



# Linkages between environmental and socio-economic impacts of biofuel supply chains



Results of WP 5 within the  
Global-Bio-Pact project



**Nils Rettenmaier**

Final conference of the Global-Bio-Pact project,  
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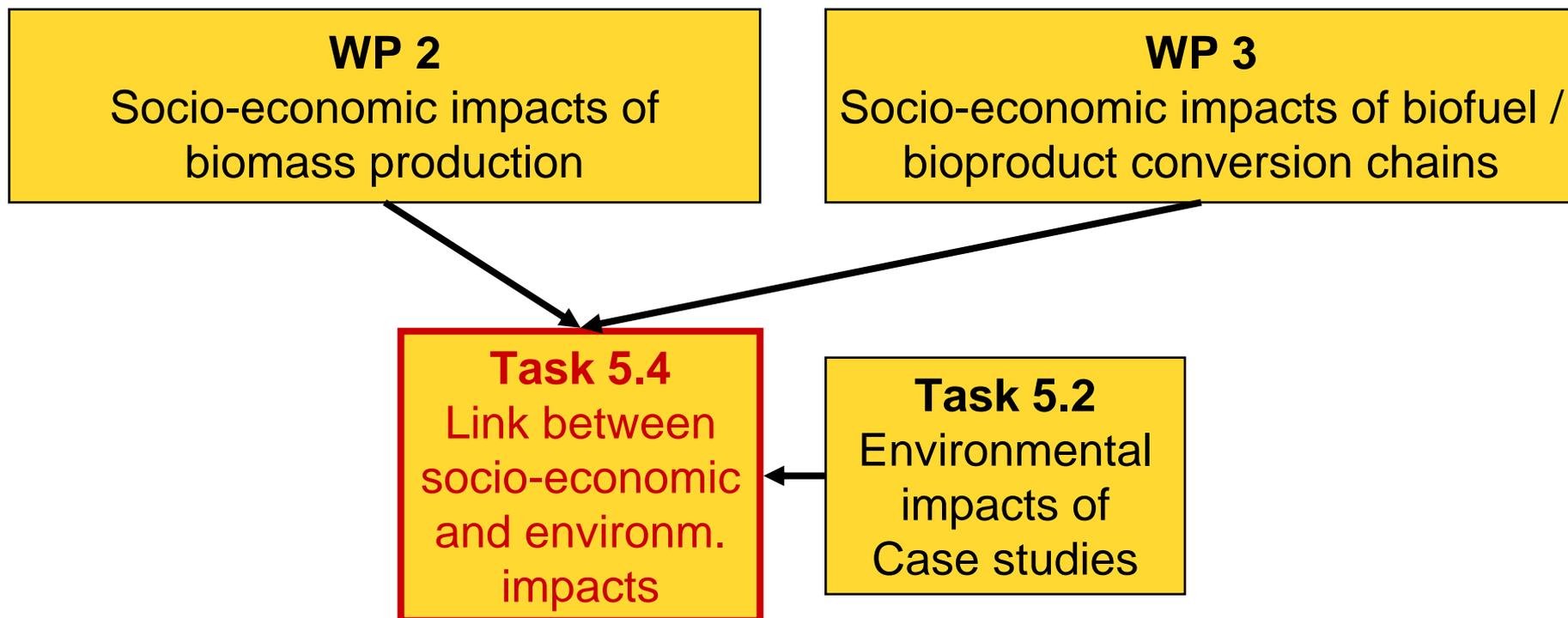


# Objectives and origin of data



## Linkage of socio-economic & environmental impacts

- Identification of hotspots of conflicts and synergies between socio-economic and environmental impacts in developing countries, based on the results of WP 2 and WP 3





# Data collection



## Environmental impacts

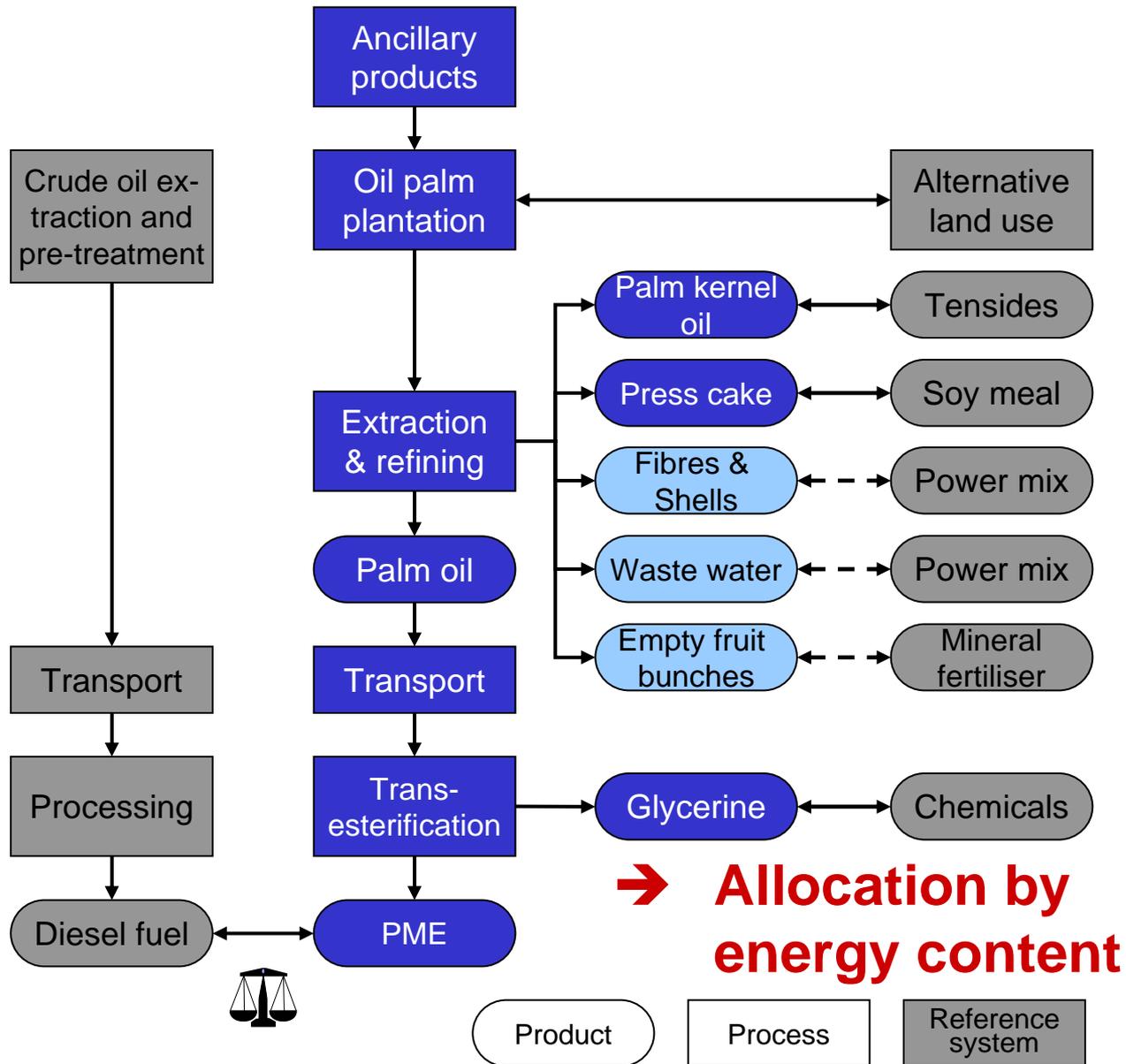
- Biodiversity
- Water resources and water quality
- Soil
- Greenhouse gas balances (covered in task 5.2)

## Socio-economic impacts

- Economics
- Employment generation
- Working conditions
- Health issues
- Food issues
- Land-use competition and conflicts
- Gender issues
- Other issues identified as important by the authors of the respective case study reports

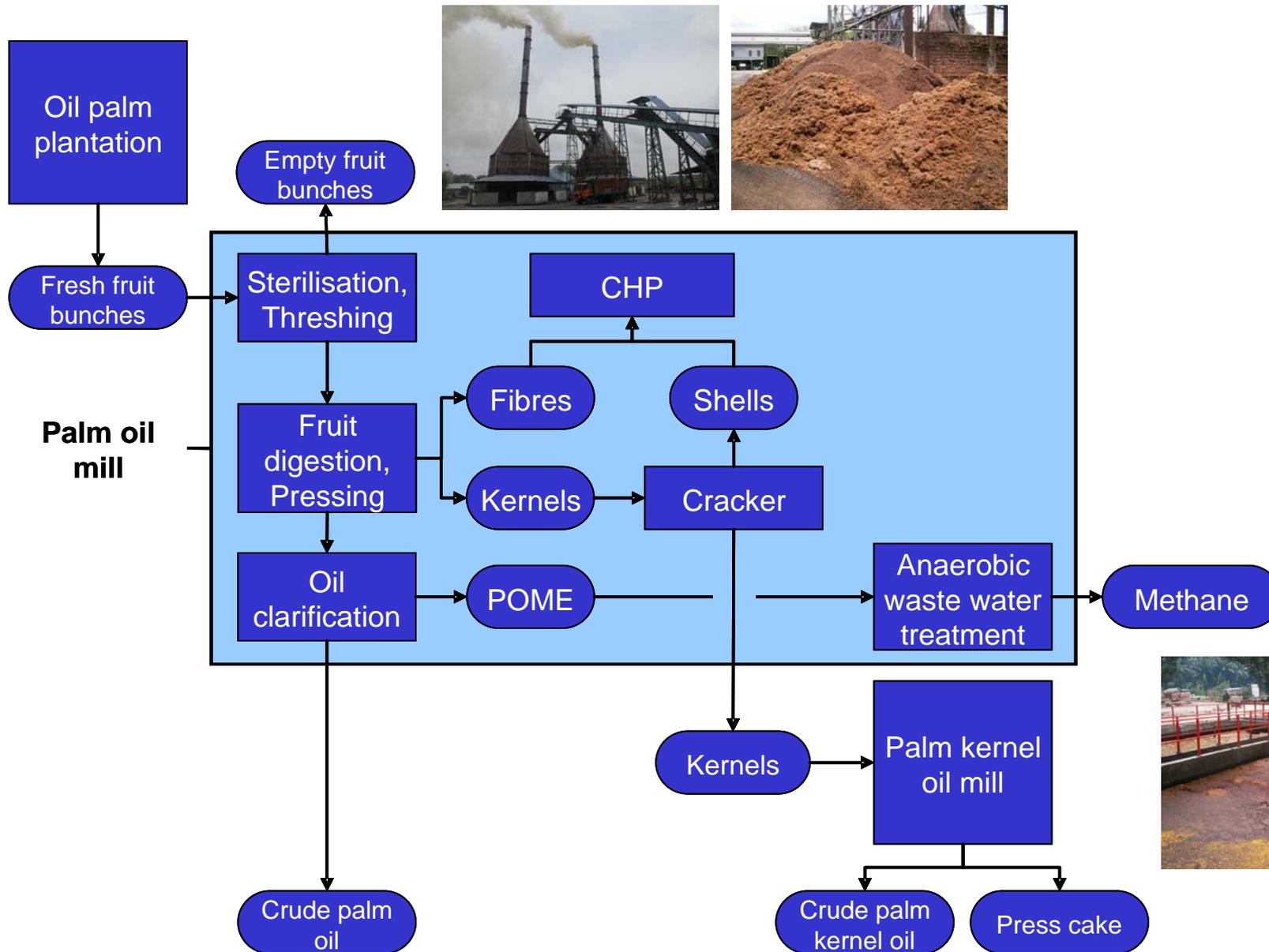


# CS Indonesia: Palm oil biodiesel





# CS Indonesia: Palm oil production

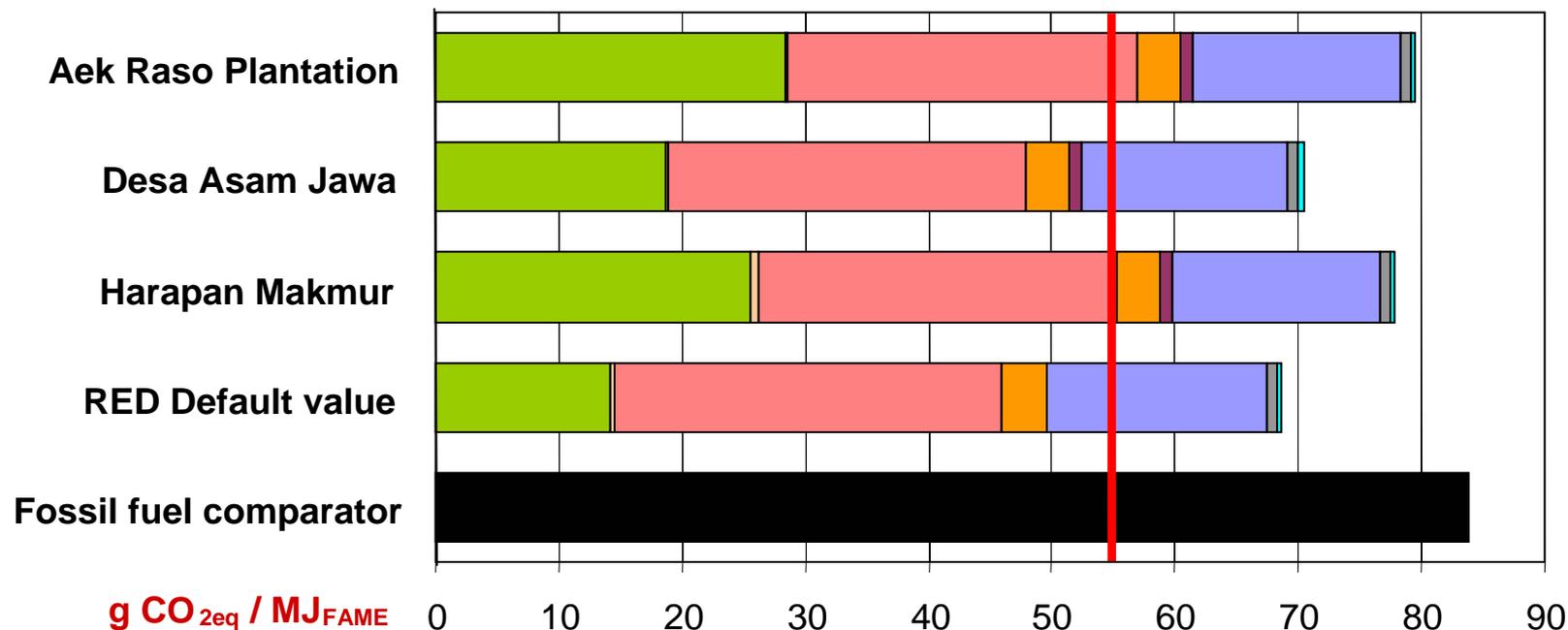




# CS Indonesia: GHG emissions



## Greenhouse effect



- Cultivation of FFBs
- Storage of FFBs
- Transport of crude palm oil
- Extraction of crude palm oil
- Refining of crude palm oil
- Transport of FAME to and from depot
- Filling station
- Fossil fuel comparator

Source: IFEU 2012  
based on GBI 2011

**BIOGRACE**

Harmonised Calculations of  
Biofuel Greenhouse Gas Emissions in Europe

[www.biograce.net](http://www.biograce.net)

Intelligent Energy Europe

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# Introduction to SWOT analysis



Favourable

Unfavourable

Internal	<b>Strengths</b>	<b>Weaknesses</b>
External	<b>Opportunities</b>	<b>Threats</b>



# CS Indonesia: SWOT analysis



## Environmental aspects: SWOT

<ul style="list-style-type: none"><li>• n/a</li></ul>	<ul style="list-style-type: none"><li>• greenhouse gas emission savings of less than 35 % (5 % - 16 %) compared to the fossil reference fuel, see chapter 6.2.4 for details</li><li>• All three case studies lie next to or within regions of high biodiversity and high soil carbon stocks respectively</li><li>• incidences of water contamination by POME and agrochemicals were reported</li><li>• decline in soil's organic matter, fertility and soil moisture and increase in soil compaction were reported</li></ul>
<ul style="list-style-type: none"><li>• n/a</li></ul>	<ul style="list-style-type: none"><li>• potential of occupation of protected areas and/or regions of high biodiversity and soil carbon stock</li></ul>



# CS Indonesia: SWOT analysis



## Socio-economic aspects I: Strengths and weaknesses

### Feedstock production

- palm oil has improved overall employment situation in most of the case study villages
- smallholders claim to be better off with palm oil compared to the past
- wages of workers and bigger farmers in smallholder case study at local level above minimum wage (110 % and about 200 % per ha respectively)
- at local level the state-owned plantation provides security of employment and social insurance for all their workers
- free healthcare for all employees of and all plasma smallholders associated the state-owned plantation at local level
- in general large plantations often have their own health clinics
- at regional level stable production of rice and slightly increased production of other food in the last ten years

### Feedstock production

- many jobs in initial phase of plantation are temporary and set with day labourers without most of the protections for permanent workers
- wages: at national level only around minimum wages; at regional level significantly below minimum wages (only 80 % of minimum wage)
- problem with child labour (age 9 to 17)
- agrochemical use, harvesting accidents and restriction of rights of association and trade unions at the regional level
- weak bargain position and low income of smallholders due to little organisation and their dependency on middlemen or farm gate prices
- competition between food use of palm oil and use as biofuel
- transition from net producers to net consumers of food makes people more vulnerable to high food prices
- smallholders of one case study region converted rice paddies into more profitable oil palm plantations causing a deficit in regional food production



# CS Indonesia: SWOT analysis



## Socio-economic aspects II: Strengths and weaknesses

<p><u>Feedstock production</u> <i>see previous slide</i></p>	<p><u>Feedstock production</u></p> <ul style="list-style-type: none"><li>• increasing number of conflicts across Indonesia over land rights and unfulfilled promises</li><li>• in the case study regions only 5 % of the workers at the plantation and 15 % at the mill are women</li><li>• female unskilled workers receive lower wages than male ones</li><li>• at national level problems for smallholders in remote areas to gain access to money (unmanageable debts), good planting material and knowledge about management</li></ul>
<p><u>Feedstock conversion</u></p> <ul style="list-style-type: none"><li>• at the mill associated with the state-owned plantation unskilled workers' wage is much higher than minimum wage (nearly 340 %)</li><li>• all permanent workers at the mill at local level are provided with housing, healthcare, children's education and other bonuses</li><li>• free healthcare for all employees of the mill on local level</li></ul>	<p><u>Feedstock conversion</u></p> <ul style="list-style-type: none"><li>• only one (state owned) company for biofuel blending paying low prices to the producers for their biodiesel</li></ul>



# CS Indonesia: SWOT analysis



## Socio-economic aspects III: Opportunities and threats

<u>Feedstock production</u> <ul style="list-style-type: none"><li>• well paid feedstock for oil production</li></ul>	<u>Feedstock production</u> <ul style="list-style-type: none"><li>• low potential for future employment generation on regional level</li></ul>
<u>Feedstock conversion</u> <ul style="list-style-type: none"><li>• Increasing market</li></ul>	<u>Feedstock conversion</u> <ul style="list-style-type: none"><li>• slower growth of the biofuel sector at national level than predicted results in less job creation</li></ul>



# Identification of interlinkages



	<b>Positive correlation</b>	<b>Trade-off</b>
Environmental	<b>+</b>	<b>-</b>
Socio-economic	<b>+</b>	<b>+</b>
Environmental	<b>+</b>	<b>-</b>
Socio-economic	<b>-</b>	<b>-</b>

**Trade-off**                      **Negative correlation**



# Summary of results: Examples



## Positive correlation:

- The *extensive* cultivation of Jatropha has a **positive impact on the socio-economic situation of the affected people and the environment**. It might improve the environmental properties of the cultivated land and the socio-economic situation of the people.

## Trade-off:

- Regarding the *intensive* cultivation of Jatropha, **negative environmental impacts** were reported (clearing of natural forest, use of heavy machinery and pesticides). This negatively influences greenhouse gas emissions and areas of high biodiversity and water quality. Also soil erosion and the loss of soil fertility are affected. An overall trade-off was identified due to **positive impacts on the socio-economic situation** of farmers and villagers.



# Summary of results: Example



## Negative correlation:

- Sugarcane bioethanol has **negative impacts on workers' health** and **increases air pollution and greenhouse gas emissions** in case the harvest involves burning of the field.
- Palm oil biodiesel **increases greenhouse gas emissions and decreases the quality of adjacent water bodies (negative impact on human health** through pollution of drinking water) in case palm oil mill effluent (POME) is not properly treated.
- Inappropriate application of agrochemicals **decreases water quality** (also drinking water) and **is harmful to the biodiversity** of adjacent areas as well as **to the workers' health**.
- Land-use changes **threaten biodiversity** and (in most cases) **increase greenhouse gas emissions**. They also often have **negative impacts on food security issues**.



# Limitations and remarks



- **Identified linkages are case study-specific!**
- Resulting impacts might be **incomplete** due to a pre-defined (potentially non-exhaustive) list of aspects and missing information on some of the aspects in some case studies.
- **A second / reference point in time was not defined** in most case study reports. Mostly, they contain a description of the status quo at a certain point in time. Because of that
  - no changes / trends could be captured
  - no causality links could be established.
- It was very difficult to distinguish between agricultural production in general and non-food biomass production.
- Advantage of extensive cultivation of Jatropha is an artefact: Jatropha differs from all other feedstocks in terms of time, scale of implementation and previous use.



# Linkages: Can we generalise?

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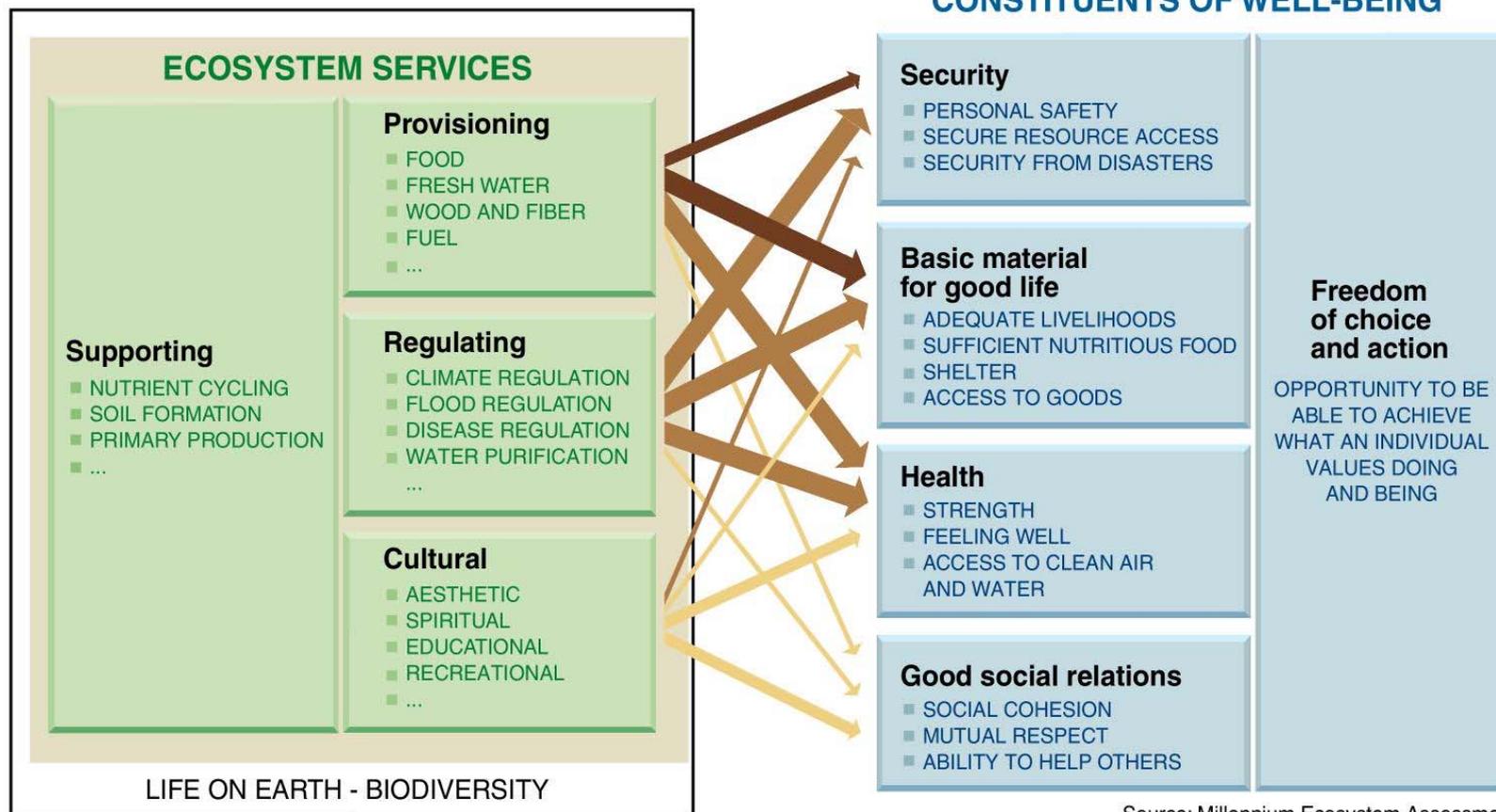


## Definition “Ecosystem services”:

- **Benefits** people obtain from ecosystems.
- Include provisioning, regulating, and cultural services that directly affect people and supporting services needed to maintain the other services.
- Changes in these services affect **human well-being** through impacts on security, the necessary material for a good life, health, and social and cultural relations.



# Linkages: Ecosystem services



Source: Millennium Ecosystem Assessment

**ARROW'S COLOR**  
Potential for mediation by socioeconomic factors

- Low
- Medium
- High

**ARROW'S WIDTH**  
Intensity of linkages between ecosystem services and human well-being

- Weak
- Medium
- Strong



# Linkages: Ecosystem services



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**Provisioning Services** are ecosystem services that describe the material outputs from ecosystems. They include food, water and other resources.



**Food:** Ecosystems provide the conditions for growing food – in wild habitats and in managed agro-ecosystems.



**Raw materials:** Ecosystems provide a great diversity of materials for construction and fuel.



**Fresh water:** Ecosystems provide surface and groundwater.



**Medicinal resources:** Many plants are used as traditional medicines and as input for the pharmaceutical industry.

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**Regulating Services** are the services that ecosystems provide by acting as regulators e.g. regulating the quality of air and soil or by providing flood and disease control.



**Local climate and air quality regulation:** Trees provide shade and remove pollutants from the atmosphere. Forests influence rainfall.



**Carbon sequestration and storage:** As trees and plants grow, they remove carbon dioxide from the atmosphere and effectively lock it away in their tissues.



**Moderation of extreme events:** Ecosystems and living organisms create buffers against natural hazards such as floods, storms, and landslides.



**Waste-water treatment:** Micro-organisms in soil and in wetlands decompose human and animal waste, as well as many pollutants.



**Erosion prevention and maintenance of soil fertility:** Soil erosion is a key factor in the process of land degradation and desertification.



**Pollination:** Some 87 out of the 115 leading global food crops depend upon animal pollination including important cash crops such as cocoa and coffee.



**Biological control:** Ecosystems are important for regulating pests and vector borne diseases.

# Ecosystem Services Review (ESR)



## Corporate Ecosystem Services Review: Summary of Methodology

Step	1. Select the scope	2. Identify priority ecosystem services	3. Analyze trends in priority services	4. Identify business risks and opportunities	5. Develop strategies
<b>Activity</b>	Choose boundary within which to conduct the ESR (a specific business unit, product, market, landholdings, major customer, supplier, etc.)	Systematically evaluate degree of company's dependence and impact on more than 20 ecosystem services. Determine highest "priority" ecosystem services—those most relevant to business performance	Research and evaluate conditions and trends in the priority ecosystem services, as well as the drivers of these trends	Identify and evaluate business risks and opportunities that might arise due to the trends in priority ecosystem services	Outline and prioritize strategies for managing the risks and opportunities
<b>Who is involved</b>	<ul style="list-style-type: none"> <li>• Executive managers ✓</li> <li>• Manager(s) from selected scope ✓</li> <li>• Analysts</li> <li>• Consultants (optional)</li> </ul>	<ul style="list-style-type: none"> <li>• Analysts ✓</li> <li>• Consultants (optional) ✓</li> </ul>	<ul style="list-style-type: none"> <li>• Analysts ✓</li> <li>• Consultants (optional) ✓</li> </ul>	<ul style="list-style-type: none"> <li>• Manager(s) from selected scope ✓</li> <li>• Analysts ✓</li> <li>• Consultants (optional) ✓</li> </ul>	<ul style="list-style-type: none"> <li>• Executive managers ✓</li> <li>• Manager(s) from selected scope ✓</li> <li>• Analysts ✓</li> <li>• Consultants (optional) ✓</li> </ul>
<b>Sources of input and information</b>	<ul style="list-style-type: none"> <li>• In-house business managers and analysts</li> <li>• Existing and new in-house analyses</li> <li>• Local stakeholders</li> <li>• Experts from universities and research institutions</li> <li>• Millennium Ecosystem Assessment publications and experts</li> <li>• Nongovernmental organizations</li> <li>• Industry associations</li> <li>• Published research</li> <li>• Other resources and tools*</li> </ul>	<ul style="list-style-type: none"> <li>• Existing and new in-house analyses ✓</li> <li>• Local stakeholders ✓</li> <li>• Published research ✓</li> <li>• Other resources and tools* ✓</li> </ul>	<ul style="list-style-type: none"> <li>• Existing and new in-house analyses ✓</li> <li>• Local stakeholders ✓</li> <li>• Experts from universities and research institutions ✓</li> <li>• Millennium Ecosystem Assessment publications and experts ✓</li> <li>• Nongovernmental organizations ✓</li> <li>• Industry associations ✓</li> <li>• Published research ✓</li> <li>• Other resources and tools* ✓</li> </ul>	<ul style="list-style-type: none"> <li>• Existing and new in-house analyses ✓</li> <li>• Local stakeholders ✓</li> <li>• Experts from universities and research institutions ✓</li> <li>• Millennium Ecosystem Assessment publications and experts ✓</li> <li>• Nongovernmental organizations ✓</li> <li>• Industry associations ✓</li> <li>• Published research ✓</li> <li>• Other resources and tools* ✓</li> </ul>	<ul style="list-style-type: none"> <li>• Nongovernmental organizations ✓</li> <li>• Industry associations ✓</li> <li>• Published research ✓</li> <li>• Other resources and tools* ✓</li> </ul>
<b>End product</b>	Boundary for ESR analysis	List of 5-7 "priority" ecosystem services	Short paper or set of data that summarizes trends for each priority ecosystem service	List and description of possible business risks and opportunities	Prioritized set of strategies
<b>Estimated time**</b>	1-2 weeks	2-3 weeks	4-6 weeks	1-2 weeks	2-3 weeks



## Interpretation of linkages:

- **Environmental impacts differ regarding several aspects** (e.g. short-term vs. long-term impacts, non-linear changes, and resilience of affected organism or ecosystem).
  - Environmental impacts lead to **changes in ecosystem services** which in turn **negatively affect the constituents of human well-being**.
  - **Gradient** from positive correlations to trade-offs to negative correlations, along which ecosystem services are increasingly deteriorated. This holds especially for 'provisioning' and 'regulating' ecosystem services.
- **By the way: there are also trade-offs between different environmental impacts**



# Conclusions: Linkages



- **Trade-offs** and **negative correlations** between environmental and socio-economic impacts are a sign of deteriorations of environmental services which negatively affect the constituents of human well-being 'security', 'basic material for good life' and 'health' DUE TO
  - **inappropriate management practices** due to absence of respective regulations or weak law enforcement by the country's institutions AND/OR
  - **land use conflicts** and **land-use change (direct and indirect)**.
- **Certification** could help to avoid inappropriate management practices and direct land-use change (dLUC) but DOES NOT resolve issue of indirect land-use change (iLUC).



# Conclusions: Linkages



- Most of the conclusions are applicable for the **general cultivation** of the respective feedstock.
  - Important to apply **same rules for all agricultural products** (irrespective of use for food, feed, fibre or fuel).
- **The main areas / linkages are food security, biodiversity and ecosystem services.**
- Some of the linkages regarding **food insecurity** need additional studies and a different methodology to be able to fully understand the connection between biofuels and food insecurity as well as rising energy prices.



# Conclusions & recommendations



- Different approaches can be taken to link environmental and socio-economic principles, criteria and indicators. There is no one single formula. **A mixture of approaches might provide the best results.**
- **The ecosystem services approach** is still new in the business and project arena and **requires further development**, particularly in the bioenergy sector.
- **Harmonisation strategies should especially focus on the mandates with sustainability requirements** such as the EU RED (2009/28/EC), since these are setting the scene.
- Set **new mandatory environmental sustainability criteria** regarding soil, water and air protection in the RED, i.e. criteria that have a strong link to ecosystem services. **This way, some social impacts** affecting 'security', 'basic material for good life' and 'health' **can be covered indirectly.**

# Thank you for your kind attention !



- Questions ?  
→ ...don't hesitate to ask !
- Suggestions / remarks ?  
→ ...are very welcome !
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