National Directorate of Forestry
Ministry of Lands, Environment and Rural Development

GIS based REnergy demand-supply analysis for REDD+ in Mozambique

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National Directorate of Forestry
Ministry of Lands, Environment and Rural Development

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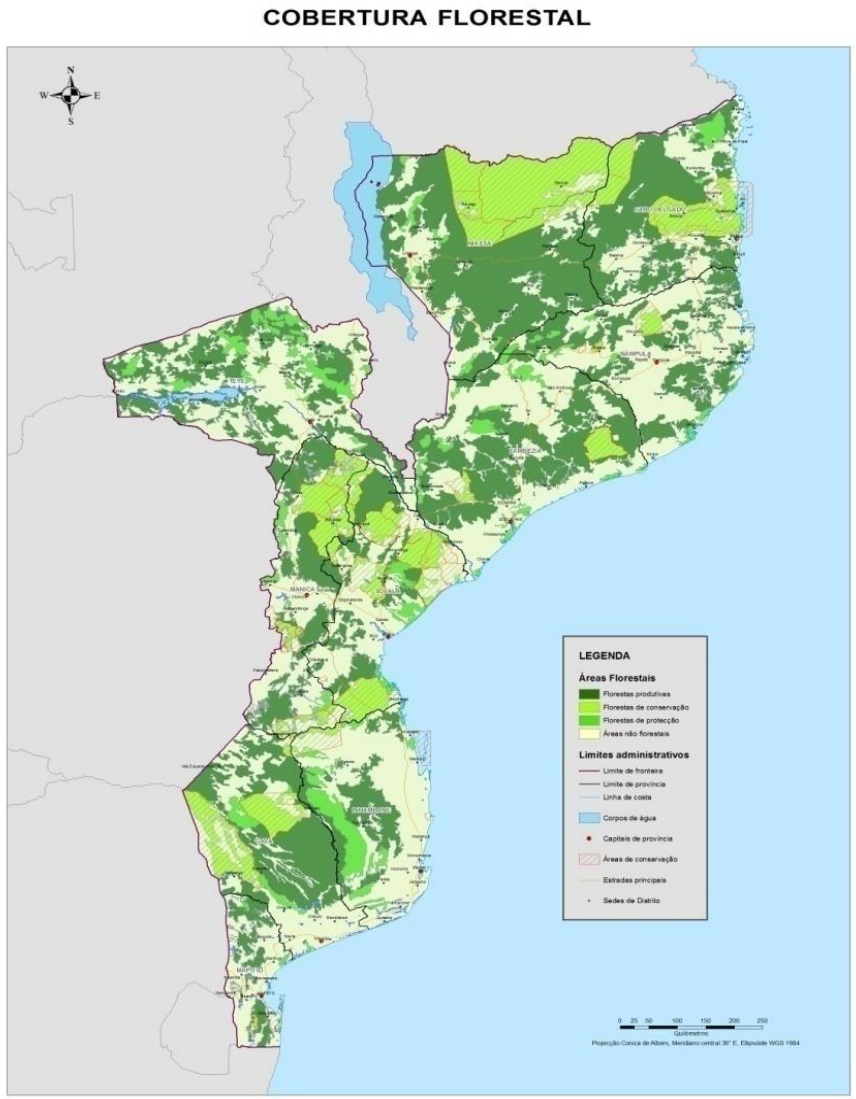
General information

- **Area** ~ 801 590 Sq km;
- **Population** ~ 27.216.000 (2017 census projection);
- **Economy** – Agro-based (cashew nuts, cotton);
  - **Resources**: Water, Wood Products, Shrimps, Natural Gas, Coal, Hydro-energy;
- **Tropical climate** with two seasons:
  - wet season from October to March, and
  - dry season from April to September;
- **Institution responsible for Forest:** National Directorate of Forestry under Ministry Land, Environment and Rural Development.

Forest resources

- **Forest cover and other woodland:** 54.8 millions ha (70% of the country)
- **Forest cover**: 40.1 million ha;
- **Potential area of timber production:** 26.9 millions ha;
- **Deforestation rate:** 0.58%/year (219.000 ha per year), (AIFM2007);



Scope of the study

Objective:

•The objective of the case study is to analyse alternative, sustainable and renewable energy development options for Mozambique **alternative** to the major use of wood based energy in both urban and rural areas which cause significant GHG emissions by deforestation and forest degradation;

Expected Results:

- Potential REDD+ effect by introduction of alternatives energy to firewood and charcoal demand;



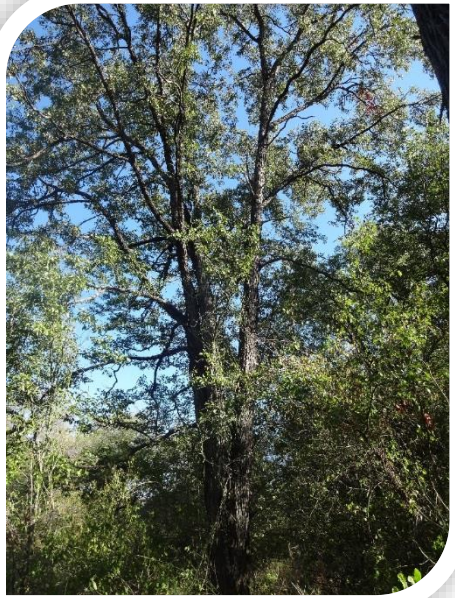

What is REDD+

- **Reducing emissions from deforestation and forest degradation and the role of conservation, sustainable management of forests and enhancement of forest carbon stocks in developing countries** (**REDD+**);

- 2005 :Started Negotiation under UNFCCC;
- 2015 : Paris agreement Article 5 and 17 UNFCCC COP decisions on methodologies;
- Countries incorporate REDD+ in NDC, for Results based Payments (GCF and others);
- Countries must submit the information on the FREL/FRL, Safeguards (social and environmental), Forest Monitoring;

Methodological approach

- The analysis of steps initially developed as the Woodfuel Integrated
- Supply/Demand Overview Mapping (2013);
- Calculations and results.



Wood Energy is one of the Largest Drivers of Deforestation

- Introduction of RE can be a potential REDD+ activity;
- However, it is not known much how to find RE as REDD+ option;

Wood demand

1. **Estimation of per-capita consumption in rural and urban areas;**
2. **Analysis of demographic projection & estimation of 2013 situation;**
3. **Creation of population distribution density and accessibility maps;**
4. **Creation of woody biomass consumption map from the energy demand;**

Analysis of Wood Energy Demand

Demand

- **Estimation of per-capita consumption in rural and urban areas based in projection of population of 2013;**
- **Convert the consumption value in Tons and PJ;**
- **Evaluation of the demand per province, and the rate to deforestation where available;**

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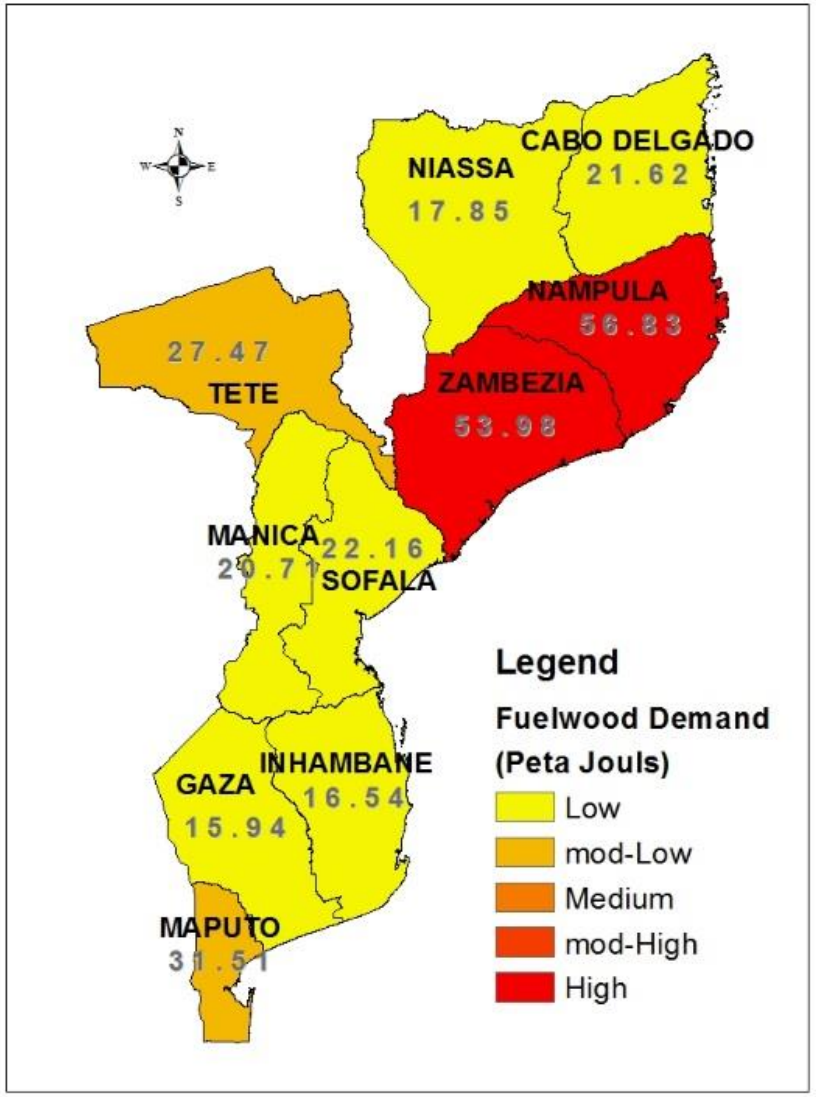
Annual Demand of Wood Energy (2013)

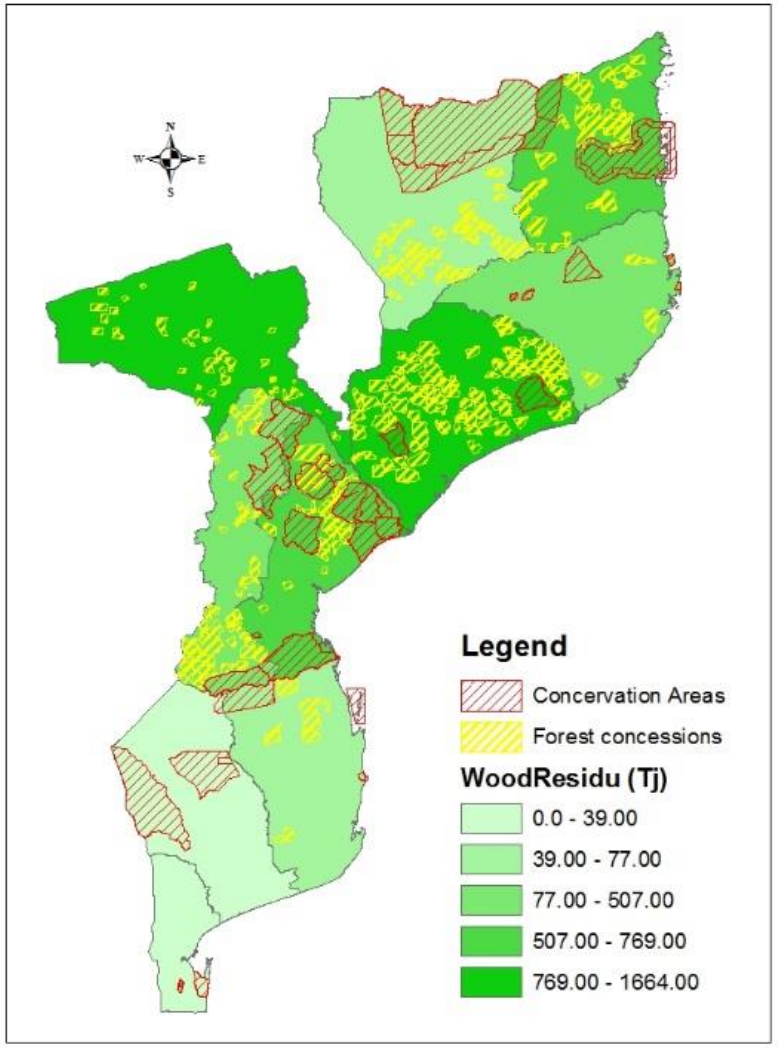
Province	Demand (PJ)
Niassa	17.85
C. Delgado	21.62
Nampula	56.83
Zambézia	53.98
Tete	27.47
Manica	20.71
Sofala	22.16
Inhambane	16.54
Gaza	15.94
Maputo	18.27

Total: 284.61 PJ/Year



Wood Residue

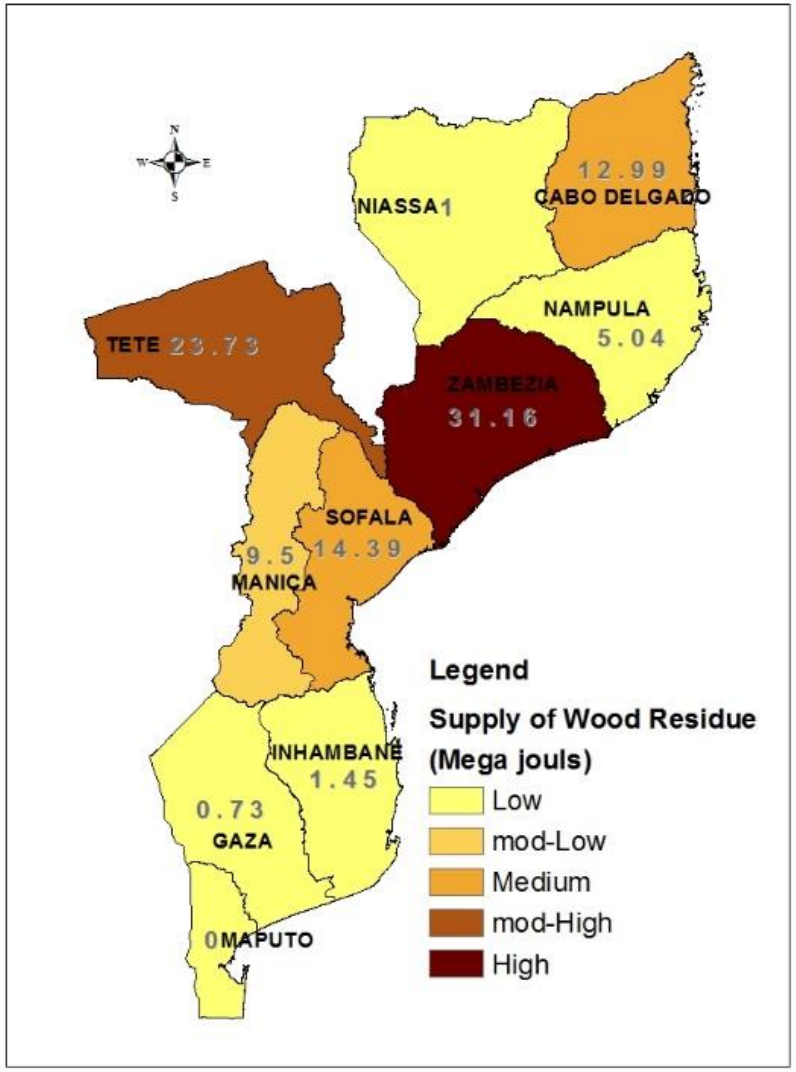
Province	Wood Residue (TJ)
Niassa	53
C. Delgado	694
Nampula	269
Zambézia	1664
Tete	1267
Manica	507
Sofala	769
Inhambane	77
Gaza	39
Maputo	0



Supply of Wood Harvest and Processing Residues Potential

Province	Wood Residue (TJ)
Niassa	53
C. Delgado	694
Nampula	269
Zambézia	1664
Tete	1267
Manica	507
Sofala	769
Inhambane	77
Gaza	39
Maputo	0

Total: 5.34 PJ/Year



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Potential supply based on currently available RE

- Bioenergy potential (115PJ) = Harvest and Process Residues from Agriculture (117PJ) + Residues from Forestry (5PJ) – Biomass Needs for Animal Feed (7PJ)

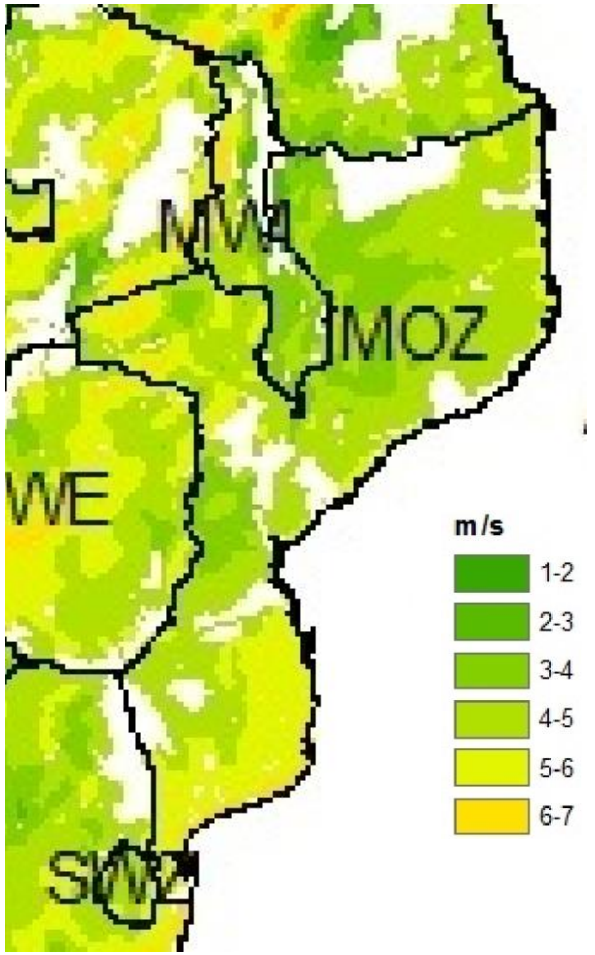
(condition for analysis)

- 25% of agro-harvest residue
- 90% of potential processing residue
- 30% of wood-harvest residue

(IRENA 2017 Africa 5 analysis based on FAO Stat, 2010)

Alternative Energy – Rooftop Solar PV and Wind Potential

Wind is one of potential RE that can be taken into consideration with a capacity which is around 6m/s to > 7m/s of wind speed in the country in more that 80% of the country. IRENA estimated **19,272 TWh** equivalent to **69,307 PJ per year** excluding protected areas**.**



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Solar PV supply the case of rooftop 3m^2 vs Solar PV supply the case of rooftop 1m^2

Prov.	Area of rooftop (km2)	Avail. Energy (PJ)
Niassa	876	208
C. Delgado	1,055	251
Nampula	2,798	665
Zambézia	2,630	625
Tete	1,339	318
Manica	1,018	242
Sofala	1,099	261
Inhambane	807	192
Gaza	780	185
Maputo	904	215
Total	**9,353**	**3,327**

Available Energy (PJ) per year per family per province without taking a land for other use

Prov.	Area of rooftop (km2)	Avail. Energy (PJ)
Niassa	292	69
C. Delgado	352	84
Nampula	933	222
Zambézia	877	208
Tete	446	106
Manica	339	81
Sofala	366	87
Inhambane	269	64
Gaza	260	62
Maputo	301	72
Total	**4,668**	**1,109**

Potential from Hydropower Expansion Plan

- Hydropower production total: 43.20 PJ

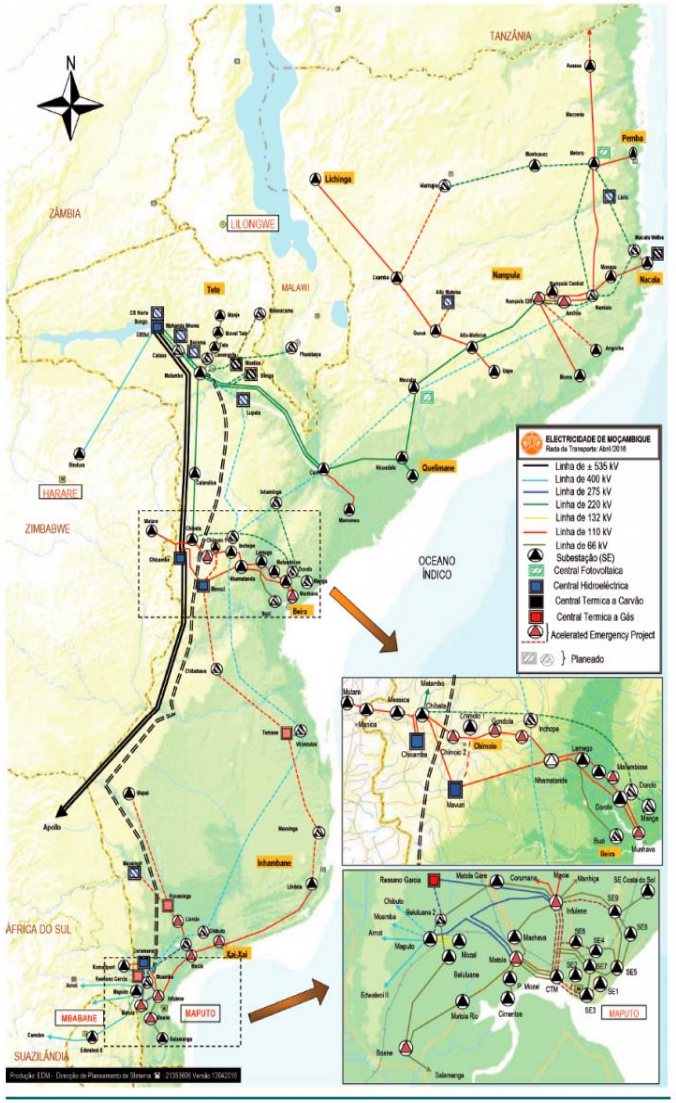
Current domestic supply: 12.17PJ

export: 31.03 PJ

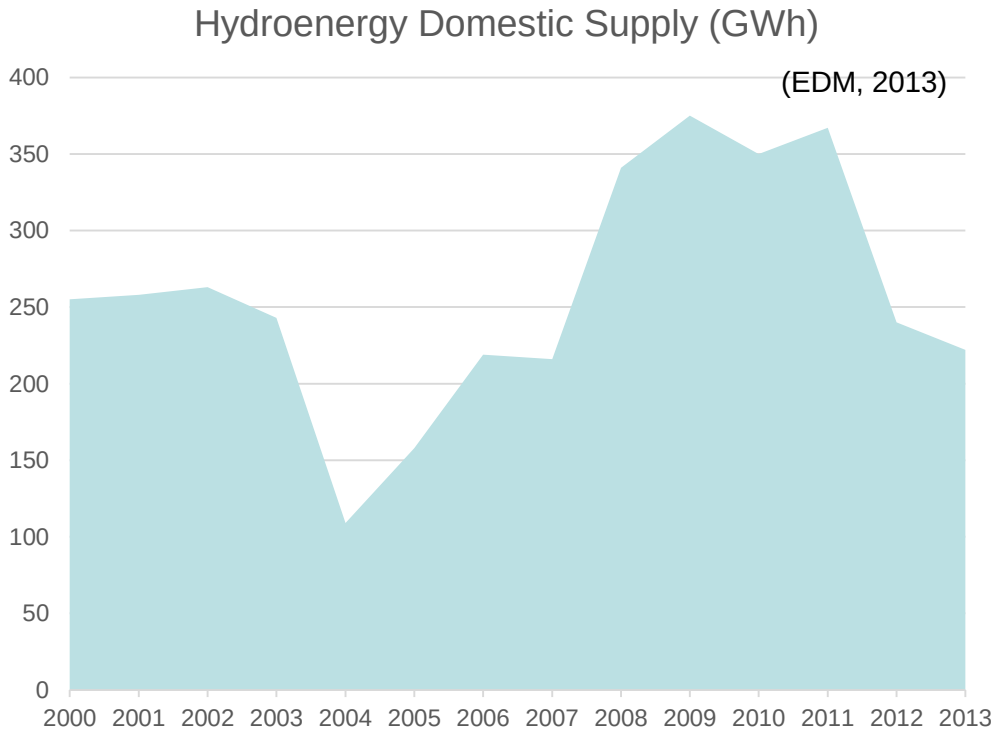
(Cahora Bassa dam 2013)

On going expansion
2500 MW to 12000 MW
(4.8 holds)

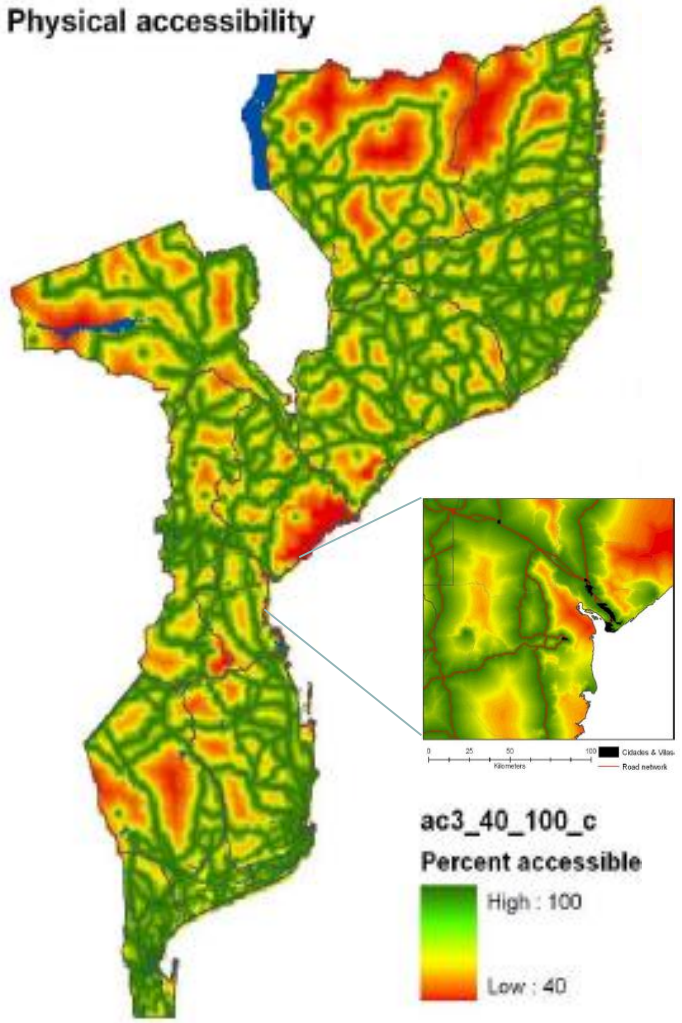
- Future Hydropower potential: 207.36 PJ / year



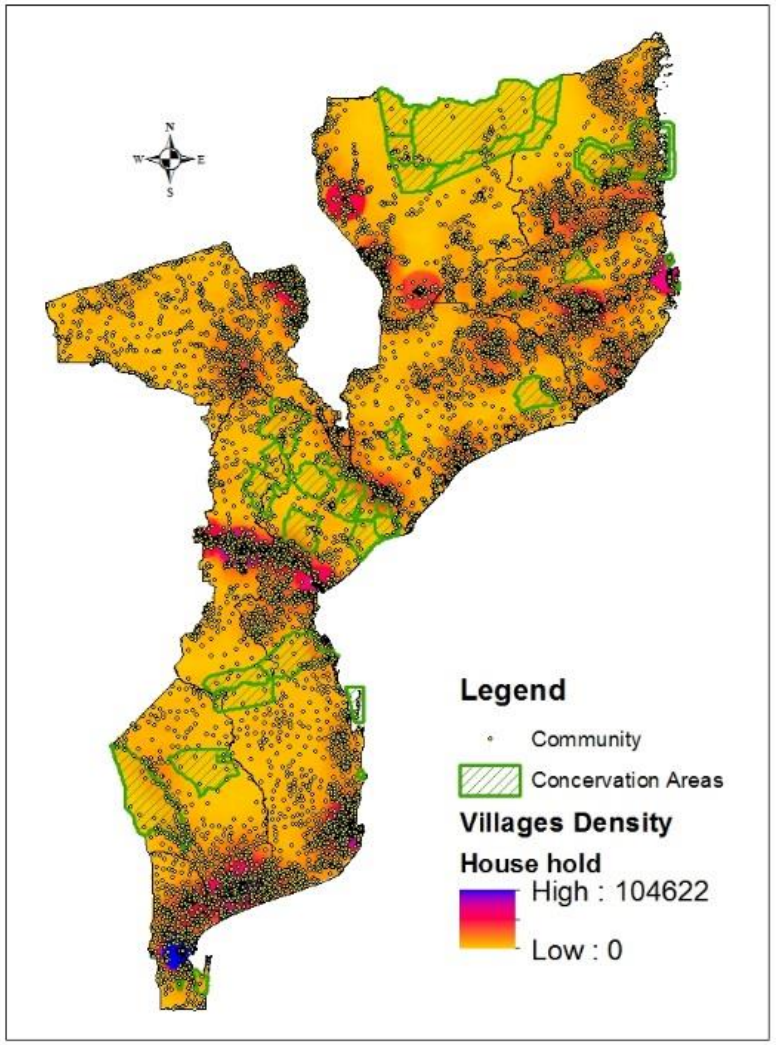
Fluctuation of Hydroenergy supply



People are Using All Land Except for Protected Areas

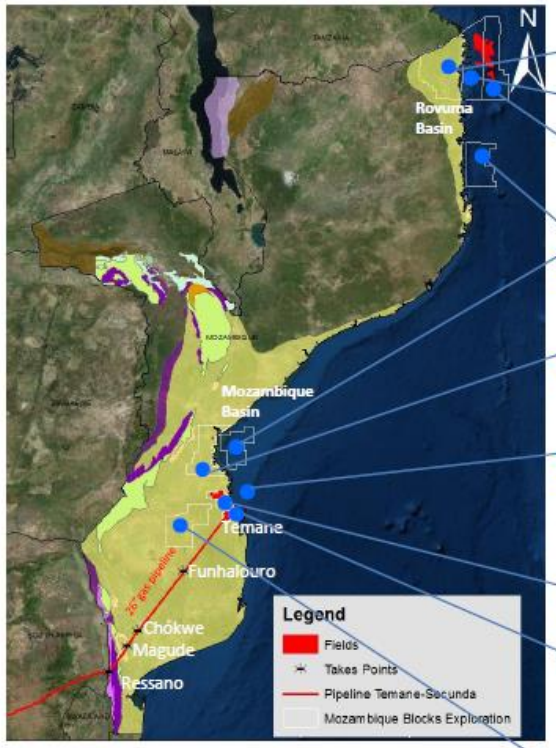


- Shifting Cultivation and Livestock Grazing;
- Biomass is precious resource for sustainable yield;
- Frequent flood and drought;



Potential from Natural Gas Exploitation

- 5,507 billion m3 in Inhambane and Rovuma deposit
  (Number one in Africa)
- 410 PJ



Sofala	
Sasol	85%
ENH	15%

Buzi	
Buzi Hydrocarbon	75%
ENH	25%

Block 16&19	
Sasol	50%
ENH	15%
Petronas	35%

Pande-Temane (PSA)	
Sasol	100%

Pande-Temane (PPA)	
Sasol	70%
ENH	25%
IFC	5%

Area A	
Sasol	90%
ENH	10%

Rovuma Onshore	
AMA1	35.7%
PTTEP	10%
ENH	15%
Maurel&Prom	27.71%
Wentworth	11.59

Area 1	
AMA1	26.5%
PTTEP	8.5%
Mitsui	20%
Bharat	10%
Beas	10%
ENH	15%
OVL	10%

Area 4	
ENI	70%
ENH	10%
Galp	10%
Kogas	10%

Areas 3 & 6	
Petronas	50%
Total	40%
ENH	10%

Aug 2014

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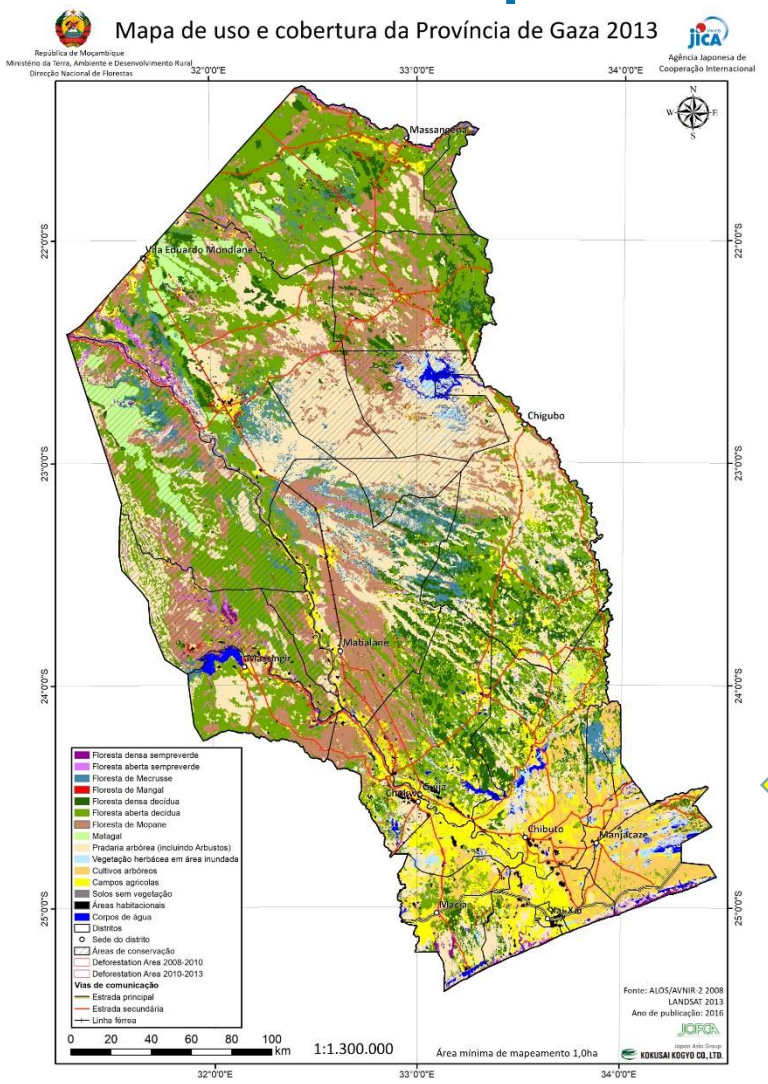
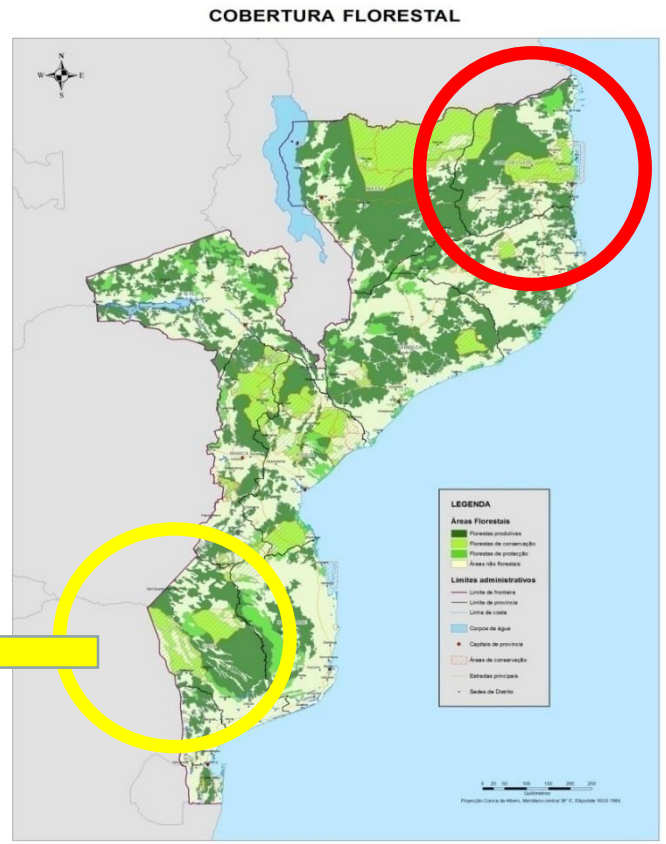
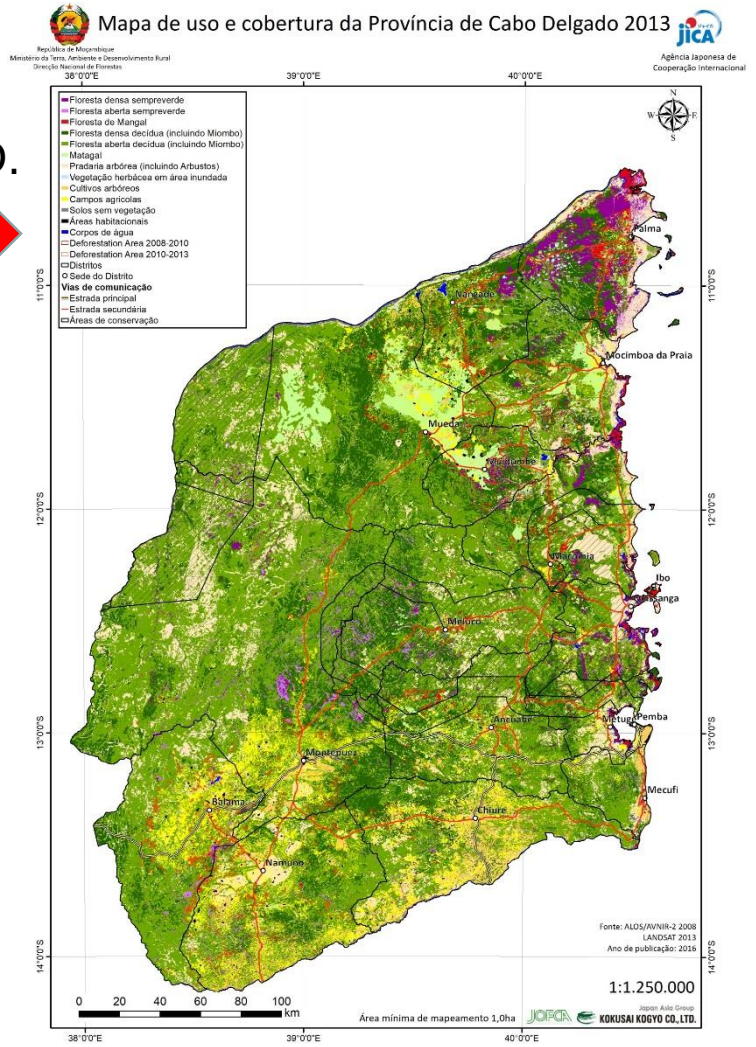
Land Cover Map of Cabo Delgado and Gaza Provinces





Gaza

C.D.



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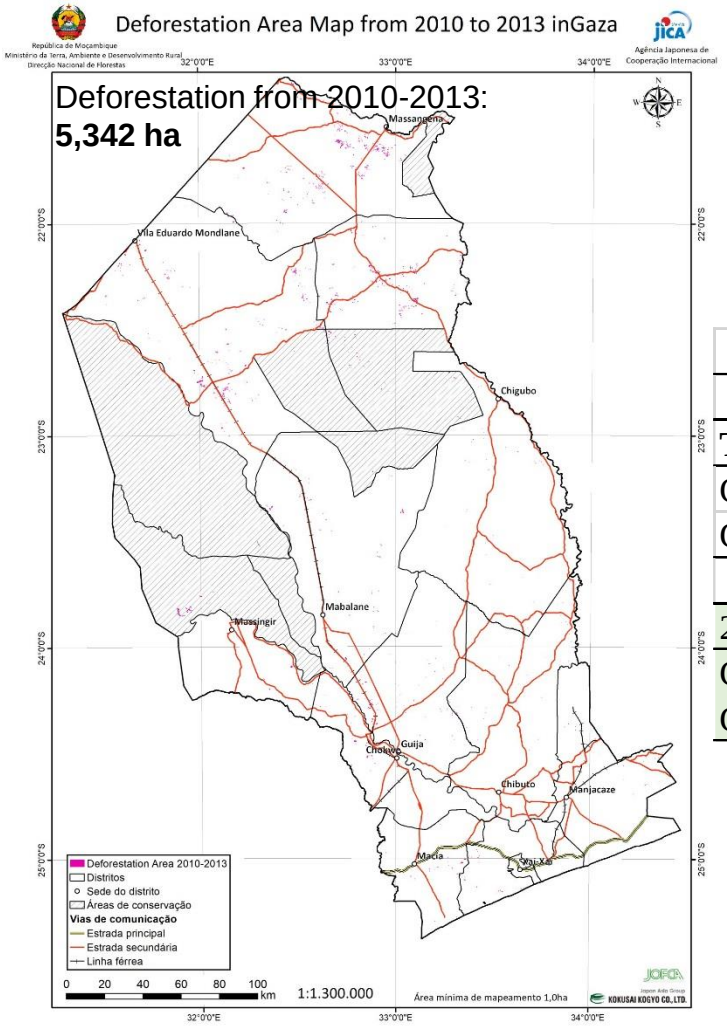
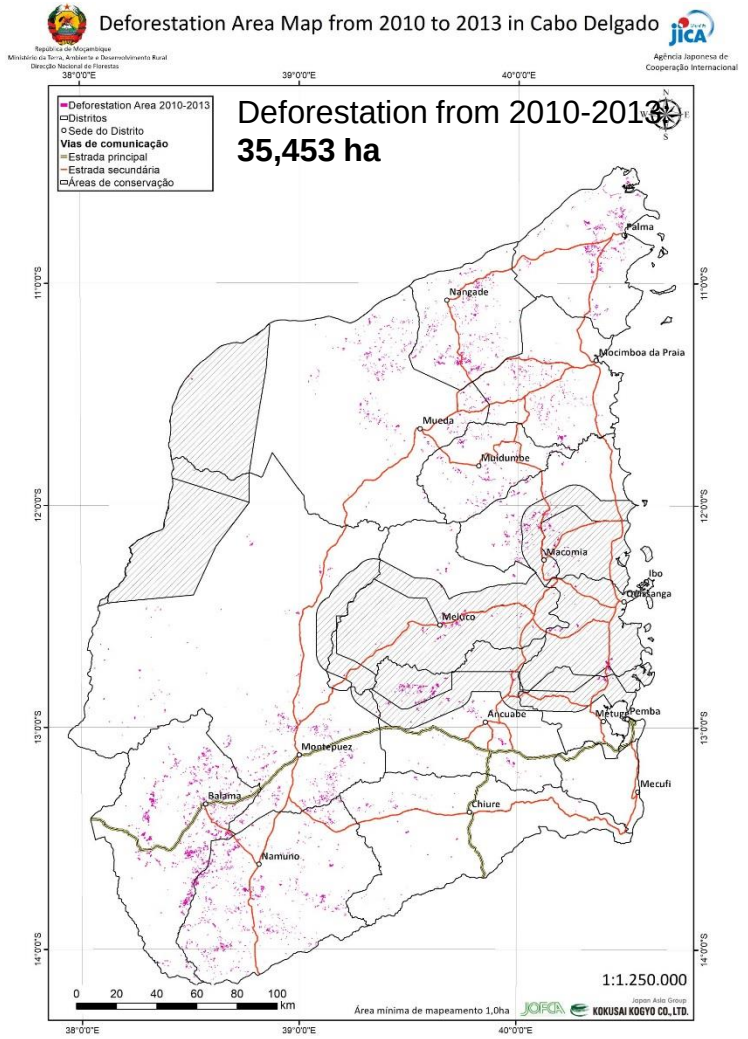
Analysis of the REDD+ Effect by Alternative Energy Deployment



If current energy demand is fulfilled by natural gas, how much REDD+ effects is expected on emission from the LUC.

GHG Emission Petential If Wood Fuel is Replaced by Natural Gas				
	PJ	**GJ**	**KgCO2**	**CO2ton**
Total	284.61	284,610,000	16,507,380,000	16,507,380
Cabo Del.	21.62	21,624,232	1,254,205,436	1,254,205
Gaza	15.94	15,937,177	924,356,295	924,356
GHG Emission from Deforestation (DINAF-JICA, 2017)				
2010-2013				**CO2ton**
Cabo Del.				1,485,013
Gaza				594,232

Natural Gas
GHG emission: 58 CO2ton/KG
(U Berkley)



Additional alternative vs current scenarios of fuelwood trade

Charcoal and fire wood sale beside full bag or big amount of fire wood

- Majority of household in urban areas can not buy one bag of charcoal at a time (1200 Mt = **19.55 USD**);
- Small amount of charcoal to supply cooking energy for almost one or two days (0.33 USD; **0.81USD**);





61.38 Mt	1 USD
20 Mt	0.325839
50 Mt	0.814598
500Mt	8.145976
1200 Mt	19.55034

Program of energy for cooking in urban areas :

- Need of <u>development and implement massively program</u> of **smaller Gas cylinder (3 kg**) and **one-burner stove** to assist population in suburban areas taking into account their economical capability (e.g. initial loan).
- One full smaller cylinder of **3 kg** of LP Gas purchased can be used per household within **10.6 days** (**3kg=2.7 USD**).
- **(11Kg LPG=8.7 USD)**



This kind of program need to be implemented as package (subsidized cylinder and one-burner stove)

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Conclusion

Charcoal Demand: **284 PJ/Year**

	Bioenergy	Hydro total production in 2012	Rooftop at 3m2	Rooftop at 1m2	Wind (6 to >7m/s)
	PJ	PJ	PJ	PJ	PJ
Pot. and avail. En.	115	43.20	3,327	1.109	69.307
Limiting factors	Development of processing industry is key	Precipitation	Weather	Weather	Weather

- REDD+ effect, combination of various RE while meets the social impact safeguard on land use is the key;
- High start-up cost of modern cooking appliances has been shown to be the key factor that hinders transition of households from woodfuel to RE in Mozambique;
- There is a need to take policy measures to facilitate transition to alternative RE, there is a potential to curb charcoal consumption which has been documented as one of the significant drivers of deforestation;
- Considering the general households' financial constraints, dramatic improvement of accessibility to RE infrastructure is very much awaited.
- RE policy measure will have a high potential to save the remaining forest resources of the country and reduce GHG emission as a potential REDD+ measure. However, it should be sought that the sources of RE must be from locally available and sustainable resources without exposing small household to financial risks.

Thank You