Water & Land Resource Center

Addis Ababa University

Estimation of current distributions of Prosopis sp., land use changes, water use of Prosopis and its impacts in the Afar Region, Ethiopia

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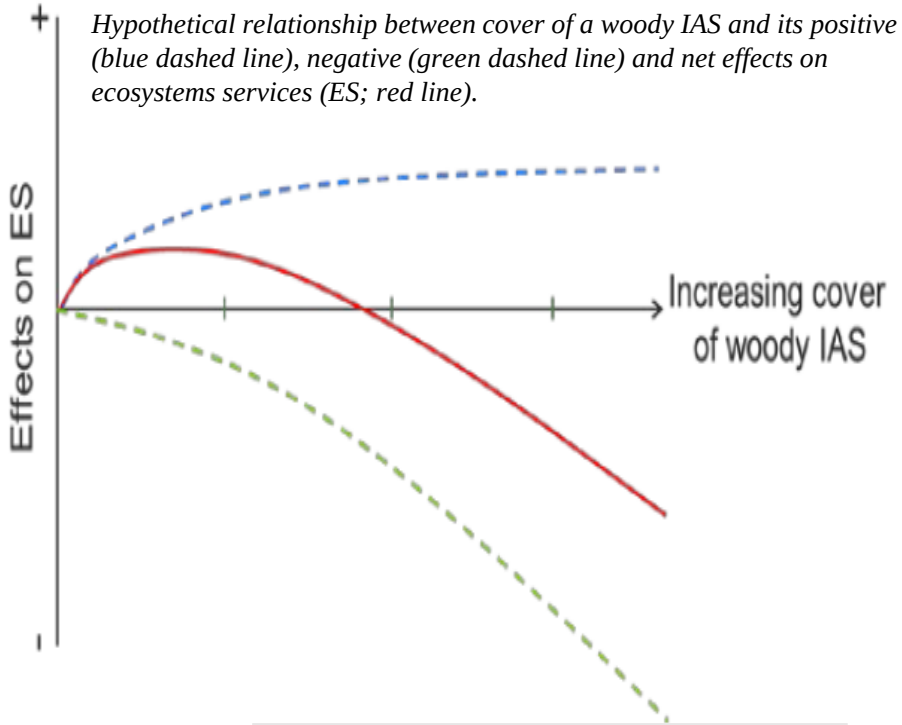
Outline

- Modelling current spatial distribution of Prosopis in Afar
- LULC changes over 31 years
- Water use
- Lesson learnt

What we do in Middle Awash

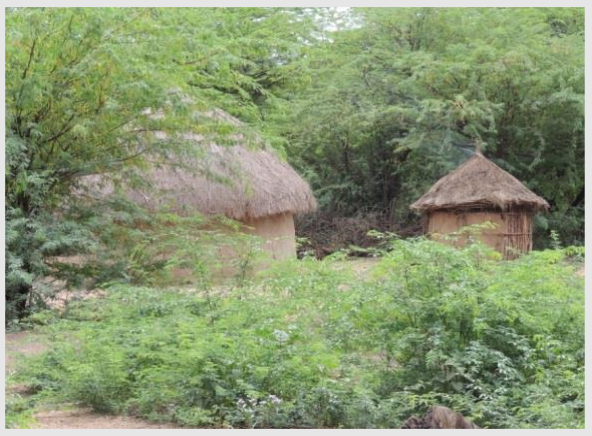
In middle Awash, we carried out researches to:

- Model the current distribution of *Prosopis* in the Afar Region;
- Model land use land cover dynamics within the last 31 years (1986-2017) since *Prosopis* introduction and estimate impacts on ecosystem services;
- Estimate of water use by *Prosopis* & other native species and impacts on ecosystems water budget
- Moreover:



Hypothetical relationship between cover of a woody IAS and its positive (blue dashed line), negative (green dashed line) and net effects on ecosystems services (ES; red line).

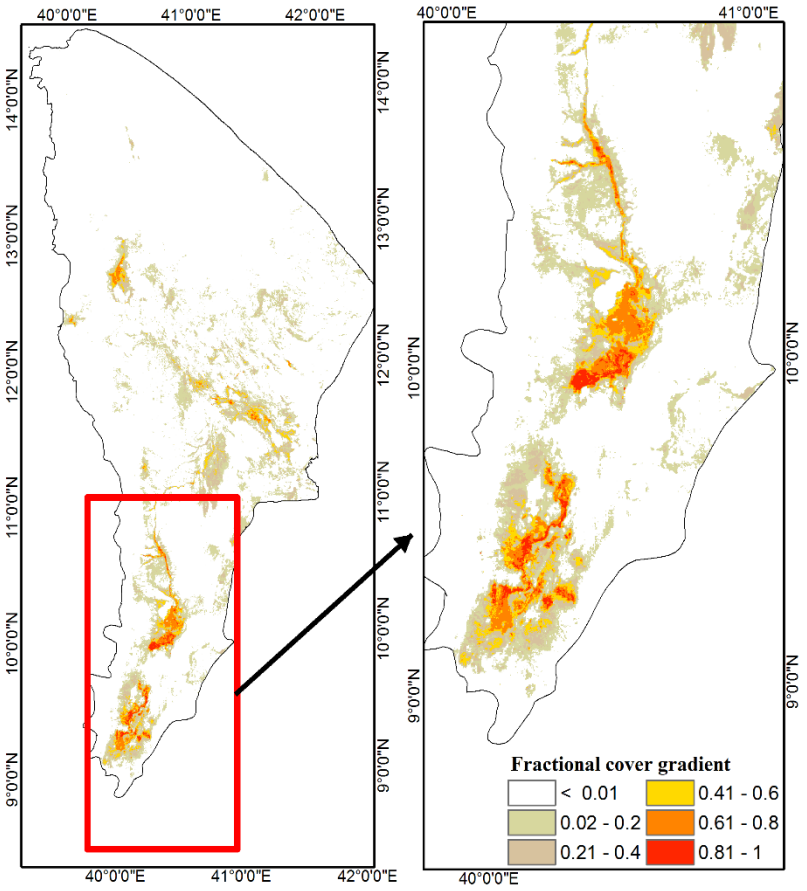
- Biodiversity and ecosystem impacts - Theo Linders;
- Socio-economics and livelihood impacts of IAS - Ketema Bekele
- Genetic mapping - Maria C.
- Test of management options - Birhanu Megersa



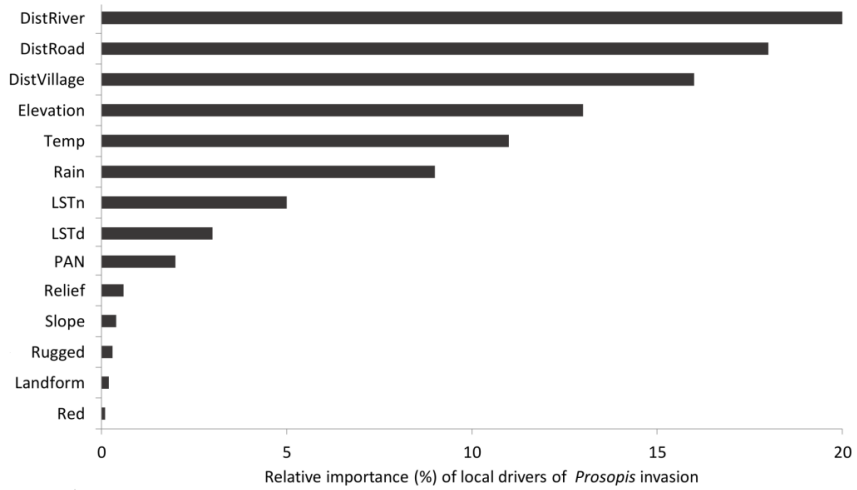
1. Current spatial distributions

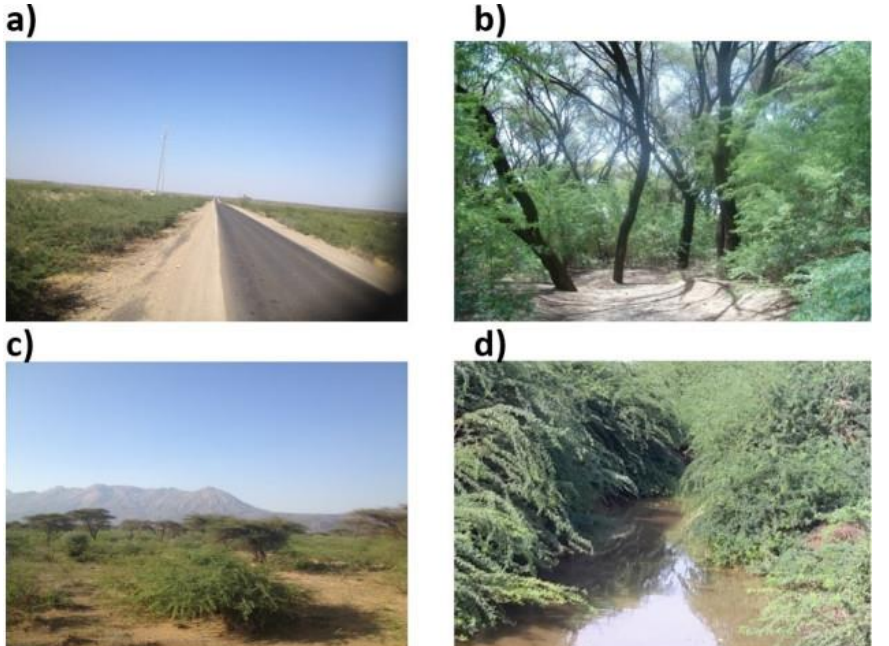
Current distribution (cover/abundance):

- The area invaded by *Prosopis* in the Afar Region is estimated to be about 1,173,000 ha (12.3% of the total regional area).
- Validation of the model performance revealed an accuracy of 92% and a Kappa coefficient of 0.8 at P < 0.001. The local invasion drivers were also identified.



- Local drivers of invasion:



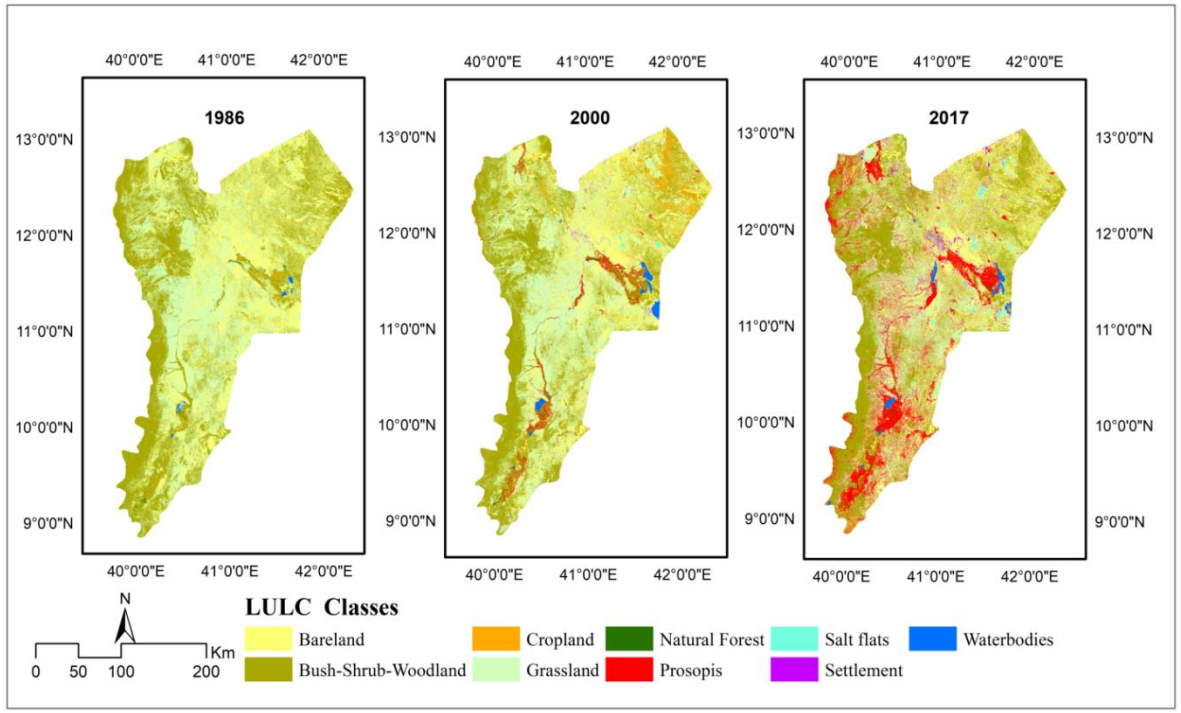


Invasions of different land sue types:
(a) on roadside,
(b) Prosopis regeneration in riverine forest,
(c) Prosopis regeneration in the rangeland invasion, and
(d) on riverbanks invasion

2. LULC changes

Land use land cover changes:

- Grassland and bush-shrub-woodland decreased while *Prosopis*, salt flats, cropland and waterbodies increased
- The annual rate of change of reductions of bareland, bush-shrub-woodland, grassland and natural forests were estimated at 10,612 ha, 10,543 ha, 19,312 ha, and 32 ha, respectively.

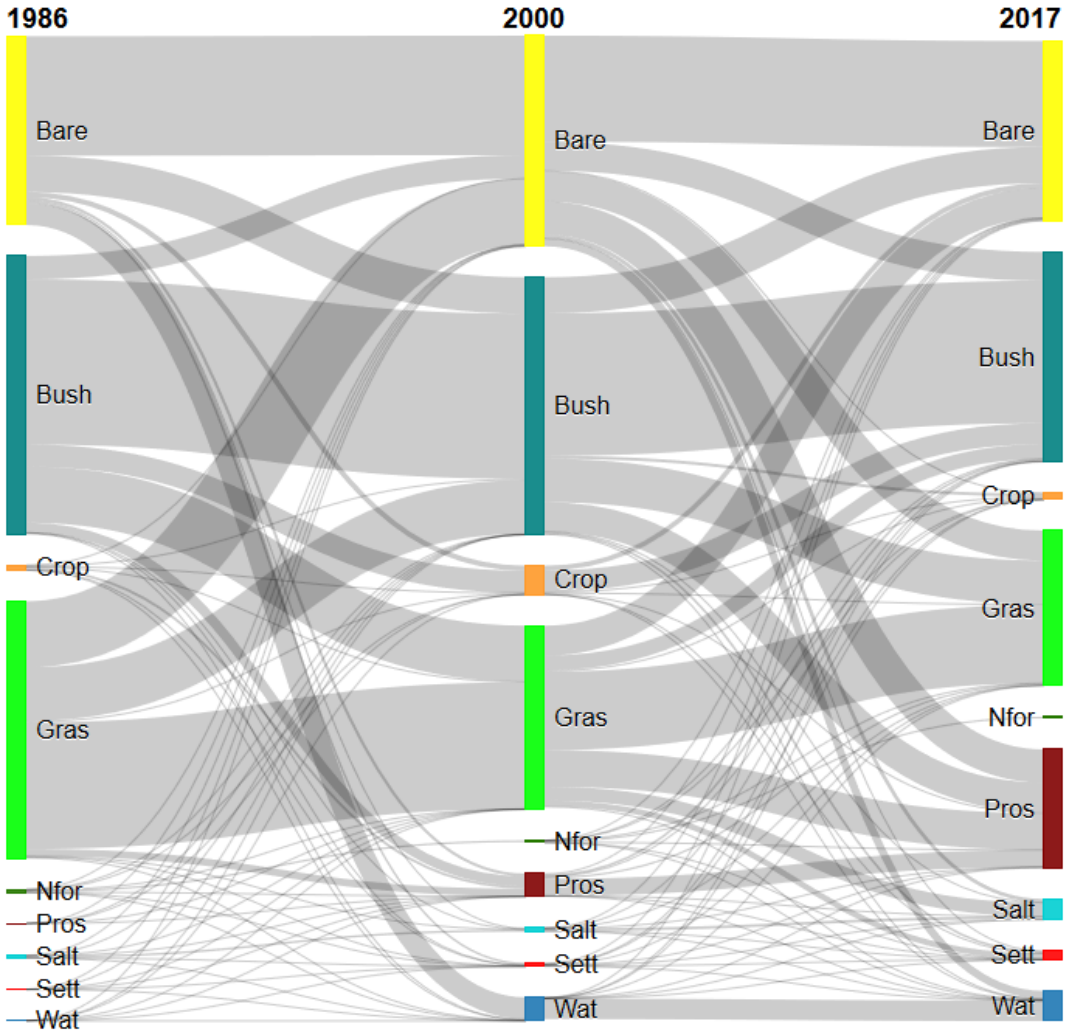


- *Prosopis* has invaded an area of about 1.2 million ha over the last 31 years in the study area (central and southern parts of Afar region).
- This reflects a mean annual invasion rate of about 31,127 ha per year.
- Our results suggest that the invasion did not increase linearly but was much faster after 2000 (1986-2000: 10,900 ha per year; and 2000-2017: 48,500 ha per year).

2. LULC changes ---

Dynamics of LULC: stable gain and loss

- *Prosopis* took (over) grassland, bush-shrub-woodland, bareland
  - 250,000 ha from bareland
  - 275,000 ha from bush-shrub-woodland
  - 305,000 ha from grassland
- 300,000 ha of grassland changed to bareland
- 450,000 ha of bush-shrub-woodland changed to bareland
- > 600,000 ha of grassland disappeared (>50% changed to *Prosopis* invaded land)
- Almost all LULC took from Natural forest but nothing changed to Natural forest
- Cropland, salt flats, waterbodies increased



2. Changes of LULC changes and ESVs loss

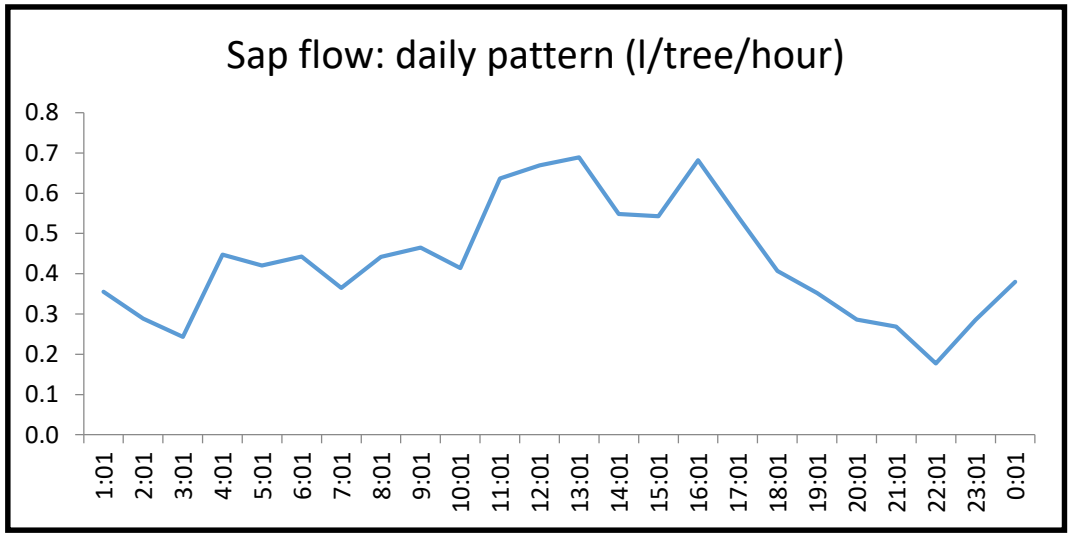
Table 4. Changes in ecosystem service values (ESVs) in US$ between 1986 and 2017 in the Afar National Regional State, Ethiopia.
* = ESV based on own calculations as explained in Appendix 1b. Average changes in ESVs over the last 31 years: US$ -16,606,623,394

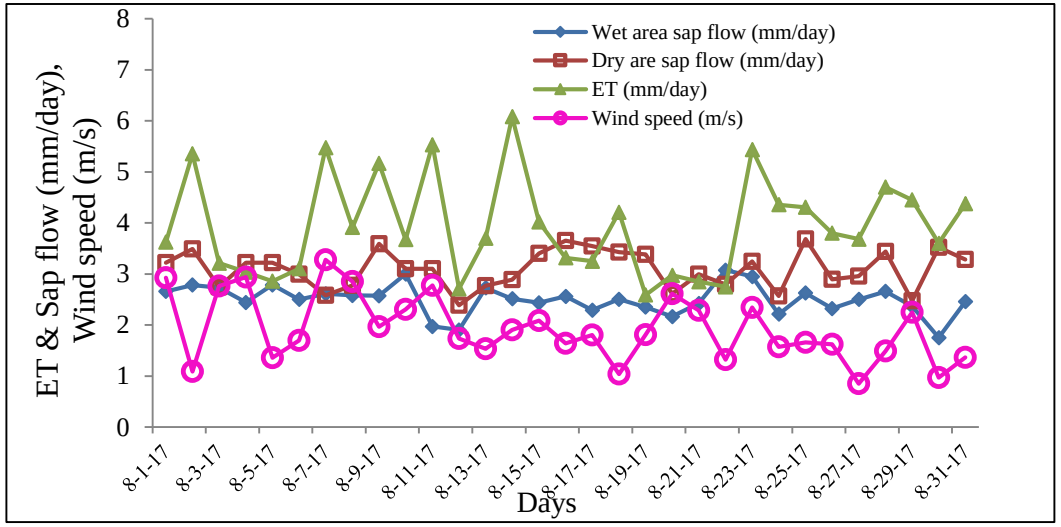
LULC Type	Local estimates (Kindu et al. 2016)	Global estimates (Costanza et al. 2014)
Bareland	-	-
Bush-shrub-woodland	-9,674,307,683	-9,996,784,606
Cropland	123,098,987	3,139,453,479
Grassland	-4,584,132,592	-67,294,389,050
Natural forest	-119,992,062	-676,325,747
Prosopis*	2,154,252,990	3,500,661,108
Salt flat	-	3,389,444,948
Settlement	-	22,578,917,393
Waterbodies	9,341,912,525	14,904,943,523
Total	-2,759,167,835	-30,454,078,952
An average from the last 31 years is US$ - 16,606,623,394 (~ -16.6 billion)		
Annual losses in ESVs are estimated at US$ 602 million (range 112 to 1,092 million).		

3. Water use of Prosopis

Water use

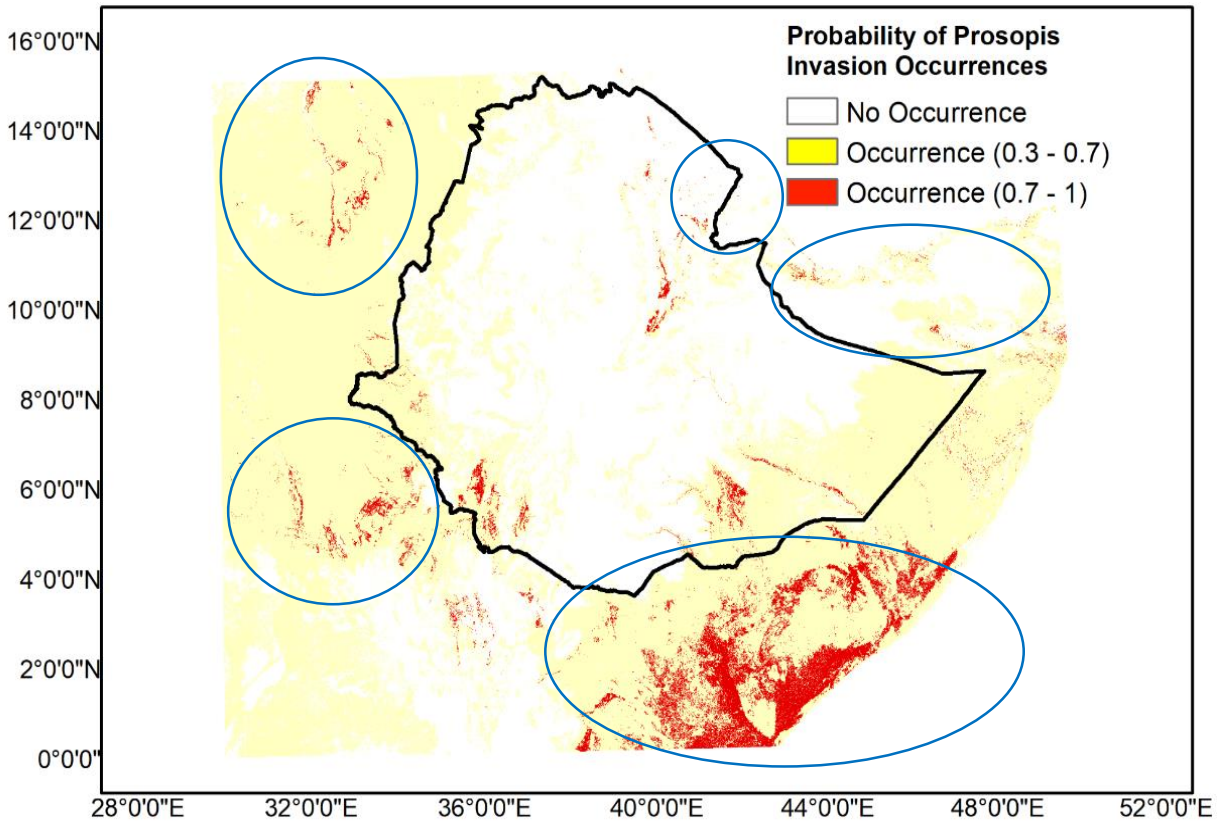
- *Prosopis* tree uses 0.5 to 0.8 liter/hour, or **7** (±2) liters/day





4. Lessons learnt

- *Prosopis* affects the biodiversity and ecosystem services of the lowland,
- It continues to invade more lowlands, even beyond the country if left uncontrolled
- Is become regional (IGAD) challenges
- This indicates that management systems should account the regional context in the East African scope, otherwise management in one of these countries is not the long lasting solution as these species are distributed by different agents such as livestock, wild animals, birds, river, and flood courses and even by people along transport corridors
- *????*



Conclusion

- currently, 1.2 million ha invaded
- A Prosopis tree use 7 litres of ground per day
- From invaded area *Prosopis* trees use and loss ca. 8.321 billion mm/day from through sap flow and ca. 9.055 billion mm/day through evapotranspiration
- It is equivalent to 3.1 and 3.3 billion m^3 of water per year
- This could irrigate 400,000 – 450,000 ha of cotton farmland (ca. 7000 m^3 water can irrigate 1ha for cotton)
- Costs us about US$ 465,000 - 500,000 per year over the invaded range in the Awash Basin (with 0.00015 US$/m3, rate payment to ES to Awash Basin Authority, accord. Ayana et al 2015)

- Affects the water budget of the ecosystems

- Indigenous palatable grasses species such as *Chrysopogon plumulosus* (Durfu), *Cenchrus ciliaris* (Serdoitas) and *Seataria acromelaena* (Mussa) and
- Multipurpose trees such as *Acacia tortilis* (Eebto), *A. senegal* (Adebo), *A. nilotica* (Keselto) and *Dobera gelabera* (Gersaito) are threatened by *Prosopis* invasion (Engda, 2009)

Thank you for your attention