Effect of Climate change on the potential water availability in Kenya

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1. Introduction

Water availability which refers to the amount of water retained is calculated as the difference between the input of water (Precipitation) and the output (Evapo-transpiration) of a particular area.

Potential evapotranspiration (PET, or ET0), which is the consumptive water use of a field situation where the soil is not under moisture stress, can be estimated using pan evaporation from a free water surface. Where pan evaporation data is not available, ET can be calculated by ET models using climatological parameters.

This study applied a simple model known as Hargreaves model which only two climatic parameter, temperature and incident radiation to calculate evapotranspiration. Together with the precipitation data, the amount of water availability was calculated both monthly and yearly for the 100 years ranging from 2001 to 2100.

2. Study Area and data

The proposed area of study is as seen on the **Fig. 1**. The map is a map of Kenya which lies between. (00 37N 034 10E, to 02 00N 038 07E)

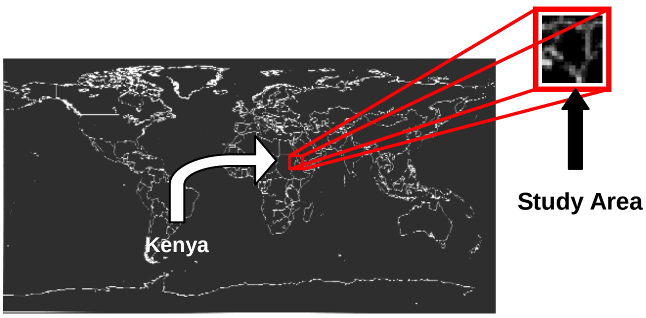

Fig 2.1 K-1 Coupled GCM (MIROC)

The data set applied was Global Climatic Model (GCM) data which has the qualities shown in the table. Data derivation was done by trimming out the area of study from global representation of the whole data set as shown in Fig. 1 above. This was then done for the whole period of 100 years.

Table 2.1 Data Set

Format	GTOOL3 2byte
Data Source	CCSR, NIES, FRCGC
Resolution	Temporal; (320x160)m Spatial; Daily, Monthly
Scenario	SRES-A1B, 2001 - 2100

3. Method

3.1 Water Availabity

Water availability WA is calculated as the difference between the Precipitations P and the evapotranspiration ET as shown below.

$$WA = P - ET \qquad (2.1)$$

3.1.1 Precipitation

In Meteorology, precipitation (also known as one class of hydrometeors, which are atmospheric water phenomena) is any product of the condensation of atmospheric water vapor that is deposited on the earth's surface. In this study, the precipitation data was derived from Miroc GCM model directly. The data has a temporal resolution of one day. Therefore, the daily precipitation is extracted in its raw format, converted to binary and the result applied in form of monthly precipitation.

This provides the values of precipitation P required in the equation 2.1 above.

3.2 Evapotranspiration

The value of evapotranspiration was calculated by use of the Hargreaves method as shown in the equation below.

$$ET_o = 0.408 \times 0.0023 \times (T_{mean} + 17.8) \times (T_{\max} - T_{\min})^{0.5} \times R_a \qquad (3.2)$$

Where;

ET_o : Evapotranspiration in mm day^{-1}

T_{mean} : Monthly mean air temperature

T_{max} : Monthly maximum air temperature

T_{min} : Monthly minimum air temperature

R_a : Extraterrestrial radiation $MJm^{-2}day^{-1}$

The extra-terrestrial radiation R_a is the amount of global horizontal radiation that a location on Earth would receive if there was no atmosphere or clouds. This number is used as the reference amount against which actual solar energy measurements are compared. The value of Extraterrestrial radiation is calculated as;

$$R_a \approx 3N\sin(0.131N - 0.95\phi) \quad \text{for} \quad |\phi| \geq \frac{23.5\pi}{180} \tag{3.3}$$

Where;

ϕ : Latitude of the area (radians)

N :Daylight hours (hrs)

N, the daylight hours is calculated as a function of the month of the year as shown below;

$$N \approx 4\phi\sin(0.53i - 1.65) + 12 \tag{3.4}$$

i : Rank of the month (January = 1)

4. Results and conclusion

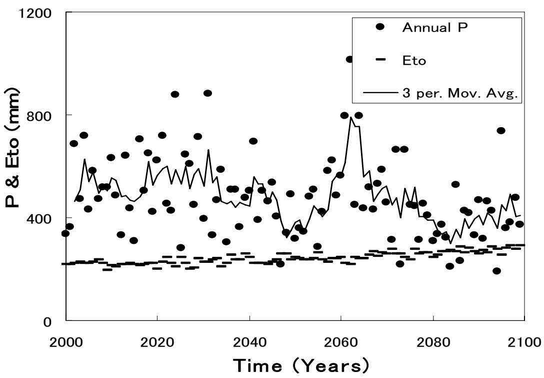

Fig. 4.1 P and ET against time (2001 – 2100)

The Fig. 4.1 above represents the variation between Precipitation and evapotranspiration against time. ET increases at an average slow and constant rate while variation in P is irregular and widespread. A 3 period moving average plotted indicates a general downtrend in P but sudden peaks appear between 2050 and 2070 and then the trends picks up again. This indicates periods of massive rain which would lead to catastrophic floods.

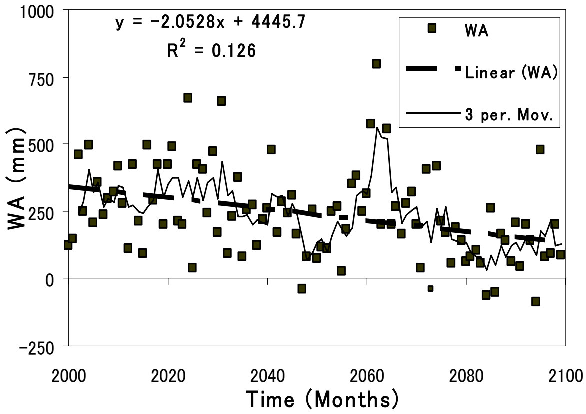

Fig. 4.2 Water availability with time

Fig. 4.2 above shows the long term variation in water availability through the whole 100 year period. An RMS trendline indicates a general downward trend with values of WA shifting to the negative position especially after 2080. However, water availability is predicted to move in a zig zag pattern with tremendous amounts around the mid-century.

5. Discussion

This study has been helpful in determining the way in which water availability will vary within the next 100 years in Kenya. Generally a decrease is expected as time goes. However, it should not be ruled out that throughout the century, there are periods of extremely high water availability which would lead to catastrophies like flood and this has a high risk of spreading water borne diseases. In result, this study recommends that in carrying out water resources management, focus should not only be made on measures to increase the amount water resources but also measures to control too much water and other problems that may arise due to flood. Also, since there are periods of alternating high and low water availability, this study recommends further research on preserving extra water on one season to be used in the next.

6. References

(1)Jackson RD. 1985. Evaluating evapotranspiration at local and regional scales. Proceedings of the IEEE 73: 1086–1096.

(2)Hargreaves GH. 1994. Defining and using reference evapotranspiration. Journal of Irrigation and Drainage Engineering 120(6): 1132–1139.