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Water–Energy–Food Security Nexus in Ethiopia: *promoting synergies and mitigating tradeoffs*

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Brussels Development Briefing n. 56 on The Land-
Water-Energy nexus and the Sustainability of the
Food System - 3rd July 2019

General WEF nexus context in Ethiopia

- 107 million population (second populous country in Africa)
- total estimated area of 110 million hectares (FAO, 2016).
- majority of population depends on agriculture for their livelihoods
 - strong livestock ownership –with 54million (5th in the world and 1st in Africa) (FAOstat.org (2013))
 - Smallholder agriculture –rain-fed and highly vulnerable to changing rainfall and rising frequency of droughts
 - characterized by low levels of input use and low share of irrigated areas in the total cropped land (only 5%) (World Bank, 2006).
- abundant water resources but unevenly distributed, an estimated 2.6 billion m³ of ground water potential less than 10% of the estimated potential of irrigable land under irrigation

General WEF Nexus context in Ethiopia

- 70 million (77%) inhabitants lacked electricity, and about 87 million (95%) still rely on solid biomass energy (IEA, 2014).
- indoor air pollution causing 72,000 death per year in Ethiopia (WHO, 2009)
- highest rates of land degradation in Africa : 4.3 billion USD of losses in ecosystem services annually (Gebreselassie et al 2016), especially through deforestation, soil erosion – higher siltation
- over reliance on hydro-electricity makes the energy sector vulnerable to climate change (Guta and Börner, 2017)

Major WEF Nexus Drivers

Demand side drivers	Supply side drivers
<ol style="list-style-type: none">1. Rapid economic growth-average annual rate of 10.8% between 2003 and 2013 (World Bank, 2015)<ul style="list-style-type: none">○ Rapidly increasing nonagricultural demands for water.○ changing preferences for food○ High demand for electricity2. Rapid population growth at 2.6% annually –estimated 107million in 2017.	<p>Climate change –challenges on food production, water availability, and hydro-energy production</p> <ul style="list-style-type: none">• high variability in seasonal and annual rainfall in the country• erratic and uncertain –climate change• 95% of the crop production is in rain-fed areas, vulnerable to drought• 83% of electricity generation from hydropower, vulnerable to drought

National Policies – strong emphasis on Nexus elements

National Growth and Transformation Plan (GTP II) (2016-2020)

- Irrigation development as an important tool to stimulate sustainable economic growth & rural development - is considered as a corner stone of food security and poverty reduction
- double the proportion of the population with access to electricity
- develop large-scale hydropower projects - construct a total of 14,561 MW generation projects

Climate Resilient Green Economy (CRGE)

- approach to sustainable economic development and creates a green economy
- aims increase the resilience of the most vulnerable sectors of the economy (including agriculture, water and energy) to climate change (i.e., adaptation)

Four pillars of CRGE

- i) improving crop and livestock production practices,
- ii) protecting forests and reforestation,
- iii) expanding electricity generation from renewable sources
- iv) leapfrogging to modern and energy-efficient technologies

Food insecurity

- Food insecurity is prominent humanitarian and development concern in Ethiopia

Year	Transitory food insecure *	Chronically food insecure **	Total
2013	2.7	7.2	9.9
2014	2.7	7.2	9.9
2015	2.9	7.2	10.1
2016	10.2	7.2	17.4
2017	5.6	7.8	13.4
Average	4.82	7.32	12.14

Ministry of Agriculture, (2014). *Productive Safety Net Program Phase IV Program Implementation Manual*. Addis Ababa

Ethiopia's water resource potential

Table 2 Drainage system and their river basins with respective characteristics in Ethiopia

Drainage system	River basin	Irrigation potential (ha)	Area of river basin (km ²)	Annual flow (billion m ³)
Nile Basin	Abay basin	523,000	199,812	52.62
	Baro- akobo	600,000	76,000	23.24
	Setit-tekezea/atbara	189,000	86,510	8.20
	Mereb	500	5,893	0.65
Rift valley	Awash	205,400	110,000	4.90
	Afar-denekali	3,000	64,380	0.86
	Omo-giba	383,000	79,000	16.60
	Central lake	139,000	52,000	5.64
Shebelle juda	Wabe-shebelea	204,000	200,214	3.16
	Genale dawa	423,300	168,100	6.10
North-East coast	Ogaden	0	77,100	0
	Gulf of aden/ayesha	0	2,223	0

Source: FAO (2016)

Water Access , Health and Gender Equity

HEALTH

- In remote areas raw water consumption, leading to severe water-borne diseases, especially among young children (Hunter et al., 2009).
- About 38% of deaths of children under the age of five and 25% of disability adjusted life-years are caused by **diarrheal and respiratory diseases** in the country (WHO, 2010).
- Source of water was found to be among key factors that could influence **stunting and malnutrition among children** (Alemayehu et al., 2015).

GENDER & EDUCATION

- High water demand coincides with shortage of water and labor (Tucker et al., 2014).
- Water quality and shortage –women and children are affected more.
- Children’s participation in water fetching negatively impacts their school (Beyene et al., 2015).

Sustainable Agricultural Intensification and irrigation

- Sustainable intensification require the introduction of high yielding crop varieties, improving livestock pedigrees, and development of agro-forestry (Awulachew et al., 2005).
- Plan to increase the area under agricultural cultivation by 13%, - conversion of rangelands and forests to agriculture (Karlberg et al. 2015).
- Increasing irrigated lands by about 400% and crop productivity by about 30% -necessitates doubling of fertilizer use (MoFED, 2010)
- Out of 3.8 million hectares of Ethiopia's potentially irrigable land, only about 0.29 mln hectares (<8%) are irrigated (Frenken, 2005)
- Only 5% of surface waters are utilized for irrigation and the underground water is virtually untapped (Gebreyohannes et al., 2013)
- water-efficient agricultural technologies and practices remains low.
- Significant risk of land degradation in the upstream areas and land use change –decline in surface runoff by 1.5% (Abebe 2015)

Ethiopia's energy balance

Table 3 Ethiopia's Energy Supply in 2015

(In '000 tons of oil equivalent (ktoe) on a net calorific value basis)

Coal	253	0.5%
Oil products	3,041	6.1%
Hydro-electric	818	1.6%
Geothermal/solar	65	0.1%
Bio-fuel	45,813	91.6%
Total	49,990	

Source: International energy Agency (IEA), 2015

Need for energy Transition to modern renewable energy sources

- Transformation of agricultural sector relies heavily on energy transition.
- Hydroelectric potential of the country is about 45GW (160 GWh a year),
 - the installed capacity reached 4,206 MW
 - hydropower provides the bulk of Ethiopia's total electricity (90%)
 - electricity export or foreign exchange earning.
 - frequent and intense droughts –water shortage
 - siltation due to land degradation and loss of reservoir volume (Michael, 2004).
 - hydrological variability may cost Ethiopia about a one-third of its growth potential (World Bank, 2006).
- Biogas - potential to produce about 10.6–14.2 million m³ of biogas and about 78,000m³ of slurry at the same time (Mengistu et al., 2015).
- Technological solutions, such as the distribution of energy- efficient cook stoves and the promotion of alternative 'modern' energy sources, such as biogas and solar

Empirical evidences

- Analysis of the full system of food and energy production inputs and activities, simultaneity of household choices applying the agricultural household model (AHM):
- Food production and energy production were found to have an important trade-off effect and synergies:
 - Competition for female family labor between fuelwood collection and food production
 - Synergy between food and energy production through tree cultivation by rural households
 - Crop production positively influenced by sustainable land management, better market access, livestock ownership
 - Agro-forestry practices –reduce labour allocation to fuelwood collection and saving labour for food production and non-farm employment

Empirical evidences

- The synergies boosting both household agricultural production and improved access to energy are catalyzed by:
 - Improved access to markets (input, output, credit, insurance)
 - Adoption of agro-forestry practices
 - Livestock ownership
 - Higher input use
 - Adoption of sustainable land management practices
 - Investing in agricultural research and extension
- Subsidies can accelerate energy transition to more efficient and cleaner energy sources in the rural areas of Ethiopia, though to a larger extent among richer households
- Improving access to non-farm jobs seems to have a substantial poverty reduction impact but associated with lower own food production

Key interventions

- **Agricultural intensification** -more irrigation, energy and fertilizer use

WATER

- Increasing **water use efficiency and productivity**
- **Integrated watershed management (IWM)** –improve land and water conservation, and increasing crop yields
- Development of **irrigation scheme** –powerful tool to diversify livelihoods and reduce vulnerability to the adverse impacts of climate change

ENERGY

- **Diversifying the energy mix to alternative renewable sources and use of energy-efficient technologies** (e.g. waste to energy initiative or land fill gas, the national biogas program, alternative sources such as solar, wind, geothermal)

LAND

- Sustainable land management practices such (reduces runoffs, increase crop yield)

**Thank you for your
attention!**