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Evaluating evapotranspiration Values in Rwanda while Using the Turc and Hargreaves-Samani Equations.

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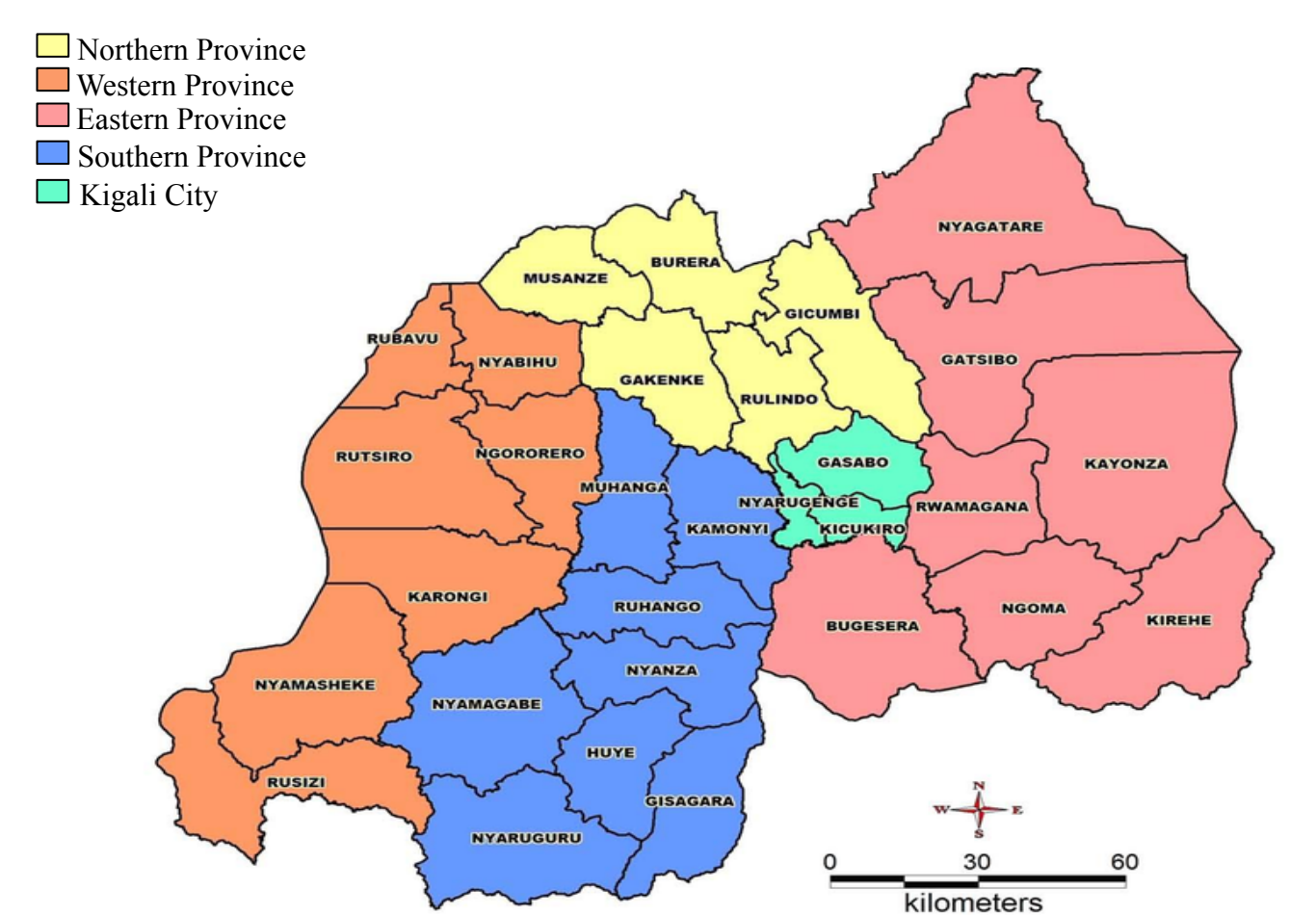
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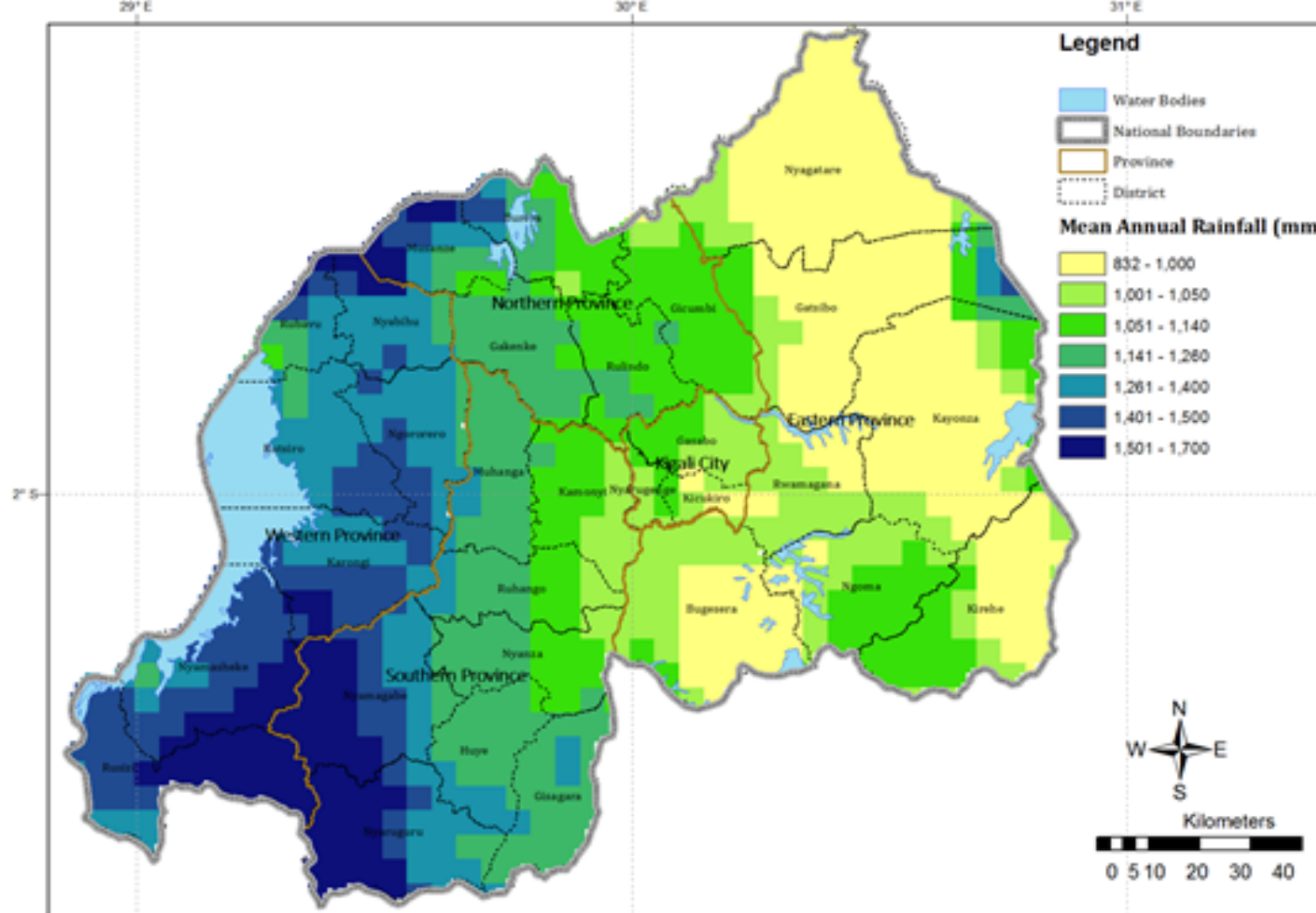
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INTRODUCTION

- Rwanda is a landlocked country located in central Africa. Agriculture is the largest sector accounting for 32 % of GDP. The unique topography of the country defines why farm activities relies on a wide range of geographical landscapes and micro-climates. Rwanda highly depends on natural resources, and it's climate variability is one of the important factors that account for the country's year to year crop production (Haggag et al. 2016).
- This study focuses on comparing reference evapotranspiration (ET) using temperature based methods - the Turc (Tu) and Hargreaves-Samani (HS), for the five provinces of Rwanda.



Source: <https://www.newtimes.co.rw>
The four provinces of Rwanda and Kigali city locations highlighted on the map.



Source: <https://www.meteorwanda.gov.rw/>
Mean rainfall amount (mm) and water bodies

METHODS

- Climatic data of min and max air temperature for reference locations in the four provinces of Rwanda including Kigali city were recoded for the past 10 years (2010-2018).
- Equations were used to calculate extra-terrestrial radiations, solar radiations, evapotranspiration using the FAO-56 guidelines - Turc method (1961) and Hargreaves-Samani (HS) method (1983).
- The obtained data was analyzed using the two methods and graph were plotted for visualization.
- Both methods have performed well in semi-humid and semi-arid environmental conditions.

HS. equations

$$ET_o = 0.0023(T_{\text{mean}} + 17.8)(T_{\text{max}} - T_{\text{min}})^{0.5} R_a$$

$$R_s = k R_s (T_{\text{max}} - T_{\text{min}})^{0.5} R_a$$

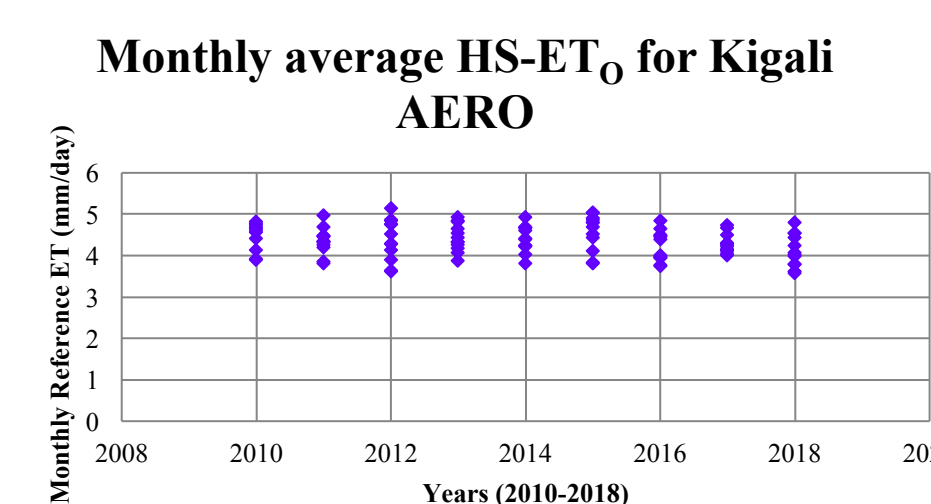
Turc. equation

$$ET_o = 0.0133 \left(\frac{T_{\text{mean}}}{T_{\text{mean}} + 15} \right) (R_s + 50)$$

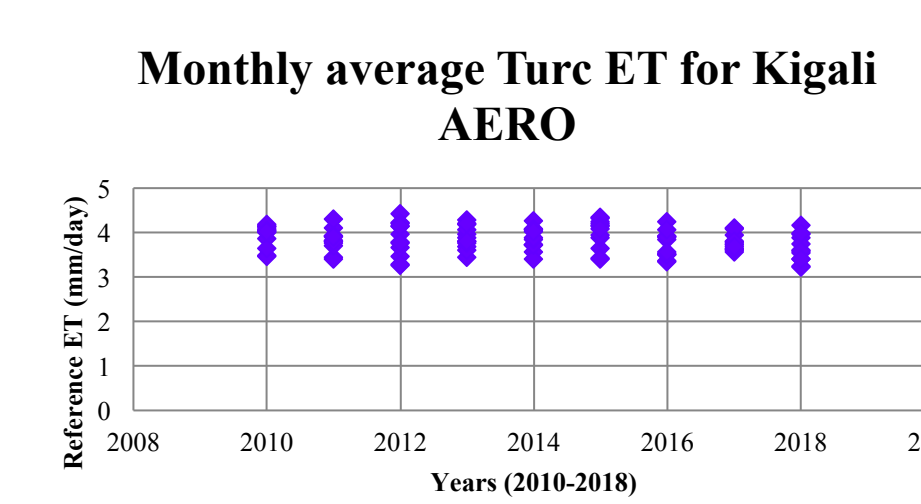
where ET_o = reference evapotranspiration ($\text{mm} \cdot \text{day}^{-1}$).

RESULTS

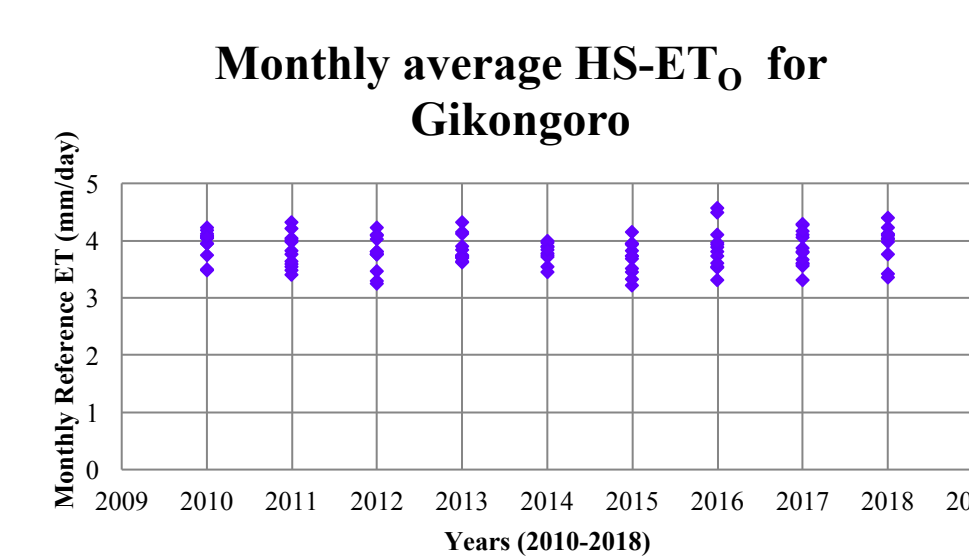
Scatter graphs for five reference locations of the provinces in Rwanda showing reference evapotranspiration calculated using Hargreaves –Samani (HS) and the Turc equations.



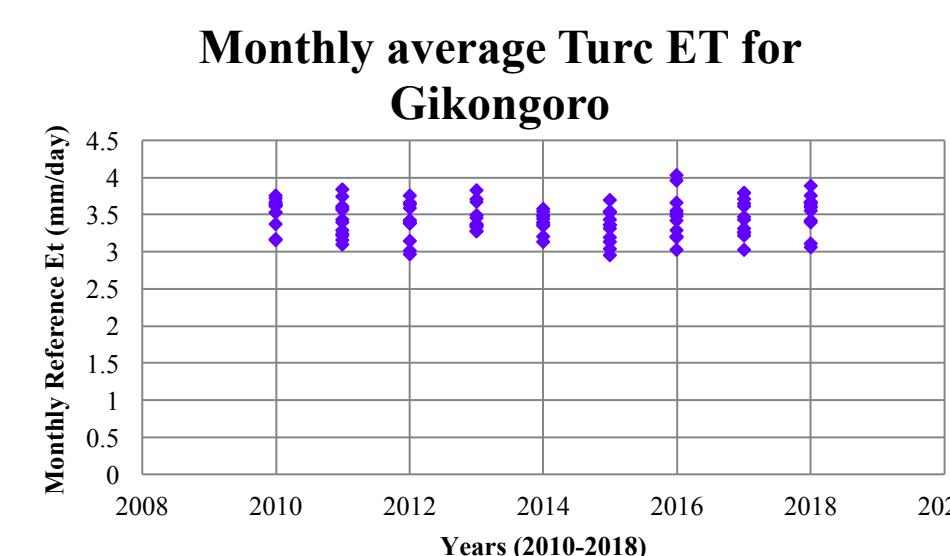
Graph 1. Reference crop evapotranspiration for Kigali AERO in Kigali City with the Hargreaves-Samani-eqn.



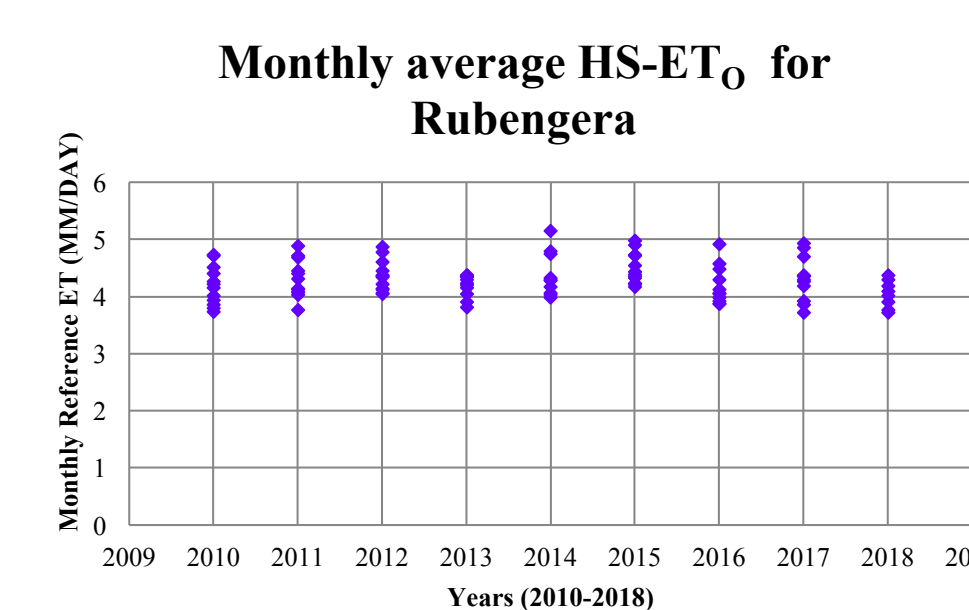
Graph 2. Reference crop evapotranspiration for Kigali AERO in Kigali City with the Turc-eqn.



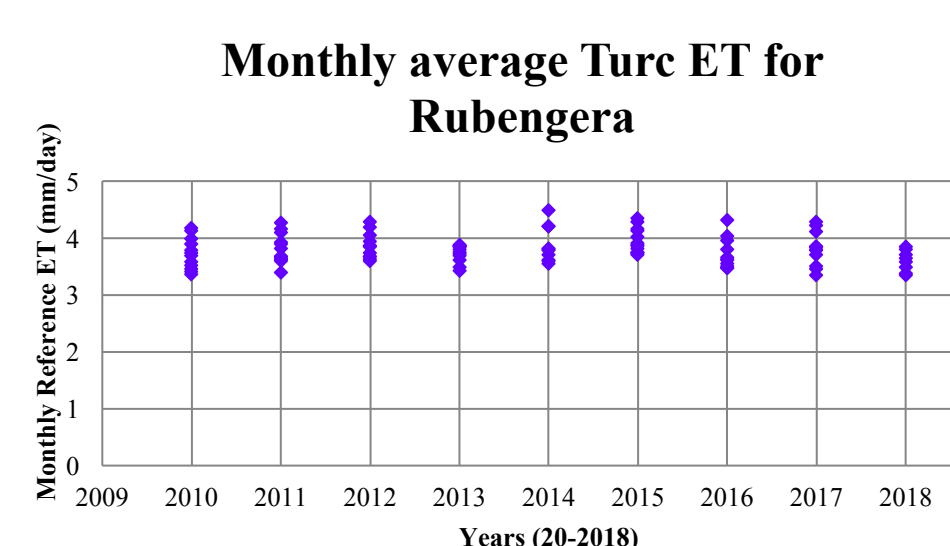
Graph 3. Reference crop evapotranspiration for Gikongoro in the south province with the Hargreaves-Samani-eqn.



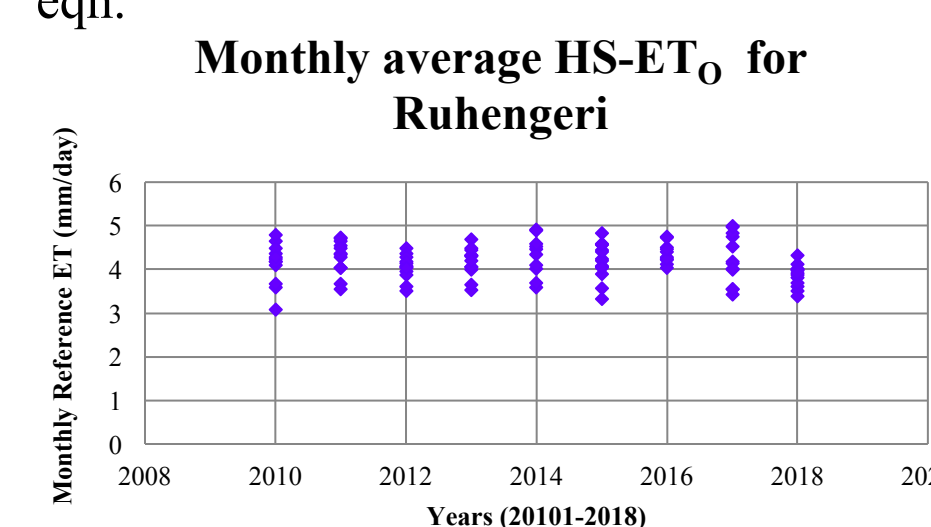
Graph 4. Reference crop evapotranspiration for Gikongoro in the south province with the Turc-eqn.



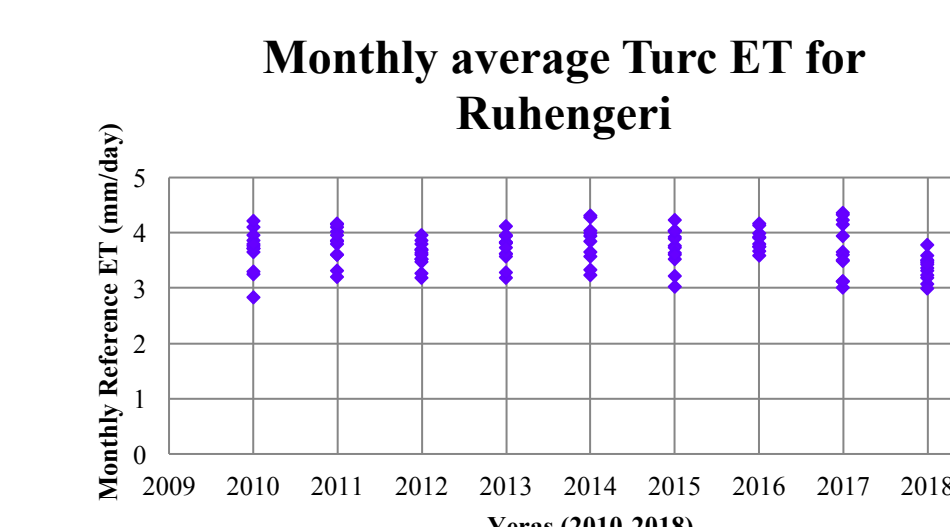
Graph 5. Reference crop evapotranspiration for Rubengera in the Western province with the Hargreaves-Samani-eqn.



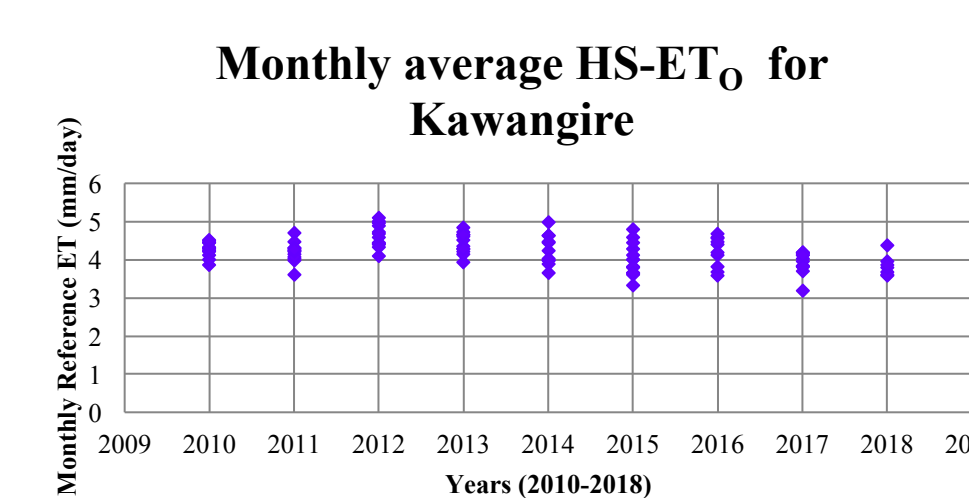
Graph 6. Reference crop evapotranspiration for Rubengera in the Western province with the Turc-eqn.



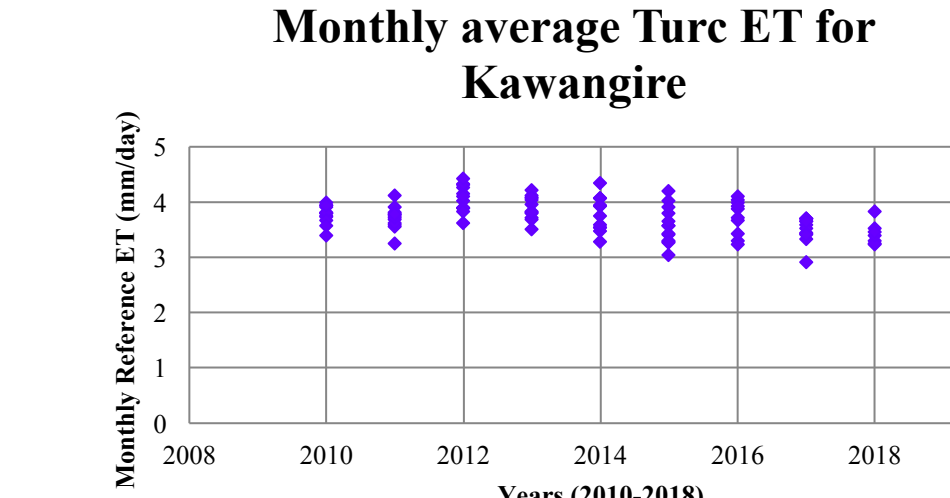
Graph 7. Reference crop evapotranspiration for Ruhengeri in the northern province with the HS-eqn.



Graph 8. Reference crop evapotranspiration for Ruhengeri in the northern province with the Turc-eqn.



Graph 9. Reference crop evapotranspiration for Kawangire in the Eastern province with the HS-eqn.



Graph 10. Reference crop evapotranspiration for Kawangire in the Eastern province with the Turc-eqn.

DISCUSSION

- The results from the graphs were analyzed and the average monthly reference crop evapotranspiration for the five locations was analyzed by comparing the efficiency of the two equations used.
- Data used was deprived from Rwanda Meteorology Agency in Kigali.
- The average monthly reference evapotranspiration for both equations ranges from 3 to 5 mm/day.
- The HS graphs for all the five locations shows a low value of reference ET (3 to 4 mm/day) for the year of 2018 compared to the previous years.

CONCLUSION

- Generally, there was consistency in variation in the reference ET through out the 10 years for both the equations. The Turc method underestimates reference ET value compared to the HS method.
- More science and technology needs to be involved to account for better agriculture management decisions in the future.
- The future research will focus on comparing both the Turc and Hargreaves-Samani (HS) equations to the FAO Penman-Monthieith equation (Allen et al.,1998) for one of the locations.

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