	266.80	267.50	270.50	270.60
10	273.34	271.98	270.66	269.34	268.30	267.23	267.14	266.73	266.83	267.55	270.60	270.60
11	273.30	271.90	270.66	269.32	268.23	267.23	267.16	266.70	266.79	267.58	270.70	270.60
12	273.30	271.88	270.68	269.32	268.20	267.30	267.12	266.70	266.74	267.60	270.80	270.55
13	273.27	271.82	270.66	269.25	268.20	267.30	267.12	266.70	266.74	267.60	270.85	270.55
14	273.20	271.76	270.56	269.13	268.20	267.30	267.05	266.68	266.80	267.60	270.85	270.50
15	273.16	271.72	270.50	269.13	268.15	267.28	267.05	266.70	266.85	267.65	270.90	270.45
16	273.10	271.70	270.47	269.13	268.08	267.28	267.02	266.70	266.80	267.80	271.00	270.40
17	273.05	271.70	270.44	269.13	268.02	267.28	267.02	266.72	266.74	267.83	271.00	270.32
18	273.00	271.64	270.44	269.13	268.02	267.32	267.02	266.75	266.82	267.90	271.00	270.30
19	272.90	271.58	270.44	269.10	267.92	267.38	267.02	266.75	266.75	268.00	271.00	270.25
20	272.88	271.56	270.40	269.10	267.90	267.38	267.05	266.70	266.78	268.05	271.00	270.25
21	272.88	271.56	270.33	268.92	267.83	267.40	267.10	266.73	266.82	268.10	271.00	270.20
22	272.88	271.52	270.29	268.90	267.80	267.35	267.05	266.75	266.76	268.25	271.00	270.16
23	272.83	271.45	270.22	268.88	267.80	267.35	267.00	266.75	266.76	268.40	271.00	270.12
24	272.78	271.40	270.15	268.85	267.80	267.35	267.00	266.78	266.78	268.52	271.00	270.10
25	272.72	271.30	270.08	268.85	267.80	267.40	267.00	266.78	266.78	268.65	271.00	270.05
26	272.60	271.30	270.00	268.85	267.75	267.40	267.05	266.80	266.80	268.75	271.00	270.05
27	272.53	271.30	269.95	268.83	267.70	267.40	267.00	266.80	266.90	268.82	271.00	270.00
28	272.50	271.28	269.90	268.83	267.68	267.43	266.98	266.80	267.05	268.95	271.00	269.96
29	272.48	271.23	269.88	268.77	267.65	267.48	266.96	266.83	267.03	269.15	271.00	269.92
30	272.38		269.88	268.70	267.60	267.50	266.94	266.90	267.05	269.25	271	269.86
31	272.38		269.84		267.52		266.94	266.90		269.38		269.86

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1976

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	274.50	273.21	271.93	270.70	269.68	268.80	267.83	268.90	270.32	273.40	275.60	274.90
2	274.45	273.20	271.90	270.64	269.60	268.72	267.78	268.95	270.38	273.58	275.62	274.80
3	274.40	273.13	271.88	270.56	269.55	268.67	267.73	269.00	270.45	273.68	275.62	274.72
4	274.37	272.98	271.84	270.49	269.52	268.60	267.73	269.05	270.48	273.75	275.62	274.70
5	274.32	272.85	271.77	270.47	269.52	268.52	267.73	269.10	270.52	273.94	275.60	274.70
6	274.29	272.78	271.70	270.40	269.50	268.48	267.77	269.15	270.60	274.10	275.55	274.68
7	274.22	272.75	271.63	270.40	269.50	268.42	267.80	269.25	270.65	274.25	275.50	274.65
8	274.19	272.73	271.56	270.40	269.43	268.40	267.80	269.32	270.70	274.34	275.46	274.62
9	274.13	272.73	271.54	270.38	269.38	268.40	267.84	269.44	270.73	274.48	275.46	274.59
10	274.06	272.70	271.48	270.34	269.38	268.45	267.84	269.50	270.80	274.70	275.40	274.58
11	274.03	272.67	271.44	270.32	269.33	268.48	267.86	269.54	270.88	274.83	275.40	274.58
12	274.00	272.63	271.40	270.29	269.30	268.48	267.90	269.60	270.90	274.94	275.40	274.52
13	273.98	272.59	271.34	270.26	269.30	268.40	267.90	269.70	270.98	275.02	275.35	274.49
14	273.96	272.55	271.30	270.26	269.28	268.40	267.98	269.73	271.04	275.12	275.30	274.44
15	273.92	272.50	271.25	270.24	269.25	268.35	268.02	269.82	271.20	275.20	275.27	274.40
16	273.90	272.48	271.20	270.18	269.25	268.30	268.10	269.88	271.32	275.23	275.22	274.32
17	273.85	272.48	271.18	270.12	269.18	268.27	268.20	269.94	271.48	275.25	275.22	274.30
18	273.80	272.46	271.14	270.09	269.18	268.23	268.28	269.94	271.50	275.52	275.22	274.25
19	273.77	272.44	271.08	270.04	269.13	268.18	268.35	269.94	271.66	275.40	275.18	274.20
20	273.72	272.40	271.03	270.02	269.07	268.13	268.40	270.05	271.80	275.48	275.10	274.13
21	273.69	272.35	271.00	269.95	269.03	268.10	268.43	270.13	271.90	275.52	275.10	274.13
22	273.65	272.28	271.00	269.95	268.97	268.10	268.48	270.18	272.02	275.55	275.08	274.13
23	273.58	272.20	271.00	269.93	268.95	268.10	268.53	270.22	272.20	275.55	275.04	274.08
24	273.48	272.15	270.00	269.88	268.92	268.10	268.55	270.24	272.25	275.60	275.00	274.00
25	273.42	272.07	270.89	269.85	268.90	268.05	268.55	270.26	272.40	275.60	274.96	273.96
26	273.38	272.00	270.86	269.83	268.87	268.00	268.58	270.28	272.75	275.63	275.00	273.93
27	273.33	271.96	270.84	269.78	268.75	267.95	268.60	270.28	272.78	275.63	274.97	273.88
28	273.30	271.93	270.84	269.78	268.80	267.90	268.63	270.28	272.88	275.68	274.90	273.84
29	273.30		270.78	269.76	268.78	267.83	268.70	270.28	273.05	275.68	274.87	273.84
30	273.30		270.78	269.74	268.82	267.83	268.80	270.30	273.23	275.68	274.87	273.80
31	273.24		270.70		268.82		268.80	270.32		275.64		273.77

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1977

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	269.80	268.55	267.22	265.53	264.05	262.62	261.38	260.50	260.50	264.10	265.65	264.34
2	269.70	268.48	267.15	265.53	264.00	262.62	261.35	260.50	260.55	264.30	265.60	264.30
3	269.70	268.80	267.15	265.50	264.00	262.60	261.35	260.40	260.55	264.40	265.60	264.25
4	269.62	268.40	267.13	265.40	263.95	262.56	261.30	260.40	260.60	264.50	265.60	264.20
5	269.62	268.44	267.10	265.35	263.85	262.50	261.28	260.40	260.75	264.58	265.52	264.12
6	269.62	268.44	267.05	265.25	263.75	262.40	261.24	260.40	260.80	264.65	265.50	264.05
7	269.58	268.40	267.00	265.25	263.70	262.36	261.15	260.40	260.90	264.90	265.45	264.00
8	269.58	268.35	266.90	265.15	263.75	262.33	261.08	260.35	260.92	264.90	265.40	264.00
9	269.55	268.30	266.80	265.10	263.70	262.30	261.00	260.30	261.00	265.00	265.36	263.90
10	269.50	268.20	266.74	265.00	263.65	262.20	261.00	260.30	261.10	265.10	265.30	263.80
11	269.45	268.10	266.70	265.00	263.60	262.15	261.00	260.30	261.20	265.25	265.20	263.80
12	269.38	268.05	266.65	264.90	263.55	262.10	260.97	260.20	261.35	265.30	265.20	263.80
13	269.32	268.00	266.60	264.80	263.45	262.05	260.95	260.20	261.45	265.45	265.20	263.73
14	269.28	268.00	266.50	264.78	263.38	262.05	260.95	260.20	261.60	265.50	265.12	263.65
15	269.25	267.90	266.40	264.70	263.35	262.00	260.90	260.20	261.75	265.50	265.12	263.65
16	269.20	267.88	266.30	264.70	263.30	261.94	260.90	260.20	262.00	265.55	265.05	263.55
17	269.12	267.84	266.25	264.60	263.25	261.80	260.82	260.20	262.15	265.60	264.98	263.50
18	269.12	267.84	266.25	264.60	263.25	261.75	260.80	260.12	262.35	265.70	264.92	263.46
19	269.04	267.75	266.20	264.60	263.20	261.82	260.80	260.12	262.40	265.70	264.90	263.40
20	268.96	267.70	266.15	264.60	263.15	261.82	260.80	260.12	262.55	265.70	264.84	263.35
21	268.90	267.65	266.10	264.60	263.08	261.90	260.78	260.12	262.70	265.70	264.78	263.33
22	268.90	267.55	266.08	264.50	263.00	261.80	260.70	260.12	262.80	265.70	264.70	263.26
23	268.90	267.55	266.00	264.40	262.96	261.65	260.65	260.12	263.00	265.80	264.67	263.24
24	268.90	267.50	265.98	264.40	262.90	261.65	260.65	260.12	263.10	265.80	264.62	263.20
25	268.84	267.40	265.90	264.40	262.85	261.60	260.65	260.12	263.20	265.80	264.55	263.15
26	268.80	267.40	265.86	264.35	262.78	261.60	260.58	260.15	263.45	265.80	264.50	263.15
27	268.76	267.40	265.80	264.30	262.75	261.56	260.56	260.15	263.60	265.80	264.50	263.08
28	268.76	267.35	265.70	264.20	262.70	261.56	260.50	260.22	263.70	265.80	264.45	263.00
29	268.70		265.60	264.10	262.67	261.45	260.50	260.30	263.85	265.75	264.40	262.90
30	268.62		265.56	264.10	262.65	261.41	260.50	260.35	264.00	265.70	264.38	262.80
31	268.62		265.53		262.65		260.50	260.45		265.70		262.77

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1978

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	262.75	261.03	259.40	257.70	256.40	255.75	255.90	256.52	257.35	259.40	261.15	260.75
2	262.70	261.03	259.35	257.60	256.35	255.80	255.85	256.55	257.40	259.60	261.15	260.75
3	262.60	260.95	259.35	257.60	256.35	255.83	255.80	256.60	257.42	259.70	261.24	260.70
4	262.55	260.84	259.30	257.60	256.30	255.83	255.80	256.60	257.48	259.75	261.28	260.65
5	262.50	260.80	259.20	257.60	256.25	255.80	255.80	256.65	257.58	259.75	261.30	260.60
6	262.47	260.70	259.20	257.50	256.25	255.75	255.80	256.65	257.70	259.80	261.38	260.55
7	262.40	260.70	259.20	257.40	256.20	255.82	255.80	256.65	257.74	259.90	261.42	260.50
8	262.30	260.70	259.20	257.40	256.20	255.90	255.80	256.68	257.80	259.90	261.44	260.45
9	262.27	260.60	259.00	257.40	256.15	255.90	255.80	256.73	257.86	259.95	261.44	260.40
10	262.25	260.50	258.90	257.30	256.10	255.94	255.88	256.75	257.91	259.95	261.51	260.40
11	262.20	260.40	258.87	257.18	256.10	255.94	255.90	256.78	257.94	260.15	261.51	260.35
12	262.10	260.50	258.85	257.18	256.10	255.98	255.86	256.78	257.98	260.25	261.44	260.30
13	262.05	260.40	258.78	257.18	256.10	256.00	255.80	256.78	258.10	260.30	261.41	260.25
14	261.98	260.30	258.78	257.10	256.10	256.02	255.80	256.78	258.20	260.30	261.39	260.20
15	261.90	260.25	258.70	257.10	256.10	256.10	255.80	256.78	258.20	260.45	261.39	260.15
16	261.85	260.15	258.65	257.00	256.05	256.10	255.88	256.80	258.20	260.50	261.35	260.05
17	261.80	260.10	258.50	257.00	256.05	256.00	255.85	256.80	258.25	260.60	261.35	260.05
18	261.75	259.95	258.42	256.90	256.05	256.00	255.90	256.86	258.28	260.60	261.32	259.98
19	261.73	259.90	258.40	256.80	256.00	256.00	255.90	256.91	258.40	260.60	261.24	259.90
20	261.70	259.90	258.37	256.75	255.95	256.00	256.00	256.91	258.50	260.60	261.24	259.80
21	261.65	259.82	258.30	256.60	255.95	256.00	256.15	256.94	258.58	260.65	261.17	259.80
22	261.58	259.82	258.20	256.60	255.95	256.03	256.15	256.94	258.60	260.65	261.14	259.80
23	261.50	259.75	258.20	256.60	255.95	256.03	256.10	256.94	258.67	260.65	261.14	259.70
24	261.47	259.75	258.15	256.60	255.95	256.05	256.20	257.00	258.80	260.65	261.14	259.65
25	261.40	259.60	258.10	256.60	255.90	256.05	256.30	257.05	258.90	260.68	261.09	259.63
26	261.35	259.60	258.00	256.55	255.90	256.02	256.30	257.05	259.05	260.68	261.00	259.60
27	261.30	259.50	258.00	256.50	255.85	256.02	256.30	257.07	259.15	260.90	260.94	259.55
28	261.25	271.23	257.88	256.50	255.85	256.02	256.35	257.15	259.22	260.90	260.94	259.50
29	261.20		257.88	256.45	255.80	256.00	256.40	257.18	259.30	260.90	260.86	259.48
30	261.15		257.80	256.45	255.75	256.00	256.40	257.20	259.40	261.05	260.82	259.48
31	261.08		257.75		255.75		256.50	257.25		261.08		259.42

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1979

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	259.38	257.90	256.30	254.50	252.95	251.50	251.45	255.40	259.80	266.30	269.85	269.13
2	259.33	257.90	256.18	254.50	252.84	251.45	254.45	255.60	259.86	266.60	269.88	269.13
3	259.30	257.80	256.18	254.50	252.84	251.45	251.45	255.80	260.10	266.90	269.90	269.10
4	259.25	257.70	256.00	254.45	252.80	251.45	254.45	256.00	260.40	267.35	269.90	269.10
5	259.20	257.60	256.00	254.40	252.72	251.45	254.50	256.21	260.55	267.65	269.96	269.05
6	259.15	257.60	256.00	254.35	252.72	251.45	251.60	256.39	260.70	267.90	270.02	269.02
7	259.15	257.50	255.95	254.25	252.59	251.45	251.60	256.50	260.90	268.05	269.90	268.95
8	259.10	257.50	255.85	254.15	252.59	251.40	251.60	256.70	261.20	268.25	269.86	268.95
9	259.03	257.40	255.80	254.05	252.49	250.40	251.65	256.88	261.40	268.41	269.86	269.25
10	258.98	257.30	255.68	254.05	252.44	250.40	251.70	257.00	261.66	267.60	269.82	269.25
11	258.90	257.25	255.60	253.95	252.41	251.35	251.70	257.05	261.95	268.68	269.80	269.15
12	258.85	257.20	255.60	253.85	252.41	251.30	251.80	257.20	262.22	268.85	269.78	269.05
13	258.80	257.10	255.60	253.80	252.34	251.30	251.85	257.25	262.32	268.93	269.77	269.00
14	258.80	257.10	255.48	253.75	252.26	251.30	251.95	257.30	262.50	269.10	269.75	269.00
15	258.72	257.10	255.38	253.72	252.26	251.25	252.05	257.40	262.80	269.15	269.70	268.90
16	258.68	257.00	255.38	253.65	252.22	251.25	252.15	257.50	263.05	269.20	269.67	268.85
17	258.60	256.90	255.32	253.65	252.22	251.25	252.23	257.50	263.13	269.20	269.67	268.80
18	258.60	256.90	255.20	253.60	252.18	251.20	252.30	257.70	263.40	269.30	269.61	268.76
19	258.56	256.90	255.20	253.60	252.15	251.20	252.40	257.79	263.60	269.40	269.59	268.70
20	258.50	256.85	255.10	253.50	252.10	251.20	252.55	257.94	263.90	269.50	269.56	268.65
21	258.45	256.70	255.00	253.35	251.95	251.20	252.70	258.05	264.10	269.55	269.52	268.65
22	258.40	256.60	255.00	253.30	251.95	251.20	252.80	258.20	264.36	269.55	269.48	268.60
23	258.36	256.50	254.95	253.20	251.90	251.20	253.04	258.43	264.60	269.57	269.43	268.60
24	258.30	256.50	254.85	253.20	251.84	251.25	253.40	258.50	264.80	269.57	269.40	268.50
25	258.22	256.50	254.85	253.10	251.74	251.30	253.70	258.71	265.00	269.57	269.35	268.50
26	258.18	256.50	254.85	253.10	251.74	251.35	254.00	258.87	265.30	269.60	269.30	268.40
27	258.13	256.40	254.80	253.10	251.74	251.35	254.10	259.00	265.40	269.65	269.24	268.35
28	258.03	256.40	254.75	253.10	251.68	251.40	254.45	259.14	265.50	269.65	269.24	268.30
29	257.97		254.65	252.95	251.60	251.40	254.70	259.25	265.78	269.68	269.20	268.30
30	257.90		254.55	252.95	251.60	251.43	254.90	259.40	266.10	269.74	269.18	268.25
31	257.90		254.50		251.56		255.10	257.25		269.80		268.20

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1980

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	268.10	265.64	264.12	262.10	260.48	259.00	257.75	256.90	259.35	265.85	268.00	267.33
2	268.02	265.60	264.01	262.10	260.45	259.00	257.70	256.90	259.57	266.04	268.03	267.30
3	268.00	265.58	263.92	262.10	260.42	259.00	257.55	256.90	259.70	266.15	268.08	267.20
4	267.90	265.53	263.85	262.05	260.42	258.95	257.50	256.96	259.80	266.35	268.12	267.15
5	267.90	265.50	263.85	262.00	260.35	259.90	257.50	256.96	259.95	266.50	268.12	267.10
6	267.80	265.45	263.70	262.00	260.28	259.85	257.55	256.92	260.15	266.60	268.15	267.10
7	267.73	265.40	263.70	261.90	260.20	258.90	257.55	256.90	260.40	266.75	268.18	267.05
8	267.70	265.33	263.64	261.80	260.12	258.77	257.50	256.87	260.60	266.75	268.18	266.90
9	267.65	265.20	263.60	261.80	260.08	258.70	257.40	256.95	260.79	267.00	268.10	266.90
10	267.65	265.10	263.50	261.70	260.00	258.70	257.40	257.04	261.02	267.05	268.06	266.80
11	267.52	265.00	263.42	261.65	259.95	258.70	257.34	257.12	261.21	267.12	268.06	266.80
12	267.45	265.00	263.40	261.60	259.95	258.65	257.25	257.18	261.55	267.15	268.00	266.75
13	267.40	264.98	263.25	261.60	259.89	258.65	257.25	257.25	261.80	267.15	267.90	266.73
14	267.40	264.90	263.20	261.50	259.80	258.65	257.20	257.30	262.05	267.24	267.87	266.70
15	267.35	264.90	263.20	261.40	259.72	258.55	257.10	257.37	262.30	267.24	267.87	266.65
16	267.35	264.80	263.04	261.35	259.72	258.50	257.10	257.50	262.57	267.32	267.85	266.59
17	267.30	264.80	263.04	261.30	259.72	258.50	257.00	257.65	262.75	267.32	267.80	266.55
18	267.20	264.70	263.00	261.22	259.70	258.45	257.00	257.74	262.99	267.32	267.80	266.45
19	267.20	264.70	262.90	261.15	259.64	258.40	256.96	257.80	263.25	267.55	267.75	266.45
20	267.10	264.65	262.90	261.08	259.55	258.40	256.90	257.84	263.45	267.55	267.75	266.36
21	267.00	264.57	262.80	261.03	259.48	258.30	256.90	257.96	263.86	267.60	267.70	266.30
22	266.30	264.52	262.75	260.98	259.45	258.20	256.85	258.13	264.17	267.62	267.70	266.20
23	266.15	264.48	262.70	260.90	259.38	258.20	256.95	258.24	264.35	267.68	267.67	266.15
24	266.10	264.40	262.70	260.80	259.35	258.20	256.90	258.31	264.55	267.80	267.65	266.10
25	266.05	264.30	262.60	260.70	259.30	258.20	256.90	258.44	264.79	267.82	267.60	265.97
26	265.95	264.30	262.52	260.70	259.22	258.10	257.00	258.52	265.10	267.74	267.56	265.94
27	265.95	264.20	262.40	260.70	259.18	258.00	257.00	258.64	265.20	267.95	267.50	265.94
28	265.90	264.12	262.40	260.60	259.16	257.95	256.90	258.78	265.40	267.95	267.45	265.85
29	265.80	271.23	262.40	260.60	259.14	257.85	256.96	258.84	265.50	267.90	267.40	265.73
30	265.75		262.30	252.95	259.10	251.43	256.96	258.98	266.10	268.00	269.18	265.65
31	257.90		254.50		251.56		255.10	257.25		269.80		268.20

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1981

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	265.60	263.90	262.30	260.55	258.70	257.40	255.95	255.75	257.90	260.60	261.08	259.75
2	265.60	263.85	262.20	260.48	258.70	257.30	255.95	255.76	258.00	260.70	261.08	259.70
3	265.54	263.80	262.13	260.45	258.75	257.25	255.91	255.76	258.05	260.70	261.08	259.70
4	265.50	263.70	262.08	260.40	258.75	257.20	255.85	256.00	258.05	260.75	261.05	259.64
5	265.45	263.65	262.00	260.30	258.70	257.10	255.85	256.10	258.20	260.92	261.00	259.54
6	265.40	263.60	262.00	260.25	258.65	257.00	256.00	256.25	258.26	260.97	260.95	259.50
7	265.34	263.58	262.00	260.18	258.65	256.95	255.90	256.25	258.38	260.97	260.90	259.40
8	265.28	263.50	261.90	260.10	258.52	256.95	255.87	256.35	258.53	260.97	260.84	259.38
9	265.20	263.45	261.80	260.00	258.50	256.95	255.87	256.35	258.53	261.10	260.80	259.36
10	265.13	263.40	261.70	259.94	258.42	256.80	255.84	256.42	258.60	261.10	260.80	259.32
11	265.06	263.37	261.70	259.90	258.40	256.80	255.75	256.50	258.74	261.10	260.70	259.25
12	265.00	263.30	261.68	259.80	258.40	256.70	255.75	256.52	258.83	261.25	260.70	259.18
13	264.96	263.20	261.68	259.80	258.35	256.65	255.75	256.60	258.92	261.25	260.70	259.10
14	264.90	263.15	261.60	259.70	258.25	256.60	255.75	256.65	259.00	261.30	260.63	259.10
15	264.88	263.09	261.60	259.65	258.20	256.60	255.75	256.75	259.05	261.30	260.63	259.08
16	264.80	263.00	261.50	259.57	258.20	256.50	255.70	256.80	259.15	261.32	260.55	259.00
17	264.76	262.96	261.38	259.50	258.10	256.40	255.70	256.84	259.34	261.32	260.51	258.95
18	264.76	262.88	261.30	259.40	258.05	256.40	255.70	256.86	259.45	261.32	260.45	258.95
19	264.67	262.80	261.24	259.40	258.00	256.40	255.70	257.10	259.50	261.32	260.35	258.92
20	264.62	262.74	261.15	259.46	258.00	256.30	255.65	257.10	259.60	261.32	260.35	258.90
21	264.58	262.70	261.15	259.40	258.00	256.30	255.74	257.10	259.65	261.32	260.30	258.82
22	264.50	262.67	261.13	259.30	257.90	256.30	255.74	257.20	259.84	261.32	260.30	258.78
23	264.45	262.67	261.06	259.30	257.90	256.30	255.70	257.30	259.90	261.32	260.20	258.75
24	264.40	262.60	260.96	259.25	257.84	256.25	255.70	257.40	260.04	261.25	260.20	258.70
25	264.36	262.54	260.90	259.20	257.80	256.20	255.62	257.40	260.05	261.20	260.10	258.64
26	264.28	262.48	260.90	259.10	257.70	256.08	255.62	257.44	260.20	261.25	260.04	258.55
27	264.24	262.40	260.80	259.10	257.70	256.08	255.70	257.62	260.25	261.25	259.94	258.48
28	264.24	262.37	260.75	259.00	257.65	256.02	255.74	257.62	260.35	261.25	259.94	258.45
29	264.20		260.65	258.90	257.55	256.02	255.70	257.70	260.40	261.20	259.84	258.38
30	264.10		260.60	258.85	257.45	255.95	255.70	257.80	260.50	261.15	259.8	258.35
31	264.00		260.60		257.45		255.70	257.90		261.15		258.30

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1982

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	258.30	256.50	254.95	253.10	251.40	250.20	248.84	247.90	247.58	249.30	249.50	248.44
2	258.24	256.45	254.85	253.00	251.40	250.10	248.80	247.85	247.58	249.34	249.40	248.38
3	258.18	256.35	254.80	253.00	251.35	250.00	248.80	247.80	248.52	249.38	249.45	248.40
4	258.14	256.25	254.80	252.90	251.30	249.85	248.76	247.77	247.60	249.45	249.40	248.30
5	258.10	256.20	254.72	252.90	251.25	249.80	248.70	247.73	247.60	249.45	249.40	248.25
6	257.98	256.18	254.65	252.80	251.20	249.74	248.70	247.73	247.72	249.45	249.40	248.25
7	257.96	256.10	254.55	252.80	251.20	249.70	248.70	247.73	247.80	249.54	249.30	248.25
8	257.90	256.05	254.45	252.75	251.15	249.72	248.67	247.68	247.80	249.58	249.30	248.20
9	257.85	256.05	254.40	252.65	251.15	249.58	248.67	247.65	247.85	249.58	249.30	248.20
10	257.78	256.00	254.35	252.60	251.10	249.58	248.60	247.62	247.90	249.60	249.25	248.10
11	257.70	255.90	254.30	252.55	251.00	249.58	248.60	247.55	247.95	249.70	249.25	247.97
12	257.65	255.80	254.30	252.50	250.95	249.55	248.60	247.55	248.00	249.70	249.25	247.95
13	257.60	255.70	254.25	252.42	250.86	249.50	248.56	247.50	248.10	249.70	249.20	247.90
14	257.52	255.62	254.15	252.35	250.80	249.42	248.50	247.50	248.15	249.70	249.20	247.90
15	257.48	255.62	254.15	252.30	250.80	249.38	248.47	247.50	248.25	249.75	249.16	247.80
16	257.42	255.52	254.10	252.30	250.75	249.30	248.42	247.50	248.40	249.80	249.12	247.72
17	257.38	255.52	254.10	252.25	250.70	249.20	248.35	247.50	248.48	249.80	249.12	247.68
18	257.25	255.45	254.02	252.25	250.70	249.20	248.35	247.53	248.51	249.80	249.12	247.65
19	257.25	255.45	253.90	252.18	250.60	249.15	248.35	247.62	248.60	249.80	249.08	247.58
20	257.18	255.42	253.80	252.10	250.60	249.15	248.35	247.55	248.70	249.75	249.00	247.53
21	257.18	255.38	253.80	252.00	250.60	249.10	248.30	247.50	248.72	249.75	248.96	247.48
22	257.15	255.30	253.75	251.90	250.50	249.10	248.27	247.50	248.85	249.70	248.90	247.42
23	257.15	255.30	253.75	252.85	250.46	249.10	248.27	247.47	248.88	249.67	248.87	247.38
24	257.00	255.16	253.70	251.80	250.46	249.05	248.25	247.47	248.95	249.65	248.82	247.34
25	256.95	255.10	253.60	251.75	250.40	249.10	248.20	247.47	249.02	249.60	248.78	247.30
26	256.90	255.05	253.50	251.75	250.38	249.00	248.17	247.40	249.10	249.60	248.70	247.30
27	256.80	255.05	253.45	251.70	250.38	248.94	248.12	247.35	249.10	249.58	248.70	247.25
28	256.75	254.95	253.45	251.60	250.38	248.94	248.08	247.30	249.15	249.58	248.65	247.20
29	256.65		253.30	251.50	250.30	248.90	248.03	247.30	249.18	249.50	248.60	247.15
30	256.60		253.30	251.50	250.30	248.87	247.97	247.45	249.25	249.50	248.52	247.10
31	256.55		253.25		250.25		247.90	247.53		249.50		247.05

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1983

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	247.00	245.30	243.94	242.33	241.05	239.89	239.59	239.67	239.91	241.54	241.32	240.35
2	246.96	245.25	243.88	242.29	241.00	239.84	239.54	239.69	239.89	241.58	241.28	240.35
3	246.90	245.18	243.88	242.26	240.97	239.84	239.54	239.66	239.94	241.60	241.22	240.35
4	246.90	245.12	243.82	242.26	240.94	239.84	239.54	239.66	239.96	241.64	241.22	240.35
5	246.85	245.00	243.74	242.20	240.89	239.84	239.54	239.66	239.99	241.73	241.18	240.31
6	246.78	244.96	243.67	242.15	240.84	239.79	239.54	239.70	240.14	241.78	241.15	240.27
7	246.75	244.94	243.60	242.08	240.78	239.74	239.60	239.70	240.14	241.78	241.12	240.22
8	246.75	244.88	243.50	242.05	240.72	239.69	239.64	239.70	240.16	241.74	241.08	240.20
9	246.70	244.82	243.48	241.98	240.69	239.69	239.64	239.74	240.19	241.74	241.04	240.17
10	246.55	244.75	243.42	241.98	240.64	239.69	239.64	239.74	240.19	241.74	241.00	240.11
11	246.50	244.70	243.39	241.98	240.63	239.69	239.61	239.74	240.19	241.74	240.97	240.06
12	246.40	244.66	243.32	241.94	240.56	239.69	239.59	239.70	240.25	241.74	240.94	240.06
13	246.35	244.62	243.28	241.88	240.51	239.69	239.59	239.70	240.36	241.70	240.94	240.06
14	246.30	244.58	243.22	241.83	240.44	239.64	239.64	239.67	240.41	241.79	240.89	240.06
15	246.20	244.50	243.18	241.78	240.44	239.60	239.64	239.64	240.49	241.79	240.87	240.02
16	246.20	244.47	243.10	241.72	240.44	239.60	239.64	239.64	240.49	241.75	240.85	240.02
17	246.10	244.43	243.05	241.65	240.44	239.54	239.69	239.60	240.49	241.72	240.85	239.97
18	246.10	244.38	243.00	241.60	240.39	239.54	239.69	239.60	240.56	241.72	240.82	239.94
19	246.05	244.30	242.95	241.58	240.32	239.54	239.69	239.64	240.64	241.70	240.78	239.94
20	246.00	244.27	242.88	241.58	240.29	239.59	239.69	239.69	240.67	241.68	240.76	239.89
21	245.95	244.22	242.83	241.54	240.24	239.71	239.72	239.74	240.74	241.66	240.72	239.84
22	245.87	244.20	242.76	241.52	240.18	239.71	239.69	239.79	240.79	241.62	240.67	239.80
23	245.83	244.16	242.73	241.40	240.12	239.64	239.69	239.84	241.04	241.60	240.62	239.80
24	245.80	244.10	242.68	241.35	240.09	239.60	239.69	239.89	241.08	241.60	240.57	239.80
25	245.76	244.04	242.62	241.32	240.04	239.66	239.69	239.89	241.14	241.56	240.54	239.80
26	245.73	244.00	242.58	241.28	240.02	239.66	239.73	239.89	241.19	241.54	240.49	239.80
27	245.65	244.00	242.48	241.23	240.00	239.69	239.76	239.89	241.21	241.44	240.45	239.76
28	245.60	243.97	242.45	241.23	240.00	239.69	239.76	239.89	241.30	241.44	240.43	239.74
29	245.53		242.40	241.18	239.98	239.64	239.74	239.91	241.40	241.38	240.39	239.69
30	245.45		242.37	241.14	239.94	239.59	239.69	239.94	241.44	241.38	240.39	239.64
31	245.37		242.35		239.92		239.67	239.94		241.35		239.62

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1984

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	239.59	251.22	249.55	247.72	245.92	244.24	243.00	242.16	246.10	254.62	257.53	256.33
2	239.54	251.18	249.50	247.64	245.88	244.20	242.93	242.16	246.40	254.76	257.53	256.27
3	239.54	251.12	249.44	247.60	245.82	244.14	242.88	242.14	246.58	254.95	257.50	256.27
4	239.50	251.04	249.40	247.57	245.77	244.10	242.82	242.22	246.92	255.10	257.50	256.22
5	239.48	251.00	249.34	247.53	245.69	244.04	242.78	242.28	247.32	255.17	257.42	256.16
6	239.45	250.94	249.28	247.45	245.62	243.97	242.72	242.32	247.60	255.33	257.40	256.12
7	239.40	250.90	249.88	247.39	245.60	243.93	242.65	242.35	248.02	255.55	257.38	256.10
8	239.40	250.84	249.15	247.32	245.52	243.90	242.63	242.40	248.32	255.62	257.33	256.06
9	239.37	250.80	249.08	247.25	245.47	243.83	242.63	242.50	248.63	255.70	257.30	256.00
10	239.34	250.73	249.00	247.20	245.42	243.76	242.63	242.54	248.95	255.85	257.28	255.98
11	239.29	250.66	248.95	247.12	245.34	243.70	242.63	242.66	249.24	256.03	257.24	255.94
12	239.24	250.60	248.90	247.04	245.30	243.68	242.59	242.70	249.58	256.24	257.18	255.88
13	239.19	250.52	248.83	246.97	245.24	243.64	242.53	242.75	249.80	256.40	257.13	255.80
14	239.19	250.48	248.75	246.90	245.16	243.60	242.49	242.82	249.96	256.50	257.11	255.78
15	239.15	250.42	248.67	246.82	245.10	243.55	242.44	242.88	250.40	256.54	257.08	255.73
16	239.15	250.38	248.63	246.78	245.02	243.48	242.42	242.98	250.68	256.58	257.05	255.68
17	239.14	250.30	248.60	246.70	244.96	243.40	242.42	243.22	251.00	256.88	257.00	255.64
18	239.14	250.24	248.53	246.66	244.90	243.37	242.38	243.27	251.24	257.00	256.95	255.62
19	239.12	250.18	248.48	246.62	244.85	243.30	242.34	243.42	251.55	257.10	256.90	255.56
20	239.08	250.10	248.42	246.59	244.80	243.25	242.29	243.57	251.78	257.15	256.88	255.50
21	239.08	250.02	248.38	246.54	244.74	243.22	242.25	243.65	252.10	257.30	256.84	255.44
22	239.05	249.96	248.34	246.50	244.70	243.20	242.25	243.75	252.40	257.33	256.78	255.42
23	239.05	249.88	248.28	246.42	244.64	243.20	242.20	244.00	252.73	257.38	256.75	255.40
24	239.01	249.82	248.20	246.34	244.60	243.18	242.14	244.20	253.00	257.45	256.69	255.33
25	238.96	249.76	248.13	246.29	244.52	243.14	242.14	244.32	253.31	257.45	256.63	255.28
26	238.90	249.70	248.05	246.24	244.48	243.10	242.16	244.54	253.52	257.50	256.58	255.22
27	238.84	249.62	247.98	246.16	244.43	243.10	242.20	244.72	253.80	257.53	256.52	255.18
28	238.76	249.58	247.90	246.10	244.40	243.10	242.22	244.93	254.02	257.53	256.47	255.13
29	238.76		247.88	246.04	244.36	243.08	242.22	245.20	254.20	257.53	256.43	255.10
30	238.70		247.83	246.00	244.32	243.05	242.16	245.52	254.41	257.53	256.36	255.04
31	238.63		247.79		244.30		242.16	245.83		257.53		254.97

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1985

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	246.37	245.17	244.03	242.85	241.65	240.37	239.42	241.52	247.84	256.45	259.64	258.92
2	246.33	245.17	244.00	242.85	241.65	240.37	239.42	241.60	248.08	256.60	259.64	258.90
3	246.28	245.14	243.93	242.80	241.62	240.35	239.50	241.70	248.30	256.90	259.68	258.90
4	246.20	245.12	243.80	242.75	241.58	240.20	239.52	241.79	248.55	257.20	259.65	258.85
5	246.13	245.07	243.74	242.70	241.52	240.16	239.52	241.82	248.95	257.40	259.62	258.82
6	246.13	245.00	243.70	242.67	241.47	240.08	239.52	242.00	249.20	257.60	259.62	258.80
7	246.09	244.94	243.65	242.65	241.47	239.94	239.52	242.28	249.50	257.80	259.60	258.75
8	246.01	244.94	243.62	242.60	241.42	239.92	239.54	242.32	249.75	258.05	259.55	258.70
9	245.98	244.92	243.60	242.54	241.42	239.89	239.57	242.42	250.10	258.20	259.53	258.60
10	245.93	244.86	243.57	242.50	241.36	239.87	239.60	242.64	250.34	258.40	259.53	258.60
11	245.93	244.82	243.57	242.48	241.30	239.87	239.70	242.84	250.60	258.60	259.53	258.54
12	245.93	244.75	243.53	242.48	241.25	239.84	239.77	243.03	250.97	258.82	259.48	258.50
13	245.90	244.72	243.48	242.42	241.20	239.84	239.82	243.18	251.20	259.00	259.48	258.50
14	245.84	244.67	243.48	242.37	241.14	239.80	239.90	243.30	251.50	259.10	259.46	258.47
15	245.80	244.63	243.46	242.32	241.08	239.76	240.10	243.58	251.98	259.20	259.40	258.45
16	245.80	244.55	243.46	242.26	241.03	239.71	240.15	243.84	252.30	259.25	259.37	258.42
17	245.80	244.48	243.44	242.24	241.00	239.65	240.22	243.98	252.55	259.40	259.32	258.37
18	245.80	244.43	243.40	242.19	240.97	239.65	240.30	244.40	252.90	259.45	259.30	258.30
19	245.73	244.43	243.35	242.13	240.97	239.65	240.42	244.70	253.25	259.45	259.30	258.25
20	245.68	244.38	243.32	242.10	240.95	239.65	240.57	245.00	253.46	259.48	259.25	258.20
21	245.64	244.32	243.26	242.04	240.95	239.62	240.65	245.18	253.82	259.58	259.20	258.14
22	245.57	244.28	243.22	242.00	240.90	239.57	240.65	245.48	254.10	259.60	259.16	258.10
23	245.50	244.23	243.20	241.94	240.85	239.52	240.72	245.70	254.37	259.60	259.12	258.05
24	245.45	244.23	243.15	241.90	240.82	239.50	240.78	246.00	254.77	259.68	259.12	258.00
25	245.42	244.17	243.10	241.87	240.77	239.44	240.85	246.24	254.98	259.68	259.12	257.97
26	245.37	244.12	243.06	241.83	240.71	239.50	240.88	246.50	255.28	259.68	259.10	257.95
27	245.37	244.12	243.02	241.83	240.65	239.44	240.94	246.75	255.48	259.65	259.04	257.90
28	245.33	244.08	243.00	241.78	240.59	239.38	241.05	246.95	255.70	259.65	259.00	257.87
29	245.29		242.96	241.74	240.57	239.42	241.10	247.20	256.00	259.65	259.00	257.82
30	245.29		242.92	241.70	240.51		241.40	247.32	256.30	259.62	258.85	257.80
31	245.24		242.87		240.45		241.45	247.56		259.62		257.78

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1986

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	257.72	256.26	255.08	253.77	252.48	251.30	250.15	249.24	249.92	253.45	255.15	254.40
2	257.65	256.22	255.04	253.76	252.48	251.25	250.09	249.22	250.00	253.55	255.20	254.38
3	257.63	256.20	255.00	253.72	252.48	251.16	250.05	249.28	250.10	253.68	255.15	254.34
4	257.60	256.13	254.94	253.70	252.46	251.15	250.03	249.24	250.20	254.08	255.10	254.28
5	257.56	256.10	254.90	253.65	252.48	251.10	250.03	249.21	250.28	254.14	255.08	254.25
6	257.50	256.05	254.84	253.62	252.38	251.00	250.03	249.21	250.28	254.18	255.10	254.18
7	257.50	255.97	254.78	253.58	252.28	250.97	250.03	249.30	250.40	254.20	255.10	254.15
8	257.45	255.95	254.76	253.55	252.35	250.00	250.00	249.35	250.40	254.33	255.10	254.12
9	257.39	255.95	254.72	253.50	252.28	250.90	249.96	249.35	250.60	254.42	255.10	254.06
10	257.34	255.91	254.70	253.48	252.22	250.85	249.94	249.35	250.80	254.60	255.10	254.00
11	257.30	255.85	254.69	253.46	252.22	250.80	249.94	249.31	250.90	254.66	255.12	253.93
12	257.28	255.82	254.66	253.42	252.22	250.80	249.90	249.35	251.10	254.75	255.10	253.85
13	257.26	255.80	254.60	253.40	252.16	250.75	249.85	249.35	251.18	254.80	255.12	253.75
14	257.23	255.74	254.54	253.36	252.08	250.75	249.85	249.35	251.35	254.86	255.10	253.70
15	257.18	255.67	254.48	253.34	252.05	250.75	249.80	249.40	251.50	254.97	255.08	253.68
16	257.13	255.63	254.44	253.20	252.05	250.70	249.74	249.42	251.65	255.02	255.02	253.68
17	257.07	255.57	254.42	253.10	252.00	250.66	249.70	249.42	251.80	255.04	254.98	253.64
18	257.00	255.51	254.40	253.05	251.93	250.60	249.66	249.42	251.92	255.04	254.92	253.58
19	256.95	255.49	254.38	253.02	251.90	250.55	249.60	249.42	252.00	255.12	254.86	253.54
20	256.90	255.44	254.32	253.00	251.83	250.48	249.58	249.42	252.10	255.20	254.82	253.50
21	256.87	255.38	254.28	252.92	251.73	250.46	249.54	249.42	252.24	255.22	254.77	253.47
22	256.82	255.34	254.22	252.90	251.73	250.44	249.60	249.42	252.42	255.15	254.74	253.40
23	256.70	255.28	254.16	252.87	251.65	250.44	249.66	249.42	252.46	255.15	254.72	253.32
24	256.68	255.26	254.10	252.82	251.65	250.40	249.62	249.48	252.54	255.15	254.70	253.27
25	256.65	255.22	254.06	252.78	251.65	250.40	249.58	249.65	252.60	255.15	254.65	253.22
26	256.58	255.20	254.00	252.75	251.53	250.35	249.52	249.65	252.74	255.15	254.60	253.18
27	256.52	255.13	253.98	252.73	251.52	250.35	249.47	249.65	252.96	255.13	254.54	253.16
28	256.48	255.10	253.95	252.70	251.50	250.30	249.38	249.65	253.04	255.10	254.50	253.12
29	256.42		253.90	252.60	251.45	250.25	249.35	249.70	253.20	255.10	254.50	253.04
30	256.36		253.84	252.55	251.35	250.20	249.32	249.80	253.30	255.10	254.44	252.98
31	256.30		253.79		251.30		249.30	249.86		255.15		252.93

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1987

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	252.88	251.22	249.55	247.72	245.92	244.24	243.00	242.16	246.10	254.62	257.53	256.33
2	252.82	251.18	249.50	247.64	245.88	244.20	242.93	242.16	246.40	254.76	257.53	256.27
3	252.75	251.12	249.44	247.60	245.82	244.14	242.88	242.14	246.58	254.95	257.50	256.27
4	252.70	251.04	249.40	247.57	245.77	244.10	242.82	242.22	246.92	255.10	257.50	256.22
5	252.64	251.00	249.34	247.53	245.69	244.04	242.78	242.28	247.32	255.17	257.42	256.16
6	252.58	250.94	249.28	247.45	245.62	243.97	242.72	242.32	247.60	255.33	257.40	256.12
7	252.52	250.90	249.88	247.39	245.60	243.93	242.65	242.35	248.02	255.55	257.38	256.10
8	252.50	250.84	249.15	247.32	245.52	243.90	242.63	242.40	248.32	255.62	257.33	256.06
9	252.48	250.80	249.08	247.25	245.47	243.83	242.63	242.50	248.63	255.70	257.30	256.00
10	252.40	250.73	249.00	247.20	245.42	243.76	242.63	242.54	248.95	255.85	257.28	255.98
11	252.35	250.66	248.95	247.12	245.34	243.70	242.63	242.66	249.24	256.03	257.24	255.94
12	252.30	250.60	248.90	247.04	245.30	243.68	242.59	242.70	249.58	256.24	257.18	255.88
13	252.28	250.52	248.83	246.97	245.24	243.64	242.53	242.75	249.80	256.40	257.13	255.80
14	252.20	250.48	248.75	246.90	245.16	243.60	242.49	242.82	249.96	256.50	257.11	255.78
15	252.15	250.42	248.67	246.82	245.10	243.55	242.44	242.88	250.40	256.54	257.08	255.73
16	252.08	250.38	248.63	246.78	245.02	243.48	242.42	242.98	250.68	256.58	257.05	255.68
17	252.00	250.30	248.60	246.70	244.96	243.40	242.42	243.22	251.00	256.88	257.00	255.64
18	251.94	250.24	248.53	246.66	244.90	243.37	242.38	243.27	251.24	257.00	256.95	255.62
19	251.90	250.18	248.48	246.62	244.85	243.30	242.34	243.42	251.55	257.10	256.90	255.56
20	251.86	250.10	248.42	246.59	244.80	243.25	242.29	243.57	251.78	257.15	256.88	255.50
21	251.82	250.02	248.38	246.54	244.74	243.22	242.25	243.65	252.10	257.30	256.84	255.44
22	251.78	249.96	248.34	246.50	244.70	243.20	242.25	243.75	252.40	257.33	256.78	255.42
23	251.72	249.88	248.28	246.42	244.64	243.20	242.20	244.00	252.73	257.38	256.75	255.40
24	251.68	249.82	248.20	246.34	244.60	243.18	242.14	244.20	253.00	257.45	256.69	255.33
25	251.62	249.76	248.13	246.29	244.52	243.14	242.14	244.32	253.31	257.45	256.63	255.28
26	251.55	249.70	248.05	246.24	244.48	243.10	242.16	244.54	253.52	257.50	256.58	255.22
27	251.50	249.62	247.98	246.16	244.43	243.10	242.20	244.72	253.80	257.53	256.52	255.18
28	251.44	249.58	247.90	246.10	244.40	243.10	242.22	244.93	254.02	257.53	256.47	255.13
29	251.40		247.88	246.04	244.36	243.08	242.22	245.20	254.20	257.53	256.43	255.10
30	251.35		247.83	246.00	244.32	243.05	242.16	245.52	254.41	257.53	256.36	255.04
31	251.28		247.79		244.30		242.16	245.83		257.53		254.97

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1988

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	254.93	253.24	251.52	249.74	248.05	246.31	245.06	246.17	249.00	257.62	260.80	259.68
2	254.88	253.18	251.50	249.68	247.96	246.28	245.06	246.24	249.17	257.90	260.77	259.66
3	254.80	253.10	251.48	249.65	247.88	246.23	245.06	246.24	249.35	258.02	260.75	259.62
4	254.76	253.06	251.46	249.63	247.80	246.17	245.10	246.30	249.58	258.45	260.75	259.57
5	254.68	252.98	251.40	249.57	247.75	246.13	245.10	246.36	249.82	258.73	260.72	259.54
6	254.62	252.92	251.32	249.53	247.73	246.10	245.06	246.46	250.03	258.97	260.70	259.50
7	254.55	252.88	251.28	249.45	247.70	246.04	245.02	246.48	250.30	259.14	260.70	259.47
8	254.50	252.80	251.22	249.39	247.65	245.97	245.02	246.55	250.61	259.40	260.64	259.44
9	254.42	252.78	251.18	249.34	247.58	245.93	245.02	246.62	250.88	259.58	260.60	259.38
10	254.40	252.75	251.10	249.28	247.50	245.90	245.06	246.66	251.08	259.70	260.57	259.35
11	254.34	252.72	251.02	249.25	247.42	245.85	245.20	246.68	251.30	259.90	260.53	259.32
12	254.30	252.69	250.97	249.17	247.34	245.82	245.25	246.68	251.60	260.02	260.50	259.27
13	254.22	252.62	250.90	249.09	247.27	245.77	245.32	246.68	251.94	260.20	260.46	259.24
14	254.16	252.55	250.82	249.05	247.22	245.70	245.37	246.68	252.10	260.33	260.44	259.20
15	254.12	252.47	250.77	248.98	247.18	245.65	245.37	246.70	252.28	260.44	260.42	259.16
16	254.05	252.40	250.70	248.94	247.14	245.62	245.37	246.80	252.53	260.54	260.38	259.13
17	253.98	252.32	250.64	248.88	247.10	245.65	245.42	246.90	253.02	260.60	260.34	259.08
18	253.90	252.24	250.50	248.84	247.02	245.62	245.46	246.98	253.35	260.68	260.30	259.03
19	253.86	252.21	250.50	248.80	246.94	245.60	245.54	247.00	253.77	260.72	260.65	258.98
20	253.80	252.18	250.45	248.77	246.86	245.56	245.62	247.16	254.00	260.78	260.22	258.93
21	253.77	252.10	250.42	248.70	246.82	245.50	245.65	247.30	254.36	260.80	260.17	258.87
22	253.75	252.03	250.38	248.67	246.79	245.43	245.75	247.38	254.70	256.80	260.13	258.82
23	253.72	251.95	250.31	248.60	246.75	245.38	245.78	247.50	255.03	260.84	260.08	258.78
24	253.66	251.88	250.23	248.54	246.68	245.32	245.78	247.65	244.40	260.84	260.02	258.75
25	253.58	251.80	250.15	248.46	246.66	245.26	245.80	247.82	255.80	260.87	259.97	258.70
26	253.52	251.75	250.12	248.39	246.60	245.24	245.86	247.88	256.12	260.87	259.92	258.65
27	253.44	251.70	250.09	248.32	246.55	245.20	245.98	248.05	256.50	260.85	259.86	258.60
28	253.40	251.65	250.04	248.24	246.50	245.14	246.02	248.16	256.79	260.85	259.82	258.54
29	253.34	251.56	249.98	248.20	246.48	245.08	246.06	248.40	257.15	260.82	259.78	258.48
30	253.30		249.90	248.12	246.40	245.06	246.06	248.60	257.42	260.82	259.72	258.42
31	253.27		249.82		246.35		246.10	248.82		260.82		258.36

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1989

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	258.30	256.58	254.95	253.26	251.46	249.69	248.80	250.60	255.40	268.64	274.30	273.52
2	258.26	256.52	254.90	253.20	251.45	249.61	248.85	250.70	255.80	268.97	274.32	273.47
3	258.22	256.47	254.83	253.13	251.42	249.55	248.85	250.74	256.13	269.30	274.32	273.43
4	258.16	256.46	254.75	253.06	251.35	249.50	248.90	250.78	256.40	269.60	274.32	273.40
5	258.10	256.39	254.67	252.99	251.28	249.45	249.01	250.90	257.15	269.96	274.32	273.34
6	258.04	256.32	254.60	252.92	251.24	249.41	249.12	251.00	257.78	270.35	274.32	273.32
7	257.98	256.25	254.55	252.85	251.18	249.37	249.12	251.07	258.05	270.62	274.32	273.28
8	257.91	256.18	254.50	252.79	251.10	249.30	249.12	251.12	258.52	270.85	274.29	273.24
9	257.85	256.11	254.46	252.73	251.04	249.23	249.09	251.15	259.00	271.15	274.29	273.22
10	257.78	256.05	254.42	252.66	251.00	249.18	249.09	251.20	259.50	271.48	274.25	273.17
11	257.72	256.01	254.38	252.58	250.97	249.14	249.14	251.28	259.94	271.70	274.22	273.13
12	257.66	255.96	254.32	252.51	250.94	249.10	249.25	251.30	256.45	271.92	274.19	273.10
13	257.61	255.89	254.26	252.45	250.87	249.04	249.33	251.33	260.84	272.18	274.17	273.07
14	257.56	255.83	254.22	252.38	250.83	249.00	249.38	251.40	261.27	272.40	274.15	273.02
15	257.50	255.78	254.20	252.32	250.77	249.00	249.40	251.44	261.90	272.60	274.12	272.96
16	257.43	255.73	254.15	252.26	250.70	248.98	249.42	251.60	262.33	272.86	274.09	272.93
17	257.39	255.68	254.09	252.19	250.62	248.96	249.50	251.70	262.90	273.02	274.05	272.90
18	257.32	255.63	254.02	252.13	250.57	248.94	249.65	251.85	263.28	273.28	274.02	272.88
19	257.25	255.59	253.98	252.08	250.52	248.94	249.72	251.92	263.70	273.48	274.00	272.83
20	257.20	255.53	253.93	252.02	250.46	248.89	249.80	252.00	264.27	273.54	273.96	272.80
21	257.16	255.48	253.90	251.97	250.40	248.83	249.86	252.05	264.62	273.68	273.92	272.75
22	257.12	255.42	253.83	251.93	250.33	248.79	249.86	252.23	256.08	273.85	273.87	272.70
23	257.09	255.35	253.77	251.88	250.28	248.79	249.96	252.35	265.50	273.93	273.81	272.65
24	257.05	255.28	253.72	251.82	250.24	248.77	250.07	252.60	266.00	274.03	273.77	272.60
25	256.98	255.22	253.66	251.77	250.20	248.76	250.10	252.98	266.40	274.14	273.75	272.54
26	256.91	255.16	253.60	251.71	250.16	248.74	250.18	253.15	266.78	274.18	273.73	272.48
27	256.85	255.09	253.55	251.65	250.08	248.74	250.28	253.46	267.22	274.22	273.70	272.40
28	256.80	255.02	253.50	251.57	250.00	248.70	250.32	253.80	267.60	274.25	273.66	272.33
29	256.75		253.44	251.52	249.92	248.64	250.36	254.20	267.95	274.25	273.61	272.27
30	256.69		253.37	251.46	249.84	248.62	250.42	254.64	268.30	274.28	273.55	272.25
31	256.62		253.32		249.76		250.55	255.00		274.28		272.25

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1990

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	272.25	270.70	269.23	267.47	266.12	264.77	263.70	263.32	263.90	265.42	265.14	263.81
2	272.22	270.64	269.18	267.40	266.08	264.70	263.66	263.36	263.96	265.42	265.12	263.76
3	272.16	270.58	269.12	267.35	266.03	264.64	263.64	263.42	263.98	265.44	265.07	263.70
4	272.09	270.53	269.08	267.28	266.00	264.60	263.62	263.42	264.08	265.48	265.03	263.64
5	272.02	270.49	269.00	267.23	265.97	264.55	263.60	263.42	264.10	265.50	264.98	263.57
6	271.98	270.45	268.93	267.17	265.95	264.54	263.58	263.42	264.14	265.50	264.95	263.51
7	271.90	270.42	268.87	267.13	265.93	264.50	263.58	263.42	264.17	265.50	264.90	263.44
8	271.80	270.39	268.83	267.08	265.90	264.44	263.58	263.42	264.22	265.50	264.84	263.40
9	271.75	270.33	268.78	267.04	265.86	264.40	263.58	263.42	264.28	265.53	264.78	263.36
10	271.73	270.28	268.72	267.00	265.82	264.37	263.60	263.42	264.28	265.53	264.75	263.30
11	271.70	270.24	268.68	266.94	265.79	264.32	263.60	263.42	264.28	265.53	264.70	263.26
12	271.67	270.18	268.65	266.90	265.74	264.25	263.56	263.44	264.33	265.56	264.68	263.22
13	271.62	270.12	268.62	266.87	265.70	264.22	263.56	263.44	264.40	265.56	264.64	263.16
14	271.60	270.05	268.58	266.82	265.65	264.20	263.54	263.44	264.54	265.56	264.60	263.12
15	271.54	269.98	268.52	266.78	265.60	264.18	263.52	263.44	264.64	265.56	264.55	263.08
16	271.50	269.92	268.45	266.75	265.56	264.14	263.48	263.44	264.70	265.58	264.50	263.05
17	271.44	269.87	268.37	266.72	265.50	264.10	263.45	263.46	264.74	265.58	264.48	263.00
18	271.40	269.82	268.30	266.68	265.46	264.06	263.42	263.46	264.80	265.58	264.43	262.95
19	271.34	269.74	268.22	266.62	265.42	264.03	263.38	263.46	264.90	265.58	264.40	262.89
20	271.29	269.67	268.18	266.58	265.37	264.03	263.34	263.50	264.94	265.58	264.38	262.85
21	271.26	269.62	268.12	266.56	265.32	264.03	263.30	263.54	265.05	265.55	264.33	262.80
22	271.24	269.55	268.08	266.50	265.26	264.03	263.30	263.59	265.08	265.55	264.28	262.77
23	271.20	269.49	268.05	266.45	265.20	263.98	263.28	263.59	265.10	265.52	264.22	262.77
24	271.18	269.45	268.00	266.40	265.15	263.95	263.28	263.65	265.12	265.48	264.18	262.75
25	271.12	269.41	267.95	266.34	265.11	263.93	263.30	263.65	265.16	265.44	264.12	262.75
26	271.06	269.36	267.90	266.30	265.09	263.90	263.30	263.70	265.19	265.39	264.06	262.72
27	270.98	269.32	267.84	266.27	265.06	263.86	263.30	263.75	265.27	265.33	264.00	262.68
28	270.90	269.28	267.77	266.25	265.00	263.82	263.30	263.80	265.34	265.29	263.97	262.63
29	270.84		267.70	266.20	264.95	263.80	263.30	263.80	265.40	265.25	263.92	262.57
30	271.79		267.62	266.17	264.89	263.75	263.27	263.86	265.40	265.23	263.86	262.50
31	271.74		267.55		264.83		263.27	263.90		265.18		262.47

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1991

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	262.47	260.52	258.71	256.71	255.20	254.95	255.50	259.00	265.30	272.42	275.20	274.30
2	262.42	260.48	258.68	256.66	255.15	255.00	255.50	259.22	265.59	272.54	275.20	274.26
3	262.34	260.40	258.65	256.61	255.11	255.04	255.55	259.42	265.97	272.72	275.16	274.20
4	262.26	260.30	258.60	256.57	255.08	255.12	255.68	259.58	266.22	272.82	275.16	274.15
5	262.14	260.22	258.53	256.53	255.06	255.15	255.83	259.68	266.62	273.00	275.14	274.12
6	262.09	260.17	258.47	256.46	255.03	255.20	255.90	259.94	267.00	273.30	275.14	274.08
7	262.02	260.13	258.39	256.42	255.00	255.26	255.94	260.12	267.28	273.58	275.14	274.04
8	261.94	260.08	258.30	256.34	254.97	255.33	256.00	260.38	267.43	273.80	275.10	274.00
9	261.88	259.98	258.24	256.30	254.95	255.35	256.06	260.55	267.88	273.96	275.08	273.94
10	261.83	259.90	258.18	256.26	254.93	255.38	256.11	260.77	268.12	274.13	275.04	273.90
11	261.79	259.85	258.09	256.23	254.91	255.38	256.18	260.90	268.46	274.22	275.04	273.85
12	261.75	259.78	257.00	256.18	254.87	255.38	256.28	261.05	268.72	274.33	275.00	273.81
13	261.70	259.74	257.93	256.14	254.82	255.41	256.40	261.20	269.13	274.38	275.00	273.76
14	261.64	259.68	257.84	256.10	254.78	255.44	256.46	261.32	269.44	274.43	274.97	273.73
15	261.56	259.64	257.77	256.08	254.75	255.46	256.60	261.44	269.75	274.55	274.97	273.70
16	261.49	259.60	257.70	256.02	254.73	255.48	256.75	261.62	269.92	274.60	274.95	273.66
17	261.42	259.52	257.65	255.98	254.70	255.48	256.87	261.70	270.26	274.70	274.92	273.62
18	261.40	259.48	257.60	255.90	254.70	255.44	257.02	261.90	270.40	274.76	274.88	273.57
19	261.33	259.42	257.52	255.86	254.68	255.40	257.12	262.18	270.60	274.82	274.83	273.53
20	261.25	259.32	257.44	255.84	254.68	255.34	257.28	262.35	270.80	274.88	274.78	273.47
21	261.20	259.23	257.35	255.80	254.66	255.42	257.45	262.60	270.92	274.93	274.75	273.42
22	261.12	259.18	257.27	255.74	254.63	255.47	257.64	262.73	271.03	274.96	274.70	273.37
23	261.07	259.10	257.22	255.66	254.59	255.53	257.83	263.03	271.10	275.02	274.66	273.33
24	261.00	258.98	257.18	255.58	254.54	255.55	257.96	263.10	271.40	275.04	274.63	273.30
25	260.92	258.94	257.14	255.50	254.54	255.55	258.02	263.50	271.62	275.08	274.63	273.25
26	260.87	258.85	257.07	255.43	254.54	255.55	258.10	263.74	271.72	275.14	274.57	273.20
27	260.80	258.80	257.00	255.38	254.54	255.55	258.22	263.92	271.86	275.14	274.50	273.15
28	260.74	258.75	256.92	255.31	254.59	255.50	258.45	264.24	272.02	275.14	274.42	273.09
29	260.69		256.86	255.27	254.66	255.50	258.60	264.50	272.12	275.20	274.38	273.03
30	260.62		256.82	255.24	254.78	255.50	258.82	264.70	272.20	275.20	274.33	272.98
31	260.58		256.76		254.92		259.00	265.00		275.20		272.92

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1992

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	272.87	271.10	269.43	267.58	266.09	264.70	263.70	263.32	262.53	264.32	264.34	262.94
2	272.82	271.05	269.37	267.50	266.05	264.65	263.70	263.17	262.56	264.40	264.28	262.87
3	272.75	270.99	269.32	267.44	266.00	264.62	263.67	263.13	262.56	264.46	264.22	262.81
4	272.70	270.86	269.27	267.40	265.94	264.56	263.67	263.10	262.56	264.50	264.17	262.77
5	272.65	270.80	269.20	267.36	265.89	264.52	263.62	263.10	262.60	264.50	264.13	262.71
6	272.60	270.75	269.15	267.30	265.86	264.46	263.58	263.08	262.65	264.50	264.10	262.66
7	272.56	270.70	269.07	267.25	265.83	264.44	263.55	263.08	262.65	264.53	264.08	262.60
8	272.52	270.64	269.00	267.20	265.78	264.40	263.50	263.08	262.70	264.53	264.03	262.54
9	272.44	270.59	268.94	267.16	265.73	264.35	263.48	263.04	262.70	264.55	264.00	262.47
10	272.38	270.52	268.88	267.12	265.68	264.30	263.44	263.00	262.72	264.58	263.96	262.40
11	272.30	270.47	268.83	267.10	265.63	264.27	263.42	262.95	262.80	264.85	263.92	262.33
12	272.23	270.42	268.77	267.10	265.56	264.22	263.38	262.92	262.86	264.85	263.87	262.26
13	272.17	270.37	268.72	267.05	265.50	264.18	263.33	262.90	262.90	264.85	263.82	262.20
14	272.12	270.33	268.67	267.00	265.47	264.14	263.30	262.87	262.95	264.85	263.76	262.13
15	272.06	270.29	268.60	266.93	265.43	264.10	263.30	262.83	262.95	264.80	263.72	262.05
16	272.00	270.23	268.52	266.87	265.40	264.07	263.30	262.80	263.02	264.76	263.68	261.99
17	271.95	270.17	268.44	266.82	265.36	264.05	263.30	262.77	263.15	264.74	263.64	261.94
18	271.90	270.11	268.38	266.78	265.32	264.05	263.28	262.72	263.20	264.70	263.60	261.90
19	271.83	270.06	268.33	266.75	265.30	264.05	263.28	262.69	263.25	264.70	263.54	261.84
20	271.78	270.00	268.28	266.72	265.24	264.02	263.28	262.69	263.40	264.67	263.48	261.78
21	271.72	269.96	268.24	266.68	265.18	264.02	263.26	262.65	263.58	264.67	263.42	261.73
22	271.64	269.92	268.20	266.65	265.15	264.00	263.22	262.59	263.68	264.67	263.35	261.68
23	271.60	269.84	268.15	266.62	265.08	263.95	263.18	262.53	263.75	267.65	263.30	261.62
24	271.56	269.76	268.10	266.58	265.02	263.92	263.15	262.49	263.85	264.65	263.27	261.56
25	271.50	269.70	268.02	266.52	264.98	263.87	263.12	262.46	263.92	264.65	263.23	261.50
26	271.45	269.63	267.96	266.44	264.96	263.84	263.12	262.43	264.00	264.63	263.20	261.45
27	271.40	269.57	267.91	266.36	264.94	263.80	263.12	262.43	264.14	264.60	263.17	261.39
28	271.34	269.50	267.86	266.28	264.90	263.75	263.16	262.43	264.20	264.56	263.12	261.32
29	271.28		267.80	266.22	264.85	263.72	263.22	262.43	264.24	264.50	263.07	261.25
30	271.20		267.73	266.15	264.82	263.72	263.26	262.43	264.30	264.45	263.00	261.18
31	271.14		267.65		264.76		263.26	262.48		264.40		261.11

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1993

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	261.05	258.95	257.02	254.95	253.06	251.18	249.73	248.76	251.45	257.37	258.70	257.08
2	260.98	258.90	256.94	254.87	253.00	251.14	249.65	248.80	251.70	257.50	258.65	257.02
3	260.92	258.84	256.88	254.81	252.93	251.09	249.60	248.85	251.90	257.58	258.65	256.98
4	260.86	258.76	256.82	254.74	252.88	251.03	249.55	248.92	252.12	257.70	258.60	256.95
5	260.80	258.68	256.74	254.68	252.82	250.99	249.50	249.00	252.22	257.85	258.54	256.92
6	260.75	258.60	256.68	254.60	253.78	250.99	249.50	249.14	252.40	257.90	258.48	256.86
7	260.70	258.55	256.60	254.53	252.74	250.96	249.46	249.19	252.70	258.00	258.42	256.80
8	260.65	258.47	256.53	254.48	252.70	250.93	249.46	249.27	253.00	258.00	258.38	256.73
9	260.60	258.42	256.48	254.42	252.67	250.88	249.46	249.30	253.25	258.10	258.32	256.68
10	260.52	258.34	256.42	254.37	252.60	250.85	249.42	249.40	253.50	258.23	258.25	256.63
11	260.44	258.28	256.38	254.30	252.53	250.85	249.37	249.50	253.70	258.40	258.20	256.58
12	260.36	258.20	256.34	254.23	252.45	250.80	249.32	249.55	253.70	258.50	258.13	256.52
13	260.27	258.13	256.30	254.15	252.37	250.75	249.28	249.55	254.05	258.60	258.07	256.45
14	260.18	258.06	256.24	254.07	252.30	250.67	249.23	249.60	254.30	258.65	258.03	256.40
15	260.10	257.98	256.16	254.02	252.23	250.60	249.20	249.70	254.55	258.70	257.98	256.33
16	260.02	257.92	256.10	253.95	252.15	250.54	249.17	249.75	254.80	258.70	257.92	256.26
17	259.94	257.84	256.02	253.90	252.10	250.49	249.17	249.89	254.97	258.70	257.87	256.19
18	259.88	257.76	255.94	253.85	252.05	250.42	249.17	250.00	255.10	258.75	257.82	256.12
19	259.80	257.70	255.87	253.77	252.05	250.35	249.12	250.05	255.22	258.80	257.78	256.05
20	259.73	257.64	255.82	253.70	252.00	250.29	249.08	250.10	255.50	258.80	257.72	255.98
21	259.67	257.60	255.78	253.65	251.94	250.23	249.04	250.15	255.70	258.80	257.66	255.92
22	259.60	257.53	255.72	253.62	251.87	250.20	249.00	250.20	255.93	258.80	257.60	255.85
23	259.54	257.45	255.65	253.56	251.79	250.20	248.95	250.20	256.05	258.80	257.53	255.17
24	259.48	257.37	255.57	253.50	251.73	250.17	248.90	250.30	256.30	258.80	257.46	255.70
25	259.42	257.30	255.48	253.44	251.68	250.11	248.85	250.35	256.45	258.85	257.40	255.63
26	259.35	257.22	255.40	253.36	251.60	250.04	248.78	250.60	256.70	258.85	257.35	255.57
27	259.30	257.16	255.32	253.30	251.54	249.98	248.72	250.80	256.88	258.80	257.30	255.50
28	259.25	257.08	255.25	253.25	251.48	249.94	248.70	251.00	257.03	250.80	257.26	255.42
29	259.17		255.18	253.20	251.40	249.88	248.68	251.10	257.20	258.76	257.20	255.34
30	259.10		255.09	253.13	251.33	249.80	248.68	251.20	257.30	258.74	257.13	255.28
31	259.03		255.03		251.25		248.72	251.30		258.74		255.20

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1994

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	255.12	252.69	250.43	247.88	245.77	243.62	241.95	240.22	240.85	247.95	255.65	256.00
2	255.06	252.63	250.35	247.82	245.72	243.56	241.87	240.17	241.03	248.25	255.80	255.94
3	254.98	252.55	250.28	247.74	245.68	243.50	241.78	240.12	241.22	248.70	255.90	255.90
4	254.90	252.47	250.20	247.65	245.62	243.42	241.70	240.09	241.42	249.05	256.00	255.90
5	254.80	252.40	250.13	247.60	245.54	243.35	241.60	240.07	241.54	249.30	256.15	255.85
6	254.72	252.33	250.05	247.55	245.46	243.30	241.50	240.03	241.70	249.70	256.20	255.80
7	254.63	252.24	249.96	247.48	245.38	243.27	241.42	240.00	241.82	250.05	256.25	255.75
8	254.54	252.17	249.88	247.43	245.29	243.24	241.32	239.98	242.02	250.35	256.30	255.68
9	254.48	252.08	249.78	247.43	245.20	243.20	241.24	239.95	242.18	250.70	256.35	255.62
10	254.40	251.98	249.66	247.38	245.12	243.17	241.19	239.92	242.38	251.00	256.35	255.55
11	254.32	251.89	249.57	247.32	245.06	243.14	241.15	239.87	242.50	251.25	256.40	255.48
12	254.25	251.80	249.48	247.30	245.00	243.14	241.12	239.81	242.70	251.55	256.40	255.42
13	254.20	251.72	249.40	247.25	244.96	243.10	241.09	239.75	242.95	251.80	256.40	255.35
14	254.13	251.63	249.33	247.16	244.90	243.04	241.05	239.67	243.20	252.05	256.40	255.28
15	254.08	251.56	249.27	247.07	244.83	242.96	241.00	239.60	243.52	252.25	256.40	255.22
16	254.00	251.50	249.22	247.00	244.75	242.88	240.94	239.55	243.82	252.55	256.40	255.14
17	253.92	251.42	249.16	246.93	244.67	242.78	240.88	239.50	244.10	252.80	256.40	255.08
18	253.83	251.32	249.10	246.85	244.59	242.70	240.82	239.48	244.30	253.10	256.36	255.02
19	253.74	251.23	249.00	246.80	244.50	242.60	240.77	239.48	244.55	253.30	256.36	254.95
20	253.65	251.13	248.92	246.72	244.42	242.55	240.74	239.53	244.85	253.50	256.36	254.87
21	253.58	251.04	249.82	246.63	244.34	242.50	240.70	239.58	245.20	253.72	256.36	254.70
22	253.50	250.97	248.72	246.55	244.29	242.42	240.67	239.65	245.46	253.85	256.33	254.73
23	253.42	250.92	248.66	246.46	244.25	242.34	240.65	239.69	245.70	254.00	256.30	254.68
24	253.33	250.84	248.58	246.37	244.18	242.30	240.62	239.78	245.94	254.18	256.25	254.62
25	253.23	250.78	248.50	246.28	244.09	242.28	240.58	239.88	246.26	254.40	256.22	254.55
26	253.15	250.70	248.40	246.18	244.00	242.24	240.53	239.98	246.50	254.60	256.20	254.50
27	253.06	250.62	248.30	246.10	243.94	242.20	240.48	240.15	246.75	254.75	256.20	254.45
28	252.98	250.52	248.24	246.02	243.89	242.18	240.45	240.35	247.00	254.95	256.17	254.38
29	252.90		248.14	245.93	243.83	242.12	240.41	240.50	247.30	255.15	256.12	254.33
30	252.83		248.05	245.84	243.77	242.04	240.36	240.55	247.65	255.30	256.07	254.28
31	252.77		247.95		243.70		240.30	240.72		255.50		254.22

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1995

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	254.18	252.17	250.19	248.10	246.48	244.90	243.57	243.48	249.30	256.18	259.50	258.33
2	254.12	252.12	250.11	248.06	246.45	244.83	243.54	243.55	249.53	256.32	259.50	258.28
3	254.06	252.05	250.02	248.00	246.43	244.77	243.50	243.65	249.83	256.50	259.50	258.23
4	254.00	251.98	249.93	247.93	246.38	244.71	243.48	243.77	250.00	256.70	259.50	258.18
5	253.94	251.93	249.87	247.85	246.30	244.66	243.45	243.90	250.22	256.84	259.55	258.10
6	253.87	251.88	249.81	247.78	246.25	244.61	243.45	244.00	250.43	257.02	259.60	258.05
7	253.82	251.80	249.75	247.70	246.22	244.56	243.45	244.13	250.63	257.20	259.60	258.00
8	253.78	251.72	249.67	247.62	246.18	244.50	243.42	244.24	251.00	257.38	259.55	257.93
9	253.72	251.63	249.58	247.56	246.12	244.45	243.40	244.37	251.20	257.52	259.50	257.88
10	253.65	251.54	249.50	247.50	246.07	244.40	243.38	244.50	251.40	257.70	259.48	257.82
11	253.60	251.46	249.44	247.44	246.03	244.35	243.35	244.62	251.55	257.83	259.43	257.78
12	253.54	251.41	249.39	247.38	245.98	244.30	243.33	244.75	251.72	258.00	259.40	257.73
13	253.46	251.37	249.35	247.30	245.92	244.24	243.30	244.87	251.92	258.12	259.35	257.67
14	253.37	251.30	249.30	247.26	245.86	244.19	243.27	245.05	252.25	258.28	259.30	257.61
15	253.28	251.22	246.23	247.20	245.82	244.15	243.25	245.25	252.40	258.42	259.27	257.55
16	253.20	251.13	249.15	247.16	245.75	244.10	243.22	245.43	252.60	258.58	259.22	257.48
17	253.14	251.05	249.08	247.14	245.70	244.04	243.19	245.65	252.85	258.70	259.18	257.42
18	253.08	250.98	249.03	247.12	245.64	244.00	243.14	245.85	253.15	258.78	259.12	257.37
19	253.02	250.92	248.99	247.08	245.60	243.97	243.10	245.97	253.45	258.82	259.08	257.30
20	252.95	250.88	248.95	247.04	245.53	243.94	243.08	246.20	253.75	258.90	259.04	257.23
21	252.90	250.80	248.88	246.98	245.45	243.90	243.08	246.50	254.05	259.06	259.00	257.16
22	252.84	250.72	248.82	246.94	245.38	243.85	243.08	246.80	254.30	259.12	258.94	257.09
23	252.78	250.63	248.74	246.90	245.34	243.80	243.13	247.00	254.50	259.20	258.90	257.02
24	252.70	250.56	248.67	246.86	245.30	243.75	243.20	247.30	254.85	259.25	258.84	256.98
25	252.63	250.48	248.60	246.80	245.27	243.71	243.25	247.55	255.03	259.25	258.77	256.95
26	252.58	250.40	248.53	246.75	245.23	243.68	243.28	247.90	255.27	259.28	258.70	256.90
27	252.52	250.34	248.47	246.70	245.20	243.68	243.32	248.22	255.50	259.33	258.65	256.85
28	252.44	250.26	248.40	246.66	245.15	243.68	243.37	248.42	255.67	259.40	258.57	256.78
29	252.37		248.34	246.58	245.08	243.65	243.40	248.65	255.82	259.43	258.50	256.73
30	252.28		248.26	246.52	245.03	243.60	243.40	248.85	256.02	259.43	258.42	256.68
31	252.22		248.18		244.97		243.43	249.05		259.46		256.61

DAILY WATERS LEVEL OF THE AKOSOMBO DAM, YEAR 1996

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	256.53	254.36	252.31	249.90	247.90	245.82	245.47	245.40	246.72	253.80	258.20	256.68
2	256.45	254.29	252.24	249.82	247.83	245.77	245.50	245.35	246.87	254.05	258.22	256.62
3	256.37	254.21	252.15	249.74	247.75	245.72	245.53	245.30	247.07	254.20	258.22	256.57
4	256.30	254.14	252.07	249.65	247.67	245.68	245.55	245.26	247.25	254.42	258.22	256.51
5	256.22	254.09	251.98	249.58	247.58	245.63	245.57	245.26	247.43	254.65	258.20	256.47
6	256.14	254.03	251.90	249.48	247.52	245.58	245.57	245.26	247.65	254.90	258.18	256.41
7	256.05	253.95	251.83	249.42	247.46	245.54	245.57	245.26	247.90	255.10	258.15	256.33
8	255.98	253.87	251.74	249.34	247.39	245.50	245.57	245.26	248.18	255.22	258.12	256.27
9	255.92	253.79	251.67	249.28	247.33	245.46	245.57	245.26	248.40	255.40	258.08	256.22
10	255.86	253.70	251.60	249.22	247.26	245.42	245.57	245.26	248.63	255.63	258.04	256.18
11	255.81	253.65	251.55	249.17	247.20	245.39	245.57	245.28	248.83	255.80	258.00	256.10
12	255.76	253.58	251.48	249.08	247.13	245.36	245.57	245.30	249.03	255.95	257.95	256.03
13	255.70	253.52	251.42	249.00	247.07	245.36	245.54	245.32	249.23	256.18	257.90	255.96
14	255.65	253.46	251.34	248.95	247.00	245.36	245.50	245.35	249.45	256.40	257.83	255.88
15	255.60	253.39	251.27	248.90	246.93	245.36	245.50	245.38	249.65	256.60	257.76	255.80
16	255.53	253.33	251.20	248.83	246.86	245.40	245.50	245.42	249.90	256.75	257.68	255.72
17	255.43	253.28	251.14	248.76	246.80	245.43	245.52	245.46	250.20	256.95	257.60	255.64
18	255.37	253.20	251.07	248.7	246.73	245.43	245.54	245.49	250.53	257.15	257.54	255.57
19	255.29	253.14	250.98	248.63	246.65	245.43	245.54	245.54	250.80	257.30	257.48	255.50
20	255.24	253.07	250.9	248.58	246.58	245.43	245.54	245.60	251.10	257.37	257.40	255.45
21	255.18	253.00	250.82	248.53	246.5	245.40	245.54	245.66	251.35	257.47	257.35	255.37
22	255.13	252.95	250.76	248.48	246.43	245.40	245.54	245.73	251.60	257.60	257.28	255.29
23	255.06	252.87	250.68	248.43	246.37	245.40	245.54	245.80	251.85	257.72	257.22	255.22
24	254.98	252.79	250.6	248.36	246.3	245.40	245.54	245.87	252.12	257.80	257.15	255.15
25	254.90	252.70	250.52	248.29	246.25	245.40	245.54	245.94	252.40	257.90	257.10	255.10
26	254.82	252.62	250.43	248.22	246.18	245.40	245.54	246.02	252.70	257.98	257.03	255.05
27	254.75	252.54	250.34	248.13	246.12	245.40	245.54	246.12	252.95	258.08	256.95	255.00
28	254.67	252.46	250.25	248.08	246.06	245.40	245.54	246.24	253.17	258.13	256.88	254.94
29	254.60	252.39	250.16	248.03	246	245.42	245.52	246.34	253.35	258.15	256.80	254.86
30	255.52		250.06	247.96	245.95	245.44	245.49	246.46	253.63	258.17	256.74	254.80
31	255.44		249.96		245.88		245.46	246.60		258.20		254.73

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1997

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	254.68	252.49	250.07	247.65	245.43	243.42	242.10	241.30	241.00	246.75	248.55	246.86
2	254.62	252.41	249.95	247.60	245.35	243.35	242.06	241.30	241.05	246.85	248.58	246.77
3	254.57	252.33	249.88	247.55	245.28	243.30	242.02	241.30	241.13	246.92	248.58	246.68
4	254.50	252.24	249.82	247.50	245.22	243.23	241.99	241.30	241.23	247.02	248.58	246.60
5	254.43	252.15	249.75	247.45	245.17	243.16	241.96	241.30	241.40	247.18	248.56	246.53
6	254.35	252.06	249.70	247.40	245.10	243.10	241.92	241.28	241.58	247.34	248.54	246.46
7	254.29	251.97	249.63	247.36	245.05	243.05	241.88	241.26	241.78	247.50	248.52	246.37
8	254.23	251.88	249.54	247.27	245.00	243.00	241.84	241.23	241.93	247.62	248.48	246.30
9	254.15	251.79	249.45	247.19	244.96	242.95	241.79	241.20	242.03	247.72	248.45	246.23
10	254.07	251.72	249.38	247.10	244.92	242.90	241.74	241.18	242.20	247.77	248.40	246.15
11	253.98	251.63	249.29	247.00	244.86	242.83	241.70	241.15	242.37	247.85	248.35	246.08
12	253.92	251.54	249.20	246.90	244.80	242.76	241.68	241.12	242.52	247.96	248.28	246.02
13	253.85	251.46	249.10	246.83	244.74	242.70	241.66	241.09	242.64	248.02	248.22	245.96
14	253.76	251.37	249.00	246.76	244.67	242.65	241.62	241.06	242.84	248.10	248.14	245.90
15	253.70	251.28	248.90	246.67	244.60	242.60	241.58	241.03	243.04	248.20	248.07	245.85
16	253.62	251.20	248.80	246.58	244.52	242.55	241.55	241.00	243.20	248.25	248.00	245.77
17	253.56	251.12	248.72	246.49	244.45	242.50	241.55	240.97	243.40	248.25	247.92	245.68
18	253.48	251.03	248.63	246.40	244.38	242.45	241.55	240.94	243.60	248.28	247.83	245.60
19	253.42	250.94	248.55	246.30	244.32	242.40	241.55	240.92	243.95	248.34	247.74	245.52
20	253.35	250.85	248.46	246.22	244.25	242.36	241.55	240.90	244.30	248.38	247.65	245.43
21	253.26	250.76	248.38	246.15	244.17	242.32	241.55	240.90	244.55	248.40	247.58	245.34
22	253.18	250.67	248.29	246.08	244.10	242.28	241.55	240.88	244.85	248.40	247.50	245.25
23	253.10	250.60	248.19	246.02	244.05	242.24	241.52	240.88	245.05	248.42	247.43	245.17
24	253.04	250.53	248.12	245.97	244.00	242.20	241.50	240.88	245.35	248.42	247.36	245.08
25	252.98	250.44	248.06	245.90	243.94	242.20	241.48	240.86	245.70	248.46	247.30	245.00
26	252.92	250.35	248.00	245.82	243.88	242.20	241.45	240.86	246.00	248.46	247.22	244.95
27	252.87	250.26	247.95	245.75	243.80	242.20	241.41	240.86	246.15	248.50	247.13	244.90
28	252.80	250.17	247.90	245.68	243.72	242.18	241.37	240.86	246.30	248.52	247.06	244.85
29	252.72		247.82	245.60	243.65	242.16	241.33	240.89	246.48	248.52	247.00	244.78
30	252.64		247.76	245.52	243.57	242.13	241.30	240.92	246.60	248.52	246.92	244.70
31	252.57		247.70		243.49		241.30	240.96		248.55		244.63

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1998

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	244.55	242.24	240.60	238.85	237.74	236.98	237.28	237.85	239.98	245.45	251.80	251.00
2	244.50	242.16	240.54	238.80	237.72	236.95	237.30	237.85	240.10	245.75	251.90	250.95
3	244.42	242.08	240.50	238.74	237.70	236.93	237.30	237.85	240.25	246.00	251.95	250.90
4	244.34	242.02	240.46	238.68	237.67	236.93	237.30	237.90	240.35	246.25	251.95	250.84
5	244.25	241.96	240.40	238.62	237.65	236.93	237.32	237.98	240.50	246.55	251.98	250.78
6	244.17	241.88	240.36	238.58	237.65	236.93	237.32	238.02	240.60	246.90	251.98	250.72
7	244.09	241.82	240.32	238.54	237.65	236.93	237.30	238.04	240.75	247.10	251.98	250.67
8	244.00	241.77	240.26	238.50	237.63	236.93	237.30	238.04	240.90	247.30	252.00	250.62
9	243.92	241.70	240.20	238.47	237.60	236.93	237.32	238.04	241.10	247.60	252.00	250.56
10	243.83	241.64	240.15	238.42	237.57	236.96	237.35	238.08	241.20	247.90	252.00	250.52
11	243.77	241.59	240.08	238.38	237.55	236.98	237.35	238.08	241.30	248.25	251.97	250.48
12	243.68	241.52	240.00	238.32	237.52	236.98	237.37	238.08	241.50	248.55	251.95	250.42
13	243.60	241.46	239.92	238.28	237.49	236.98	237.37	238.12	241.60	248.80	251.92	250.36
14	243.52	241.40	239.85	238.25	237.46	237.00	237.37	238.15	241.80	249.10	251.90	250.30
15	243.43	241.35	239.77	238.22	237.42	237.00	237.37	238.20	242.00	249.42	251.87	250.25
16	243.34	241.30	239.72	238.20	237.38	237.03	237.35	238.25	242.15	249.60	251.84	250.20
17	243.26	241.25	239.67	238.15	237.36	237.05	237.32	238.32	242.30	249.80	251.80	250.14
18	243.20	241.20	239.63	238.10	237.34	237.05	237.32	238.40	242.45	250.05	251.75	250.08
19	243.13	241.15	239.58	238.06	237.34	237.05	237.32	238.50	242.60	250.30	251.70	250.02
20	243.07	241.08	239.53	238.03	237.34	237.03	237.30	238.62	242.80	250.50	251.64	249.95
21	242.98	241.00	239.48	238.00	237.32	237.03	237.30	238.70	243.00	250.60	251.58	249.89
22	242.92	240.95	239.42	237.98	237.29	237.06	237.35	238.85	243.30	250.78	251.53	249.82
23	242.86	240.90	239.38	237.96	237.26	237.10	237.40	239.00	243.50	250.95	251.47	249.76
24	242.80	240.86	239.32	237.92	237.24	237.15	237.45	239.08	243.65	251.10	251.40	249.68
25	242.72	240.82	239.24	237.89	237.22	237.15	237.50	239.20	243.90	251.25	251.34	249.58
26	242.64	240.78	239.16	237.86	237.18	237.18	237.55	239.28	244.15	251.40	251.28	249.50
27	242.55	240.72	239.10	237.83	237.15	237.20	237.60	239.38	244.30	251.50	251.22	249.44
28	242.48	240.66	239.04	237.81	237.12	237.20	237.68	239.48	244.50	251.60	251.16	249.35
29	242.42		238.98	237.78	237.10	237.25	237.74	239.55	244.85	251.65	251.10	249.28
30	242.35		238.93	237.76	237.06	237.28	237.80	239.76	245.25	251.70	251.05	249.22
31	242.30		238.90		237.02		237.85	239.88		251.74		249.17

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 1999

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	249.12	247.13	245.54	243.78	242.38	240.83	239.63	239.64	242.55	254.10	263.60	263.20
2	249.06	247.07	245.48	243.72	242.32	240.80	239.60	239.66	242.85	254.55	263.68	263.16
3	249.00	247.00	245.42	243.68	242.26	240.77	239.60	239.70	243.18	255.00	263.73	263.12
4	248.94	246.95	245.35	243.62	242.20	240.73	239.60	239.73	243.40	255.40	263.78	263.07
5	248.88	246.90	245.30	243.56	242.15	240.70	239.58	239.73	243.70	256.00	263.82	263.04
6	248.82	246.85	245.24	243.50	242.08	240.67	239.58	239.73	244.00	256.45	263.85	263.02
7	248.77	246.80	245.16	243.46	242.02	240.63	239.58	239.73	244.30	256.72	263.88	262.98
8	248.72	246.74	245.08	243.42	241.95	240.58	239.58	239.75	244.58	257.20	263.90	262.93
9	248.67	246.67	245.00	243.37	241.90	240.54	239.60	239.80	244.90	257.62	263.90	262.90
10	248.62	246.59	244.93	243.32	241.85	240.50	239.60	239.85	245.20	258.10	263.90	262.85
11	248.56	246.51	244.88	243.26	241.80	240.45	239.60	239.95	245.64	258.45	263.88	262.80
12	248.50	246.44	244.82	243.20	241.74	240.42	239.60	240.05	246.00	258.75	263.88	262.75
13	248.42	246.37	244.74	243.13	241.68	240.38	239.60	240.10	246.30	259.10	263.85	262.70
14	248.35	246.30	244.68	243.08	241.63	240.35	239.60	240.10	246.70	259.45	263.82	262.65
15	248.27	246.24	244.62	243.04	241.60	240.32	239.60	240.12	247.12	259.85	263.80	262.59
16	248.20	246.20	244.57	243.00	241.56	240.28	239.62	240.12	247.45	260.12	263.77	262.53
17	248.14	246.16	244.52	242.96	241.52	240.23	239.62	240.15	247.75	260.50	263.74	262.46
18	248.08	246.12	244.46	242.93	241.48	240.20	239.62	240.20	248.10	260.80	263.70	262.40
19	248.02	246.08	244.40	242.88	241.45	240.15	239.60	240.30	248.64	261.10	263.67	262.35
20	247.95	246.04	244.35	242.83	241.41	240.10	239.58	240.45	249.10	261.46	263.63	262.30
21	247.87	246.00	244.30	242.80	241.37	240.05	239.54	240.60	249.72	261.70	263.60	262.25
22	247.80	245.95	244.25	242.75	241.32	240.00	239.54	240.70	250.05	261.90	263.56	262.20
23	247.72	245.90	244.20	242.70	241.26	239.95	239.54	240.90	250.50	262.20	263.53	262.14
24	247.65	245.85	244.15	242.66	241.22	239.90	239.52	241.00	251.05	262.45	263.50	262.08
25	247.60	245.78	244.10	242.63	241.16	239.86	239.52	241.12	251.45	262.75	263.45	262.02
26	247.52	245.72	244.04	242.58	241.12	239.82	239.52	241.40	251.90	262.95	263.40	261.98
27	247.45	245.65	243.98	242.52	241.06	239.78	239.52	241.50	252.40	263.10	263.35	261.93
28	247.38	245.58	243.94	242.48	241.00	239.74	239.52	241.70	252.80	263.20	263.32	261.88
29	247.30		243.90	242.46	240.97	239.70	239.54	241.85	253.30	263.32	263.28	261.82
30	247.25		243.87	242.43	240.92	239.67	239.56	242.10	253.70	263.45	263.24	261.76
31	247.20		243.82		240.88		239.60	242.30		263.50		261.69

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2000

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	261.62	260.03	258.26	256.42	254.88	253.15	252.24	252.36	255.05	260.20	263.13	261.56
2	261.56	260.00	258.22	256.35	254.84	253.10	252.24	252.36	255.12	260.55	263.10	261.50
3	261.52	259.96	258.16	256.30	254.80	253.06	252.24	252.36	255.20	260.70	263.06	261.44
4	261.48	259.90	258.10	256.26	254.75	253.03	252.26	252.38	255.25	260.90	263.03	261.38
5	261.44	259.84	258.05	256.22	254.70	252.98	252.26	252.40	255.30	261.00	263.01	261.32
6	261.40	259.80	258.00	256.14	254.63	252.95	252.26	252.40	255.36	261.20	262.98	261.26
7	261.35	259.75	257.93	256.10	254.54	252.93	252.30	252.43	255.50	261.40	262.96	261.21
8	261.30	259.70	257.87	256.07	254.46	252.90	252.34	252.47	255.70	261.50	262.93	261.16
9	261.24	259.64	257.83	256.02	254.41	252.85	252.37	252.50	255.80	261.70	262.90	261.10
10	261.18	259.57	257.80	255.98	254.36	252.80	252.40	252.60	255.95	261.90	262.86	261.03
11	261.10	259.50	257.75	255.93	254.32	252.76	252.44	252.70	256.20	262.05	262.80	261.00
12	261.03	259.42	257.70	255.87	254.26	252.73	252.47	252.85	256.40	262.20	262.70	260.93
13	260.98	259.35	257.63	255.84	254.20	252.70	252.50	252.95	256.54	262.32	262.67	260.86
14	260.92	259.27	257.55	255.78	254.13	252.65	252.54	253.10	256.70	262.45	262.62	260.80
15	260.86	259.20	257.47	255.74	254.07	252.60	252.58	253.20	256.80	262.60	262.58	260.73
16	260.82	259.14	257.38	255.70	254.01	252.56	252.60	253.30	256.96	262.70	262.54	260.65
17	260.78	259.08	257.28	255.64	253.95	252.53	252.63	253.40	257.20	262.75	262.48	260.55
18	260.72	259.00	257.16	255.60	253.90	252.50	252.67	253.43	257.50	262.80	262.42	260.50
19	260.66	258.94	257.08	255.56	253.84	252.50	252.67	253.50	257.70	262.90	262.38	260.42
20	260.58	258.88	257.00	255.52	253.78	252.47	252.67	253.60	257.90	262.92	262.34	260.34
21	260.54	258.80	256.95	255.45	253.72	252.45	252.62	253.65	258.20	262.94	262.28	260.26
22	260.50	258.73	256.90	255.40	253.66	252.42	252.59	253.73	258.45	263.00	262.22	260.18
23	260.45	258.66	256.83	255.36	253.60	252.40	252.57	253.85	258.60	263.10	262.14	260.10
24	260.40	258.58	256.78	255.30	253.55	252.40	252.54	253.95	258.80	263.15	262.07	260.02
25	260.36	258.52	256.74	255.24	253.50	252.37	252.51	254.15	259.05	263.20	262.00	259.94
26	260.30	258.46	256.70	255.18	253.45	252.37	252.48	254.25	259.30	263.25	261.94	259.88
27	260.25	258.40	256.67	255.10	253.40	252.33	252.45	254.38	259.44	263.25	261.88	259.82
28	260.18	258.35	256.64	255.02	253.36	252.30	252.42	254.50	259.68	263.25	261.80	259.74
29	260.14	258.30	256.58	254.96	253.32	252.30	252.40	254.65	259.85	263.22	261.72	259.66
30	260.10		256.53	254.92	253.26	252.26	252.38	254.80	260.00	263.20	261.64	259.58
31	260.06		256.48		253.20		252.36	254.90		263.17		259.52

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2001

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	259.46	257.29	255.27	253.08	251.28	249.56	247.84	246.78	246.30	250.55	251.44	249.31
2	259.40	257.22	255.19	253.00	251.23	249.50	247.80	246.75	246.33	250.65	251.40	249.25
3	259.32	257.15	255.10	252.92	251.18	249.44	247.77	246.72	246.36	250.85	251.35	249.20
4	259.27	257.07	255.01	252.86	251.11	249.39	247.72	246.68	246.40	251.00	251.29	249.13
5	259.20	257.02	254.92	252.78	251.05	249.32	247.70	246.65	246.45	251.12	251.23	249.07
6	259.13	256.92	254.86	252.72	251.00	249.26	247.65	246.62	246.48	251.28	251.14	249.01
7	259.04	256.88	254.80	252.67	250.95	249.20	247.60	246.60	246.52	251.45	251.05	248.96
8	258.98	256.80	254.74	252.62	250.90	249.13	247.56	246.56	246.57	251.55	250.96	248.91
9	258.90	256.74	254.68	252.56	250.84	249.07	247.52	246.53	246.64	251.70	250.88	248.86
10	258.82	256.68	254.60	252.50	250.79	249.00	247.47	246.50	246.80	251.78	250.79	248.80
11	258.74	256.62	254.52	252.42	250.73	248.94	247.43	246.47	247.00	251.82	250.71	248.74
12	258.67	256.56	254.45	252.34	250.65	248.89	247.40	246.44	247.10	251.88	250.64	248.69
13	258.60	256.50	254.36	252.28	250.61	248.82	247.40	246.42	247.26	251.88	250.56	248.62
14	258.52	256.45	254.28	252.22	250.56	248.74	247.37	246.40	247.40	251.90	250.48	248.55
15	258.45	256.38	254.23	252.16	250.50	248.66	247.33	246.40	247.60	251.90	250.39	248.48
16	258.38	256.31	254.17	252.12	250.45	248.58	247.30	246.40	247.78	251.90	250.32	248.42
17	258.30	256.24	254.10	252.08	250.40	248.50	247.28	246.42	247.90	251.90	250.25	248.36
18	258.22	256.15	254.02	252.00	250.33	248.43	247.24	246.44	248.10	251.94	250.19	248.30
19	258.14	256.07	253.95	251.93	250.28	248.36	247.20	246.44	248.25	251.94	250.12	248.23
20	258.06	255.99	253.87	251.87	250.23	248.28	247.17	246.42	248.40	251.90	250.05	248.16
21	258.00	255.91	253.80	251.80	250.18	248.21	247.13	246.42	248.50	251.86	249.98	248.08
22	257.95	255.83	253.72	251.75	250.12	248.15	247.10	246.40	248.65	251.80	249.91	248.02
23	257.88	255.75	253.66	251.70	250.06	248.10	247.06	246.40	248.85	251.75	249.85	247.95
24	257.82	255.67	253.58	251.65	250.00	248.05	247.03	246.38	249.10	251.72	249.79	247.89
25	257.76	255.59	253.50	251.58	249.95	248.05	247.00	246.36	249.20	251.69	249.72	247.84
26	257.69	255.51	253.42	251.53	249.89	248.05	246.96	246.34	249.40	251.64	249.66	247.77
27	257.63	255.43	253.36	251.48	249.83	248.00	246.92	246.34	249.60	251.60	249.59	247.71
28	257.57	255.35	253.30	251.42	249.78	247.95	246.90	246.32	249.85	251.57	249.52	247.64
29	257.50		253.24	251.38	249.72	247.92	246.87	246.30	250.10	251.54	249.45	247.56
30	257.43		253.20	251.34	249.67	247.88	246.83	246.30	250.30	251.50	249.38	247.50
31	257.36		253.13		249.62		246.80	246.30		251.47		247.45

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2002

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	247.38	245.39	243.38	241.50	239.88	238.64	237.55	237.60	239.82	244.30	246.70	245.84
2	247.33	245.32	243.30	241.44	239.84	238.60	237.52	237.64	239.94	244.33	246.72	245.79
3	247.28	245.25	243.25	241.39	239.80	238.55	237.50	237.66	240.08	244.35	246.72	245.72
4	247.22	245.18	243.20	241.32	239.75	238.50	237.48	237.68	240.18	244.35	246.74	245.64
5	247.16	245.10	243.13	241.25	239.70	238.45	237.46	237.68	240.32	244.40	246.76	245.59
6	247.12	245.02	243.05	241.18	239.66	238.40	237.46	237.70	240.50	244.45	246.76	245.54
7	247.07	244.96	242.98	241.11	239.61	238.35	237.46	237.72	240.75	244.50	246.78	245.47
8	247.02	244.88	242.90	241.05	239.56	238.30	237.44	237.76	241.00	244.55	246.78	245.40
9	246.98	244.81	242.85	240.99	239.52	238.25	237.42	237.80	241.22	244.62	246.78	245.32
10	246.93	244.73	242.80	240.93	239.48	238.20	237.40	237.84	241.40	244.72	246.80	245.27
11	246.87	244.66	242.75	240.87	239.44	238.16	237.40	237.90	241.60	244.82	246.80	245.23
12	246.82	244.58	242.70	240.82	239.41	238.12	237.40	237.95	241.78	244.90	246.78	245.18
13	246.76	244.52	242.65	240.76	239.38	238.07	237.40	238.00	241.85	245.02	246.75	245.13
14	246.71	244.44	242.60	240.71	239.35	238.03	237.40	238.06	241.95	245.12	246.72	245.07
15	246.64	244.36	242.53	240.66	239.33	238.00	237.38	238.12	242.02	245.24	246.70	245.02
16	246.57	244.27	242.47	240.61	239.30	237.96	237.35	238.20	242.32	245.37	246.67	244.96
17	246.49	244.18	242.40	240.56	239.26	237.91	237.33	238.30	242.44	245.46	246.62	244.92
18	246.41	244.09	242.33	240.51	239.23	237.86	237.31	238.38	242.62	245.58	246.57	244.90
19	246.34	244.02	242.26	240.46	239.19	237.82	237.30	238.50	242.92	245.66	246.52	244.85
20	246.27	243.94	242.20	240.41	239.16	237.79	237.30	238.62	243.10	245.76	246.48	244.80
21	246.20	243.89	242.15	240.37	239.12	237.77	237.30	238.72	243.23	245.88	246.42	244.72
22	246.12	243.82	242.08	240.33	239.08	237.74	237.32	238.85	243.33	246.00	246.36	244.65
23	246.05	243.76	242.02	240.28	239.04	237.70	237.34	238.96	243.45	246.10	246.30	244.58
24	245.98	243.69	241.97	240.23	239.00	237.67	237.38	239.05	243.57	246.18	246.25	244.50
25	245.91	243.62	241.90	240.18	238.95	237.65	237.42	239.15	243.70	246.30	246.19	244.45
26	245.84	243.56	241.83	240.13	238.90	237.65	237.45	239.25	243.82	246.40	246.13	244.38
27	245.77	243.51	241.75	240.08	238.86	237.63	237.47	239.34	243.92	246.48	246.08	244.30
28	245.70	243.46	241.68	240.03	238.82	237.60	237.50	239.45	244.00	246.55	246.00	244.22
29	245.63		241.64	239.98	238.78	237.60	237.53	239.55	244.15	246.60	245.94	244.14
30	245.55		241.60	239.93	238.74	237.58	237.56	239.62	244.25	246.63	245.90	244.08
31	245.47		241.56		238.69		237.58	239.70		246.67		244.03

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2003

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	243.98	242.32	240.66	238.94	237.84	236.52	237.10	238.43	241.20	250.00	255.70	255.57
2	243.92	242.27	240.60	238.88	237.80	236.50	237.18	238.50	241.33	250.40	255.75	255.52
3	243.88	242.20	240.55	238.82	237.75	236.50	237.24	238.55	241.50	250.73	255.80	255.46
4	243.83	242.15	240.50	238.77	237.70	236.50	237.28	238.58	241.70	251.05	255.85	255.41
5	243.78	242.09	240.46	238.72	237.65	236.48	237.28	238.60	241.95	251.35	255.88	255.35
6	243.74	242.04	240.42	238.66	237.60	236.48	237.28	238.55	242.25	251.67	255.90	255.29
7	243.70	242.00	240.37	238.62	237.54	236.46	237.28	238.53	242.70	252.00	255.93	255.25
8	243.64	241.95	240.31	238.58	237.49	236.44	237.28	238.53	243.00	252.20	255.95	255.21
9	243.58	241.89	240.25	238.53	237.43	236.44	237.30	238.53	243.25	252.44	255.95	255.18
10	243.52	241.84	240.18	238.47	237.38	236.44	237.32	238.55	243.45	252.75	255.97	255.13
11	243.48	241.76	240.10	238.42	237.34	236.42	237.34	238.60	243.70	252.95	255.97	255.07
12	243.43	241.66	240.02	238.38	237.30	236.42	237.36	238.70	244.00	253.05	256.00	255.02
13	243.37	241.58	239.95	238.34	237.25	236.44	237.36	238.76	244.30	253.30	256.02	254.96
14	243.32	241.52	239.88	238.30	237.20	236.46	237.36	238.80	244.60	253.55	256.04	254.90
15	243.26	241.47	239.83	238.28	237.14	236.46	237.38	238.85	244.85	253.80	256.04	254.85
16	243.20	241.43	239.77	238.28	237.08	236.48	237.38	238.93	245.10	254.00	256.04	254.80
17	243.15	241.40	239.72	238.28	237.04	236.50	237.40	239.00	245.40	254.30	256.04	254.76
18	243.08	241.37	239.66	238.26	237.00	236.54	237.45	239.08	245.66	254.53	256.02	254.73
19	243.00	241.32	239.60	238.22	236.97	236.58	237.50	239.20	246.00	254.70	256.00	254.70
20	242.95	241.26	239.55	238.22	236.94	236.60	237.55	239.30	246.40	254.80	255.97	254.67
21	242.88	241.18	239.50	238.22	236.90	236.63	237.62	239.42	246.70	254.92	255.95	254.65
22	242.82	241.10	239.44	238.20	236.87	236.65	237.68	239.60	247.10	254.96	255.92	254.62
23	242.76	241.03	239.40	238.17	236.83	236.70	237.74	239.80	247.50	255.10	255.90	254.57
24	242.70	240.98	239.35	238.14	236.80	236.76	237.82	239.95	247.80	255.22	255.87	254.52
25	242.65	240.92	239.29	238.10	236.77	236.80	237.90	240.15	248.14	255.34	255.83	254.46
26	242.60	240.85	239.25	238.04	236.73	236.86	238.00	240.40	248.50	255.45	255.80	254.42
27	242.56	240.79	239.20	237.98	236.70	236.90	238.06	240.60	248.80	255.50	255.75	254.39
28	242.53	240.73	239.14	237.94	236.66	236.94	238.16	240.70	249.00	255.54	255.70	254.37
29	242.49		239.08	237.90	236.62	236.98	238.24	240.80	249.30	255.60	255.65	254.34
30	242.44		239.04	237.88	236.59	237.04	238.30	240.95	249.56	255.63	255.61	254.30
31	242.38		239.00		236.55		238.38	241.10		255.67		254.25

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2004

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	254.20	252.87	251.20	249.48	248.06	246.89	245.56	245.58	248.80	254.75	256.73	255.83
2	254.15	252.82	251.15	249.44	248.03	246.87	245.51	245.66	248.95	254.95	256.75	255.79
3	254.12	252.78	251.10	249.40	248.00	246.84	245.46	245.72	249.10	255.10	256.75	255.74
4	254.08	252.74	251.05	249.35	247.95	246.80	245.42	245.80	249.30	255.20	256.73	255.68
5	254.03	252.70	251.02	249.30	247.89	246.77	245.38	245.88	249.50	255.28	256.70	255.62
6	254.00	252.65	250.98	249.25	247.83	246.75	245.34	246.00	249.70	255.40	256.70	255.58
7	253.95	252.60	250.94	249.21	247.78	246.72	245.32	246.10	249.90	255.55	256.68	255.52
8	253.90	252.54	250.90	249.18	247.74	246.70	245.30	246.16	250.06	255.65	256.65	255.46
9	253.86	252.48	250.85	249.15	247.70	246.67	245.28	246.22	250.30	255.75	256.62	255.40
10	253.82	252.42	250.80	249.10	247.66	246.64	245.28	246.26	250.55	255.85	256.60	255.34
11	253.78	252.36	250.73	249.05	247.61	246.60	245.28	246.30	250.80	255.97	256.57	255.28
12	253.75	252.30	250.66	249.00	247.57	246.55	245.30	246.35	251.10	256.10	256.53	255.22
13	253.70	252.23	250.60	248.94	247.53	246.50	245.32	246.45	251.30	256.18	256.50	255.16
14	253.65	252.16	250.56	248.88	247.48	246.44	245.32	246.60	251.55	256.28	256.47	255.10
15	253.58	252.10	250.50	248.82	247.45	246.39	245.35	246.75	251.80	256.36	256.43	255.05
16	253.54	252.04	250.44	248.77	247.42	246.35	245.37	246.83	252.00	256.43	256.38	254.98
17	253.50	251.98	250.37	248.71	247.40	246.30	245.37	246.90	252.20	256.48	256.34	254.92
18	253.45	251.92	250.30	248.66	247.37	246.25	245.39	246.97	252.40	256.52	256.29	254.85
19	253.40	251.85	250.23	248.62	247.34	246.20	245.39	247.03	252.58	256.54	256.25	254.80
20	253.35	251.78	250.17	248.57	247.32	246.15	245.40	247.08	252.80	256.57	256.20	254.75
21	253.31	251.72	250.10	248.52	247.28	246.10	245.40	247.14	252.90	256.59	256.17	254.70
22	253.27	251.66	250.05	248.46	247.24	246.05	245.40	247.18	253.05	256.60	256.14	254.64
23	253.24	251.60	250.00	248.41	247.21	246.00	245.40	247.28	253.25	256.60	256.10	254.59
24	253.20	251.55	249.93	248.37	247.18	245.94	245.40	247.40	253.50	256.60	256.07	254.55
25	253.16	251.50	249.86	248.32	247.14	245.88	245.40	247.55	253.70	256.62	256.04	254.50
26	253.13	251.43	249.79	248.26	247.10	245.83	245.40	247.72	253.90	256.64	256.00	254.44
27	253.10	251.38	249.73	248.22	247.06	245.77	245.40	247.85	254.10	256.66	255.97	254.40
28	253.06	251.31	249.67	248.18	247.02	245.72	245.42	248.00	254.25	256.68	255.94	254.34
29	253.02		249.62	248.15	246.99	245.67	245.45	248.20	254.40	256.68	255.90	254.28
30	252.98		249.57	248.10	246.95	245.62	245.48	248.40	254.55	256.70	255.87	254.21
31	252.93		249.52		246.92		245.52	248.65		256.70		254.15

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2005

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	254.10	252.23	250.35	248.63	247.00	245.28	244.40	244.80	246.28	250.12	253.40	251.97
2	254.05	252.15	250.30	248.56	246.97	245.22	244.40	244.88	246.38	250.22	253.40	251.90
3	254.00	252.07	250.22	248.50	246.92	245.18	244.40	244.98	246.50	250.30	253.42	251.82
4	253.95	251.99	250.17	248.45	246.87	245.15	244.40	245.10	246.60	250.40	253.42	251.76
5	253.90	251.93	250.12	248.40	246.84	245.12	244.37	245.20	246.70	250.50	253.40	251.76
6	253.86	251.85	250.07	248.35	246.80	245.10	244.35	245.25	246.85	250.62	253.38	251.70
7	253.82	251.78	250.03	248.28	246.74	245.06	244.35	245.30	246.95	250.72	253.35	251.54
8	253.78	251.70	249.98	248.21	246.70	245.02	244.32	245.34	247.05	250.85	253.32	251.48
9	253.72	251.63	249.94	248.16	246.67	244.98	244.28	245.38	247.20	251.00	253.28	251.43
10	253.66	251.55	249.88	248.10	246.63	244.95	244.23	245.43	247.35	251.20	253.23	251.37
11	253.59	251.48	249.82	248.04	246.58	244.92	244.20	245.46	247.50	251.35	253.18	251.32
12	253.52	251.40	249.74	247.98	246.52	244.90	244.15	245.48	247.60	251.50	253.13	251.27
13	253.44	251.32	249.66	247.91	246.46	244.87	244.12	245.50	247.70	251.65	253.10	251.22
14	253.37	251.26	249.60	247.85	246.39	244.84	244.09	245.54	247.85	251.80	253.05	251.17
15	253.27	251.20	249.56	247.80	246.32	244.80	244.07	245.57	248.00	251.94	253.00	251.12
16	253.20	251.14	249.50	247.75	246.26	244.75	244.03	245.60	248.10	252.10	252.95	251.06
17	253.13	251.07	249.44	247.70	246.20	244.70	244.00	245.65	248.20	252.25	252.90	251.00
18	253.13	251.00	249.40	247.66	246.14	244.65	244.00	245.68	248.35	252.38	252.84	250.93
19	253.06	250.92	249.35	247.61	246.07	244.60	244.00	245.72	248.50	252.50	252.78	250.87
20	253.00	250.85	249.31	247.57	246.00	244.56	244.00	245.74	248.60	252.60	252.72	250.80
21	252.95	250.79	249.27	247.52	245.94	244.53	244.02	245.77	248.70	252.74	252.66	250.74
22	252.90	250.72	249.23	247.47	245.90	244.50	244.05	245.80	248.80	252.86	252.58	250.70
23	252.83	250.66	249.18	247.42	245.85	244.48	244.10	245.80	248.92	252.92	252.50	250.63
24	252.77	250.59	249.14	247.38	245.80	244.46	244.15	245.83	249.05	253.00	252.44	250.54
25	252.70	250.53	249.10	247.35	245.73	244.43	244.18	245.85	249.20	253.10	252.36	250.50
26	252.64	250.48	249.04	247.31	245.66	244.43	244.23	245.85	249.35	253.18	252.30	250.45
27	252.56	250.44	248.98	247.25	245.60	244.43	244.30	245.88	249.50	253.24	252.25	250.40
28	252.48	250.40	248.92	247.18	245.53	244.40	244.40	245.92	249.70	253.30	252.20	250.33
29	252.42		248.85	247.11	245.46	244.40	244.46	246.00	249.85	253.35	252.13	250.25
30	252.36		248.77	247.04	245.39	244.40	244.56	246.10	250.00	253.38	252.05	250.17
31	252.30		248.70		245.33		244.68	246.20		253.40		250.10

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2006

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	250.03	247.92	246.03	243.75	241.49	239.73	238.49	236.99	236.73	241.10	246.10	245.65
2	249.97	247.86	245.96	243.67	241.44	239.68	238.45	236.96	236.73	241.20	246.20	245.61
3	249.90	247.78	245.88	243.59	241.38	239.64	238.42	236.93	236.75	241.50	246.30	245.57
4	249.82	247.72	245.80	243.51	241.31	239.60	238.38	236.90	236.79	241.70	246.30	245.53
5	249.74	247.65	245.73	243.43	241.25	239.56	238.34	236.90	236.84	241.90	246.30	245.49
6	249.67	247.59	245.65	243.35	241.17	239.51	238.30	236.90	236.90	242.00	246.30	245.44
7	249.60	247.52	245.58	243.27	241.10	239.46	238.25	236.92	237.00	242.15	246.30	245.39
8	249.54	247.44	245.52	243.19	241.04	239.41	238.21	236.94	237.08	242.30	246.35	245.34
9	249.48	247.37	245.45	243.10	240.96	239.36	238.17	236.94	237.20	242.55	246.38	245.29
10	249.42	247.31	245.37	243.02	240.89	239.32	238.13	236.94	237.40	242.70	246.40	245.25
11	249.36	247.25	245.30	242.94	240.82	239.27	238.08	236.94	237.55	242.90	246.42	245.20
12	249.30	247.19	245.23	242.85	240.74	239.23	238.04	236.94	237.65	243.15	246.42	245.14
13	249.22	247.12	245.16	242.76	240.66	239.18	237.98	236.92	237.85	243.30	246.40	245.08
14	249.15	247.05	245.08	242.67	240.60	239.13	237.92	236.90	238.00	243.50	246.36	245.00
15	249.00	247.00	245.00	242.58	240.54	239.08	237.87	236.90	238.15	243.80	246.32	244.92
16	248.92	246.95	244.93	242.50	240.48	239.04	237.82	236.90	238.30	243.95	246.27	244.84
17	248.84	246.89	244.86	242.42	240.43	239.00	237.77	236.87	238.50	244.05	246.23	244.77
18	248.84	246.83	244.80	242.34	240.37	238.96	237.71	236.84	238.70	244.20	246.20	244.70
19	248.78	246.78	244.73	242.27	240.32	238.92	237.66	236.82	238.90	244.40	246.16	244.63
20	248.72	246.73	244.67	242.22	240.27	238.88	237.60	236.80	239.10	244.70	246.13	244.56
21	248.65	246.67	244.59	242.15	240.22	238.85	237.55	236.80	239.40	244.90	246.10	244.49
22	248.59	246.59	244.50	242.07	240.17	238.82	237.50	236.80	239.55	245.00	246.05	244.42
23	248.52	246.52	244.43	241.98	240.12	238.78	237.45	236.80	239.70	245.20	246.00	244.35
24	248.44	246.44	244.36	241.90	240.07	238.75	237.40	236.80	239.85	245.40	245.95	244.28
25	248.37	246.36	244.30	241.83	240.02	238.72	237.34	236.78	240.00	245.50	245.90	244.21
26	248.30	246.28	244.22	241.77	239.98	238.69	237.29	236.75	240.20	245.60	245.86	244.15
27	248.22	246.20	244.14	241.70	239.94	238.65	237.24	236.75	240.40	245.70	245.82	244.09
28	248.16	246.11	244.06	241.64	239.90	238.61	237.18	236.77	240.60	245.80	245.77	244.02
29	248.10		243.98	241.58	239.87	238.57	237.13	236.77	240.75	246.00	245.73	243.95
30	248.04		243.90	241.53	239.82	238.53	237.08	236.75	240.90	246.00	245.69	243.89
31	247.97		243.82		239.78		237.03	236.73		246.00		243.82

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2007

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	243.75	241.47	239.35	237.32	236.30	235.86	235.48	235.28	239.85	252.80	256.40	255.71
2	243.68	241.40	239.27	237.27	236.27	235.84	235.46	235.36	240.25	253.10	256.40	255.67
3	243.61	241.33	239.20	237.22	236.24	235.82	235.44	235.46	240.55	253.40	256.40	255.65
4	243.55	241.27	239.12	237.17	236.22	235.80	235.42	235.56	240.95	253.75	256.45	255.65
5	243.49	241.20	239.05	237.13	236.19	235.80	235.39	235.61	241.40	254.05	256.50	255.65
6	243.42	241.13	238.97	237.09	236.17	235.78	235.36	235.61	241.80	254.20	256.50	255.63
7	243.36	241.05	238.89	237.05	236.15	235.78	235.33	235.68	242.30	254.55	256.40	255.61
8	243.30	240.97	238.82	237.02	236.13	235.78	235.30	235.73	242.85	254.70	256.40	255.58
9	243.23	240.90	238.75	236.99	236.10	235.78	235.27	235.80	243.25	254.90	256.40	255.56
10	243.16	240.83	238.68	236.96	236.08	235.78	235.24	235.88	243.80	255.10	256.40	255.53
11	243.09	240.76	238.61	236.93	236.06	235.80	235.21	236.00	244.30	255.30	256.38	255.50
12	243.00	240.69	238.55	236.90	236.06	235.80	235.18	236.10	244.80	255.40	256.38	255.46
13	242.93	240.62	238.48	236.87	236.06	235.80	235.16	236.18	245.40	255.50	256.38	255.41
14	242.85	240.55	238.41	236.83	236.04	235.78	235.13	236.24	245.80	255.60	256.34	255.35
15	242.70	240.47	238.33	236.80	236.04	235.78	235.10	236.34	246.10	255.70	256.30	255.30
16	242.62	240.39	238.26	236.77	236.04	235.78	235.07	236.48	246.50	255.80	256.25	255.25
17	242.55	240.30	238.20	236.74	236.04	235.76	235.04	236.60	246.95	255.85	256.25	255.22
18	242.55	240.22	238.14	236.71	236.04	235.74	235.02	236.75	247.45	255.85	256.22	255.19
19	242.47	240.14	238.08	236.68	236.04	235.72	235.00	237.00	247.85	256.00	256.16	255.15
20	242.39	240.06	238.02	236.65	236.04	235.70	234.98	237.20	248.30	256.00	256.10	255.10
21	242.31	239.99	237.96	236.62	236.04	235.68	234.96	237.40	248.75	256.05	256.05	255.07
22	242.24	239.90	237.90	236.60	236.04	235.66	234.96	237.60	249.20	256.10	256.00	255.05
23	242.17	239.82	237.84	236.58	236.02	235.64	234.96	237.78	249.60	256.10	255.96	255.02
24	242.09	239.74	237.78	236.55	236.00	235.62	234.96	238.00	250.00	256.10	255.93	255.00
25	242.01	239.66	237.72	236.51	235.98	235.60	234.96	238.20	250.45	256.15	255.90	254.97
26	241.93	239.59	237.66	236.47	235.96	235.58	234.98	238.38	251.00	256.20	255.88	254.93
27	241.85	239.51	237.60	236.43	235.94	235.56	235.01	238.54	251.30	256.25	255.85	254.90
28	241.77	239.43	237.54	236.39	235.94	235.54	235.05	238.80	251.70	256.35	255.82	254.87
29	241.70		237.48	236.36	235.92	235.52	235.10	239.04	252.20	256.35	255.80	254.84
30	241.62		237.43	236.33	235.90	235.50	235.15	239.27	252.50	256.35	255.75	254.79
31	241.54		237.37		235.88		235.20	239.50		256.40		254.74

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2008

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	254.70	253.05	251.30	249.16	247.43	246.00	245.00	246.55	253.10	261.60	266.35	265.09
2	254.68	253.00	251.21	249.11	247.38	245.95	245.00	246.65	253.40	261.85	266.35	265.03
3	254.65	252.94	251.12	249.07	247.34	245.90	245.00	246.85	253.70	262.10	266.35	264.97
4	254.60	252.90	251.04	249.02	247.30	245.87	245.00	247.10	254.10	262.40	266.33	264.91
5	254.55	252.84	250.96	248.97	247.26	245.85	244.97	247.30	254.40	262.65	266.31	264.86
6	254.50	252.77	250.87	248.92	247.23	245.82	244.95	247.40	254.75	262.90	266.27	264.81
7	254.46	252.70	250.78	248.88	247.20	245.80	244.95	247.48	255.10	263.10	266.23	264.78
8	254.40	252.64	250.69	248.82	247.15	245.80	244.98	247.60	255.40	263.25	266.21	264.75
9	254.35	252.60	250.62	248.76	247.10	245.76	245.00	247.75	255.70	263.45	266.17	264.70
10	254.30	252.55	250.56	248.69	247.06	245.72	245.00	247.90	256.00	263.65	266.14	264.65
11	254.23	252.50	250.48	248.60	247.02	245.68	245.02	248.10	256.40	263.85	266.09	264.60
12	254.17	252.45	250.42	248.52	246.98	245.63	245.04	248.20	256.70	264.10	266.05	264.54
13	254.12	252.41	250.37	248.44	246.93	245.59	245.07	248.40	257.00	264.35	266.00	264.49
14	254.06	252.35	250.30	248.36	246.89	245.56	245.10	248.60	257.35	264.60	265.97	264.44
15	253.98	252.28	250.23	248.29	246.86	245.54	245.12	248.80	257.70	264.70	265.94	264.40
16	253.90	252.22	250.18	248.23	246.80	245.50	245.15	249.00	258.00	264.90	265.90	264.35
17	253.84	252.17	250.13	248.18	246.76	245.47	245.20	249.20	258.30	265.10	265.87	264.30
18	253.80	252.12	250.05	248.13	246.70	245.44	245.23	249.45	258.60	265.25	265.82	264.25
19	253.76	252.06	250.00	248.07	246.65	245.42	245.27	249.60	258.80	265.35	265.77	264.20
20	253.70	252.00	249.93	247.99	246.58	245.39	245.30	249.75	259.05	265.55	265.72	264.15
21	253.66	251.95	249.88	247.92	246.53	245.34	245.34	249.90	259.30	265.75	265.66	264.11
22	253.62	251.90	249.82	247.84	246.46	245.30	245.40	250.10	259.55	265.85	265.60	264.06
23	253.57	251.84	249.77	247.78	246.38	245.26	245.50	250.35	259.80	265.90	265.55	264.00
24	253.52	251.76	249.73	247.73	246.32	245.22	245.56	250.65	259.95	266.00	265.50	263.95
25	253.47	251.68	249.67	247.68	246.27	245.18	245.62	250.95	260.15	266.10	265.44	263.90
26	253.41	251.60	249.60	247.63	246.23	245.15	245.68	251.20	260.35	266.15	265.37	263.84
27	253.35	251.53	249.52	247.60	246.18	245.10	245.80	251.38	260.55	266.20	265.30	263.79
28	253.30	251.44	249.45	247.57	246.14	245.06	246.00	251.60	260.85	266.25	265.24	263.75
29	253.23	251.38	249.36	247.52	246.10	245.03	246.15	252.00	261.15	266.30	265.18	263.70
30	253.17		249.28	247.48	246.07	245.00	246.30	252.40	261.35	266.35	265.13	263.64
31	253.11		249.21		246.04		246.40	252.85		266.35		263.58

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2009

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	263.53	261.61	259.84	258.07	256.85	254.96	253.98	254.11	258.95	266.50	270.37	270.24
2	263.47	261.54	259.79	258.01	256.80	254.88	253.95	254.14	259.15	266.75	270.37	270.20
3	263.41	261.47	259.73	257.95	256.75	254.80	253.93	254.18	259.35	266.95	270.39	270.14
4	263.36	261.40	259.67	257.89	256.71	254.73	253.91	254.23	259.55	267.20	270.40	270.08
5	263.31	261.33	259.61	257.84	256.66	254.66	253.91	254.30	259.70	267.50	270.40	270.02
6	263.25	261.27	259.55	257.80	256.61	254.59	253.91	254.40	259.90	267.75	270.42	269.97
7	263.18	261.20	259.48	257.76	256.56	254.53	253.89	254.52	260.15	268.00	270.42	269.92
8	263.12	261.14	259.43	257.73	256.51	254.48	253.89	254.67	260.40	268.20	270.42	269.86
9	263.05	261.08	259.38	257.70	256.46	254.42	253.89	254.87	260.70	268.40	270.45	269.80
10	262.98	261.02	259.32	257.66	256.41	254.37	253.89	255.10	260.90	268.60	270.47	269.74
11	262.93	260.96	259.26	257.61	256.37	254.32	253.89	255.25	261.15	268.75	270.50	269.67
12	262.87	260.90	259.20	257.57	256.31	254.27	253.89	255.40	261.40	268.90	270.50	269.60
13	262.80	260.84	259.14	257.53	256.25	254.23	253.92	255.55	261.65	269.00	270.50	269.53
14	262.74	260.78	259.08	257.50	256.19	254.19	253.92	255.75	261.95	269.15	270.50	269.46
15	262.68	260.72	259.03	257.46	256.12	254.15	253.92	255.85	262.20	269.25	270.50	269.38
16	262.62	260.67	258.98	257.42	256.06	254.11	253.92	256.00	262.50	269.35	270.50	269.30
17	262.56	260.61	258.93	257.38	256.00	254.08	253.92	256.20	262.80	269.45	270.50	269.20
18	262.51	260.55	258.88	257.34	255.95	254.06	253.92	256.40	263.10	269.55	270.50	269.10
19	262.46	260.49	258.83	257.31	255.88	254.04	253.94	256.60	263.40	269.70	270.50	269.00
20	262.40	260.43	258.78	257.28	255.81	254.02	253.96	256.80	263.70	269.80	270.50	268.92
21	262.34	260.37	258.73	257.25	255.74	254.02	253.96	257.00	264.00	269.90	270.50	268.86
22	262.28	260.30	258.67	257.22	255.67	254.02	253.98	257.20	264.25	270.00	270.50	268.80
23	262.22	260.24	258.61	257.19	255.60	254.02	254.00	257.35	264.50	270.08	270.48	268.74
24	262.17	260.17	258.55	257.15	255.54	254.02	254.00	257.50	264.70	270.08	270.46	268.66
25	262.12	260.09	258.49	257.11	255.48	254.00	254.00	257.70	264.95	270.13	270.43	268.60
26	262.06	260.01	258.43	257.07	255.42	254.00	254.01	257.90	265.20	270.20	270.40	268.54
27	262.00	259.95	258.37	257.03	255.35	254.00	254.03	258.05	265.50	270.20	270.37	268.46
28	261.93	259.90	258.30	256.99	255.27	254.00	254.03	258.20	265.80	270.20	270.33	268.38
29	261.85		258.24	256.95	255.19	254.00	254.05	258.35	266.00	270.25	270.30	268.30
30	261.77		258.19	256.90	255.11	253.98	254.07	258.55	266.25	270.30	270.27	268.22
31	261.69		258.13		255.03		254.09	258.75		270.35		268.16

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2010

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	268.08	266.09	264.40	262.56	260.66	258.95	257.95	257.68	259.80	270.10	277.07	276.64
2	268.02	266.03	264.35	262.48	260.60	258.89	257.95	257.68	260.00	270.50	277.27	276.60
3	267.97	265.98	264.28	262.40	260.55	258.85	257.95	257.64	260.12	270.80	277.33	276.54
4	267.92	265.90	264.23	262.32	260.50	258.76	257.95	257.60	260.32	271.10	277.32	276.50
5	267.84	265.84	264.15	262.28	260.45	258.71	257.95	257.57	260.52	271.40	277.35	276.48
6	267.78	265.80	264.07	262.22	260.40	258.67	257.93	257.54	260.70	271.70	277.40	276.44
7	267.72	265.75	264.02	262.16	260.35	258.63	257.88	257.51	260.90	272.00	277.50	276.40
8	267.64	265.70	263.97	262.08	260.30	258.60	257.84	257.51	261.10	272.30	277.54	276.35
9	267.56	265.62	263.90	262.00	260.25	258.60	257.80	257.50	261.35	272.60	277.54	276.30
10	267.50	265.56	263.82	261.94	260.20	258.60	257.77	257.50	261.55	273.00	277.42	276.26
11	267.45	265.48	263.76	261.88	260.14	258.63	257.77	257.50	261.75	273.30	277.50	276.22
12	267.39	265.42	263.70	261.82	260.08	258.63	257.80	257.50	262.10	273.50	277.50	276.18
13	267.31	265.38	263.65	261.74	260.03	258.58	257.80	257.50	262.40	273.70	277.42	276.14
14	267.23	265.32	263.60	261.66	259.98	258.54	257.80	257.50	262.70	274.00	277.35	276.08
15	267.17	265.27	263.55	261.58	259.92	258.50	257.80	257.50	262.95	274.20	277.35	276.05
16	267.11	265.21	263.49	261.52	259.87	258.46	257.80	257.55	263.30	274.40	277.32	276.02
17	267.06	265.13	263.43	261.46	259.80	258.42	257.80	257.60	263.65	274.60	277.28	275.98
18	267.00	265.08	263.38	261.40	259.74	258.37	257.80	257.70	264.00	274.80	277.25	275.94
19	266.94	265.02	263.33	261.34	259.66	258.32	257.80	257.85	264.50	275.00	277.10	275.88
20	266.89	264.94	263.27	261.28	259.60	258.28	257.80	257.95	265.00	275.15	277.13	275.82
21	266.81	264.88	263.22	261.23	259.55	258.25	257.82	258.15	265.50	275.50	277.00	275.78
22	266.75	264.83	263.17	261.17	259.50	258.20	257.84	258.35	266.00	275.70	276.94	275.74
23	266.68	264.78	263.12	261.12	259.45	258.17	257.84	258.55	266.50	275.80	276.90	275.70
24	266.63	264.73	263.06	261.06	259.40	258.13	257.84	258.75	267.00	275.85	276.84	275.66
25	266.57	264.65	262.98	261.00	259.35	258.13	257.84	258.90	267.50	276.05	276.80	275.61
26	266.49	264.57	262.92	260.95	259.30	258.10	257.84	259.00	268.00	276.25	276.78	275.56
27	266.41	264.50	262.87	260.89	259.25	258.08	257.82	259.15	268.50	276.40	276.75	275.50
28	266.33	264.45	262.82	260.84	259.20	258.05	257.80	259.25	269.00	276.45	276.70	275.47
29	266.25		262.76	260.78	259.14	258.00	257.77	259.40	269.40	276.60	276.70	275.45
30	266.19		262.68	260.72	259.09	257.97	257.75	259.55	269.80	276.80	276.68	275.42
31	266.14		262.62		259.02		257.72	259.65		276.98		275.40

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2011

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	275.37	273.75	272.36	270.75	269.08	267.39	266.40	266.65	267.70	271.67	274.73	273.57
2	275.33	273.70	272.32	270.69	269.02	267.35	266.37	266.65	267.80	271.80	274.73	273.52
3	275.30	273.65	272.26	270.63	268.96	267.30	266.33	266.65	267.95	271.90	274.73	273.47
4	275.26	273.62	272.20	270.57	268.90	267.26	266.30	266.65	268.10	272.00	274.73	273.42
5	275.22	273.59	272.15	270.52	268.85	267.22	266.27	266.65	268.15	272.10	274.73	273.37
6	275.16	273.54	272.10	270.46	268.79	267.18	266.24	266.70	268.25	272.20	274.73	273.32
7	275.10	273.50	272.05	270.40	268.73	267.14	266.20	266.73	268.32	272.28	274.70	273.27
8	275.05	273.44	272.00	270.34	268.67	267.11	266.16	266.77	268.40	272.38	274.67	273.22
9	275.00	273.36	271.95	270.27	268.61	267.08	266.13	266.81	268.50	272.48	274.64	273.18
10	274.95	273.28	271.90	270.22	268.56	267.06	266.10	266.84	268.65	272.60	274.60	273.13
11	274.90	273.23	271.86	270.17	268.51	267.04	266.08	266.87	268.75	272.75	274.57	273.08
12	274.85	273.18	271.80	270.10	268.44	267.02	266.08	266.90	268.85	272.90	274.54	273.03
13	274.80	273.10	271.74	270.04	268.38	267.00	266.08	266.93	269.00	273.10	274.50	272.98
14	274.75	273.06	271.69	270.00	268.33	266.95	266.08	266.97	269.12	273.30	274.44	272.92
15	274.70	273.00	271.63	269.95	268.28	266.91	266.08	267.00	269.22	273.45	274.40	272.86
16	274.65	272.95	271.58	269.89	268.23	266.89	266.08	267.00	269.32	273.55	274.35	272.80
17	274.60	272.90	271.54	269.83	268.17	266.84	266.08	267.03	269.42	273.65	274.30	272.75
18	274.55	272.82	271.49	269.79	268.12	266.80	266.10	267.06	269.57	273.80	274.24	272.69
19	274.50	272.76	271.44	269.75	268.07	266.78	266.14	267.06	269.70	273.92	274.19	272.63
20	274.45	272.72	271.39	269.69	268.02	266.76	266.17	267.06	269.90	274.00	274.14	272.57
21	274.38	272.68	271.34	269.63	267.97	266.72	266.21	267.08	270.05	274.00	274.09	272.51
22	274.30	272.63	271.30	269.58	267.93	266.67	266.26	267.10	270.25	274.05	274.03	272.45
23	274.27	272.58	271.25	269.53	267.90	266.64	266.31	267.10	270.45	274.15	273.98	272.40
24	274.22	272.54	271.22	269.49	267.84	266.60	266.36	267.10	270.67	274.25	273.93	272.35
25	274.16	272.48	271.17	269.45	267.78	266.58	266.42	267.12	270.80	274.30	273.90	272.30
26	274.09	272.45	271.11	269.40	267.70	266.55	266.48	267.15	271.00	274.40	273.85	272.25
27	274.02	272.42	271.05	269.32	267.64	266.52	266.54	267.18	271.15	274.48	273.79	272.20
28	273.95	272.40	271.00	269.26	267.58	266.50	266.58	267.24	271.30	274.58	273.72	272.14
29	273.90		270.94	269.20	267.53	266.47	266.61	267.36	271.42	274.64	273.66	272.09
30	273.84		270.88	269.14	267.48	266.44	266.63	267.50	271.52	274.69	273.61	272.03
31	273.80		270.82		267.43		266.65	267.58		274.73		271.97

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2012

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	271.90	269.77	267.92	265.92	264.08	262.55	261.40	263.20	264.04	267.60	270.75	270.00
2	271.83	269.70	267.84	265.84	264.04	262.49	261.38	263.28	264.10	267.75	270.75	269.96
3	271.76	269.63	267.76	265.78	264.00	262.44	261.38	263.34	264.14	267.90	270.75	269.92
4	271.70	269.56	267.68	265.70	263.96	262.40	261.38	263.40	264.18	268.05	270.75	269.88
5	271.64	269.49	267.60	265.62	263.91	262.36	261.38	263.44	264.20	268.20	270.75	269.82
6	271.57	269.42	267.54	265.54	263.86	262.32	261.38	263.48	264.25	268.35	270.75	269.76
7	271.50	269.35	267.48	265.46	263.80	262.28	261.38	263.52	264.30	268.45	270.75	269.71
8	271.43	269.29	267.40	265.38	263.75	262.22	261.38	263.56	264.40	268.60	270.75	269.66
9	271.35	269.22	267.32	265.31	263.70	262.18	261.40	263.60	264.50	268.75	270.75	269.60
10	271.27	269.17	267.24	265.24	263.65	262.15	261.50	263.65	264.60	268.95	270.75	269.54
11	271.20	269.12	267.18	265.16	263.60	262.11	261.60	263.70	264.75	269.10	270.75	269.48
12	271.14	269.05	267.13	265.10	263.56	262.06	261.70	263.75	264.85	269.25	270.75	269.43
13	271.09	268.98	267.09	265.02	263.51	262.01	261.85	263.79	264.95	269.40	270.75	269.38
14	271.03	268.92	267.03	264.94	263.47	261.96	261.95	263.82	265.05	269.55	270.75	269.33
15	270.97	268.84	266.98	264.88	263.44	261.92	262.10	263.85	265.15	269.70	270.73	269.28
16	270.90	268.76	266.93	264.82	263.40	261.88	262.25	263.85	265.25	269.85	270.70	269.24
17	270.83	268.68	266.87	264.76	263.35	261.83	262.35	263.85	265.35	269.95	270.70	269.20
18	270.76	268.60	266.82	264.72	263.30	261.79	262.45	263.85	265.45	270.05	270.68	269.15
19	270.68	268.54	266.77	264.68	263.25	261.74	262.50	263.85	265.55	270.13	270.64	269.10
20	270.60	268.50	266.72	264.64	263.20	261.70	262.56	263.85	265.65	270.18	270.60	269.06
21	270.52	268.44	266.67	264.60	263.15	261.67	262.61	263.85	265.75	270.23	270.55	269.02
22	270.44	268.38	266.62	264.54	263.11	261.63	262.66	263.88	265.85	270.28	270.50	268.98
23	270.36	268.32	266.57	264.48	263.06	261.59	262.70	263.88	266.00	270.33	270.45	268.94
24	270.30	268.27	266.50	264.42	263.01	261.59	262.75	263.88	266.20	270.38	270.40	268.90
25	270.24	268.20	266.45	264.36	262.96	261.59	262.78	263.88	266.40	270.44	270.35	268.84
26	270.18	268.14	266.38	264.32	262.91	261.59	262.84	263.90	266.55	270.49	270.30	268.78
27	270.10	268.10	266.30	264.28	262.85	261.59	262.88	263.92	266.75	270.54	270.24	268.72
28	270.02	268.06	266.22	264.23	262.79	261.59	262.94	263.95	266.95	270.60	270.17	268.66
29	269.97	268.00	266.15	264.18	262.72	261.59	263.00	263.98	267.20	270.65	270.10	268.60
30	269.90		266.08	264.13	262.65	261.59	263.06	264.00	267.40	270.70	270.04	268.55
31	269.84		266.00		262.60		263.14	264.00		270.75		268.50

DAILY WATER LEVELS OF THE AKOSOMBO DAM, YEAR 2013

DATE	JAN	FEB	MAR	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
1	268.44	266.25	264.25	262.16	260.30	258.72	257.20	256.15	255.08	258.10	260.75	259.36
2	268.38	266.19	264.20	262.10	260.25	258.67	257.15	256.15	255.10	258.25	260.75	259.30
3	268.30	266.12	264.14	262.05	260.20	258.63	257.10	256.15	255.13	258.35	260.75	259.25
4	268.22	266.04	264.07	262.00	260.13	258.58	257.04	256.15	255.16	258.45	260.75	259.20
5	268.14	265.98	264.00	261.94	260.08	258.54	256.98	256.15	255.19	258.55	260.68	259.15
6	268.06	265.89	263.94	261.88	260.03	258.51	256.93	256.12	255.22	258.65	260.62	259.10
7	268.00	265.81	263.86	261.82	259.98	258.48	256.87	256.09	255.25	258.75	260.56	259.05
8	267.94	265.74	263.80	261.76	259.93	258.44	256.81	256.06	255.30	258.85	260.50	259.00
9	267.86	265.66	263.74	261.68	259.88	258.40	256.77	256.03	255.35	258.95	260.45	258.96
10	267.78	265.59	263.68	261.62	259.83	258.36	256.72	256.00	255.40	259.10	260.40	258.91
11	267.70	265.53	263.62	261.54	259.78	258.31	256.67	255.95	255.50	259.25	260.34	258.86
12	267.63	265.47	263.54	261.48	259.73	258.26	256.62	255.90	255.60	259.40	260.28	258.80
13	267.57	265.40	263.46	261.42	259.68	258.21	256.58	255.85	255.70	259.44	260.23	258.75
14	267.49	265.32	263.40	261.36	259.63	258.16	256.54	255.79	255.85	259.54	260.18	258.70
15	267.41	265.24	263.35	261.30	259.58	258.11	256.50	255.74	255.95	259.69	260.12	258.66
16	267.33	265.17	263.30	261.24	259.51	258.06	256.46	255.69	256.10	259.84	260.06	258.61
17	267.25	265.10	263.24	261.17	259.46	258.00	256.42	255.64	256.20	259.99	260.00	258.57
18	267.17	265.02	263.18	261.10	259.39	257.95	256.38	255.59	256.35	260.14	259.95	258.53
19	267.09	264.94	263.12	261.03	259.32	257.90	256.34	255.54	256.50	260.29	259.90	258.49
20	267.02	264.85	263.04	260.96	259.27	257.84	256.30	255.50	256.65	260.39	259.85	258.44
21	266.95	264.78	262.96	260.90	259.21	257.78	256.26	255.46	256.75	260.49	259.80	258.38
22	266.87	264.73	262.90	260.84	259.17	257.72	256.23	255.40	256.85	260.56	259.76	258.33
23	266.77	264.66	262.84	260.77	259.11	257.67	256.20	255.35	256.95	260.61	259.71	258.27
24	266.69	264.58	262.76	260.70	259.06	257.62	256.17	255.30	257.10	260.66	259.67	258.21
25	266.63	264.50	262.70	260.63	259.02	257.57	256.15	255.25	257.25	260.70	259.62	258.16
26	266.57	264.44	262.62	260.56	258.97	257.50	256.15	255.20	257.45	260.73	259.57	258.10
27	266.51	264.38	262.54	260.50	258.94	257.44	256.15	255.15	257.60	260.75	259.54	258.04
28	266.46	264.32	262.46	260.45	258.90	257.38	256.15	255.11	257.70	260.75	259.50	257.99
29	266.40		262.39	260.40	258.86	257.32	256.15	255.08	257.85	260.75	259.45	257.93
30	266.35		262.31	260.35	258.81	257.26	256.15	255.06	257.95	260.75	259.41	257.87
31	266.30		262.22		258.77		256.15	255.06		260.75		257.80