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Simulating hydro-economic impacts of potential water rights trade in the Lake Naivasha Basin in Kenya

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Background & Objective

- In most of the developing world, demand for water has been rapidly growing while the supply is deteriorating. This calls for institution that ensures efficient allocation of scarce water.
- Water rights trading is considered as important economic incentive for efficient allocation of water resources.
- The objective study is to simulate the effect of potential water rights trade among water resource users associations (WRUAs) on irrigation water use and land allocation in Kenya.

The Lake Naivasha Basin

- The second largest fresh water lake and Ramsar site located in Kenyan Rift Valley
  - Covers an area of 3400 km^2 and divided into 12 WRUAs
  - The Lake is fed by three major inflows – Malewa (80%), Gilgil (10%), Karati and other small streams (10%)
  - Substantial irrigation water use (horticultural industry)
- Some water demand management measures, e.g. Issuing abstraction permits, Allocating based on water availability

Methodology – Individual Optimization in LANA-HEBAMO

The water trade scenario is simulated using **integrated** hydro economic model LANA-HEBAMO. The water trade scenario is implemented in the model as **equilibrium constraint** using the MOPEC solution format. Two scenarios – fixed water rights and tradable water rights are compared. Water use rights are allocated based on historic water use.

Hydrologic component

- Water supply is determined by rainfall runoff model using 50 years historic monthly rainfall data
- Water balances are modeled at crop field level and agricultural demand sites using node-network relationship
- The water source includes river reaches, reservoir, lake and groundwater

Economic component

- Maximizes individual agricultural profits subject to bio-physical and institutional constraints in LANA-HEBAMO
- Model runs with fixed (FWR) and tradable water rights (TRD) distributed according to historical use.
- The model is calibrated to baseline data for crop area using PMP approach.

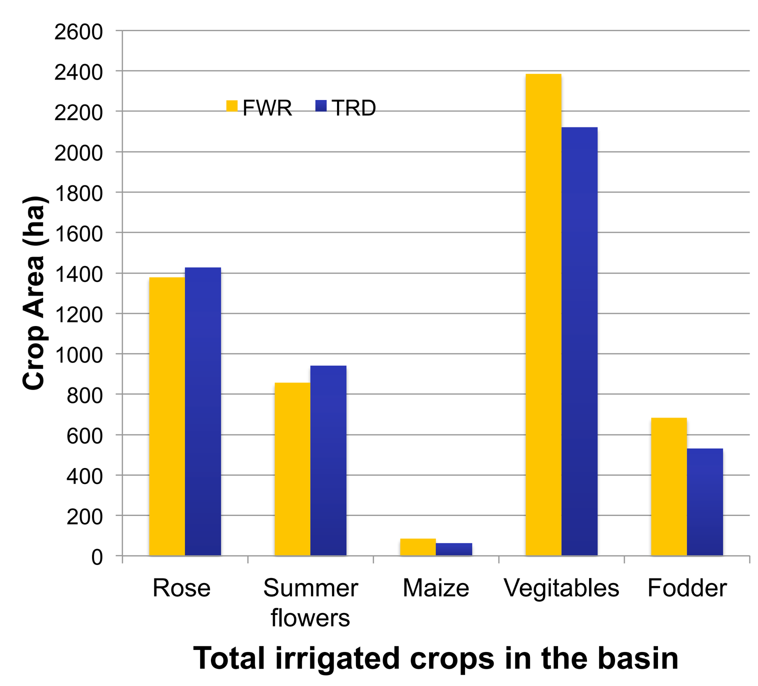
Agronomic component

- Crop specific water requirement for specific yield is obtained from rain and supplementary irrigation
- Crop water requirement derived using site specific ET0 and crop and stage specific Kc.
- Crop water response is determined using the FAO relative yield and relative Evapotranspiration relations.

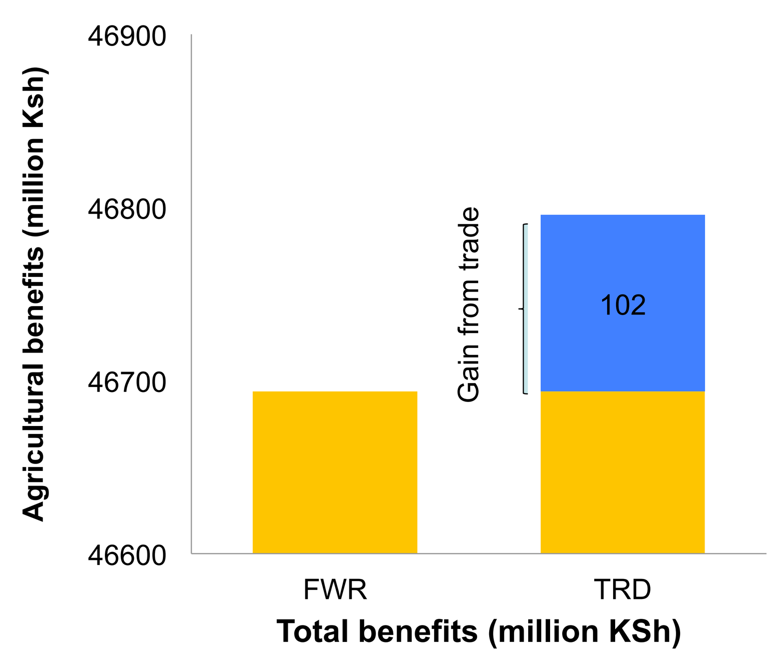
Results and discussion

	Monthly water withdrawals (000 m^3)	
WRUAs	FWR	TRD
WANWUA	1096	986
UPPMAL	560	492
MIDMAL	1100	1012
KIAWUA	80	68
UPPTUR	206	194
MKUWUA	38	27
LOWMAL	296	287
UPPGIL	234	233
LOWGIL	582	420
KARWUA	2957	3012
NWLAKE	23586	23860
MARWUA	463	316
SELAKE	34487	35216
Total	**65685**	**66123**

- Simulated irrigation water use with and without water trade



- Irrigated crop area with and without water trade.



- Potential gains from water trade

Conclusion and outlook

- Results indicate monthly water withdrawals slightly increases when trade is allowed but varies among WRUAs.
- Water markets resulted in cropping pattern change in the basin. Compared to high value crops, area for crops with relatively low returns to water use are reduced
- As a result of water trading water moves from less productive crops to high value crops and increased income.
- Next steps will be to include stochastic scenario simulation for rainfall uncertainty using recursive dynamic model.

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