MESQUITE TREE INFESTATION ON GASH SPATE IRRIGATION SYSTEM: Impacts and Remedial Measures

Regional Conference on Invasive Species in ASAL-Managing *Prosopis Juliflora* (Mesquite) for better(agro-) pastoral livelihoods in the Horn of Africa @Desalegn Hotel, Addis Ababa, Ethiopia

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Outlines

1. Introduction
2. Problem statement
3. Research objectives
4. Research Questions and Methodology
5. Results and Major findings
6. Conclusions and Recommendations

INTRODUCTION

Sudan, Kassala state and Gash Delta maps

INTRODUCTION cont…

- Agriculture is the main activity in Sudan
  - -contribute about 38% of GDP
  - -80 % of the population dependent on agriculture
  - -provides about 80 % of the country's export
  - - Main crops are Sorghum, Cotton, Groundnuts
- Gash Agricultural Scheme (GAS)
  - -pilot projects , that serves the local population(approx. 1.5million people) around Kassala state
- Gash River
  - -originates from the Eritrea/Ethiopian Plateau and ends up in Gash delta
- The Kassala state is heavily impacted by desertification
- The scheme has been invaded by Mesquite trees

Mesquite Tree

- Mesquite (*Prosopis spp.)* - exotic plant , invasive having ecological, economic and social impacts, (Osmond *et al.,2003)*

- Mesquite tree was introduced in 1917 in northern and eastern parts of Sudan for the purposes of dune stabilization

(Broun &Makey,1929)

PROBLEM STATEMENT

- Over 100,000 ha of irrigable land is estimated to be infested
- Mesquite blocks irrigation canals and reduces water capacity
- Invades the agriculture areas hence diminishing the cultivated land
- Absence of permanent land leads to lack of user right

RESEARCH OBJECTIVES

- ✓To quantify spatial and temporal land cover changes of the Mesquite tree in the GAS using satellite imageries from 1979 to 2013
- ✓To analyze the impact of mesquite tree infestation on the agricultural production in GAS
- ✓To assess the effectiveness of measures used to control Mesquite trees in Gash area
- ✓To recommend alternative technical and economical feasible control measures of mesquite tree infestation in Gash area

RESEARCH QUESTIONS & METHODOLOGY

Research question	Methodology
How the Mesquite tree infestation has changed over the years	✓Review of relevant literature (journals, books, publications, conference papers, previous thesis) ✓ analysis of Remote Sensing land cover maps of mesquite infestation trends ✓Changing detection analysis-calculation on the arcgis 9.3.1
What are the factors that have contributed to those changes	✓Review of relevant literatures ✓Interview with stakeholders (local farmers, research institutes)-Questionnaires
What are the impacts of Mesquite trees infestation on agriculture production in GAS	✓Literature review ✓Analysis of the remote sensing imageries of the Gash delta (1979–2013) ✓Canal Capacity measurement, water use calculations ✓Aqua-crop modeling
How effective are the existing measures to reduce or eradicate the infestation of mesquite trees has been done	✓Literature reviews ✓References from articles &consultants consultation, Researcher 's results on the measure to improve ✓Interviews with stakeholders ✓Field observation & satellite based analysis
What alternative measures if any, could be recommended	✓Interviews with stakeholders (local farmers, research institutes) ✓Research resulted validated in the stakeholder consultants

Methodology

	Landsat(1 - 3 MSS)	Landsat(4-5 TM)	Landsat(4-5 TM)	Landsat 8 OLI
Date acquired	13/05/1979	13/05/1985	13/05/1998	26/04/2013
Path	184	171	171	171
Row	49	49	49	49
Spatial resolution (m)	60	30	30	30
Temporal resolution (days)	18	16	16	16
Number of bands	4	7	7	11
Spectral-Band combination used (RGB)	6-5-4 (NIR-R-G)	7-4-2(SWIR-NIR-G)	7-4-2(SWIR-NIR-G)	6-5-4 (NIR-R-G)
Image size (swath-km^2)	180 x180	185 x185	185X185	185x185
Cloud cover (%)	0		0	0

SWIR band (1.55 – 1.75 µm) **Overall Accuracy assessment from confusion matrix is 76%**

Ground Truthing

- Field Work
- ✓ 91 GCPs covered in Gash Delta
- ✓ Changing detection from imageries of Landsat 1-3(MSS)-1979,Landsat 4-5(TM) 1985,1998 and Landsat 8(OLI) 2013
- ✓ Data analysis from interviews-questionnaires, consultations, agriculture, irrigation, hydrology and livestock stakeholders

RESULTS

Major finding 1-How the Mesquite Tree infestation has changed over the years

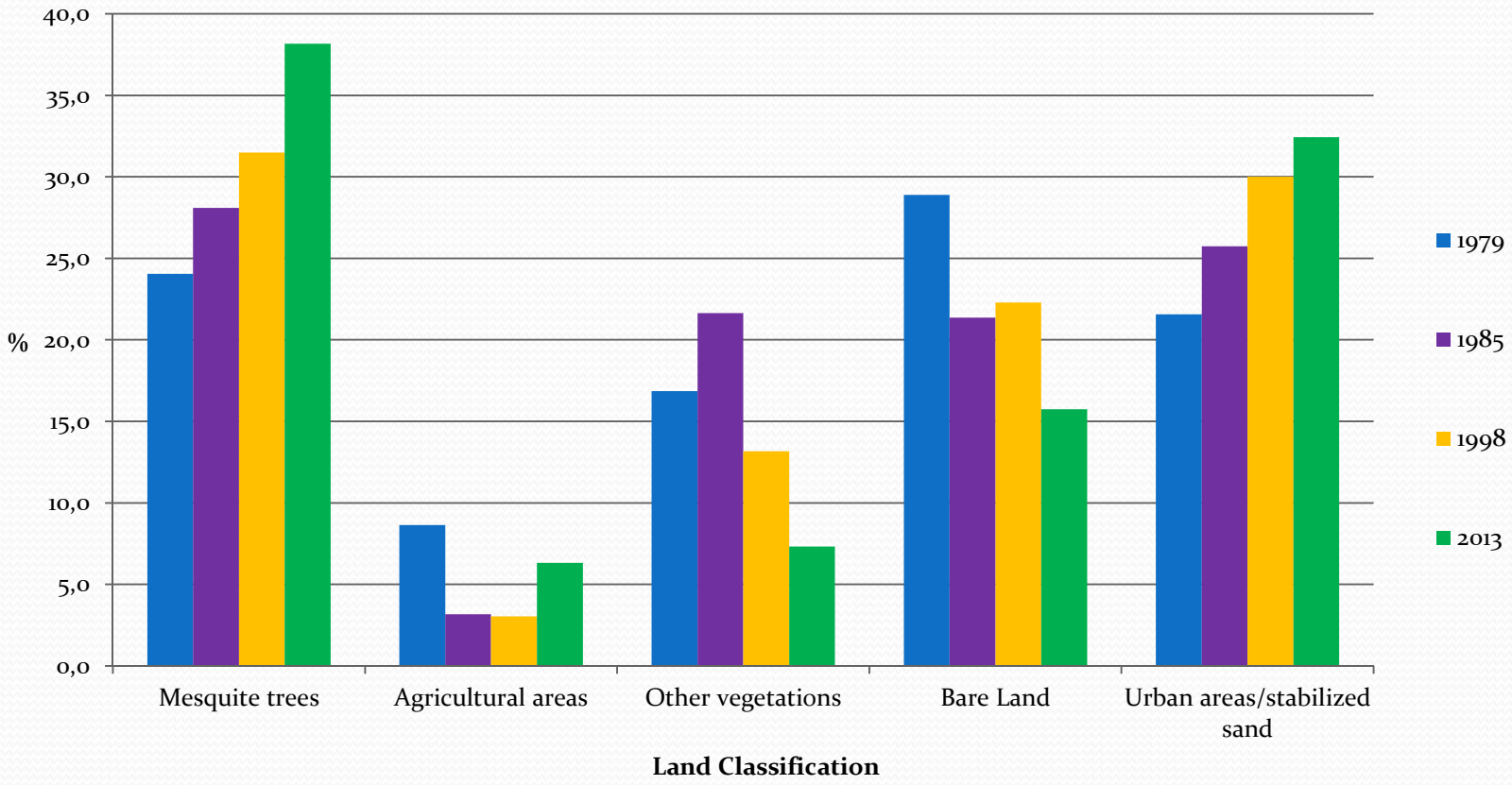
	Area(ha)	%	Area(ha)	%	Area(ha)	%	Area(ha)	%
	1979		1985		1998		2013	
Mesquite trees	89,428	24	104,483	28	117,076	32	141,942	38
Agricultural areas	32,125	9	11,777	3	11,326	3	23,538	6
Other vegetations	62,652	17	80,445	22	48,971	13	27,210	7
Bared Land	107,443	28.9	79,455	21	82,914	22	58,572	16
Urban areas	80,217	21.6	95,710	26	111,583	30	120,608	32

Change detected

Change detected, gained & disappeared areas by mesquite trees

	Areas (Ha)		
	Mesquite trees Disappeared	Mesquite trees Gain	Net gain
Change Detection 1998 vs 1985	7,290	58,583	51,293
Change Detection 2013 vs 1998	18,841	56,975	38,134
Change Detection 2013 vs 1985	10,708	100,135	89,427

Land Cover Change on GAS, Kassala state in Sudan (1979-2013)



Major finding 2- what are the factors that contribute to the trends-Livestock cause

- Livestock dung characterized by high water retention capacity ensure germination
- No damage through the digestive tract of the animals
- Seeds characterized by coat imposed dormancy
- High sugar(16%),protein(12%)-(*Mohamed,2001*)

Poor Water Management

- Pods are float easily transported
- Flood water transport the seeds, poor irr facility cause poor proper water flow

➢ Lack of natural enemies

➢ Can grow in any type of soil

➢ Wide range of dry tolerance, able to find water using its tap root during drought

Major Finding 3- What are the impacts of mesquite trees infestation on the agriculture production of GAS

- Case 1-25% Canal capacity reductions.
  - Assumptions-maintain the current water application of 987mm
  - Consequences-irrigable land will reduces for 37,500 ha
  - Yield/ton-remain the same 5 ton/ha(aquacrop simulations)
- Case 2-50% canal capacity reduction-worst scenarios in the same canal
  - Assumptions-maintained the same water application of 987mm
  - Consequences; irrigable land will reduced to 25,000 ha
  - Yield/ton; 2.5ton/ha

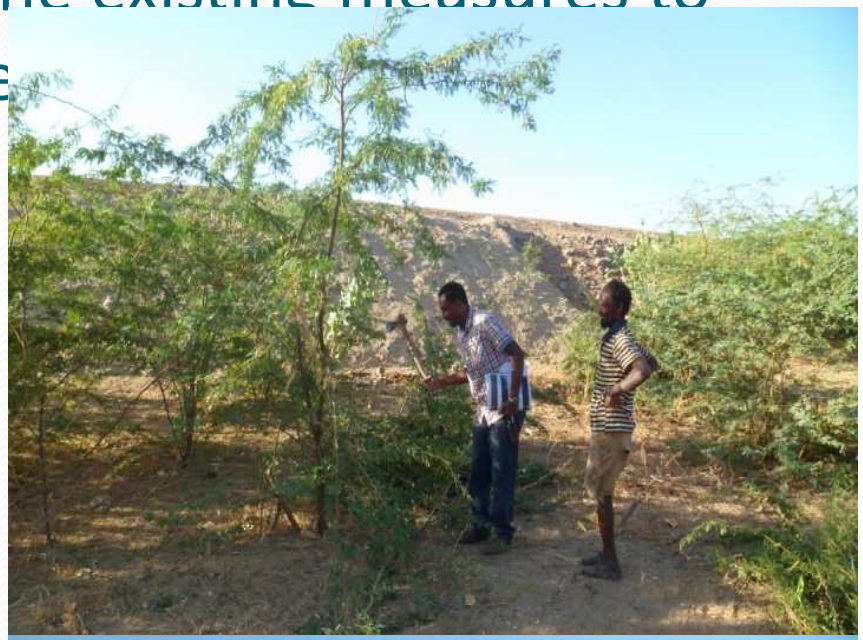
Mesquite water consumptions

	Consumption per Tree (liters/day)	Number of tree per ha	Total consumption per ha/day	Total annual water consumption per ha	Irrigated area infested per ha	Total water consumed per total area	Total annual water consumption per total area
Gross consumption	18	952	17,143	6,257,143	42,600	730,285,714	266,554,285,714
Evapotransipiration			11,429	4,171,429		486,857,143	177,702,857,143
Net water consumption(l/day)			5,714	2,085,714		243,428,571	88,851,428,571
Net water consumption(m3/yr)							88,851,428.57
Net water consumption(Mm3/yr							88.85

- ✓Mean Annual rainfall (mm/year)=180
- ✓Gash river annual flood flow(Mm^3) as per 2010 data = 560

Major finding 4-How effective are the existing measures to reduce or eradicate/control the infe

- Cutting the mesquite trees on the stem
- Hand puling, hoeing, tilling up to 10 weeks
- use diesel and 2-4 D chemicals to eradicate and control the mesquite
- Planting *Sorub*/*Kormot* trees to overcome Mesquite
- Allowing bees to produces honey from mesquite

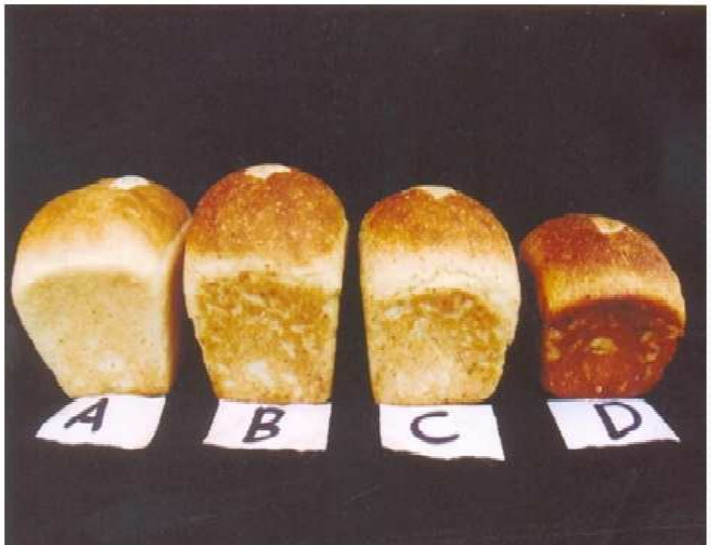


Major finding 5-What alternative measures could be recommended

- Biological ,Physical and Chemical control *(New Halfa scheme)*
- Controlled management for productive use
- Charcoal productions *(Afar scheme Ethiopia)*
- Honey produces *(India & Yemen)*
- Increase agricultural areas(mesquite area for agriculture activities
- Bio fuel
- Biomass to generate power *(Nema electricity power plant, Kenya)*

Mesquite Cost Benefit analysis

- ✓Area considered is irrigable area (42,600 ha)
- ✓Only Sorghum crop considered for analysis
- ✓Only Charcoal productions considered
- ✓The rate of 1USD=5.67SDG was used



No.	Item	Cost (USD)		Benefit(USD)	
		per ha	per 42,600ha	per ha	per 42,600ha
1	Mechanical Removal	196	8,367,851		
2	Charcoal	2,082	88,699,286	2,946	125,517,857
3	Sorghum	875	37,286,964	1,719	73,218,750
4	Total	3,153	134,304,101	4,665	198,736,607
5	Total Net Profit			1,513	64,432,506

CONCLUSIONS

✓Mesquite infestation has increased from 89,000 ha in 1979 to 142,000 ha in 2013- a 14% total increment

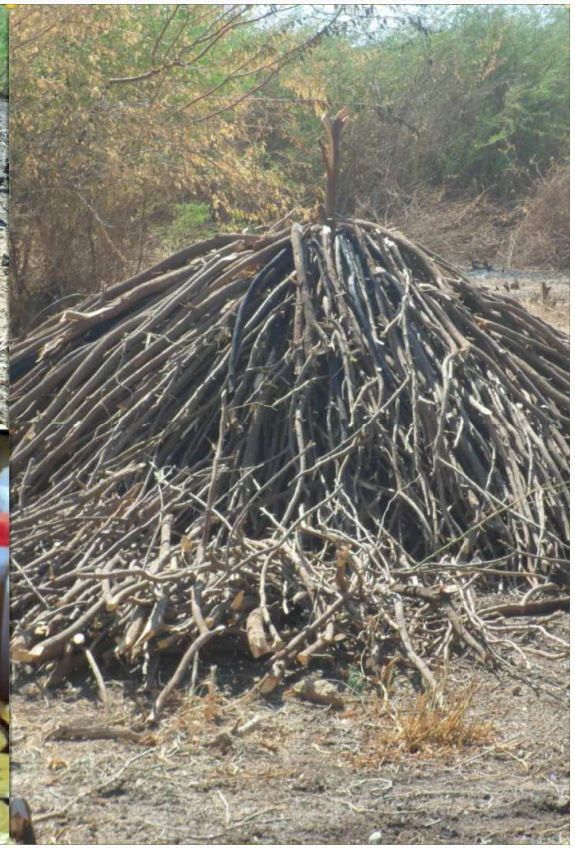
✓Landsat MSS,TM and OLI have been reliable (mesquite invaded much on the canal, river banks and farm road sides)

✓Existing measure have been ineffective
•Lack of land ownership (land tenure)

•Lack of institutional backing from central and local governments(Control has been disappointed due to luck of commitment and follow up from the state government

•Non connectivity between eradication/control program and benefit generated

✓Mesquite has several uses to its credit



Salinity control, Land reclamation, Charcoal, Wood chips, Fodder, Bio fuel, Biomass to generate power, Honey and gum, Pods for animal food, Medicinal purposes , Timber, Fencing, bread productions

Recommendations

- Eradication and Control to maximize the income to citizens
- Cost benefit analysis -effective and is an essential component of a noxious mesquite management strategy
- Prevent Land rotation and promote long term permanent land user right
- High resolution satellites (ALOS, RapidEye, Meteosat, GeoEye, DigitalGlobe, ERDAS, ASTER ‘s) could be used to find and effecting the monitoring expansion of mesquite
- Coordinate national management programme that select the appropriate management procedures
- Regular monitoring and annual evaluations determine adequacy of the plan(a case study of New Halfa scheme)

THANK YOU

ANY

QUESTIONS

OR

COMMENTS