Modelling the impact of agroforestry on hydrology of Mara River basin in East Africa using a distributed model

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Background

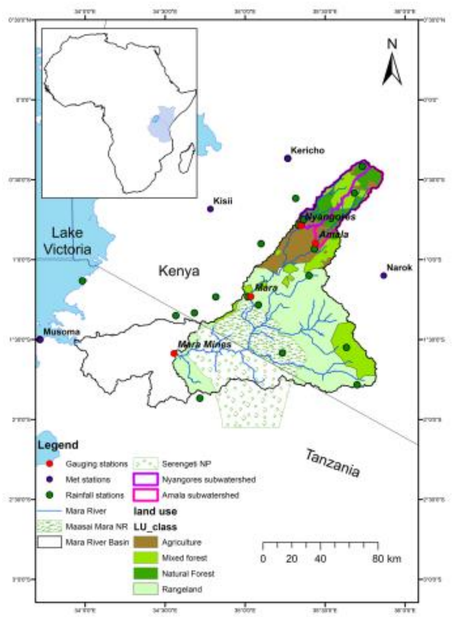
- Mara River Basin (MRB) has undergone significant deforestation (conversion to agriculture) in the last fifty years
- Government of Kenya keen to increase tree cover in the watershed
- Agroforestry is a feasible option
- Knowledge gap exists on the impact of agroforestry on water balance of MRB and the size of the watershed that can sustainably be put under agroforestry

Methods

- SWAT (Soil and Water Assessment Tool) model used for simulation of agroforestry
- SWAT was first calibrated and validated for water yield (streamflow)
- Agroforestry simulated as woodlots
- Scenarios based on increment of tree cover in agricultural land
- Accomplished in SWAT by conversion of some agricultural HRUs to woodlots
- Selection of target HRUs based on slope criteria

Study Area

(Mara River Basin, Kenya/Tanzania)

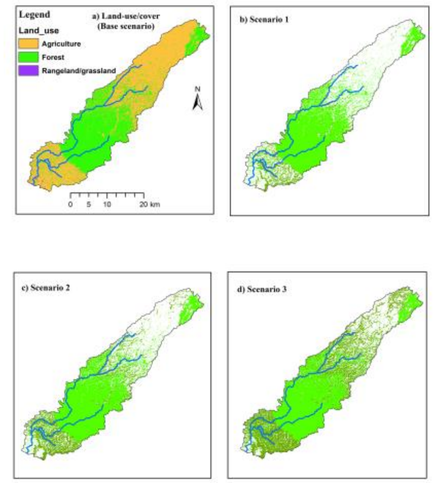


Size of the watershed simulated with agroforestry

Scenario	Lower slope threshold (%)	area (ha)	% of watershed area
Mara River Basin (area = 10,550 km^2)			
S1	20	18,559	1.8
S2	15	34,321	3.3
S3	10	63,810	6.0
Nyangores sub-watershed (area = 692 km^2)			
S1	20	4,420	6.4
S2	15	9,965	14.4
S3	10	19,380	27.9

Agroforestry Scenarios

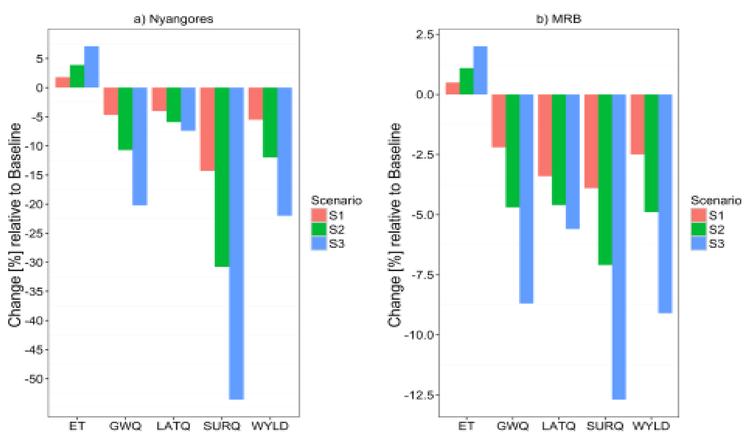
(Nyangores sub-watershed only)



Light green: Current forest cover based on 2014 land use map (figure a).
Dark green: areas simulated with woodlots for the three agroforestry scenarios

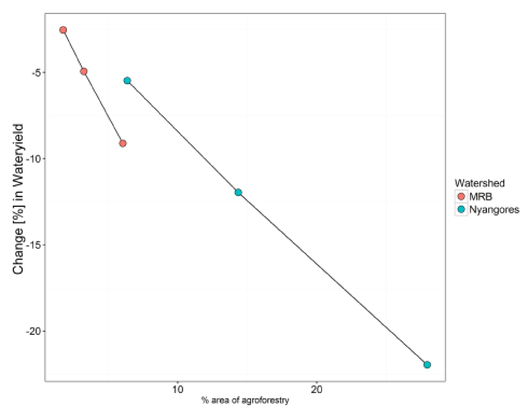
Results and conclusions

Impact of agroforesty on water balance



- Impact proportional to increase in tree cover
- Increased: Evapotranspiration (*attr. to increased water uptake by trees*)
- Reduced: Surface runoff (*attr. to enhanced infiltration*)
- Reduced: baseflow (*attr. to increased groundwater removal by trees*)
- Reduced: total wateryield *(overall effect)*

Impact of spatial scale



- Slope of change in water yield with increase in tree cover (agroforestry) higher for MRB than for Nyangores
- Attributed to climate variability (rainfall and temperature) within the MRB
- Implies extrapolation of findings from small (experimental) study sites to larger watersheds need to take climate variability into account.

Conclusions

- Impact of agroforestry on water balance proportional with increase size of watershed under agroforestry
- Surface runoff, baseflow and total water yield decreased with increase in area under agroforestry
- Evapotranspiration increased with increase in watershed area under agroforestry
- Slope (rate) of change change in water yield with increase in tree cover higher for MRB than for Nyangores, which was ttributed to climate variability (rainfall and temperature) within the MRB

Reference:
Mwangi et al., 2016. Modelling the impact of agroforestry on watershed hydrology of Mara River Basin in East Africa. Hydrological Processes, doi:10.1002/hyp.10852.