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iLUC – risks, remedies and regulations: The role of good governance for a sustainable development

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Abstract

The aim of this paper is to illustrate why an increasing biomass demand is of major importance when trying to achieve international climate protection goals. It shows that development goals can be reached by more climate friendly agriculture. The increasing demand for agricultural land is often answered by the conversion of natural land with a high carbon stock. This conversion is hence connected to a great carbon loss causing high greenhouse gas emissions. This increase in production has therefore to be examined critically. As such land use changes can occur not only direct but also indirect (indirect land use change, iLUC) legal regulations and instruments are necessary to reduce iLUC and support climate friendly agriculture.

The analysis shows that the currently used and developed regulation instruments in Europe and the USA are highly speculative and doubtful. These countries work with global iLUC-factors, that are determined based on mathematical models for global future predictions. The paper presents alternative regulation approaches, which base on national level and the respective land use policies of the past.

Keywords:.
indirect Land Use Change, iLUC, Palm Oil Production, Biodiesel, Palmoil Biodiesel, Regulation, Climate Protection, EU Biofuel Regulation,
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1. Introduction

Biofuels have been a success story throughout Europe for many years. The annual sales volume is rising until today and further increase was expected. Figure 1 shows the development of the biofuel market in Europe including a prediction until 2020.

In comparison to other regions, Europe pursues a very ambitious climate protection policy, which also includes the transportation sector. The greenhouse gas emissions of the transportation sector shall be reduced by 10%; main factors therefore are biofuels. Their implementation alone can achieve a reduction in greenhouse gas emissions of 7%.

Biofuels are gained from biomass. The biomass used originates mainly from agricultural products. Considering the competition between food and biofuel production from agricultural products, a controversial debate was raised in the last few years in the western countries.

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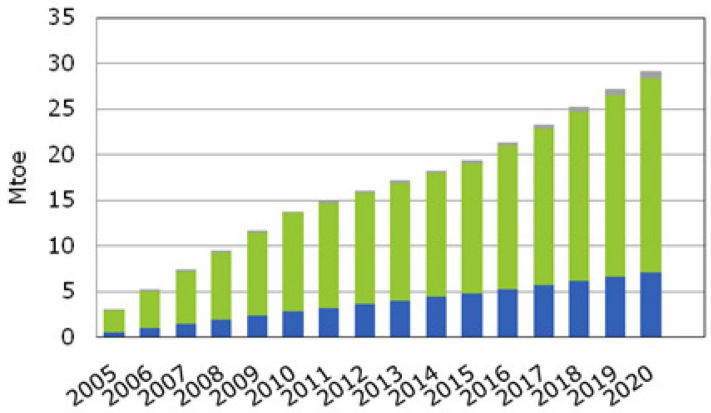

Figure 1: Biofuel demand in the EU following the members' "National Renewable Action Plans"[1]

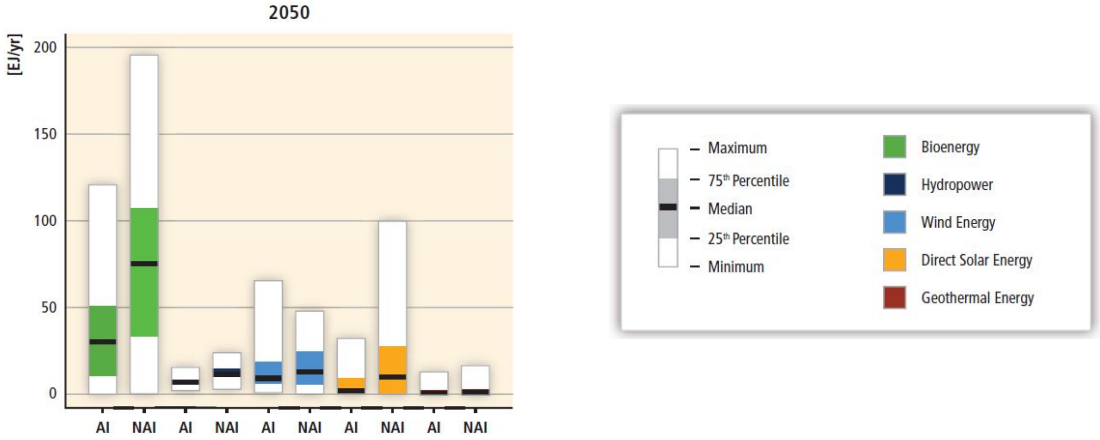

Figure 2: Results of the analysis of 164 climate change scenarios: Global RE primary energy supply (direct equivalent) by source
AI = Annex 1 States (industrialized countries), NAI = Non annex 1 States[2]

Nevertheless arrives science at the conclusion, that the climate protection targets (e.g. max. Temperature rise of 2°C, 450 ppm-target) can only be reached if enough biomass is provided, not only for the transportation sector. Figure 2 shows the results of the analysis of 164 different climate change scenarios concerning the global primary energy supply. It becomes obvious that biomass will be by far the most important energy source in developing and emerging countries as well as in industrialized countries to achieve the climate protection goals.

2. Change of atmosphere

At least among NGO's in Europe the mood towards the idea of using biomass for climate protection has changed. This change of mood mainly emerged through critical views towards biofuels and also politicians are increasingly taken by this new idea. However outside Europe it is stillrather difficult to communicate. It appears more and more as if it was the greater sin to refuel with biofuel than using conventional oil-based fuels.

The main argument, explaining this change of mood, is the change in and use and with it itsindirect effects more than the direct effects.

The following link leads to a short video explaining the indirect effects of land use from the environmental and conservation organisations (NGO) point of view.

http://www.youtube.com/watch?v=igUtLwruUjA

Their line of arguments is the following:

1. Via climate protection policy in the transportation sector an additional demand of biomass is created.

2. This demand can only be generated through the additional cultivation of biomass.
3. Part of the additional biomass needs to be cultivated on new agricultural land, which did not belong to the agricultural sector before, e.g. natural land.
4. Most of this natural land has greater carbon stocks in its vegetation or soil than agricultural land or palm oil plantations can take.
5. Land use change is therefore the reason for carbon loss in these areas. Which is nothing else than additional greenhouse gas emissions.
6. Land use Change can be direct (dLUC) or indirect (iLUC). Indirect Land use Change means that the additional demand for biomass displaces areas used to cultivate other agriculture at first. Not until then it comes to a damaging land use change as a reaction, which was caused indirectly.
7. Ergo: These effects need to be assessed in a greenhouse gas balance of biomass, and decrease its contribution to climate protection.

3. Scientific Research of iLUC-effects

First of all scientific research of the iLUC-effect asserts that the whole context is very complex. Besides satisfying the growing demand for biomass by converting former high-carbon nature land, the demand could also be satisfied through increased productivity of existing agricultural land. Furthermore could fallow land be used in case of an extension of agricultural land. Fallow land does not have any special value, neither for climate protection nor for biodiversity. To which extent the different option will be realized can strictly speaking only be determined afterwards.

The complexity of the iLUC-effects is moreover raised by the fact, that depending on the reason for new demand of biomass the effects can occur transnational. The displacement of nature could hence be moderated on the world market. An additional effect that can be moderated through the world market is a change in consumption of different agricultural products. A consumption change could as well influenceiLUC,dependent on the elasticity of price of the respective products or sectors.Scientists finally point out that iLUC can occur with short or long time delay.In this context our task force, working at TU Darmstadt, researches another important factor: Governance.

Besides the rather economically regulated process chain of iLUC, the regional land use policy is a major variable. For example, land use policies in extreme cases can foster land use change of e.g. tropical rain forests, or on the other hand it can simply forbid it.
iLUC research is a rather new discipline, only existing about 5 years. Meanwhile the number of research groups worldwide working on that field increases. The aim of the research is to assess the effect of iLUC described before using mathematical models. Based on existing agronometrical models, new models have been developed over the last years. These models include all needed complex process chains and options and are hence able to describe the additionally needed areas and its greenhouse gas emissions. To illustrate the work Table 1 describes the carbon stocks of different land uses.

The data shown in Table 1 is representative for each land use. Nevertheless the exact values for specific places on earth can differ. However the default values are representative for most of these areas.

An important factor that needs to be considered is that the models themselves differ quite a lot in respect of their structure, mathematical combinations and the respectively used determining factors.Table 2 gives an example for these differences[3].

It is therefore no surprise that different models gain very different iLUC-results, even when fed with the same data or scenario. The variety of models and results leads to a scientific dilemma: because we are dealing with every complex phenomenon that defies direct observation, only with the help of complex mathematical methods this phenomenon can be caught. But on the other side the models itself and their calibration and validation are the major weakness of today`s iLUC-research.

To validate iLUC-model regional governance also need to be considered. To predict the land use change caused by increasing biomass demand using iLUC-models, these models also need to implicate and predict future governance. But can science predict reliably decisions of governments? Governance is already an implicit part of iLUC-modelling, as economically derived land use change can only be realised if it is legally feasible. If the land use change assumed to be feasible, the

Table 1: Carbon stock (in vegetation and soil) for different land uses, in Mg C/ha

Land use	Carbon stock	Land use	Carbon stock
Rain Forest, **Default**	300 Mg C/ha	Grassland, **Default**	100 Mg C/ha
Rain Forest, Asia, soil = 0	205 Mg C/ha	Bushland, Africa	90 Mg C/ha
Rain Forest, Asia, Peatland	970 Mg C/ha	Woody Cerrado, South America	75 Mg C/ha
Rain Forest, Amazon	265 Mg C/ha	Grassy Cerrado, South America	65 Mg C/ha
		Savanna wet	130 Mg C/ha
Forest, **Default**	150 Mg C/ha	Grassland tropical	75 Mg C/ha
Forest North America	140 Mg C/ha	Grassland temperate	70 Mg C/ha
Forest Europe	130 Mg C/ha	Pasture temperate, minimal	40 Mg C/ha
Plantage	110–130 Mg C/ha		
Wetland	100 Mg C/ha	Cropland annual harvest,**Default**	55 Mg C/ha
		Cropland annual harvest, soil = 40	45 Mg C/ha
		Cropland annual harvest, minimal	30 Mg C/ha

governance-scenario used would then be a laissez-fair scenario.

In contrast a more or less distinct restriction of land use change would be the governmental alternative. This approach is nothing extraordinary, but the common legal situation in Europe and Northern America.

This is why the authors of this paper stay doubtfully, whether the scientific claim to predict the correspondent iLUC-effect of increased biomass demand while including the prediction of the one and only governance-scenario for the whole world is simply too much for science. Maybe the claim for complete prediction could even induce to cross scientific borders for serious modeling. But science can and should definitely execute the evaluation of different possible policy-scenarios on a country to country level, which quantify the consequences of the respective political actions and governances.

4. EU Biofuel Regulations

The European Fuel Quaiity Directive (FQD) and the Renewable Energy Directive (RED) contain minimum standards for biofuels. The minimum greenhouse gas emission saving per MJ must be 35%. The life cycle assessment method (LCA) is used to calculate the greenhouse gas emission savings. The assessment of upstream processes includes the possible emissions of direct effects of land use change. Indirect effects are not included, because methods were not scientifically available to include them at the time of legislation. But the EU commission was already instructed back then to eliminate this deficit.

Working on this task over the past 3 years, the European Commission (EC) gained different results. Out of this there are also different proposals for regulations on the table. Parts of the EC give preference to integrate a global iLUC characterization factors in the biofuel LCA. In this case an iLUC characterization factor would be the greenhouse gas emission of 1 MJ biofuel, which arises from indirect land use changes caused by the increasing demand of biofuel in Europe for the year 2020. This factor (or factors for different commodities/technologies used) were seen globally and should be predicted using model calculations.

As might be expected, the different research teams commissioned to develop such a factor, determined very different iLUC-results. In general no explicit restriction-scenarios (Governance) were taken into account and still the results differed a lot. Using the determined iLUC-factors in legislation would have created diverse results on the biofuel market. But regulation needs one factor and not a variety of factors! Which factor Europe should choose?

Table 2: Properties of models, analyzing direct and indirect land use change

Model	General feature		Bio-energy chain		Endogenous ...			Emission from iLUC		References
Name	Type	Sectors	Types of biofuel crops	Byproducts	Expansion	Intensification	Consumption change	Emission from fertiliser use	CO2 land conversion	
DART	GE	All	WT, MA, OS, VO, SC, SB	No	No	Yes	Yes	No	No	Kretschmer et al., 2008
EPPA	GE	All	not specified, 2nd generation	No	No	No	Yes	No	No	Reilly and Pltsev, 2009
GTAP	GE	All	WT, MA, SC	Yes	Yes	Yes	Yes	Yes	partly	Lee, 2005; Taheripour, 2008; Hertel et al,. 2008; Birur et al., 2008
GTEM	GE	All	2nd generation	n/a	No	No	Yes	No	No	De Vries, 2009
LEITAP	GE	All	VO, WT, MA, SC, SB, 2nd generation	Yes	Yes	Yes	Yes	No (but Yes via IMAGE)	No (but Yes via IMAGE)	Eickhout et al., 2009
MIRAGE	GE	All	bioethanol, biodiesel	Yes	Yes	Yes	Yes	No	partly	Valin et al., 2009; al-Raffai, 2010
AGLINK/COSMO	PE	Agriculture	VO, WT, MA, SC, SB, 2nd generation	Yes	Yes	Yes	Yes	No2)	No2)	OECD, 2008; De Vries, 2009
CAPRI	PE	Agriculture	WT, MA, OC, OS, VO, SB	Yes	No1)	Yes	Yes	Included in DNDC-Europe	No	Britz et al., 2007; Leip et al., 2008
FAPRI	PE	Agriculture	bioethanol, biodiesel	Yes	Yes	Yes	Yes	Yes	Yes	Searchinger et al., 2008; Fabiosa et al., 2009: Dumortier and Haynes, 2009; Dumortier et al., 2009
GLOBIOM	PE	Agriculture, Forestry	1st generation, 2nd generation	Yes	Yes	Yes	Yes	Yes	Yes	De Vries, 2009; Havlik et al., 2010
IMPACT	PE	Agriculture	SC, SB, MA, WT, OC	No	Yes	Yes	Yes	No	No	Pers. Com. S. Msangi, 2009; De Vries, 2009
G4M	Allocation, coupled to GLOBIOM	n/a	not explicit	n/a	Yes	n/a	n/a	No	Yes	De Vries, 2009
GCAM	IAM & PE	Energy, Agriculrure, GHG emissions	2nd generation	No	Yes	Yes	Yes	No	Yes	Wise et al., 2009; Brenkert et al., 2003
IMAGE	IAM, coupled to any GE or PE3)	n/a	WT, MA, OS, SC, 2nd generation	n/a	Yes	n/a	n/a	Yes	Yes	Leemans and Van de Born, 1994; Eickhout et al., 2009

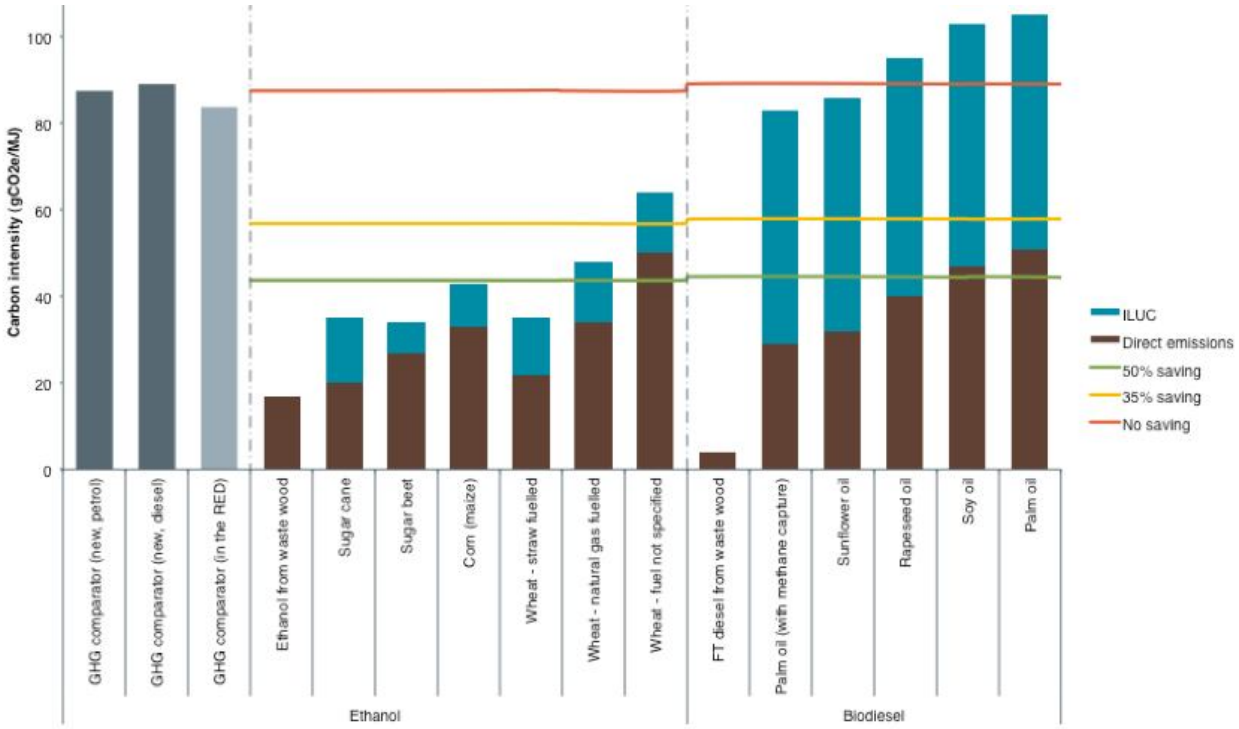

Figure 3: Best science – iLUC-factors from the IFPRI study [4]

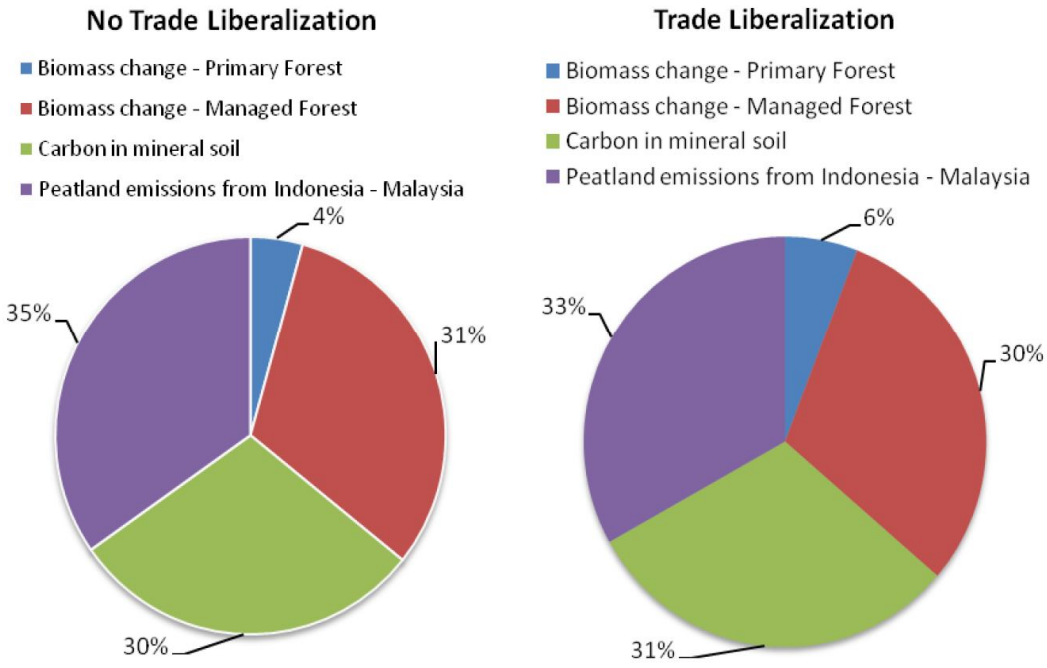

Figure 4: Reasons for the calculated iLUC-effects (iv)

To solve this dilemma it was, like in the USA, decided to use the most comprehensive and reliable model that was approved by most experts, thus best science.

5. IFPRI-Study 2011

In 2011 the results of the Washington International Food Policy Research Institute (IFPRI) was published. Figure 3 shows the main results.

The yellow line indicates the minimum standards for biofuels in Europe (35 % savings). If this line is crossed the biofuel is not marketable anymore. The brown bars show the results of the LCA (the upstream processes), calculated in accordance with the existing legislation in Europe. The blue bars on top show the calculated indirect land use change effects. It is notable that all vegetable oil based biofuels could not manage the EU standards, when including iLUC-effects.

After publishing the study, the results and especially the calculation model used were strongly debated. The different objections shall not be discussed further in this paper.

The question was raised among biofuel producers from Europe about the reasons for this poor performance of vegetable oil. Figure 4 gives an answer: Besides other reasons, a main point is that IFPRI expects excessive land use change in Malaysia and Indonesia to enlarge oil palm plantations. It is assumed that this expansion takes place on peatland, which would result in very high greenhouse gas emissions.

For European rapeseed-oil farmers, who could not sell their products for biofuel production anymore if the IFPRI-factors would be implemented, these results are rather hard to understand, especially as they do not feel connected to the land use developments in Malaysia or Indonesia.

Considering the development of land use change in Malaysia and Indonesia over the past, the expansion of oil palm plantations at the expense of rain forests as well as peatlands is a fact and cannot be denied and its ecological impacts are fatal.

But what was true in the past may not be true for the future. There are different scenarios possible depending on the future governance in these countries.

Meanwhile the governments in Indonesia and Malaysia have taken considerable legal steps. If these legal decisions are followed such great iLUC-effects should or could not occur in those countries anymore.

So the degree of implementation of legal actions poses a challenge to modelling. If it is assumed that both countries do follow their decisions then the future would look much better than in figure 3 and 4. If not, a policy-scenario leading to the very high (or even higher) greenhouse gas emissions in Malaysia and Indonesia could exist and the IFPRI-results will happen in reality.

The main problem is that the different governance options, which do exist worldwide, are not sufficiently implemented to limit indirect land use change effects. Although the IFPRI study has implemented some possible future scenarios, they did not take the positive scenarios into account, which give high credit to the legal decisions made by the governments e.g. in Indonesia and Malaysia.

Likewise it happens in the USA. Figure 5 shows the results of LCA calculations for palm oil biodiesel published by the Environmental Protection Agency (EPA) in the beginning of 2012. It becomes obvious how important LUC and iLUC is in the upstream process chain of palm-oil based biodiesel. Similar to the results of the EC IFPRI study it is again the land use changes in Malaysia and Indonesia that is the main reason for the high values. The results are currently being discussed. Would these results get legally accepted from EPA at the end of the ongoing procedure, it would no longer be acceptable to produce biodiesel from palm-oil for the US market.

What are the backgrounds that Southeast Asian land use policy is credited so little in the current scientific research? Europe is dominated by a common scepticism towards the implementation of the decided rain forest protection. And it has to be admitted that this scepticism does not exist without any reason considering the developments of the past and present in Southeast Asia. But there is also light besides the dark, nothing can only be seen black and white. There are starting points, probably not sufficient from a European NGO's point of view, showing also positive elements. Moreover, would it not be more efficient for climate protection to develop regulations in Europe, which could help to implement the rather complicated and maybe not perfect land use regulation made in Malaysia and Indonesia.

But it has to stay in focus that the main problem is actually the decision in Europe (and the USA) to use iLUC characterization factors as the regulatory instrument. Such an instrument can only work

properly if one specific value exists, that can be used for LCA calculation. This specific value can only be generated, when one possible "future" is assumed to be more likely than the others and used for modelling. However it would be better to let scientific research focus on considering and calculating different scenarios and give the political question on which policy will be implemented and conducted back to the politicians. But with the whole bunch of possible governance developments a biofuel life cycle assessment cannot be conducted today and find the global iLUC-factor.

6. Alternative forms of regulation

First of all it needs to be pointed out that iLUC-regulation in Europe or the USA is no arbitrariness with the goal of market protection. The integration of the iLUC-factors modelled by IFPRI into the European Fuel Quality Directive would hit European rapeseed-oil producer as hard as palm-oil importer.

Primary motive for regulations in Europe and the USA is climate protection. But as the biofuel markets are legally protected and economically subsidized, governments have with certain reservations every right to admit only those products, that fulfil sufficient greenhouse gas savings compared to fossil fuels. In case of very high greenhouse gas emissions due to land use changes in upstream processes, the authors of this paper consider it justified to ban them. Essential is the question, whether the determined iLUC-factors model the reality in a right way.

The first problem that occurs is that indirect land use change is per definition a global phenomenon. Therefore iLUC can only be calculated using global models, so the prevailing opinion in the scientific community. But the results of global models are always calculated as an arithmetic mean over all countries, so that even if the results are consistent and reproducible, countries with good governance (e.g. protection of nature land) will be disadvantaged whereas countries with bad governance will benefit from it.

An alternative solution would be a regulation per state instead of a global factor. Through this regulation national efforts towards better climate and land use change protection would pay off. So if the regulations made in Malaysia are implemented and conducted, it would result in a lower and beneficial national iLUC-factor. The sum of all national iLUC-factors related to a respective commodity, should come relatively close to the global factor calculated in global models. Hence in principle no iLUC would be lost, as some critics might fear.

Another issue to consider is whether iLUC regulations need to predict the future. The arising problems concerning different policy-scenarios for example in Malaysia and Indonesia have already been pointed out before. The necessity of predicting emerges from the policy question science has to answer. That means, if the development goal of biofuel consumption for Europe in 2020 is fixed (10 % reduction) and it should be reached including iLUC, then one need to know the amount of iLUCin 2020 and has to look for compensation. Then a mathematical model is needed to predict the future. So the scientific question stems from the goal of our regulation, which needs to predict the additional greenhouse gases to be able to implement regulations to comprehend them.

Another possible approach could be the implementation of sustainability requirements for biofuels produced domestically as well as for imported biofuels. The minimum requirements for biofuels to be permitted on European or US markets could therefore also include iLUC effects. The sustainability requirements for the USA for example are today at least a 20% greenhouse gas saving including iLUC impacts. However in contrast to today the iLUC-effects should not be calculated using a global factor, but should be assessed for all commodities and the respective country in which they were grown. Hence this regulation would determine an iLUC-factor for palm-oil grown in Malaysia and another factor for Indonesia. This form of regulation would therefore be a fair option to assess how good the land use policy of acountry is and good governance would be beneficial.

Furthermore in this approach the prediction of future development is not necessary any more. Instead could the iLUC-effect be based on the immediate past year. Depending on the country's statistics, the land use change data of the last two years could be collected and allocated to the commodities. An annual review of the iLUC-values could even be used to determine changes in LUC circumstances in a country (better or worse).

However the essential argument in favour of such an alternative approach is climate protection policy and trade policy.

Palm Oil Lifecycle GHG Analysis Results

- EPA's analysis shows that biodiesel and renewable diesel produced from palm oil do not meet the minimum 20% lifecycle GHG reduction threshold needed to qualify as renewable fuel under the RFS program.
- EPA's RFS rulemaking would not restrict the import of palm oil to the U.S. – it would only determine if palm oil qualifies for credit as a transportation fuel under the RFS program.

Lifecyle GHG Emissions Summary (kgCO2e/mmBtu)			
Emissions Category	2005 Diesel Baseline	Palm Oil Biodiesel	Palm Oil Renewable Diesel
Net Agriculture (w/o land use change)	-	5	5
Land Use Change	-	46	47
Fuel Production	18	25	31
Fuel and Feedstock Transport	-	4	4
Tailpipe Emissions	79	1	1
Net Emissions	**97**	**81**	**87**
% Reduction Relative to Baseline		**-17%**	**-11%**

Figure 5: LCA results for biodiesel produced from palm oil [5]

Instead of the compensation approach of iLUC, which is currently practised in Europe and the USA, it is more important for climate protection to gain regulations that are aimed at the prevention of iLUC-effects - especially because the market for biomass will grow in the next years. With respect to trade policy it is important to implement regulations that are based on facts and precise data, rather than on mathematical models which are hard to be understood.

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