Demand and supply balance analysis in irrigation plan towards improvement of water use efficiency
– Case study of water balance simulation in Mwea Irrigation Scheme, Kirinyaga County, Kenya–

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1. INTRODUCTION
Rice in Kenya was introduced in Kenya in early 1900s from Asia. It is one of the most important cereal crops in Kenya (It is ranked as the third most important cereal crop after maize and wheat) and its mainly grown Mwea Irrigation Scheme, MIS which contributes to about 60% of the locally produced rice in Kenya. (National Rice Development Strategy, 2014) The scheme is divided into five major irrigation blocks; Mwea, Thiba, Wamumu, Karaba and Tebere. It is supplied by irrigation water from two main rivers, R. Thiba and R. Nyamindi. MIS is divided into 60 units, each with an average area of 100ha. (Mohammed A. et al, 2003)

<table>
<thead>
<tr>
<th>Data type</th>
<th>Source</th>
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<tbody>
<tr>
<td>DEM</td>
<td>USGS Global Digital Elevation Model (30m)</td>
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<tr>
<td>Land use map</td>
<td>Global Land Cover Characterization (2009)</td>
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<tr>
<td>Soil map</td>
<td>SOIL- Food and Agriculture Organization of the United Nations database (FAO, 1995)</td>
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<tr>
<td>Weather Station</td>
<td>Climatological data from Mwea Irrigation and Agricultural Development Center(MIAD), Castle Forest and Embu Stations</td>
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<tr>
<td>Water discharge</td>
<td>Average monthly discharge data for R. Thiba and R. Nyamindi</td>
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2. METHODOLOGY
2.1 Watershed supply analysis using SWAT
SWAT is one of the several hydrological modelling tools that can be used to model and predict some of the hydrological processes (Arnold et al., 1998; Neitsch et al., 2005) Input data is as tabulated.
2.2 Paddy water balance analysis

For rice, the irrigation water need was calculated based on the following equation;

\[
\text{Irrigation Water Need} = \text{ET crop} + \text{SAT} + \text{PERC} + \text{WL} - \text{Pe} \quad (\text{FAO}, 1986)
\]

Where (ET crop) is defined as the depth/amount of water needed to meet the water loss through evapotranspiration; SAT is the amount of water needed to saturate the soil for land preparation by puddling; PERC refers to the percolation and seepage losses; WL refers to a water layer is established during transplanting and maintained throughout the growing season; Pe is the effective rainfall.

3. RESULTS AND DISCUSSION

As seen from the above figures (Figs. 2 and 3), convectional irrigation management method has a higher irrigation water demand than the available supply. This can be attributed to the higher water levels maintained in the paddy fields during the growing period. Intermittent irrigation management method was analysed to utilize lower irrigation water demand for the 3 cropping seasons. (as 31%, 32.4% and 35.7% less water requirement for the cropping seasons 2013/2014, 2014/2015, and 2015/2016 respectively) Also, intermittent irrigation management method showed a slight deficit for irrigation water over the months of September and October.

4. CONCLUSION

From the preliminary results, it is evident that currently, the crop water demand exceeds the available water supply. It is thus imperative that the MIS management considers adapting to more sustainable water management methods in order to try to alleviate the gap that currently exists between demand and supply.

The MIS has plans to incorporate a dam (Thiba dam) in the near future to try to address the water problem. However, the plans have been stalled with several impediments e.g. court cases over land compensation. This research will seek to continue to conduct integrated watershed management scenario with the dam component for MIS. The main output would be development of a crop production model that can be applied for integrated watershed management in Mwea that can be used for mathematical forecasting and planning and adopted for other schemes in Kenya.