

Spatial representation of evapotranspiration in the Mara basin: results derived from the SWAT model and remote sensing products

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Background

Evapotranspiration (ET) is a crucial as well as dominant component in a river basin water balance

Information on the amount of ET flux is essential in the design, development and monitoring of hydrological systems

Hydrological models and remote sensing products are good sources for spatially distributed ET mapping

The ET spatially variability were evaluated :

- i. using the SWAT 2012 estimated mean annual ET from 1988 - 1992 based on 1986 land cover
- ii. using the global MODIS ET product mean annual ET from 2000-2010 based on 2006 land cover

Study area

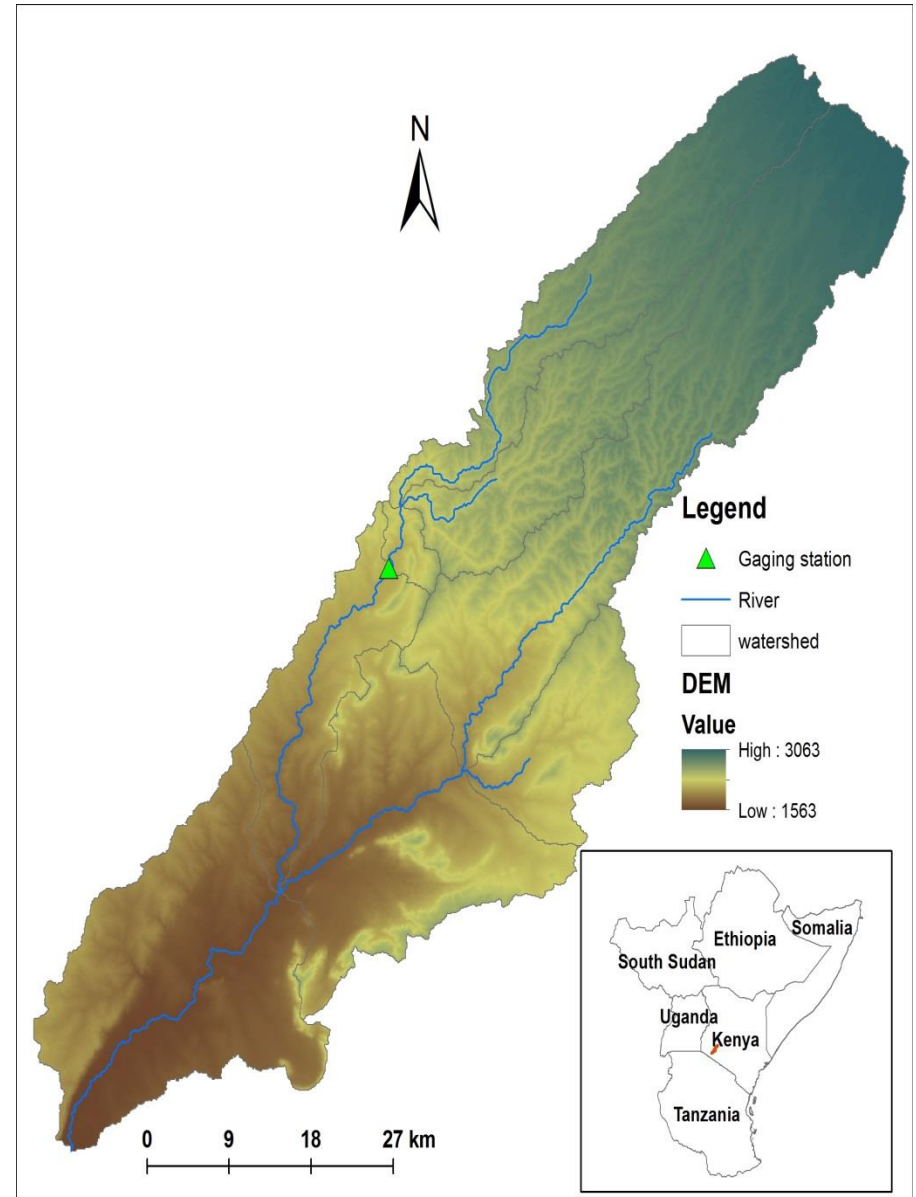
Upper Mara basin : 3000 km²

Annual rainfall : 700 – 1800 mm

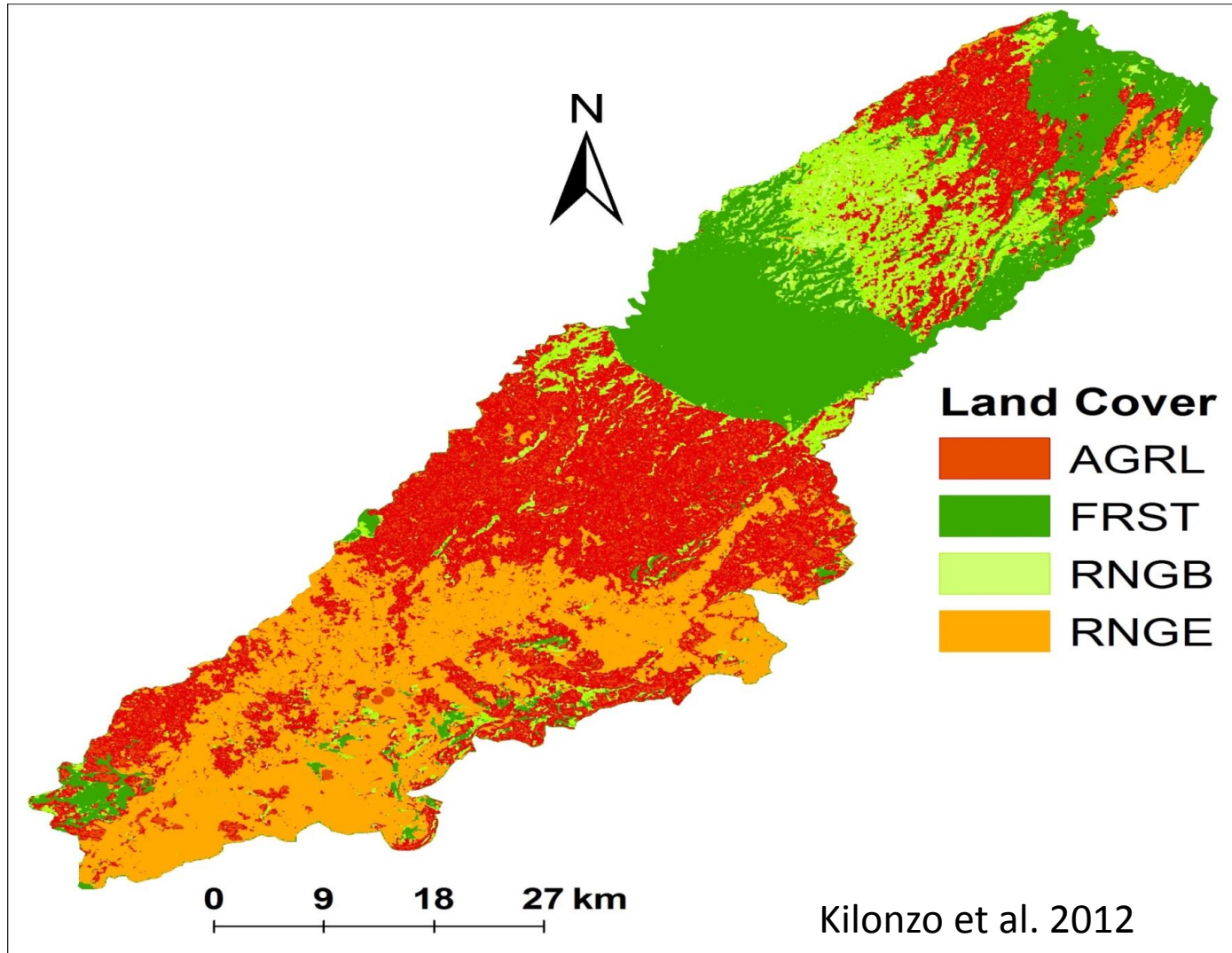
Average Temp : 25.5 °C

Potential ET : 2200 mm yr⁻¹

Flow : 8.4 m³ s⁻¹ (1980-1992)
@ Bomet station



Upstream part of the Mara basin is dominated by forest cover



Preview

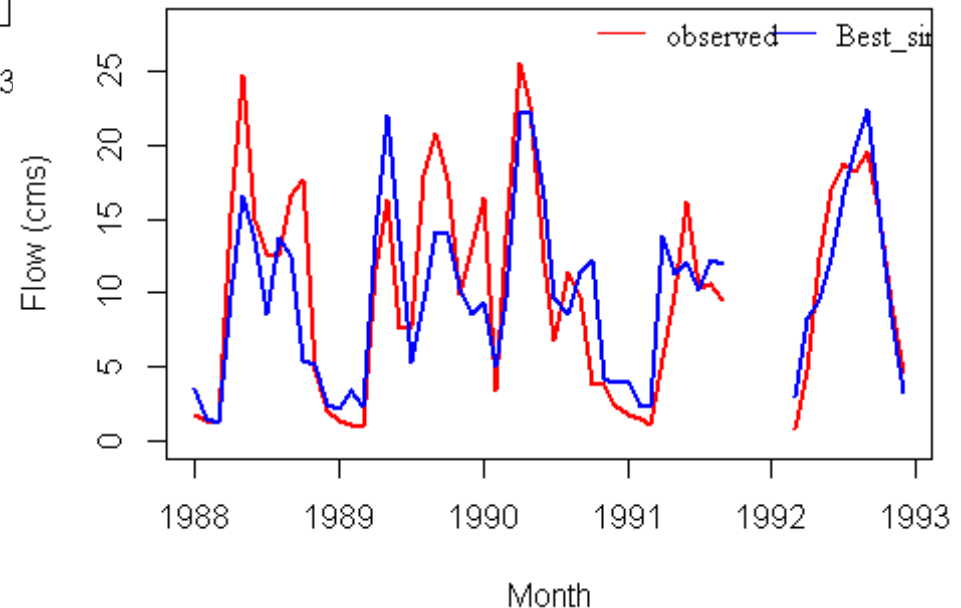
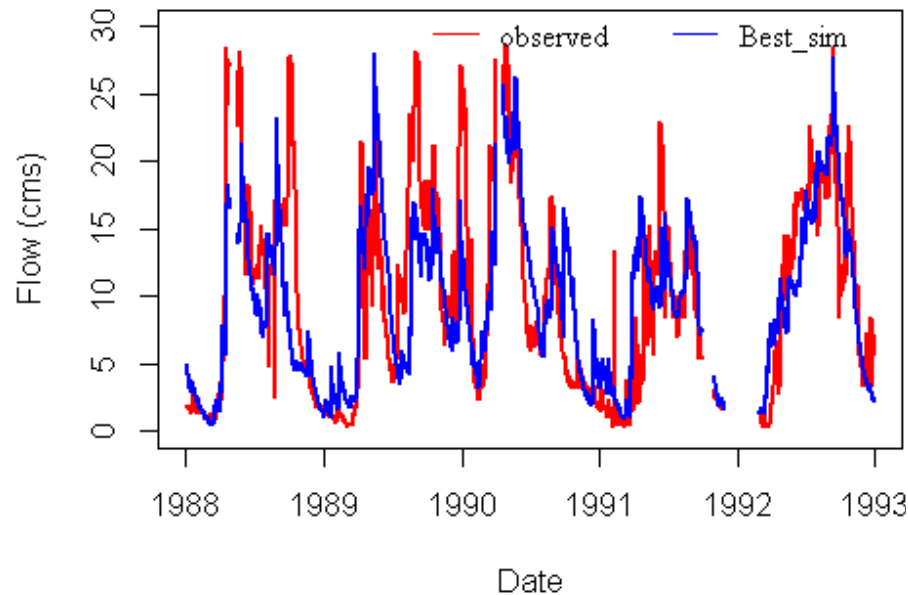
SWAT model calibration and validation

MODIS global ET product

SWAT simulated ET spatial variability

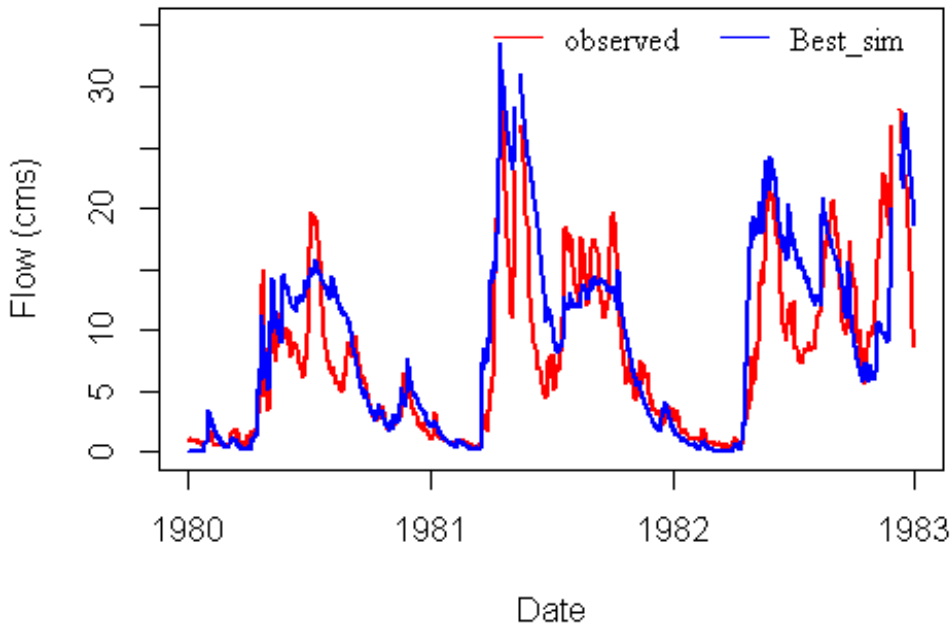
MODIS ET spatial variability

Simulated and observed flows fitted satisfactorily for the calibration period

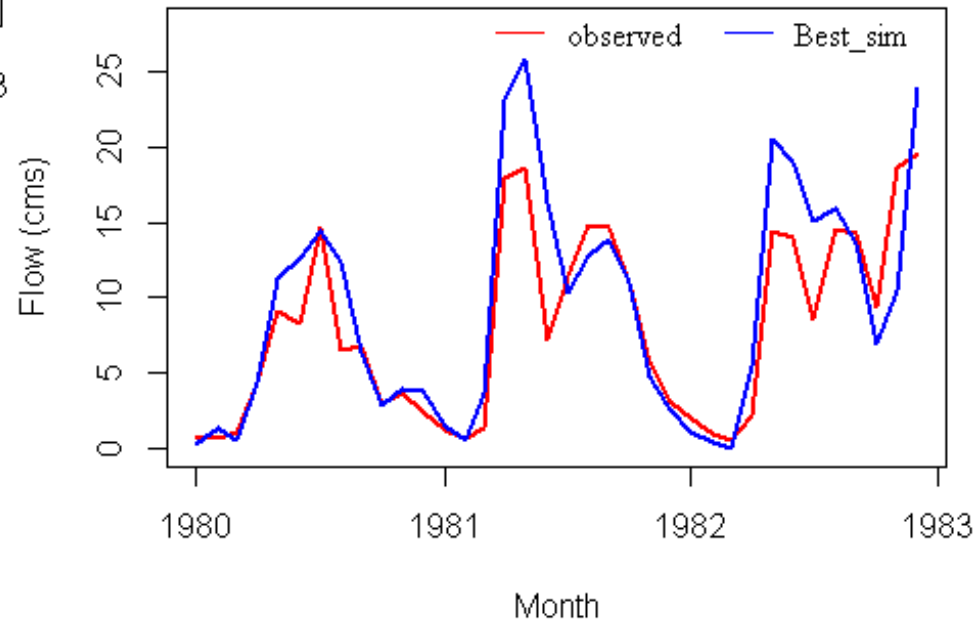


Objective function	value
p-factor	0.6
r-factor	0.89
NSE	0.58

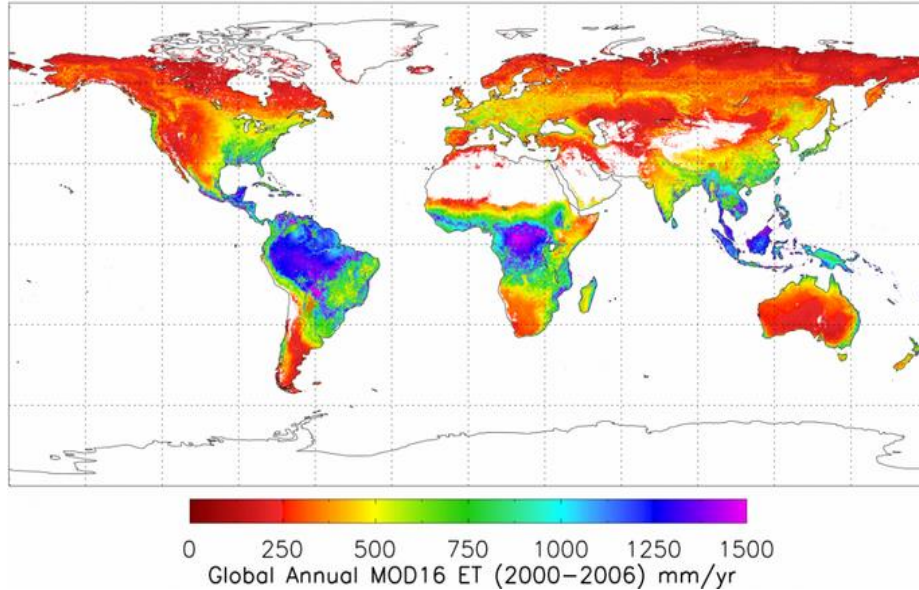
The simulated flows fairly mimicked the observed flows for the validation period



Objective function	value
p-factor	0.4
r-factor	0.39
NSE	0.55



Global MODIS ET product is a good source for ET flux estimates for regional studies



<http://www.ntsug.umd.edu/project/mod16>

==> ET for vegetated surface at a regular 1 km resolution

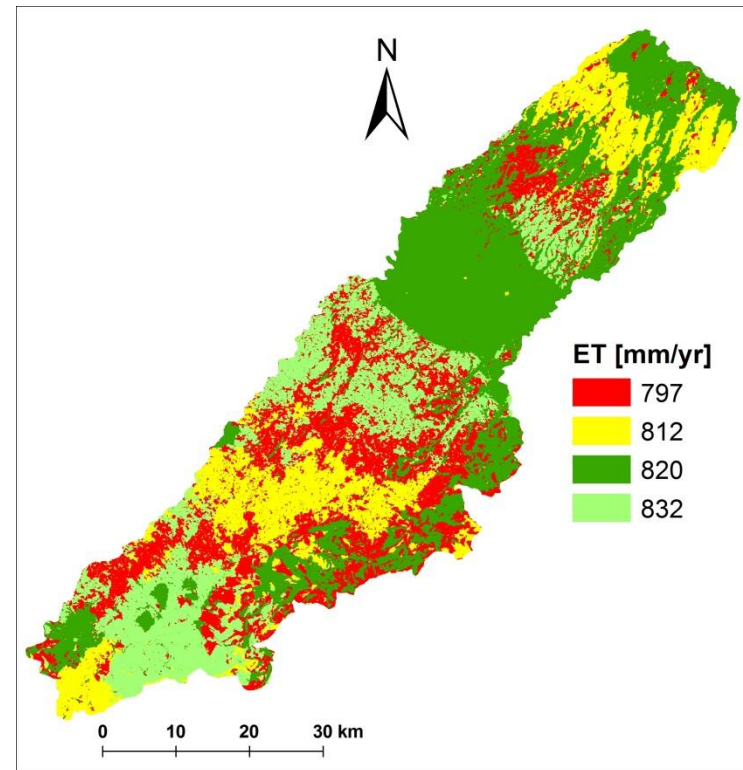
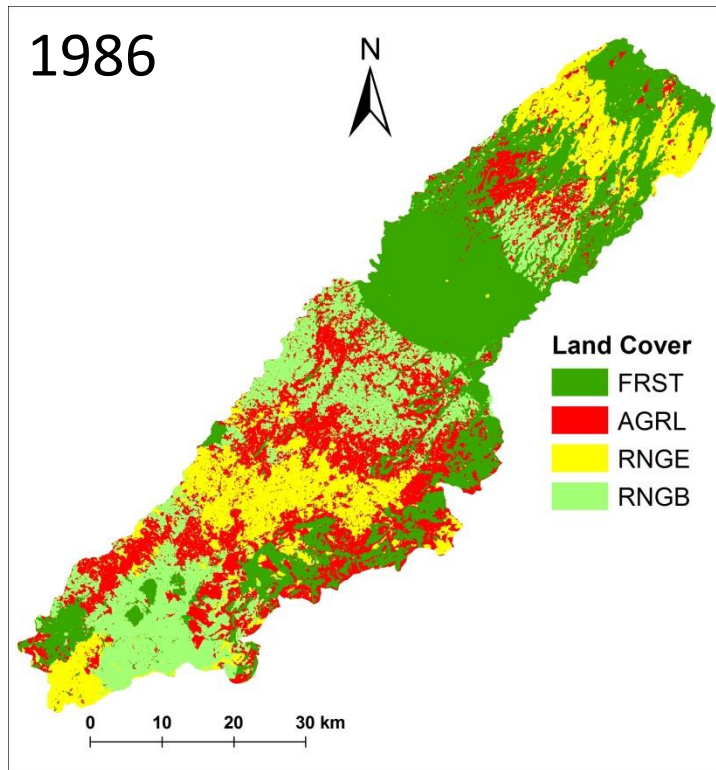
==> computed based on the Penman–Monteith logic
(Mu et al. 2011)

This product has been validated against actual measurements in several regions (Mu et al. 2011 & Kim et al. 2012)

The MODIS ET evaporation algorithm performed better at sites with forest cover (Kim et al. 2012)

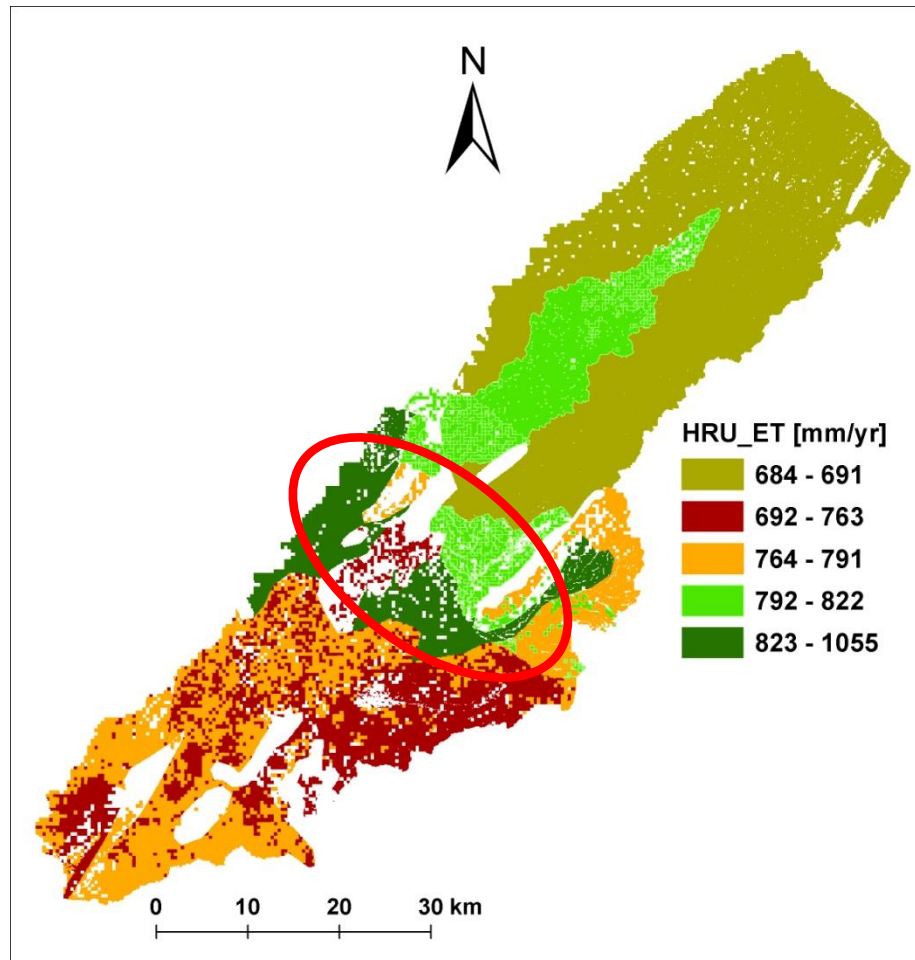
The annual MODIS ET from 2000 – 2010 were analyzed in this study for the Upper Mara basin

The SWAT simulated mean annual ET showed less spatial variability per land cover

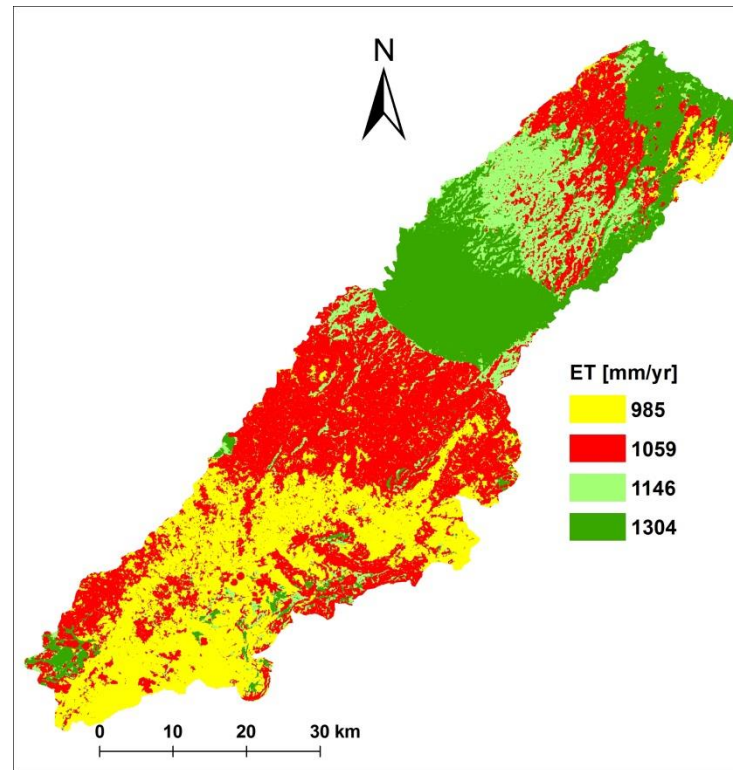
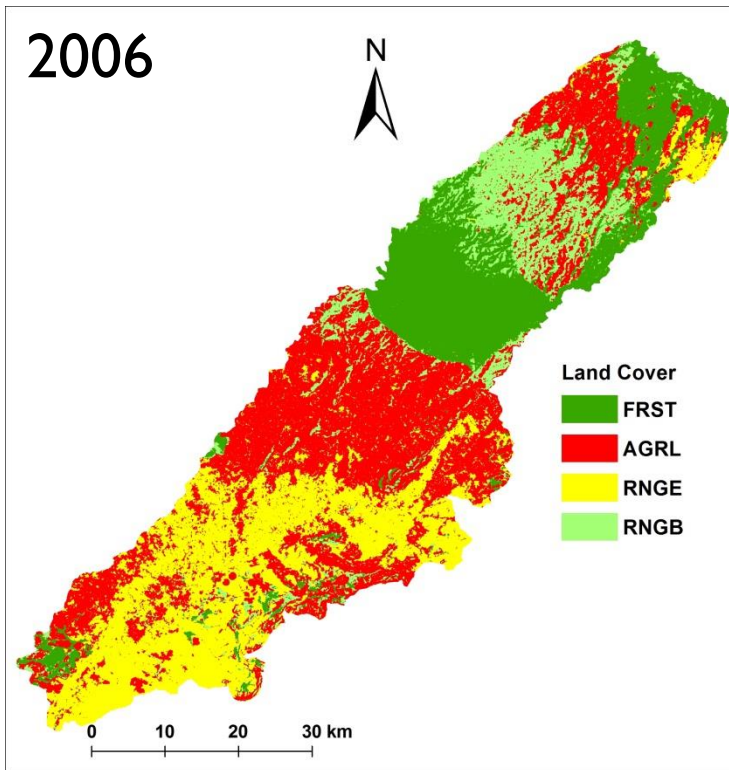


The highest mean annual ET was noted in rangelands with shrub cover

HRUs with agricultural and shrub cover type revealed the maximum ET flux

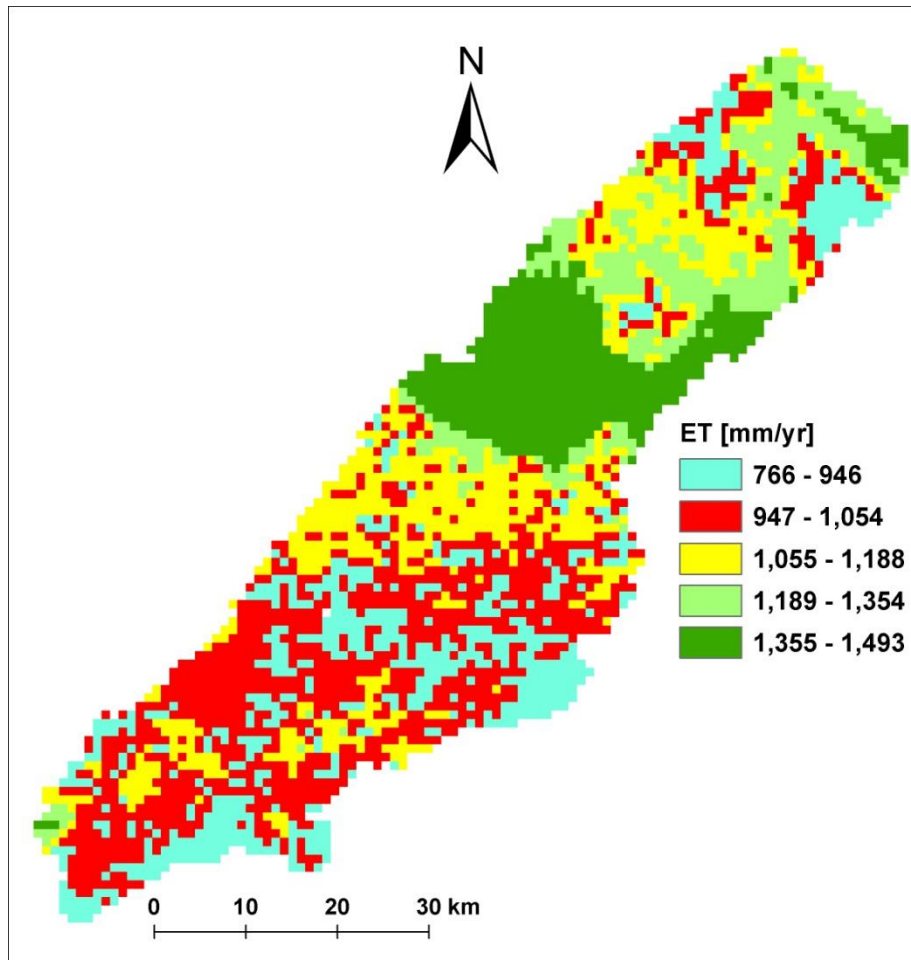


The mean annual ET from MODIS showed good spatial consistency



Portion of the basin covered by forest showed the highest ET flux

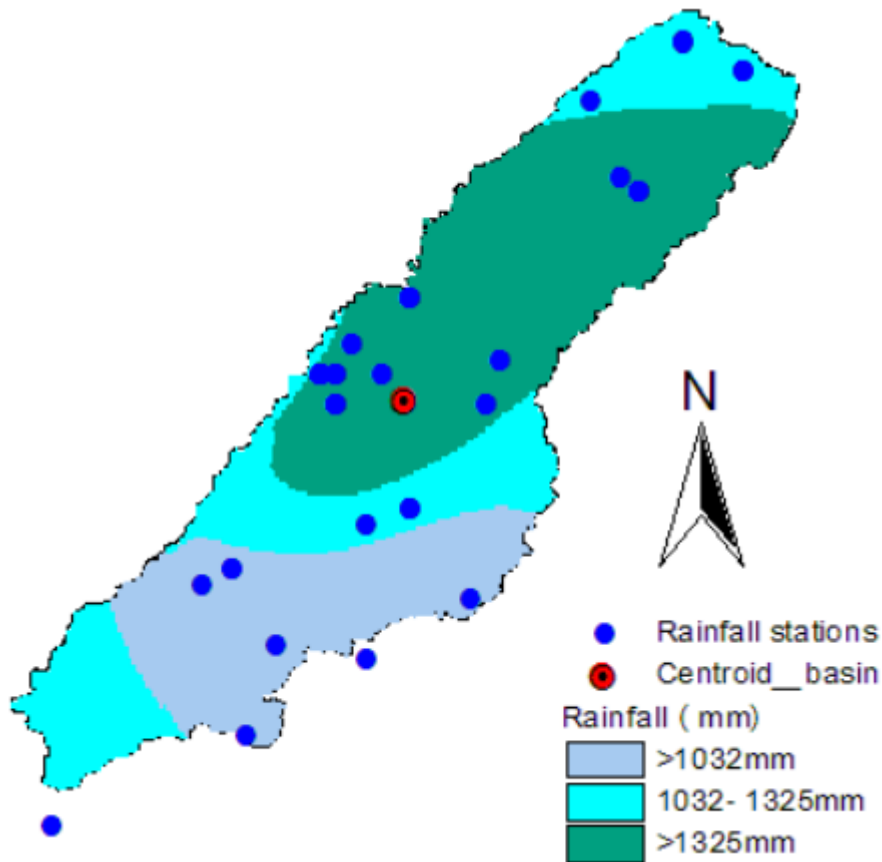
Significant spatial variability of ET was observed from MODIS product



Max ET ==> forested pixels

Min ET ==> grassland

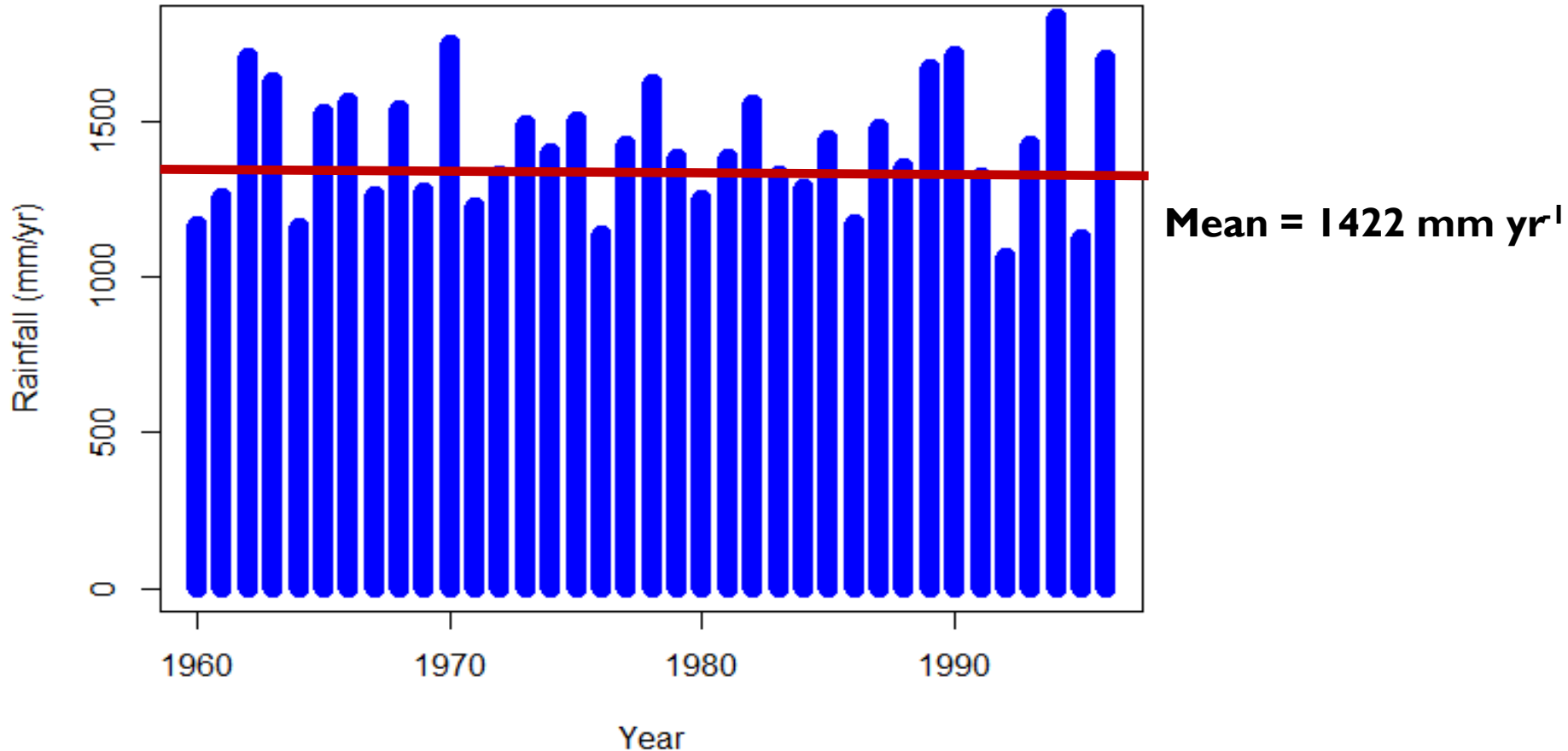
How can we verify the spatial pattern of ET without in-situ measurements?



====>The MODIS ET spatially correlated with rainfall

Kilonzo et al. 2012

The mid section of the basin receive a higher rainfall, i.e. the forested part



Given the long term rainfall pattern in the forested part, MODIS ET seems overestimated

SWAT 2012 revision 591

Slight modification on the ET computation routine in the source code

==> spotted by prof. van Griensven

Pet = Pet – canstor(j) -----> older versions

Pet = pet – canev -----> recent revision

Summary and Conclusion

The SWAT simulated ET among different cover types in the Upper Mara basin showed less spatial variability

Higher spatial variability in the ET fluxes were observed at HRU level but less consistent with the cover types

The MODIS ET followed well the land cover pattern in the study area at finer and coarser resolution

Using MODIS ET product in SWAT hydrological modeling efforts in data scarce region has a potential to improve the model's prediction skills

Thank you



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