Bioethanol Impact on Climate, Land, Energy, and Water Resources in the Philippines

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Key Messages

- Bioethanol from sugarcane has the potential to decarbonize the Philippines' transport sector.
- A 20% bioethanol target blend on gasoline (E20) has little impact on climate, land, energy, and water resources.
- Expanding past E20 to further decarbonize transport necessitates consideration of land-use policy.

La Carlota, Negros Occidental, Philippines: Screenshot from the documentary film, *"Pureza: The story of Negros sugar" by* Emilio Abello

Introduction

The Philippines enacted the Biofuels Act of 2006 (Republic Act 9367) to aid farmers in the country-side and reduce the Philippines' dependence on imported fuels. The law mandates the blending of biodiesel and ethanol in locally distributed diesel and gasoline, currently at 2% and 10%, respectively. The feedstock used is sugarcane and coconut oil for bioethanol and biodiesel, respectively. Since the Biofuels Act took effect in 2007, local production of bioethanol has faced challenges. However, the law mandates the use of locally produced biofuels four years after it came into effect. This led to the government halting the decision to increase the bio-fuel content in fuel blends. In 2019, imported bio-ethanol accounted for 31% of the total supply [1], evidence of the domestic supply challenges.

Bioethanol production faces challenges such as the conversion of land to solar farm use, competing uses of by-products (i.e., bioethanol vs. sugar among others), which necessitate revisiting the policy objective of the Biofuel Act of 2006.

To address these challenges, this brief focuses on the land-use implications of bioethanol and solar by providing an integrated assessment of the Climate, Land, Energy, and Water Systems (CLEWs) in the Philippines. The 2010 greenhouse gas emissions of the Philippines accounted for 144.9 million tonnes of CO_2 equivalent ($MTCO_2e$) [2] or 0.7 tCO_2e per US dollar of GDP. The transport sector contributed 17% of this as seen in **Table 1**.

The 5.4% annual increase in the transport sector's energy consumption translates to a significant hike in GHG emissions from its 2010 level. Energy and agriculture sectors are the highest contributors to aggregate GHG emissions with 41% and 34% shares, respectively, while land-use change, and forestry reduce this effect by a negative share of 7%. Raising the bioethanol blend will mitigate the transport sector's emissions but increases agricul-ture, forestry, and waste sector emissions, if not administered prudently.

Table 1. 2010 GHG Emission and GHG Intensity, by Sector

Sectors	2010 GHG Emission		GHG Intensity
	$MTC0_2e$	%Share	$tC0_2e$/2010 USD$
Agriculture	48.70	33.61	0.234
Energy	58.80	40.58	0.282
Industrial Processes	11.00	7.59	0.053
Land-use change & forestry	-10.70	-7.38	-0.051
Transport	25.30	17.46	0.121
Waste	11.90	8.21	0.057
TOTAL	144.90	100.00	0.695

Enacting effective and efficient biofuel policies will require the participation and common understanding of relevant government agencies, including the Department of Energy, Department of Environmental and Natural Resources, and Department of Agriculture, as well as consideration of the implications of biofuel policy on climate, land, energy, and water systems for a transition to clean transport and to the whole energy system.

Methodology and Results

For this study, a CLEWs model is developed to examine the implications of the Philippine Energy Plan (PEP) 2018–2040's bioethanol target of raising the blend from 10% (E10) to 20% (E20) by 2025 [3], focusing on sugarcane as a feedstock only. The CLEWs framework is an integrated approach developed by the United Nations agencies and academic institutions using the OSeMOSYS [4] platform. The study develops three scenarios: E10, E20 by 2025, and E30 by 2035. The model includes sugarcane flow from the production (i.e., sugarcane and waste) to the by-products (bioethanol, sugar, and molasses) to balance the ensuing impact on food security.

The study adopts the projections of the Philippine Energy Plan (PEP) 2018–2040 as the baseline energy demand. Projections of crop production beyond 2018 made use of historical data from the Food and Agriculture Organization (FAO) of the UN [5] and the 2015 Census of Population by the Philippines Statistical Authority (PSA) [6]. Data on land use and water resources are from the country profile

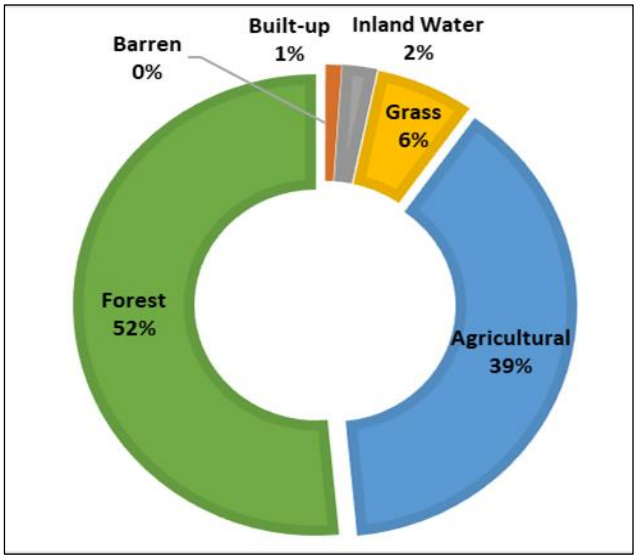

Figure 1. Philippine Land Cover (2018)

of the Philippines in FAO [7].

The Philippines has a total land area of about 298.2 thousand sq. km. In 2018, the bulk of the total land area is dedicated to 52% for forest land, 39% for agricultural land, and the rest for grassland (6%), inland water (2%), built-up land (1%), and barren land (**Figure 1)**. Inland water and built-up land are not economically viable or plausible candidates for conversion for agricultural purposes; thus, their land area has been fixed in the model.

Being a tropical and archipelagic country, the Philippines has abundant water sources, including inland water and rainfall, to provide for increased sugarcane yield.

The total land area currently dedicated for bioethanol registers 1.2 thousand sq. km. [8] or 36.8% of sugarcane land area and 1% of the agricultural land. If the current bioethanol demand is produced domestically, this entails a total land area of 3.26 thousand sq. km. Increasing the current yield of 52.8 tonnes/hectare (t/ha) to 75.8 t/ha is likely to sustain the demand until 2022, with the present

sugarcane dedicated land area of 3.28 thousand sq. km. Raising the current blend from 10% to 20% by 2025 would decrease forest cover by 1.6%. Raising this to an E30 target by 2035 decreases forest cover further to 4.4%. Other implications on CLEWs includes the following:

- Potential net emissions reduction under the E20 scenario are 36.5 $MTCO_2e$. This increases to 57.4 $MTCO_2e$ under the E30 scenario. While bioethanol blending to gasoline reduces GHG emissions, bagasse and waste heat for cogeneration plants and biogas from the distillation process of molasses also contribute to the reduction of GHG emissions. Waste-to-energy (WTE) reduces climate impact since biomass waste that is not used produces methane as it decomposes, which has higher global warming potential than carbon dioxide emitted from WTE.

Producing bioethanol locally at the E20 scenario will require an additional land area of 1.7 thousand sq. km. This increases to 5.5 thousand sq. km. of sugarcane production for the E30 scenario.

- Total agricultural land for all the estimated production of the crops under the E10 scenario reaches 153.7 thousand sq. km. by 2040. Under the E20 scenario, this increases by 2.2% and 4.4% for E30 scenario. Although, forest land is considered the most viable for conversion to cropland due to accessibility and productivity, other land types may be suitable and have lower impact, but this is beyond the scope of this study.
- The increased production of sugarcane requires additional water as well. However, the Philippines, being a tropical and archipelagic country, has abundant water resources including inland water bodies and rainfall. (**Figure 2**)

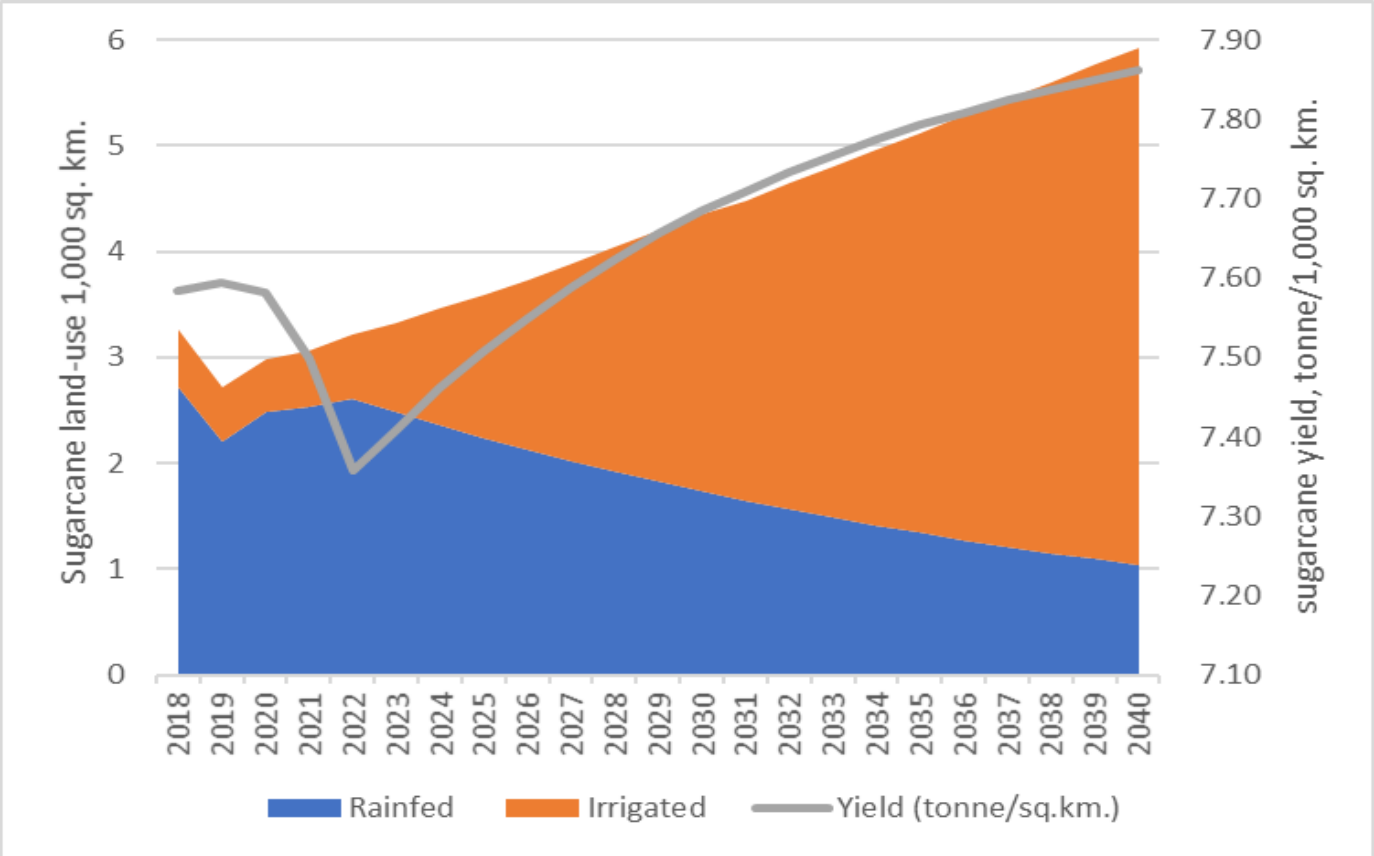

Figure *2*. E10 Scenario: Sugarcane land-use in thousand sq. km. per water resource vs. sugarcane yield in tonne/1,000 sq. km.

Recommendations

The results show that increasing bioethanol blends up to 20% has little impact on land and water systems but expanding to 30% biofuels begins to impact significantly on land resources. To address the ensuing challenges for the implementation of E20, the study recommends:

- Adopting policies that encourage increased yield for sugarcane production to limit the conversion of land for biofuels.
- Explore locating sugarcane production near water resources, since increasing bioethanol and sugarcane yields will require additional irrigated land area.
- Explore alternative feedstock as identified by the Biofuels law, i.e., sweet sorghum, and other biomass to ensure all domestic options for bioethanol are considered.
- Perform more detailed study on the implications of increasing bioethanol blends to address other identified challenges.

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Notes

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