The socio-economic drivers of land-use change
Some evidence from rainforest frontiers in Indonesia

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Introduction and motivation

• Human interaction on land plays a fundamental role in global climate change:

• Agricultural land accounts for 38% of the earth’s physical surface and expands significantly across the tropics Foley et al. 2011

• Especially global markets for cash crops encourage more cropland expansion Lambin and Meyfroidt 2011
Introduction and motivation

- Between 1980 - 2000, 55% of new agricultural land in tropical regions came at the expense of intact forests
  Gibbs et al. 2010

- World’s agricultural production is one main source of anthropogenic greenhouse gas emissions
  Burney et al. 2010

- Land-use change (LUC) poses a threat for the world’s hotspots of biodiversity and drives global climate change
Introduction and motivation

- LUC carries the potential of economic development in tropical regions:

- Cash crop cultivation increases welfare of agricultural smallholders Feintrenie et al. 2010

- Especially poorer households benefit from changing cultivation patterns towards cash crops Klasen et al. 2013
Introduction and motivation

• Commercial cropping correlates positively with infrastructure extension in rural areas Walker et al. 2002

• Remote areas gain from public policies boosting regional cash crop adoption Feintrenie et al. 2010

➢ How can LUC at rainforest margins address and balance both ecological sustainability and economic growth?
Conceptualizing LUC

- Insights into determinants of households’ LUC facilitate the balance between ecological and economic needs.

- To conceptualize the multiform dynamics of LUC...

- ...we draw on a multidisciplinary database of:
  - 70 case studies of LUC in tropical regions
  - conducted on the household and village level
  - published in 2000 - 2012
Conceptualizing LUC

Final land-use outcome:
Cash crop cultivation

Micro-level drivers of land-use change
Households’ choice parameters

Policies
Population growth
Global markets
Conceptualizing LUC

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Institutions
- Land-use rights

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Land-use rights
Accessibility & transport infrastructure

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Infrastructure
Accessibility & transport infrastructure

Characteristics
Households’ endowments & strategies

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Workshop: Green and social: managing synergies and trade-offs.
Conceptualizing LUC

Final land-use outcome:
Cash crop cultivation

Micro-level drivers of land-use change
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  - Input & output markets

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Workshop: Green and social: managing synergies and trade-offs.
LUC in Indonesia

- Indonesia comprises the world’s third largest area of tropical forest... World Bank 2006

- ...and exhibits one of the highest annual deforestation rates of 5% (2000 – 2010) Miettinen et al. 2011

- Indonesia is a key exporter of agricultural products on global markets
LUC in Indonesia

- The agricultural sector has transformed towards monoculture plantations with cash crops
  Feintrenie et al. 2010

- The agricultural sector contributes about 40% to national employment
  World Bank 2014

- Indonesia’s forests margins are epicenters of economic and ecological transformations
LUC in Central Sulawesi

- Lore Lindu region (LLR) in Central Sulawesi, Indonesia

- Lore Lindu National Park:
  - One of the largest mountainous rainforests in Indonesia
  - Area of 2,300 km²
  - A biodiversity hotspot along the Wallacea line

Forest loss in Central Sulawesi (2001-2011)

LUC in Central Sulawesi

- Due to rising cocoa prices local smallholders adopt cocoa production (1st Cocoa boom, since 1980)  
  Weber et al. 2007

- Continued rural in-migration by Bugis migrants intensify pressure on rainforest margins (2nd Cocoa boom, since 2001) ibd.
LUC in Central Sulawesi

Final land-use outcome
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Characteristics

Markets
- Input & Output markets
- Adoption of agricultural technology

Technology

Policies

Population growth

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Policies
Population growth
Global markets
Increasing world prices for cocoa

Source: International cocoa organization: http://www.icco.org
LUC in Central Sulawesi

- Since 2000: Two collaborative research centers (STORMA and EFFORTS) of the University of Göttingen focus on the LLR

- Panel data exists of 256 households based on three household surveys conducted in 13 villages in 2001, 2006 and 2013

- Ideal data base to investigate long-term dynamics of LUC in the Lore Lindu region
# Population growth

<table>
<thead>
<tr>
<th></th>
<th>2001</th>
<th>2006</th>
<th>2013</th>
</tr>
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<tbody>
<tr>
<td>Total population</td>
<td>19459</td>
<td>21202</td>
<td>22474</td>
</tr>
<tr>
<td>No. of Bugis migrants</td>
<td>789</td>
<td>798</td>
<td>812</td>
</tr>
</tbody>
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Source: Authors’ calculation based on representative household sample of 2001/2006/2013

- **Av. yearly growth rate 1.4% corresponding to national growth rate**
Extension of cultivated area

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<tr>
<td>Total cultivated area (ha)</td>
<td>5193</td>
<td>5366</td>
</tr>
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Source: Authors’ calculation based on representative household sample of 2001/2006/2013

- Between 2001-2013, 13 villages at rainforest margins extend their cultivation area with 173 ha at the expense of forests.
Area of main land uses in the LLR

Source: Authors’ calculation based on plot panel data 2001/2006/2013
Cash crops separated by origin

Mean area per household (ha)

Source: Authors’ calculation based on plot panel data 2001/2006/2013
Land use imitation by locals

- First migrants adopt cocoa and locals follow their cultivation strategy:
- Local farmers realize the financial gains of cocoa cultivation as they see how economic status of migrants improve
- The size of a Bugis community in a village correlates to the speed local farmers’ adopt cacao Weber et al 2007
Consequences of LUC in LLR

- Does less diversification of households’ cropping patterns initiate cocoa monoculture?

- Positive income effects of cocoa cultivation, but what about long-term effects:

  Does a less diverse crop portfolio raise households’ vulnerability?

  How to stabilize rainforest margins?
First ideas to balance trade-offs

- **Promoting intensification:**
  - Enhance knowledge about usage of chemical inputs such as pesticide and fertilizer
  - Usage of improved cocoa varieties to get higher prices

- **Supporting sustainable practices of cocoa cultivation:**
  - Maintain long-term soil quality and biodiversity with shadow plants
  - Canopy cover of cocoa trees prevents pests with same yield levels like open sun plantations
Conclusion

- Cash crop adoption drives land conversion for agricultural purposes across tropics
- In Central Sulawesi, land-use change for cocoa is driven by global cocoa markets and rural migration
- Local farmers imitate migrants’ crop patterns
- Less diversification of households’ crop portfolio may raise households’ vulnerability
- Pressure on forest margins could be reduced through knowledge transfer of input usage and sustainable agricultural practices
Thank you for your attention.