Assessing effectiveness of European biofuel sustainability criteria

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***Abstract* - The European Commission has recently imposed sustainability criteria on biofuel production in the Renewable Energy Directive (RED) to avoid negative environmental impacts of biofuel expansion. In this article, we analyse the effectiveness of the RED sustainability criteria for climate change mitigation and biodiversity conservation. We first use a global land use optimization model to investigate environmental effects of the European Union (EU) biofuel targets for 2020 without enforcing sustainability criteria. In a second step, we show that restricting sustainability criteria only on biofuel production is not effective. Since the majority of global crop production is produced "sustainably" in the sense of the RED anyway, more than 10 times of the total European biofuel demand in 2020 can be supplied from "sustainable" sources complying with the RED criteria if reallocated from sectors without sustainability criteria. This finding points to a potential policy failure of applying sustainability regulation to a single sector in a single region. To be effective this policy needs to target a wider scope of agricultural commodities and be more comprehensive in its membership of countries.**

Introduction to using the template

Recently, the European Union has set ambitious renewable energy targets with the RED (EC, 2009) as of 2020, 20% of the energy consumption and 10% of the total transport fuel demand should be based on renewable sources. Even though biofuels offer the potential to reduce fossil fuel based energy production and net emissions (Farell et al., 2006), increasing biofuel demand can result in higher GHG emissions through land use change (Searchinger et al., 2008). In addition, biofuel production can also lead to biodiversity losses (Hellmann and Verburg, 2010). In order to avoid negative impacts on the environment, sustainability criteria guiding biofuel production have been included in the RED.

So far numerous studies have analysed effects of biofuels on land use change and GHG emissions at global scale (i.e. Havlík et al., 2011). However, none of the studies has analysed the effects of biofuel expansion on biodiversity at global scale although there is a serious potential that similarly as the indirect land use change (ILUC) GHG emissions, the ILUC biodiversity loss, will be substantial.

In this article we use a global land use modelling framework to understand the environmental impacts of the European biofuel directive on climate change mitigation and biodiversity conservation and assess the effectiveness of European biofuel sustainability criteria in ensuring the latter.

GLOBIOM

GLOBIOM is a global recursive dynamic partial equilibrium bottom-up model integrating the agricultural, bioenergy and forestry sectors. Demand and international trade are represented in this version of the model at the level of 27 EU member states and 23 aggregated world regions outside Europe. The supply side of the model is based on a detailed disaggregation of land into Simulation Units – clusters of 5 arcmin pixels belonging to the same country, altitude, slope and soil class, and to the same 30 arcmin pixel. Crop, forest and short rotation tree plantation productivity is estimated together with related environmental parameters like i.e. GHG budgets, at the level of Simulation Units, either by means of process based biophysical models or by means of downscaling. Changes in the demand on the one side, and profitability of the different land based activities on the other side, are the major determinants of land use change in GLOBIOM. In the objective function, the global agricultural and forest market equilibrium is computed by maximizing the sum of consumer and producer surplus (Havlík et al., 2011).

Scenarios

Our Baseline scenario provides an outlook on how bioenergy markets could develop towards 2020 without any sustainability criteria related to biofuel production. The Primes Reference Scenario is used for European bioenergy demand up to 2020 and NREAPs in 2020. Total European biofuel demand in 2020 amounts to 881 PJ of biodiesel (235 PJ imported), 286 PJ of bioethanol (74 PJ imported) and 31 PJ of 2nd generation biofuels. For the rest of the world we use the POLES Baseline Scenario bioenergy projections. Other important driving forces in the model are macro-economic developments such as population and GDP growth.

The Baseline scenario is compared to the Counterfactual scenario assuming no increase in European biofuel demand above 2010 level in order to derive the effects of biofuel expansion on GHG emissions and biodiversity.

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Sustainability criteria assessment

We first use GLOBIOM to look at the Baseline scenario and compare it with the Counterfactual scenario to analyse the environmental impacts of the EU biofuel targets without sustainability criteria. Second, we assess effectiveness of the RED sustainability criteria by identifying the share of production in the Baseline scenario complying with these criteria and compare it with EU biofuel demand. Computing the "sustainable" production complying with RED sustainability criteria relies on an ex-post calculation respecting the rationale of the RED. We take article 17.2 (50% emission saving from biofuels), 17.3 (no biofuel production on high biodiversity areas) and 17.4 (no biofuel production on areas with high carbon stocks) of the RED into account.

Results and Discussion

Biodiversity and GHG emissions

When contrasting the Baseline to the Counterfactual scenario, total emissions increase by 95 Mt CO_2 eq (+1.3% additional emissions) in 2020. In the Baseline scenario rising emissions from deforestation and from change in cropland management due to biofuel expansion cannot be compensated for by an increasing carbon sink due to additional establishment of short rotation tree plantations and emission savings due to the replacement of fossil fuel with biofuels.

In addition, biofuel expansion is responsible for about 2.2 Mha losses of highly biodiverse areas, mainly highly biodiverse primary forests and grassland (12.4% additional biodiversity loss). Total deforestation rises by 2.4 Mha (+4.2%).

Effectiveness of RED sustainability criteria

European bioethanol and biodiesel demand in 2020 amounts to 286 PJ and 881 PJ respectively, and has to be processed from feedstocks complying with RED sustainability criteria. Figure 1 presents the share of the total EU biofuel demand (1.167 PJ) that could be satisfied from "sustainable" production complying with RED sustainability criteria (as identified in the ex-post calculation) per feedstock type. For example, the EU "sustainable" wheat production could satisfy 63% of total European biofuel demand in 2020 in the Baseline. Especially crops for bioethanol production like sugar cane and corn have large "sustainable" production potentials globally to satisfy the EU biofuel demand.

About 75%, of EU biofuel demand is expected to come from biodiesel, which offers limited "sustainable" production potential inside the EU (rapeseed can at most supply 33% of the EU biodiesel mandate). Consequently, a substantial share of biodiesel feedstocks will have be imported to Europe to fulfil the mandate. Globally, "sustainable" production in the sense of the RED can produce more than 10 times the 2020 EU biofuel demand.

We conclude that sustainability criteria of the RED will have little or no effect on global agricultural production systems due to leakage effects in the food, animal feed and the biofuel sector outside Europe where no sustainability criteria are applied. Since the "sustainable" production complying with RED sustainability criteria is too large compared to the "sustainable" feedstock demand resulting from the EU biofuel mandate, the "sustainable" production will be easily redirected to the demand without changing the environmental impacts compared to a situation without sustainability criteria.

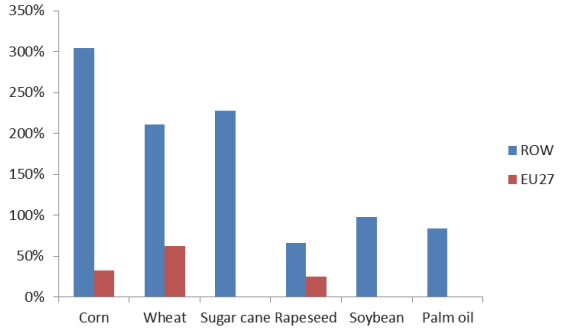

Figure 1. Share of "sustainable" production compared to total 2020 EU biofuel demand. ROW – Rest of the world.

Consequently, RED sustainability criteria are ineffective in ensuring GHG mitigation and preventing loss of highly biodiverse areas in agriculture as they only cover a small part of the global agricultural feedstock demand. Hence, to be effective this policy needs to target a wider scope of agricultural commodities and be more comprehensive in its membership of countries. In addition, a combination with wider land use change policies targeting all drivers of land use change and not only the biofuel sector may improve effectiveness.

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