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The global dimensions of bio-energy markets, trade and sustainable development.

International Conference: Biofuels for Transportation – Global Potential and Implications for Sustainable Agriculture, Energy and Security in the 21st Century
Washington DC, United States, June 7, 2006.

André Faaij

Copernicus Institute - Utrecht University

Copernicus Institute
Sustainable Development and Innovation Management

Issues covered

- Global biomass resource potentials…
- International bio-energy market developments, trade and sustainability.
- Agenda and need for international collaboration.

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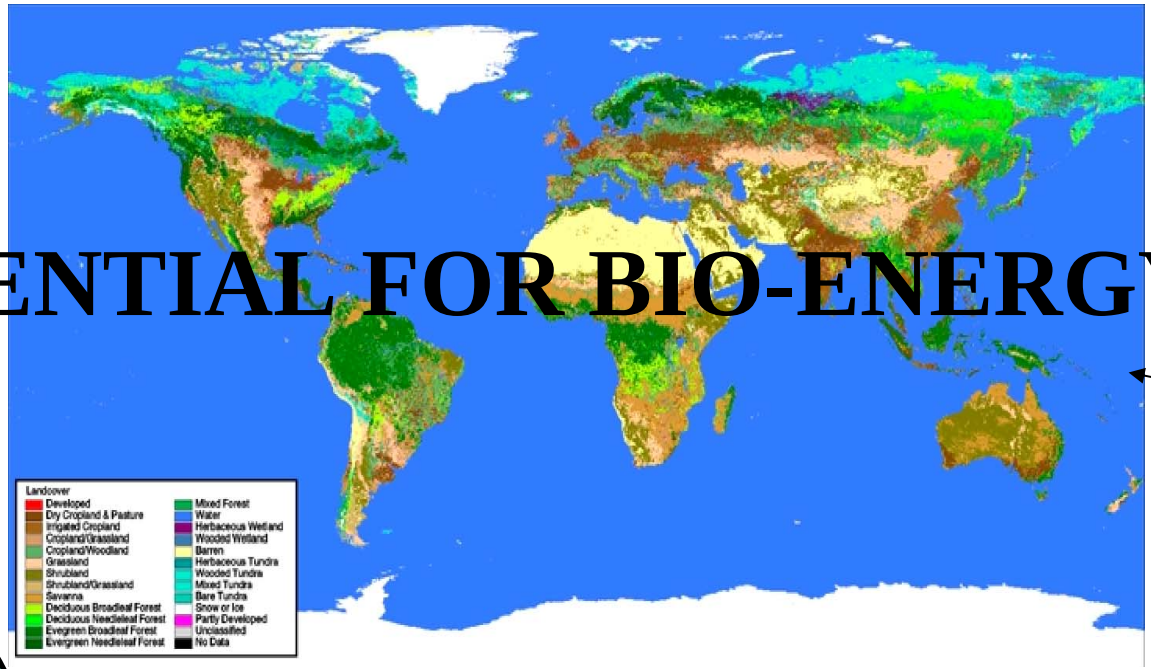
population

energy consumption

trade

future land use patterns

biotechnology



POTENTIAL FOR BIO-ENERGY?

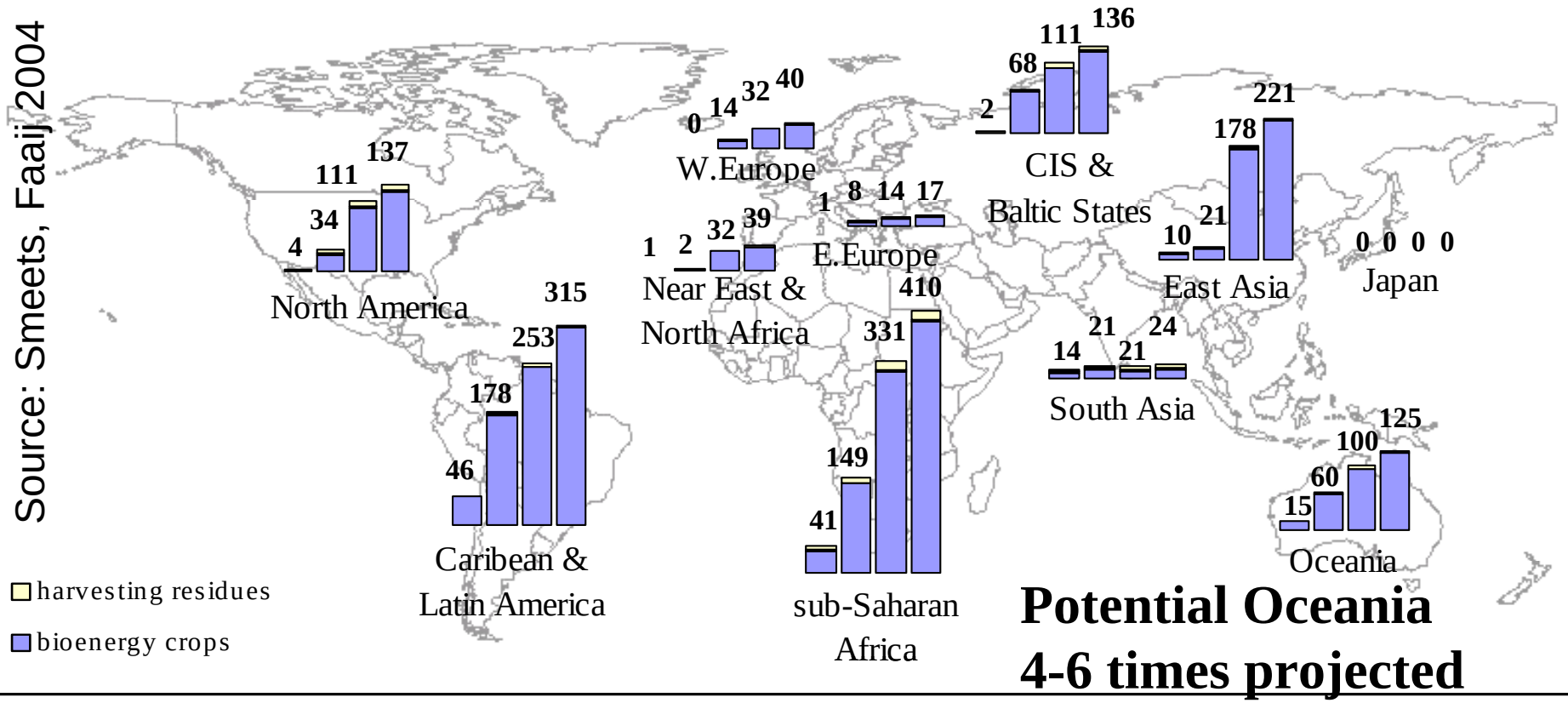
GDP

agricultural system irrigation, breeding, mechanization, chemicals

land productivity

agricultural policy

Bioenergy production potential in 2050 for different levels of change in agricultural management



Potential Oceania 4-6 times projected primary energy use

B1-2010

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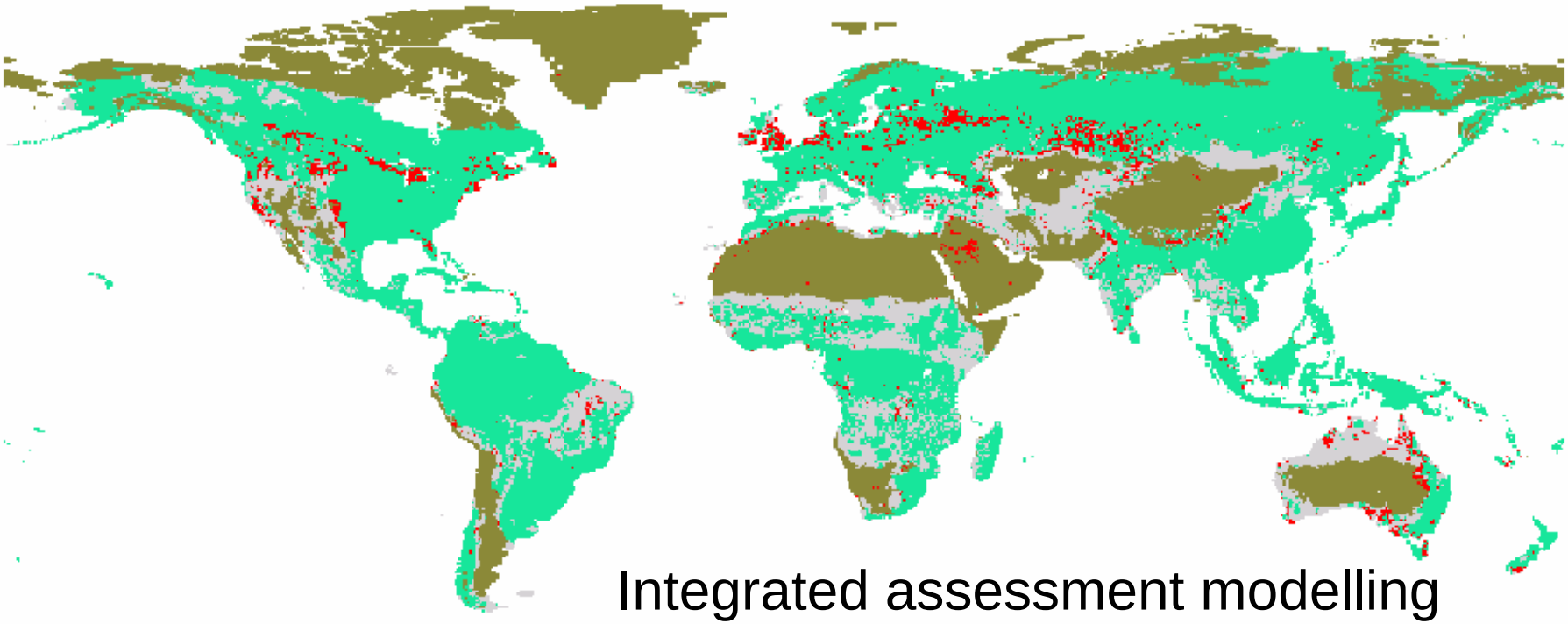

Source: Hoogwijk, Faaij 2004

rest land
Abandoned cropland
low-productive Land
Other

Integrated assessment modelling using IMAGE (RIVM) for assessing land-use and production potentials of biomass for energy

B1 2020

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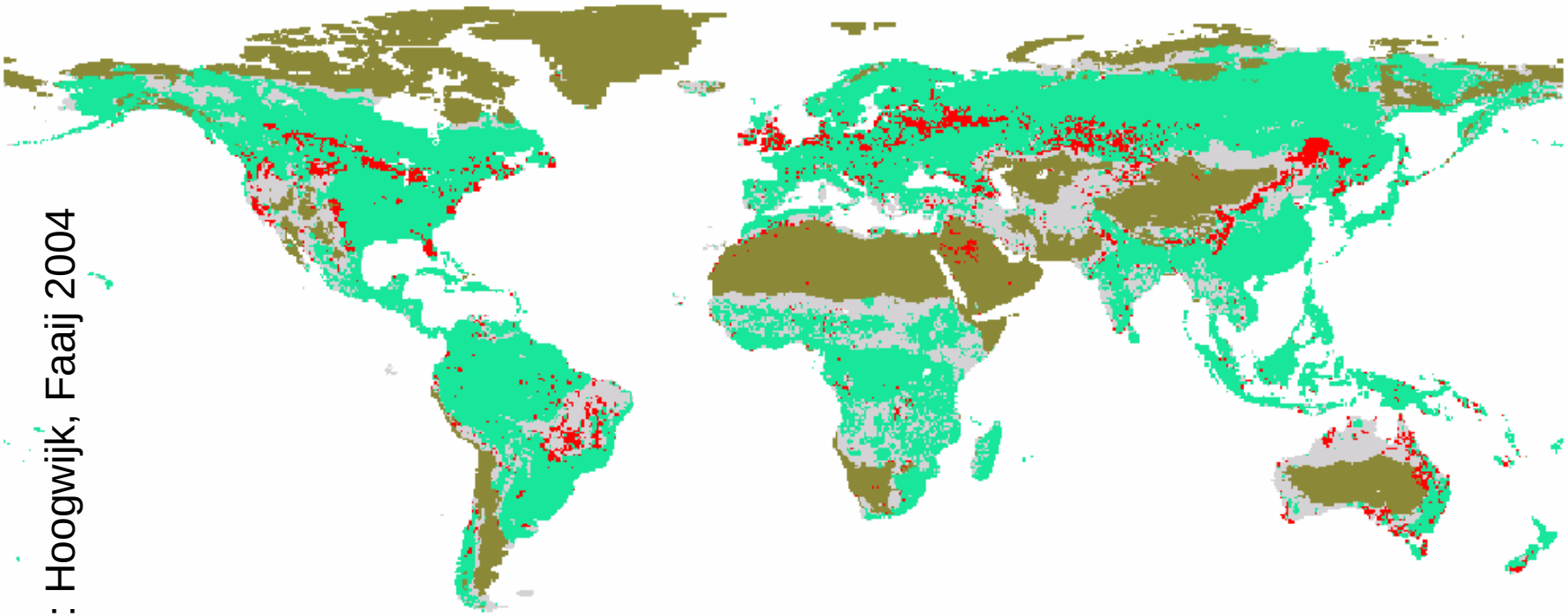

Source: Hoogwijk, Faaij 2004

rest land
Abandoned cropland
low-productive Land
Other

B1 2030

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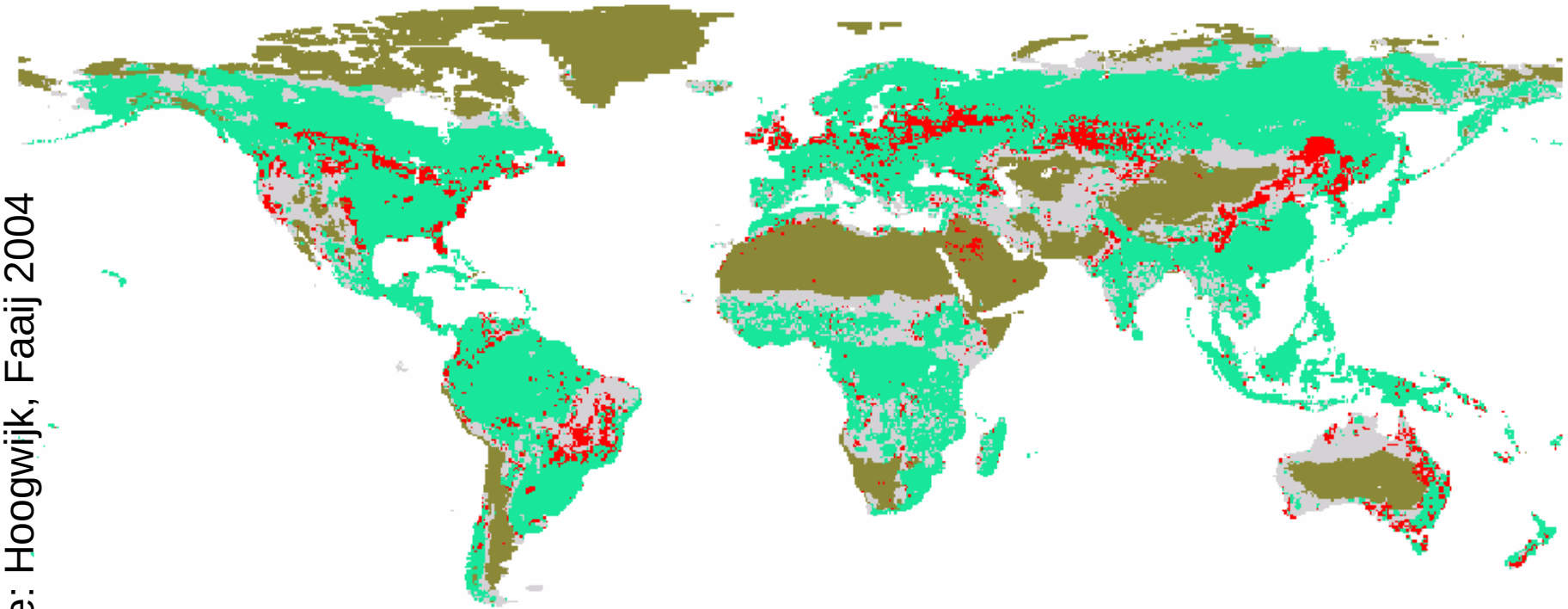

Source: Hoogwijk, Faaij 2004

rest land
Abandoned cropland
low-productive Land
Other

B1 2040

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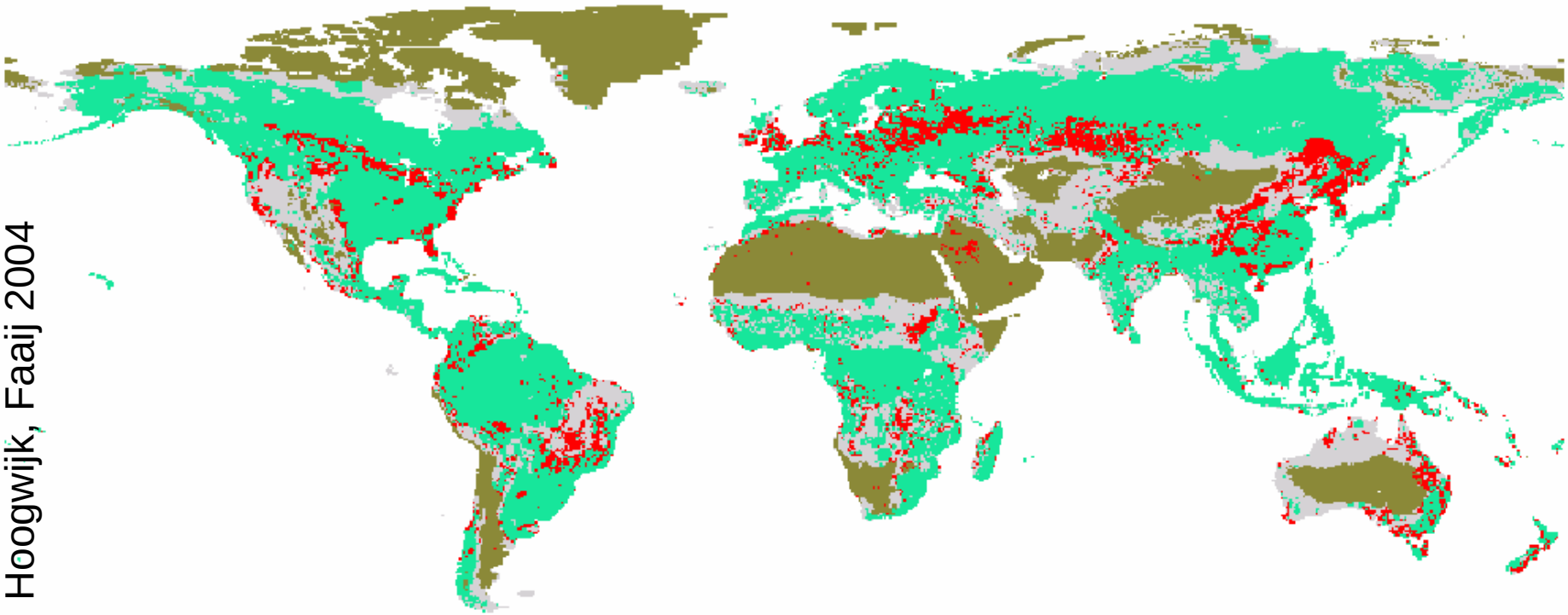
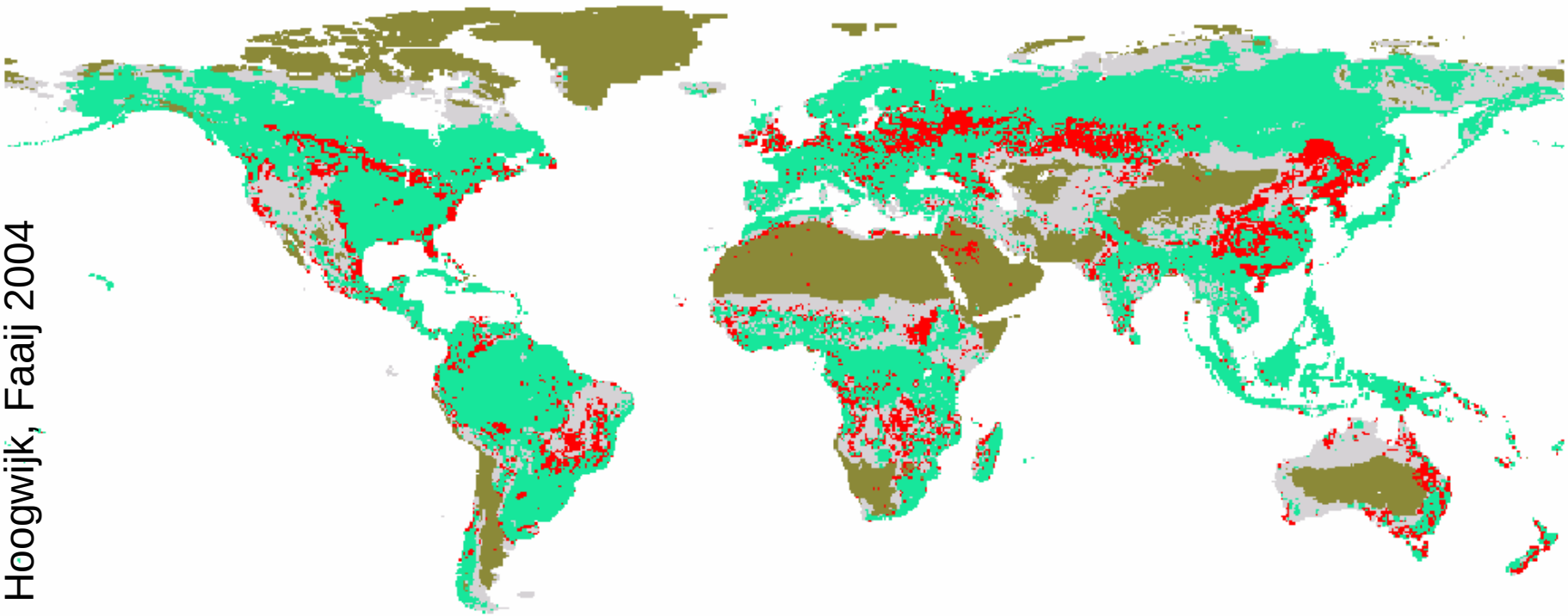


Source: Hoogwijk, Faaij 2004

rest land
Abandoned cropland
low-productive Land
Other

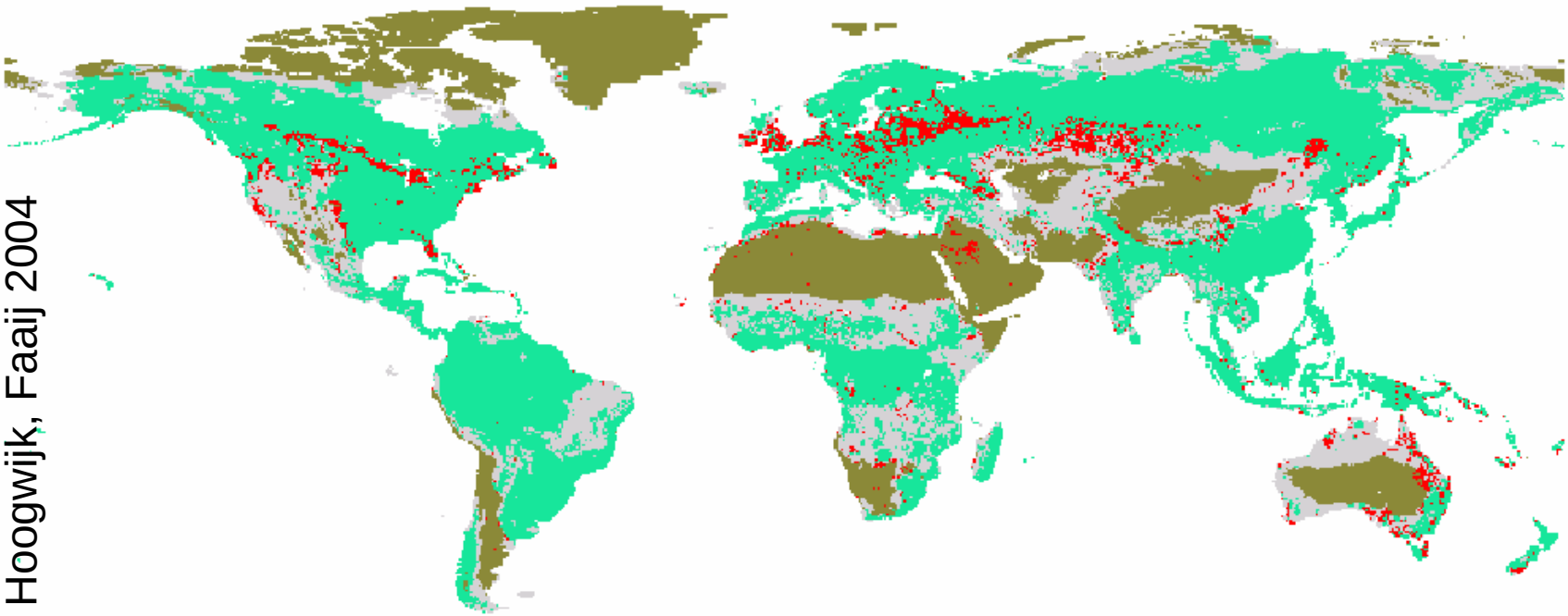
B1 2050



Source: Hoogwijk, Faaij 2004

rest land
Abandoned cropland
low-productive Land
Other

A2 2050



Source: Hoogwijk, Faaij 2004

- rest land
- Abandoned cropland
- low-productive Land
- Other

A1 2050

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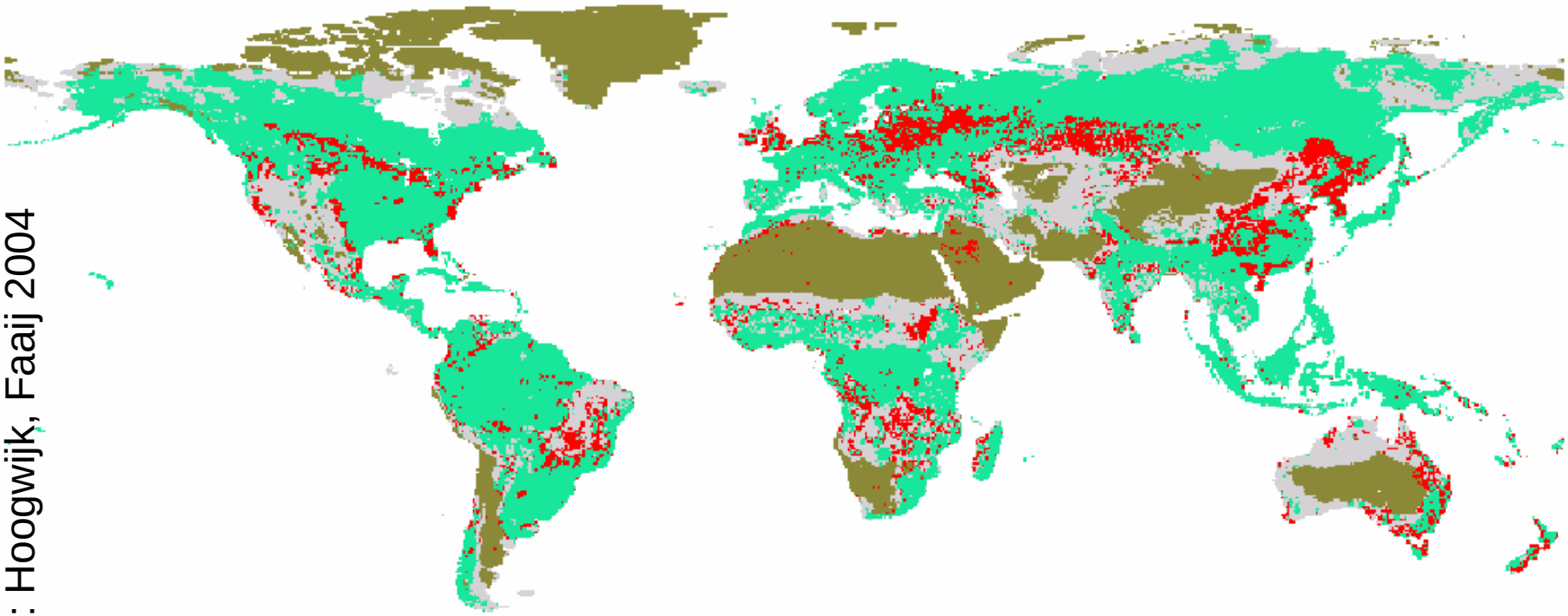

Source: Hoogwijk, Faaij 2004

rest land
Abandoned cropland
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Other

B2 2050

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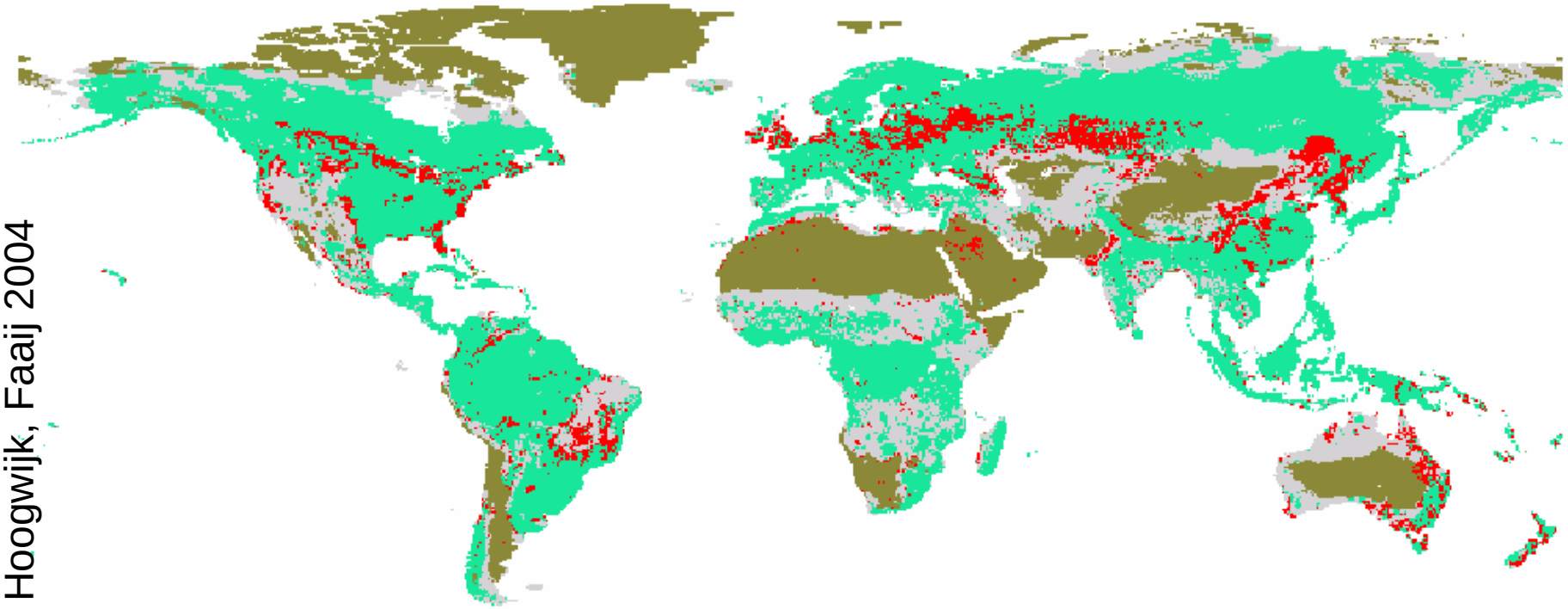

Source: Hoogwijk, Faaij 2004

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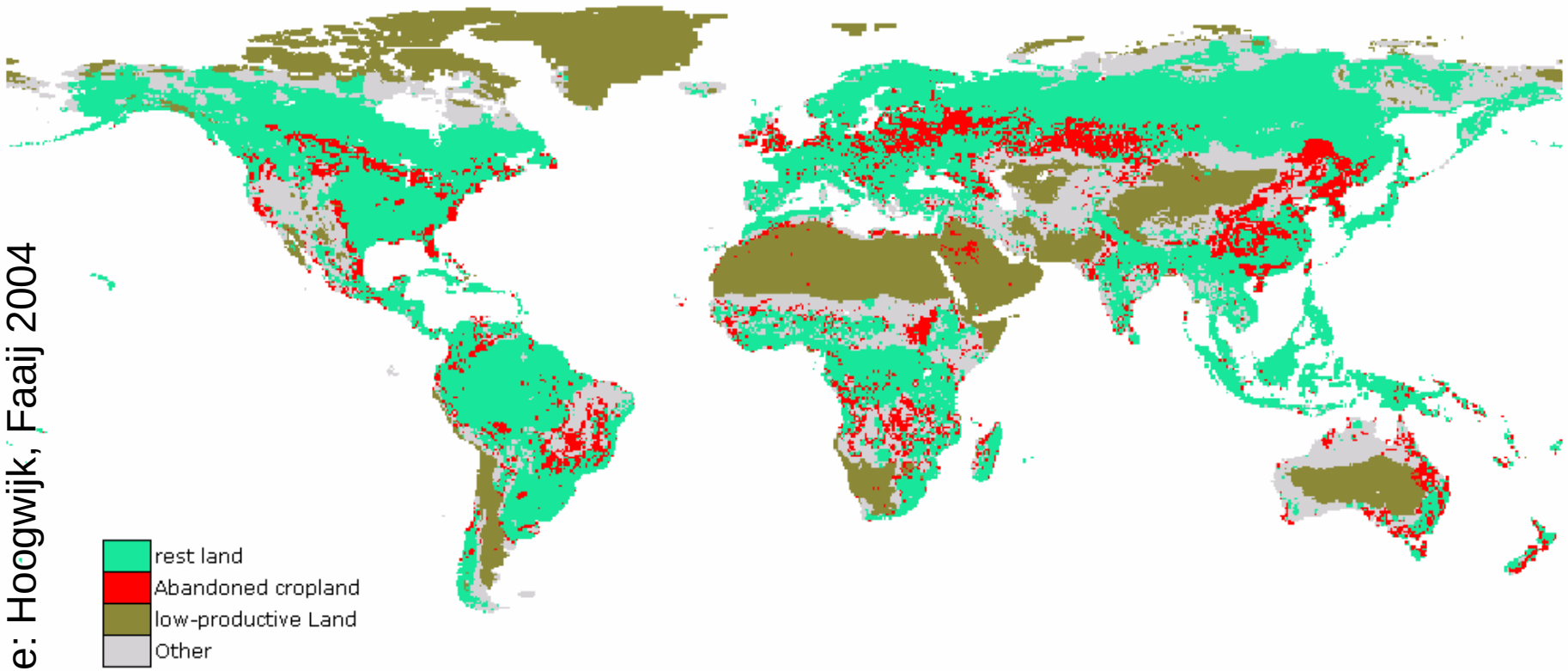
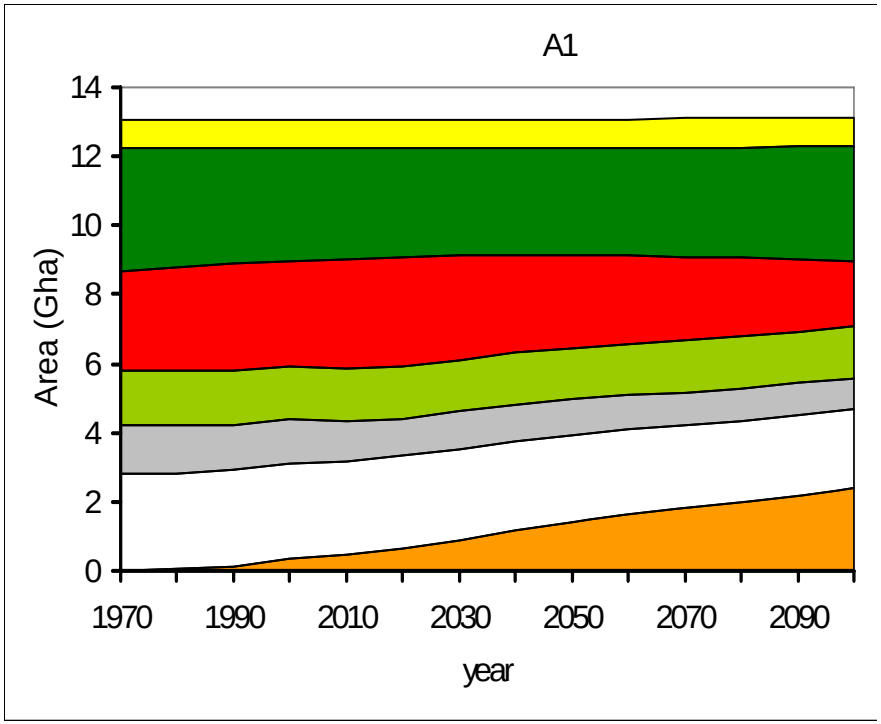
- Other

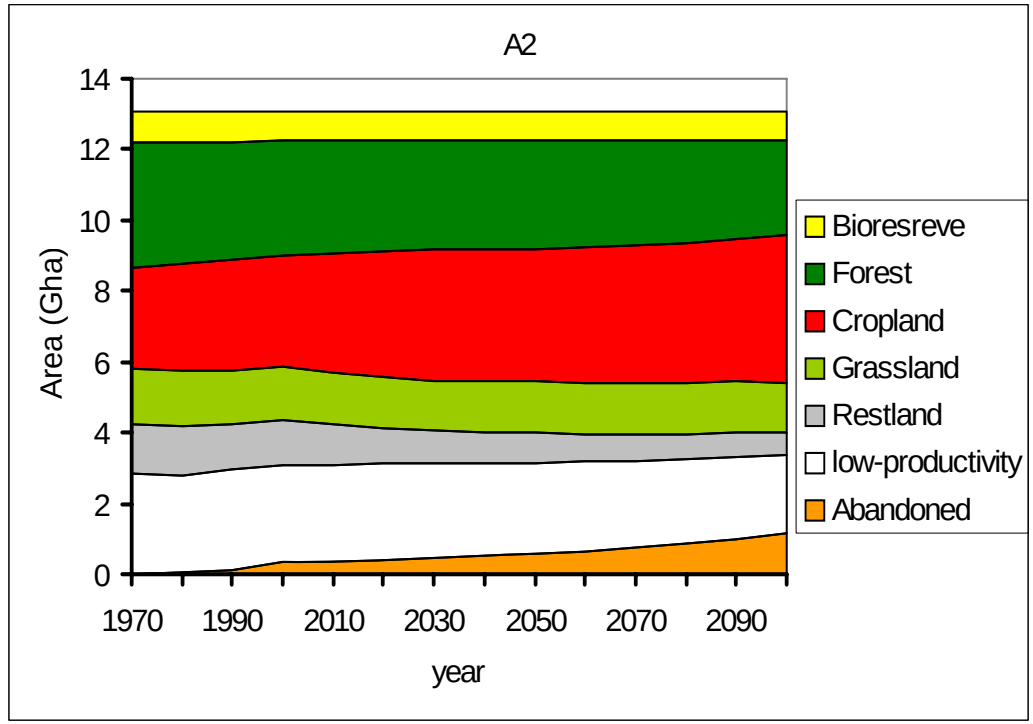
B1 2050



Source: Hoogwijk, Faaij 2004

Land-use pattern changes





Basics energy crop options (EU)

Crop		Typical yield ranges (odt/ha*yr)	Energy inputs (GJprim/ha*yr	Typical net energy yield (GJ/ha*yr)	Production cost ranges European context (Euro/GJ)
Rape	Short term	2.9 (rapeseed) 2.6 (straw)	11	110 (total)	20
	Longer term	4 (rapeseed) 4.5 (straw)	12	180 (total)	12
Sugar Beet	Short term	14	13	250	12
	Longer term	20	10	370	8
SRC-Willow	Shorter term	10	5	180	3-6
	Longer term	15	5	280	<2
Poplar	Shorter term	9	4	150	3-4
	Longer term	13	4	250	<2
Miscanthus	Shorter term	10	13-14	180	3-6
	Longer term	20	13-14	350	~2

Miscanthus - different genotypes

C_4 photosynthetic pathway

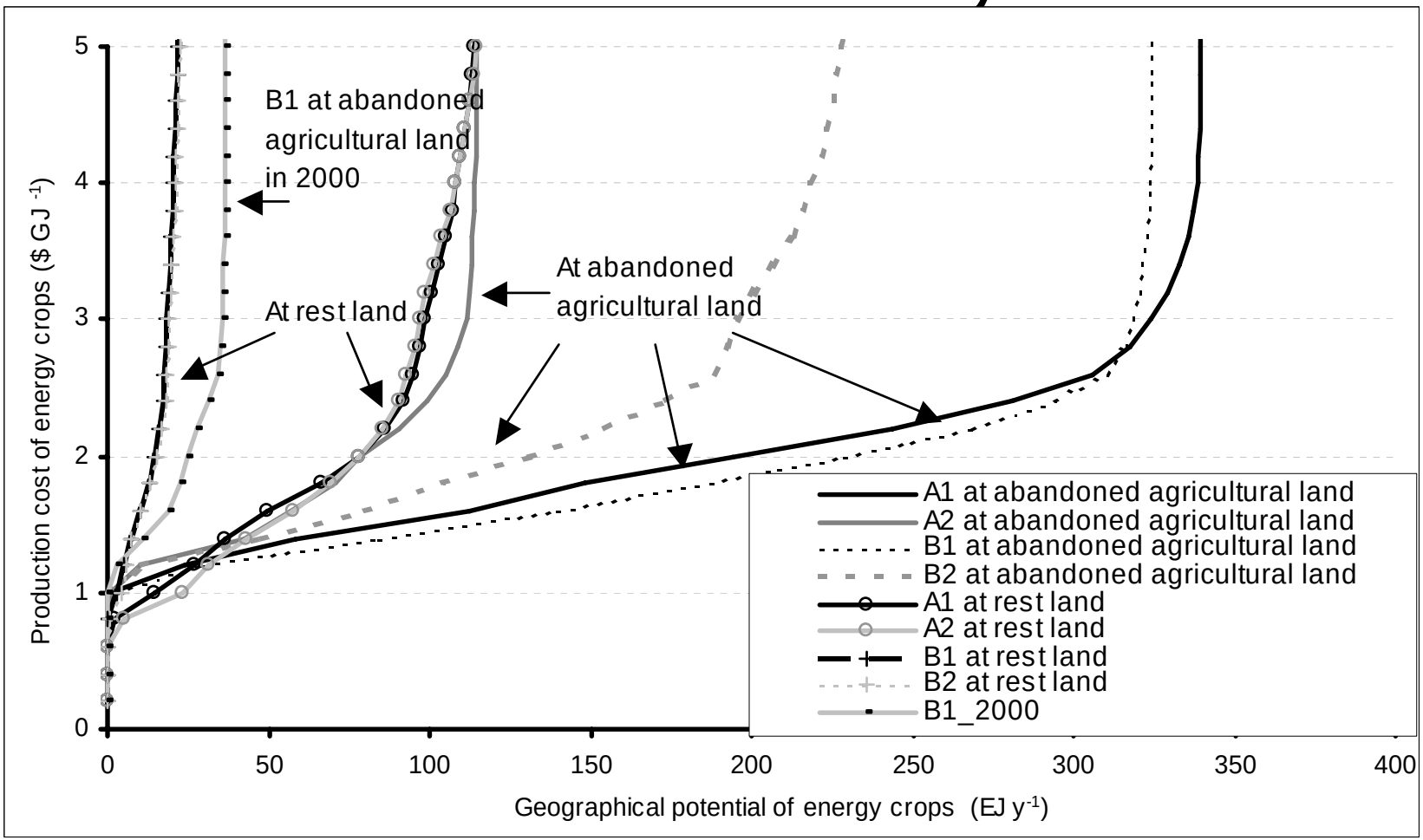
Miscanthus x giganteus

Miscanthus sacchariflorus

Miscanthus sinensis hybrid

Miscanthus sinensis

Global cost-supply curve for energy crops for four scenarios for the year 2050

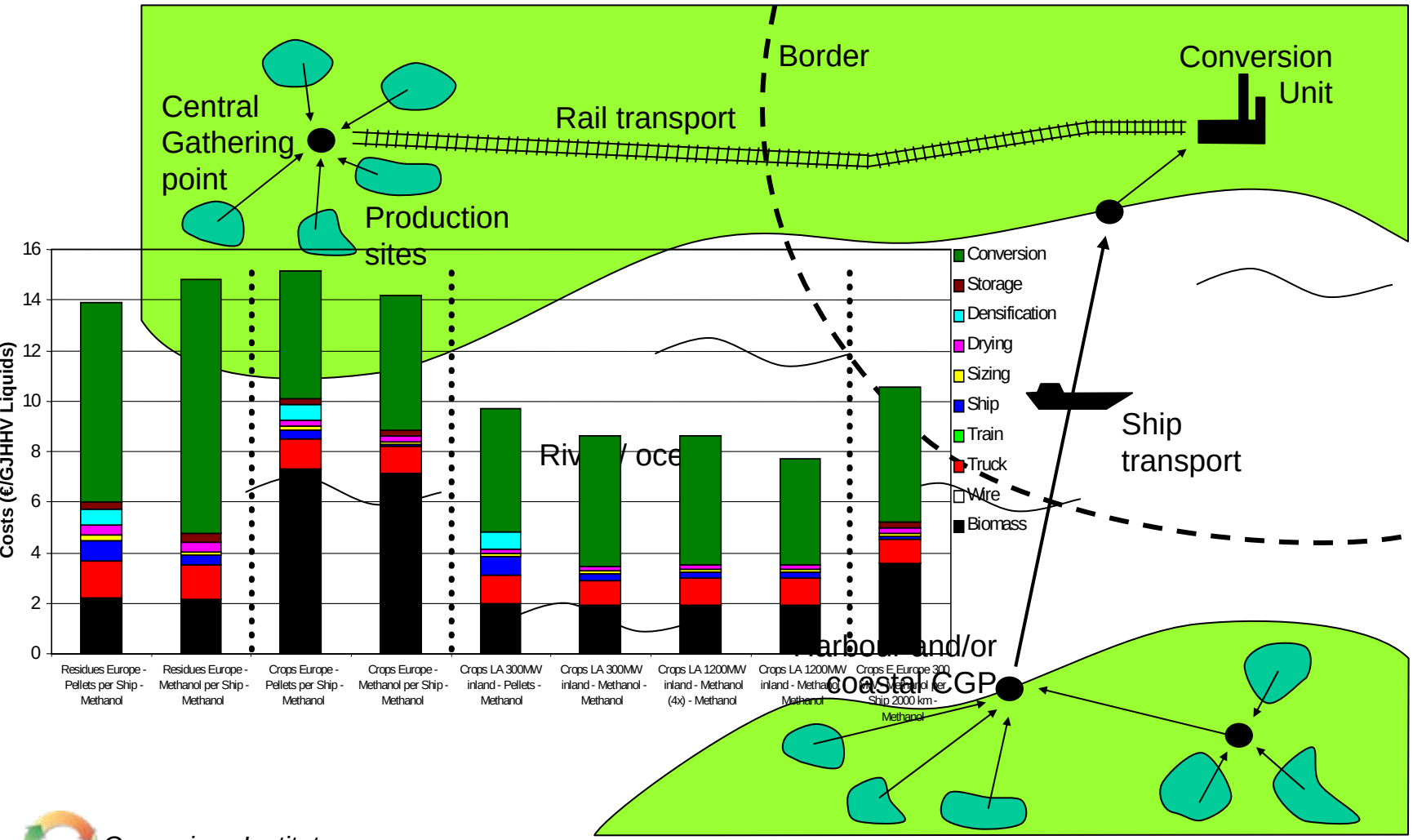


Source: Hoogwijk, Faaij, 2004

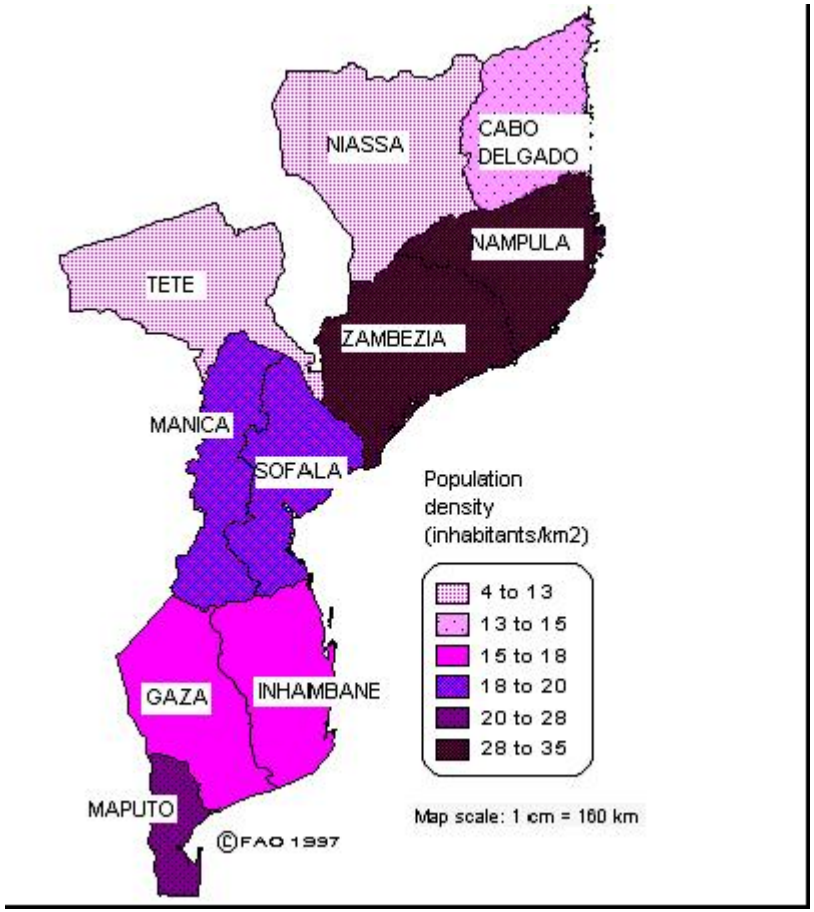
Overall picture 2050

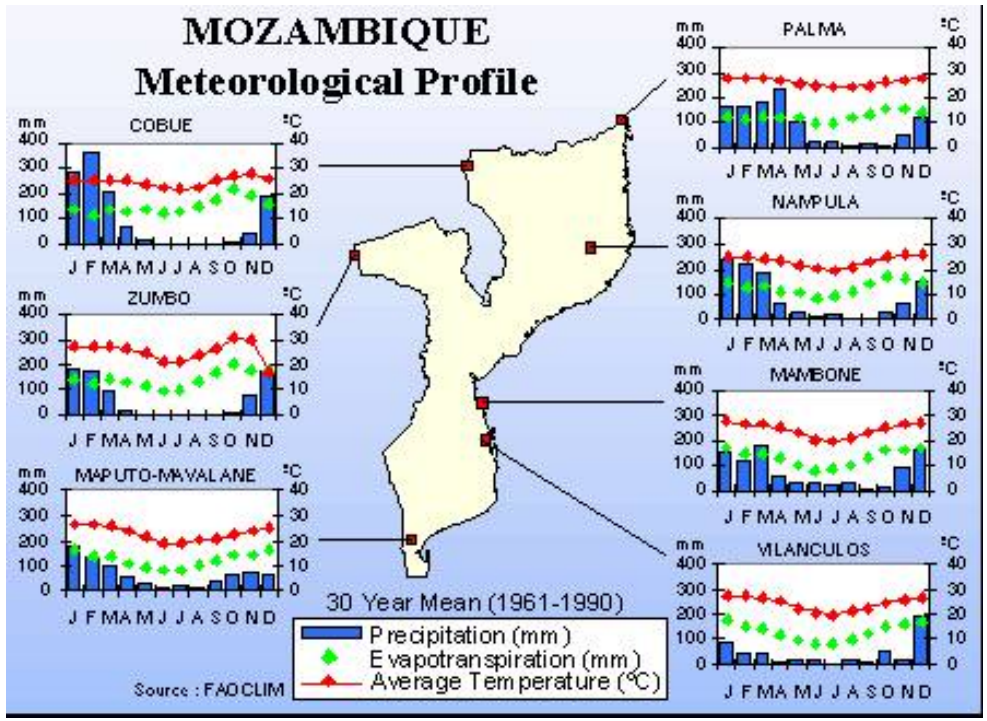
Biomass category	**Main assumptions and remarks**	**Potential bio-energy supply up to 2050.**
Agricultural land	Potential land surplus: 0-4 Gha (more average: 1-2 Gha).	0 – 700 EJ (average: 100 – 300 EJ)
Marginal lands.	On a global scale a maximum land surface of 1.7 Gha could be involved.	(0) 60 – 150 EJ
Residues agriculture	Estimates from various studies	15 – 70 EJ
Forest residues	Low value: figure for sustainable forest management. High value: technical potential. Figures include processing residues.	(0) 30 - 150 EJ
Dung	Use of dried dung. Low estimate based on global current use. High estimate: technical potential.	(0) 5 – 55 EJ
Organic wastes	Figures include the organic fraction of MSW and waste wood. Higher values possible by more intensive use of bio-materials.	5 – 50 (+) EJ
Total	Most pessimistic scenario: no land available for energy farming; only utilisation of residues. Most optimistic scenario: intensive agriculture concentrated on the better quality soils.	**40 – 1100 EJ** **(250 - 500 EJ)**

International bio-energy logistics not a showstopper when organized rightly



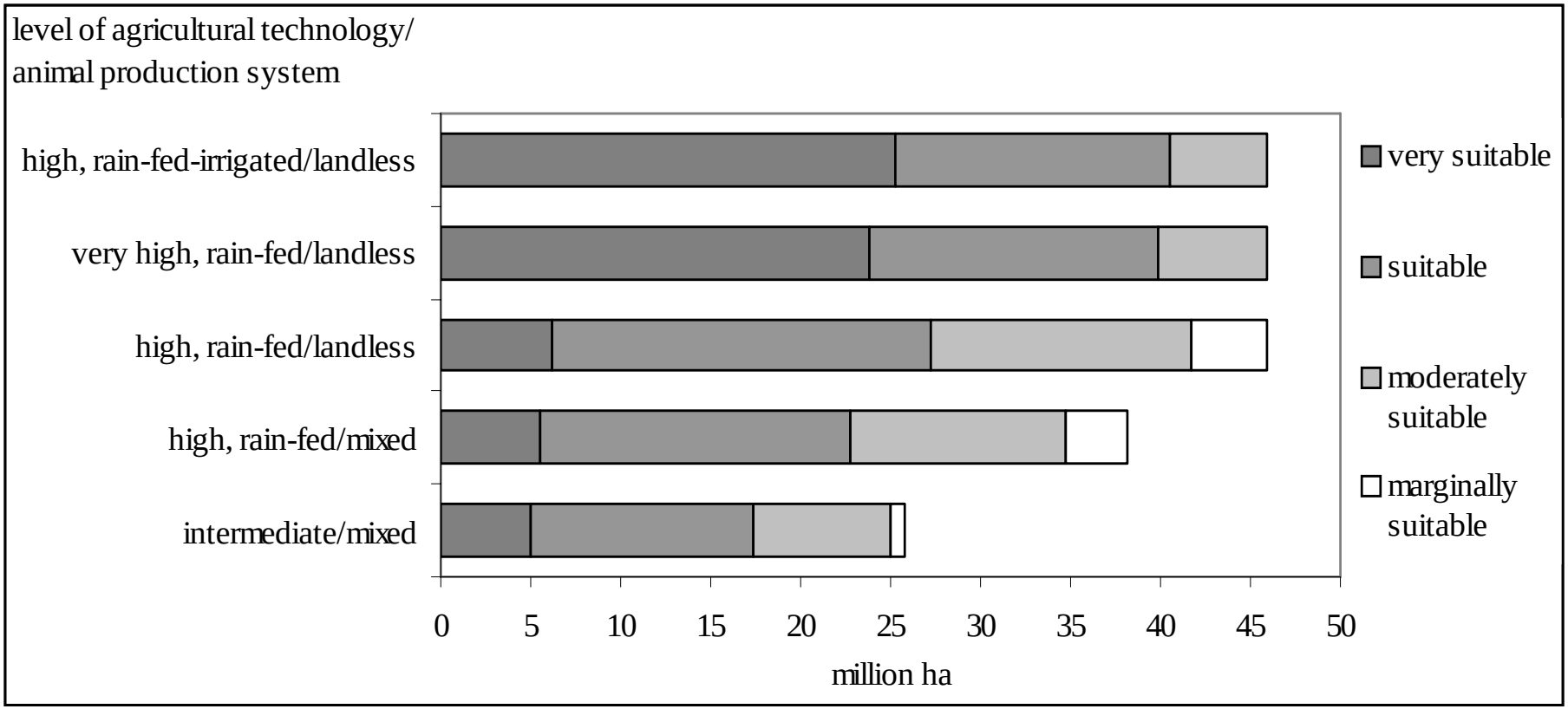
Mozambique…





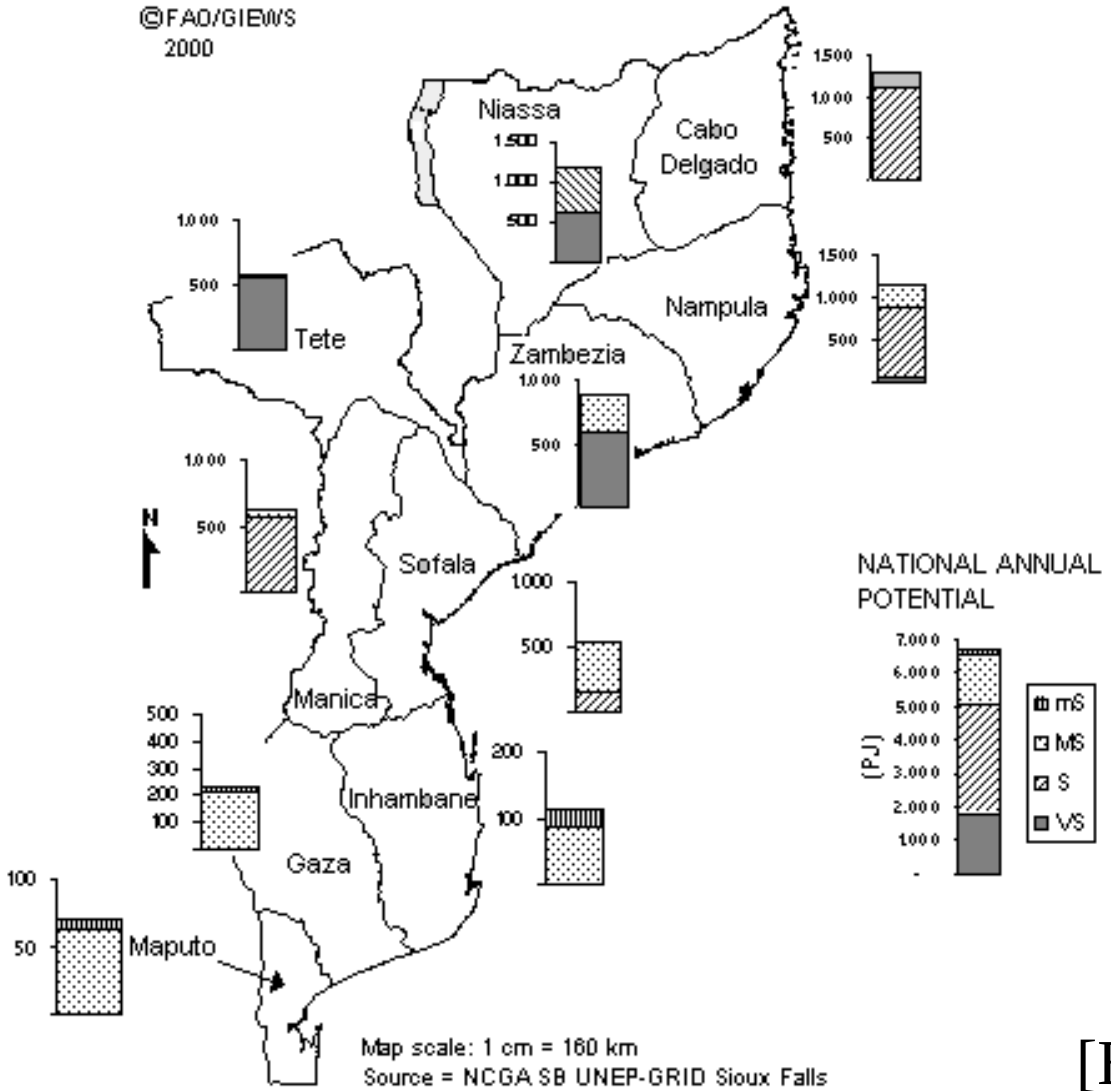
[Batidzirai & Faaij, 2005]

Potential surplus agricultural land in 2015 in Mozambique, dependant on the level of advancement of agricultural technology



[Batidzirai & Faaij, 2005]

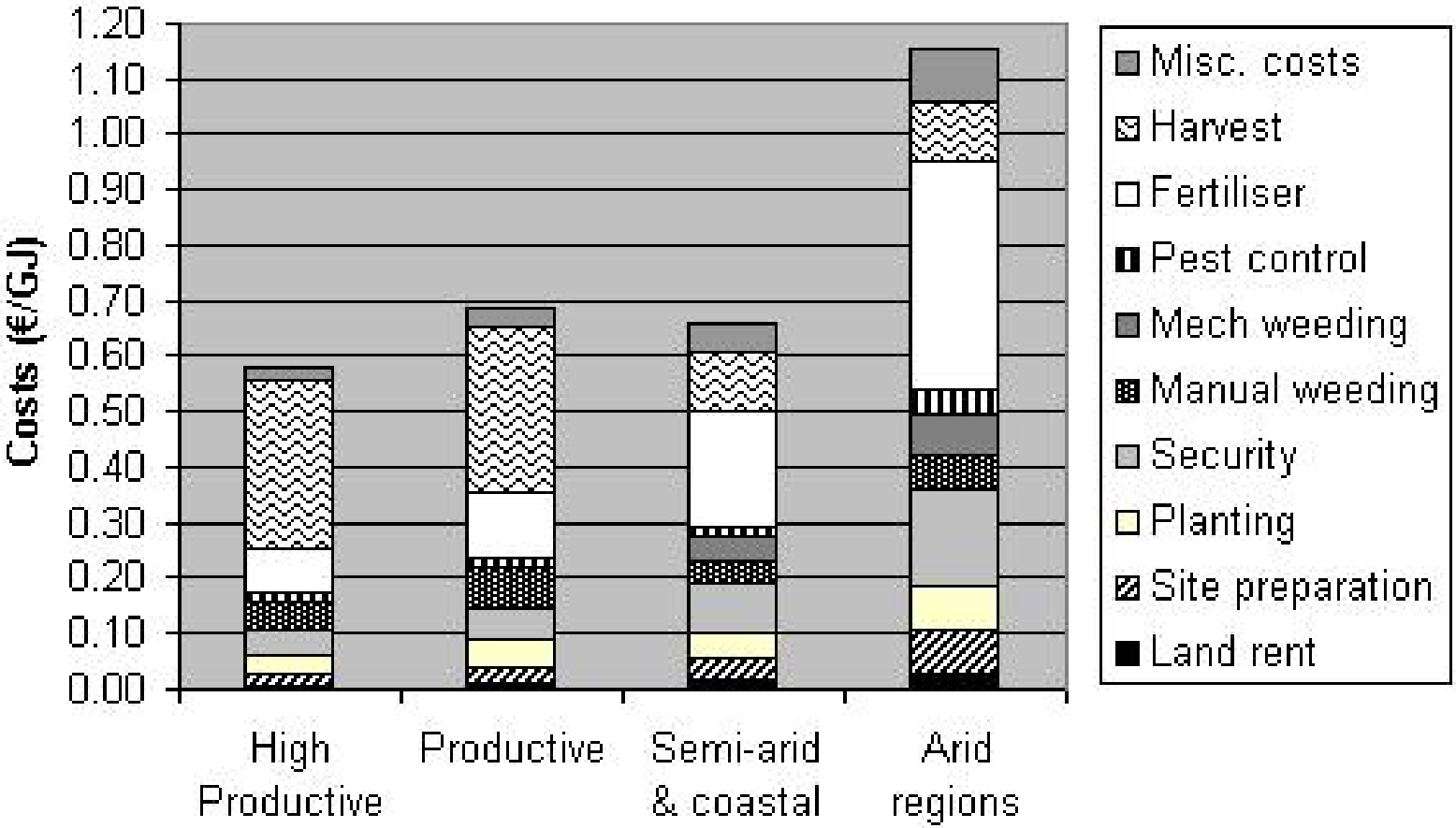
Regional biomass annual production potential in Mozambique/PJ_{HHV} (2015)



Total 7 EJ;
2.5 times the Total primary Energy demand of the Netherlands

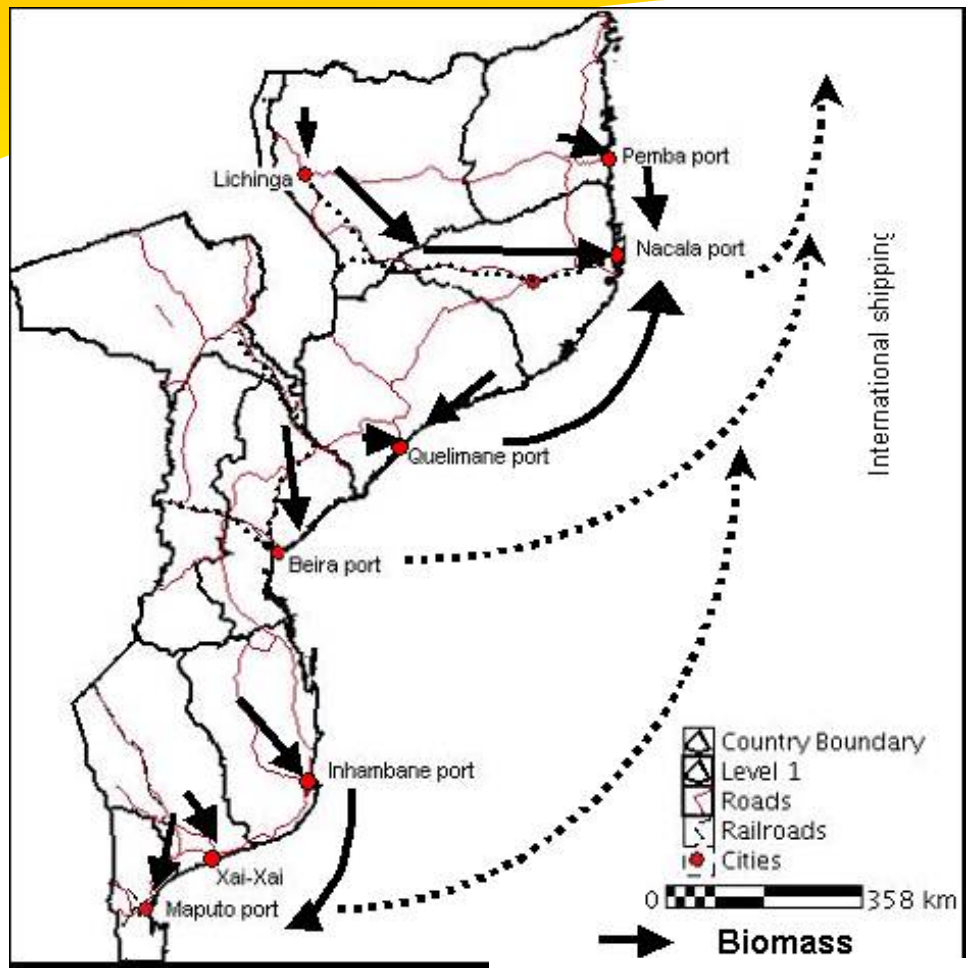
[Batidzirai & Faaij, 2005]

Comparison of bioenergy growing costs by region type (€/GJ)

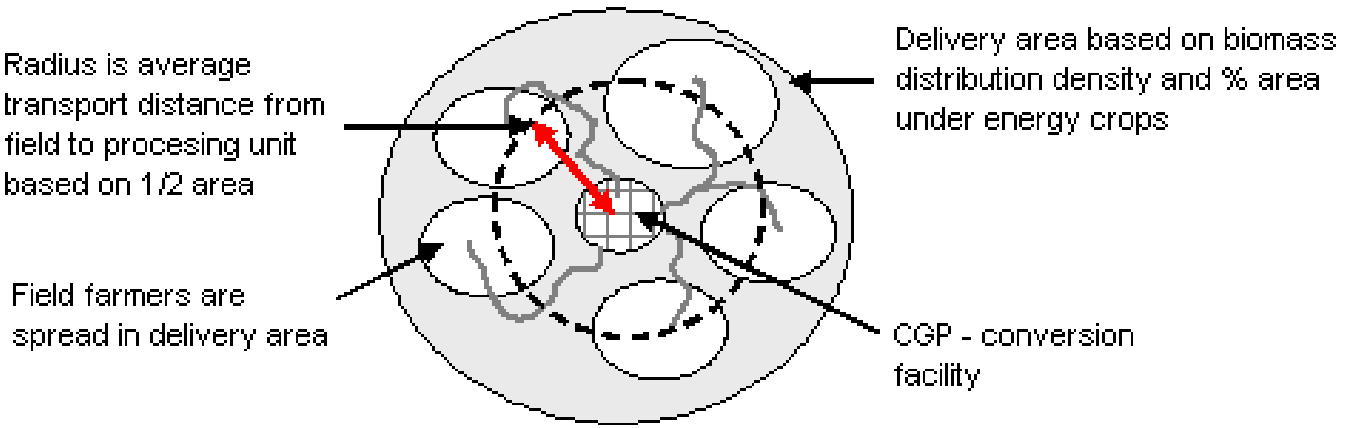


[Batidzirai & Faaij, 2005]

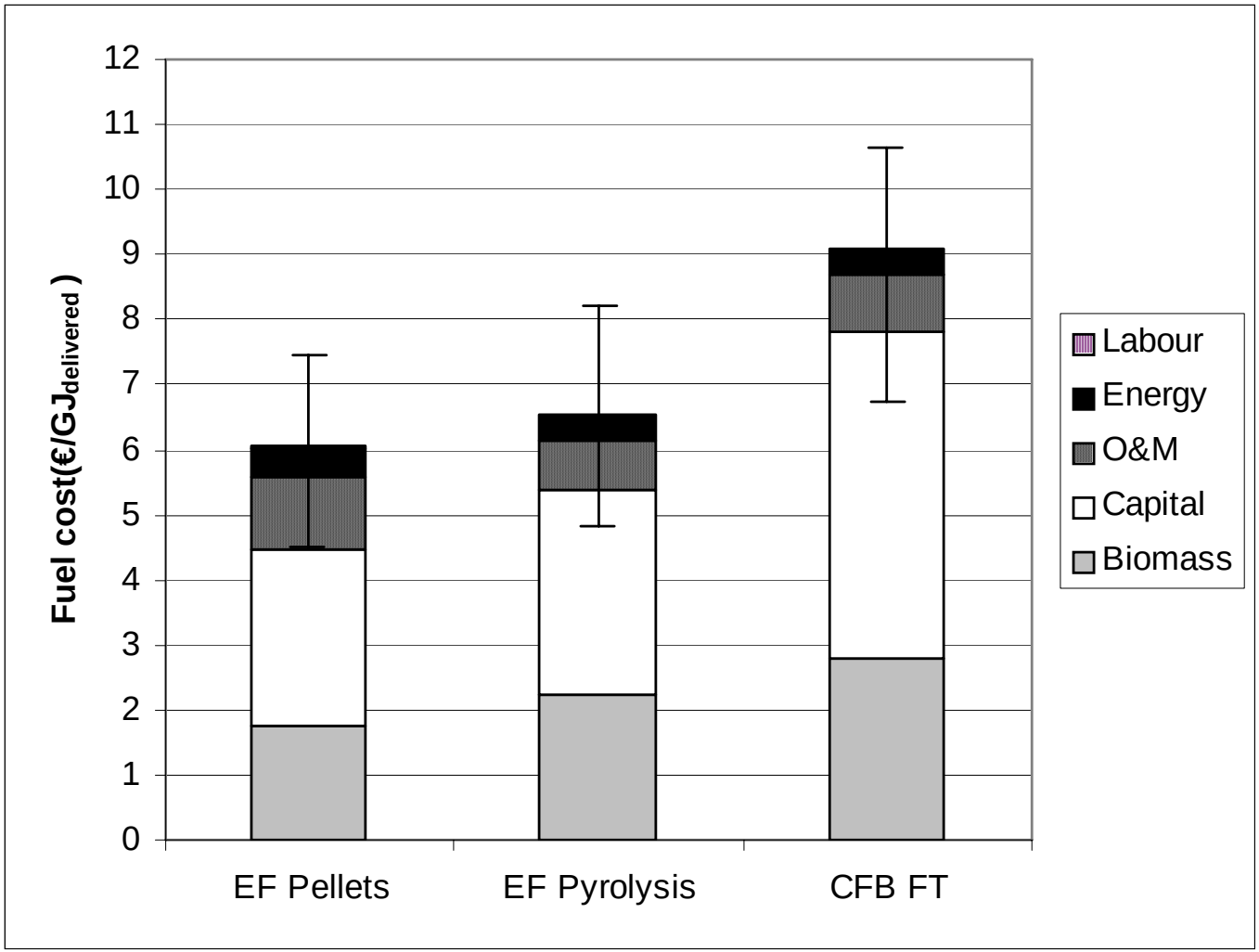
Logistics for export….



[Batidzirai & Faaij, 2005]



Range of costs for FT fuel delivered at Rotterdam Harbour



[Batidzirai & Faaij, 2005]

Bioenergy halfway this century…

- 100 EJ from forest & Ag. residues & organic wastes
- 100 EJ from restoration schemes degraded lands
- 200 EJ from good quality land released due to higher efficiency in agriculture (DC's, Eastern Europe…)

Bioenergy halfway this century…

- ~ 400 EJ is an expected 1/3 of the world's future energy needs; the key alternative for mineral oil!
- Represents 1-3 TRILLION U$ market value worldwide; larger than agriculture…
- Involves some 10% of the worlds land surface / one fifth of agricultural/pasture lands.

International bio-energy markets developing fast…

- Excitement:
  - Solid biofuels trading develops in bilateral setting; bio-ethanol entered first phases of commodity market trading; *''wild west phase''*
  - Growing bio-energy demand and international supply chains create unique opportunities for biomass producing regions.
  - Investments in large scale conversion capacity now more secure.
  - Ultimately, a real alternative for mineral oil…
- Concerns:
  - Overexploitation (water, land competition) should be avoided and fair trading principles implemented.

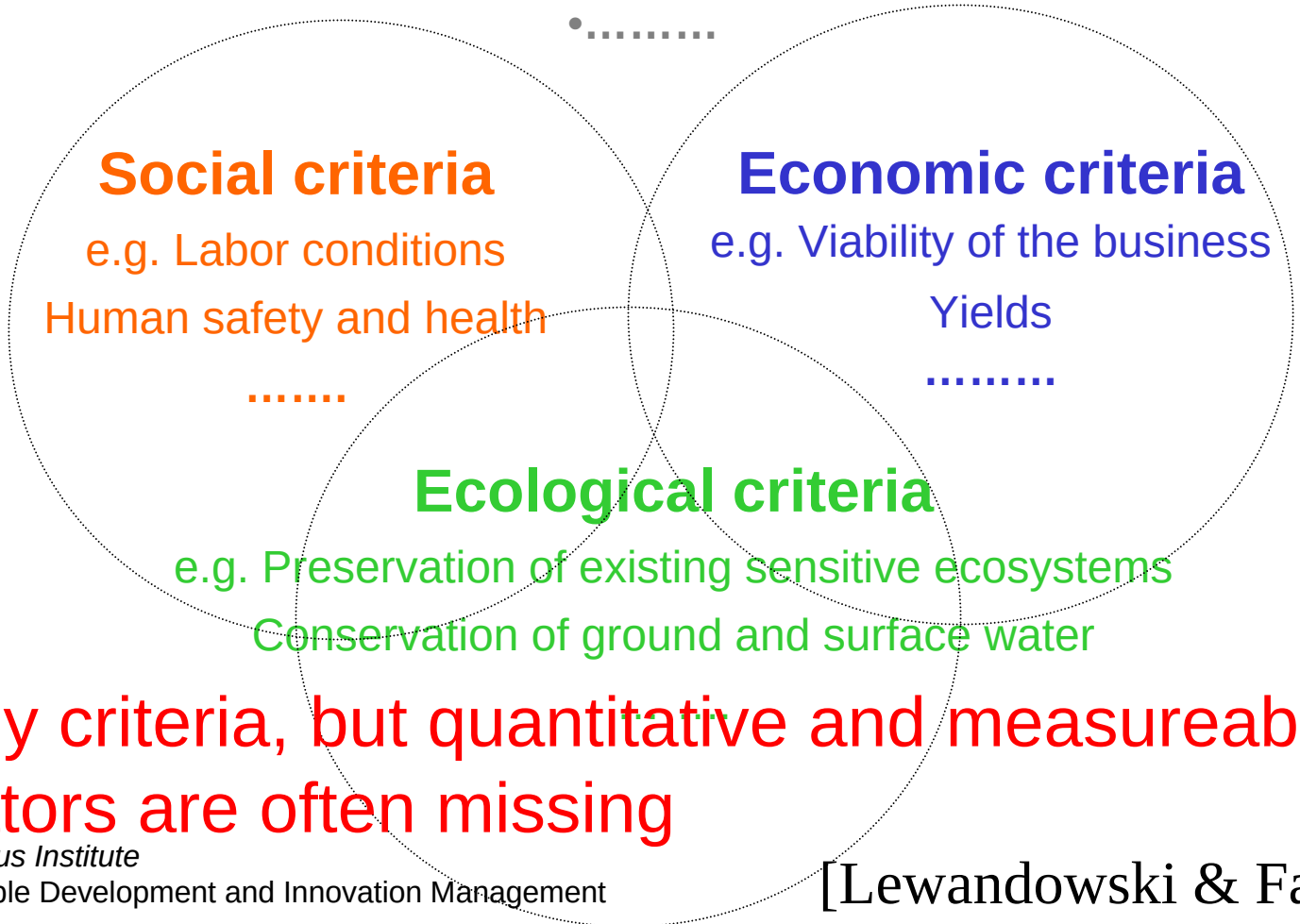
The key linkages…

- Agriculture the key for bio-energy…
- Bio-energy could be the key lever for rural development.
- Bio-energy is (and will be) propelled by sound economics; market almost unlimited (and uncontrolled)
- Sustainability to be secured in a global setting.

Areas of concern relevant for sustainability of the biomass production and trading chains

General criteria

- e.g. Traceability
- Avoidance of leakage effects
- .....



⇒Many criteria, but quantitative and measureable indicators are often missing

[Lewandowski & Faaij, 2004]

Operationalisation of sustainability criteria

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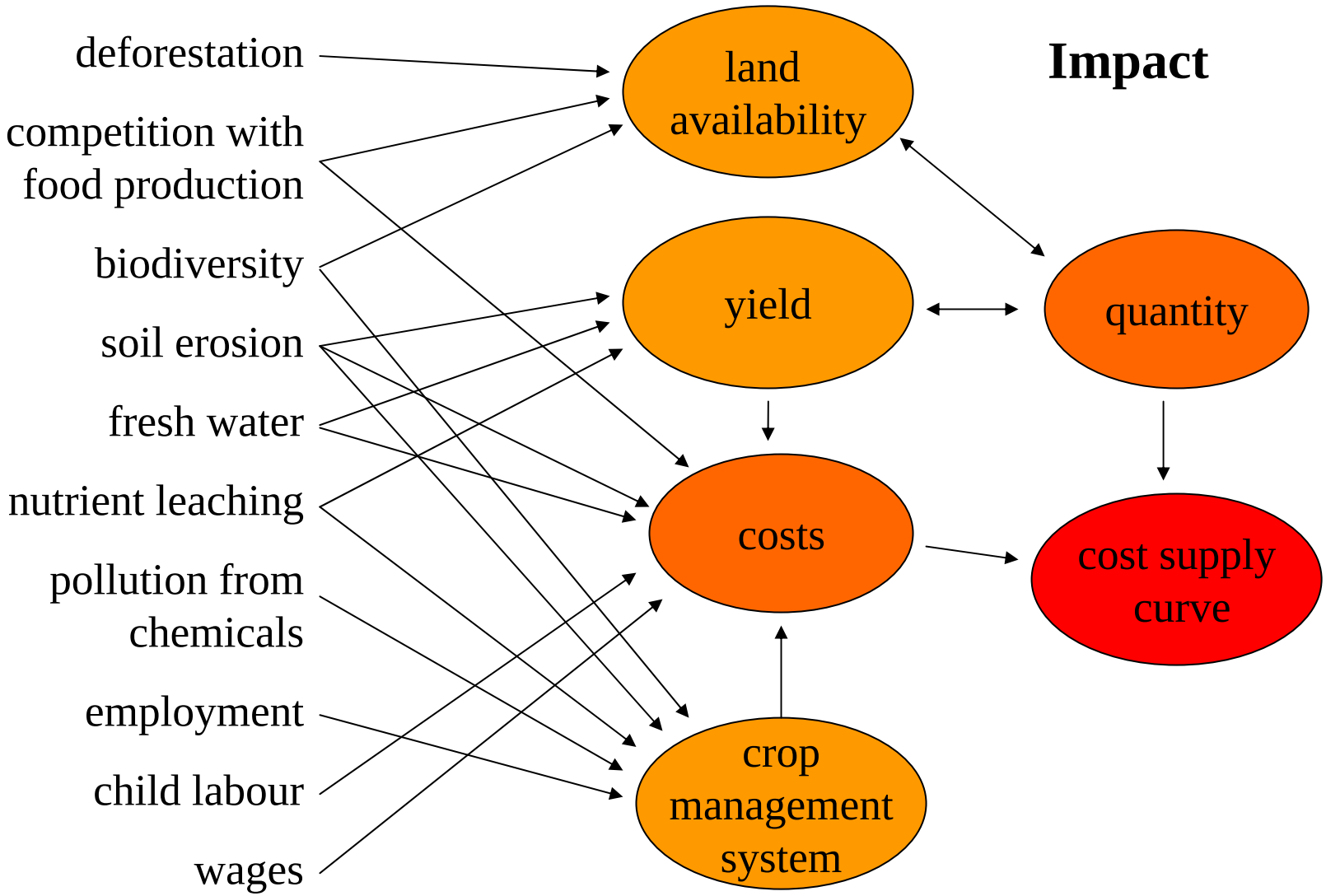
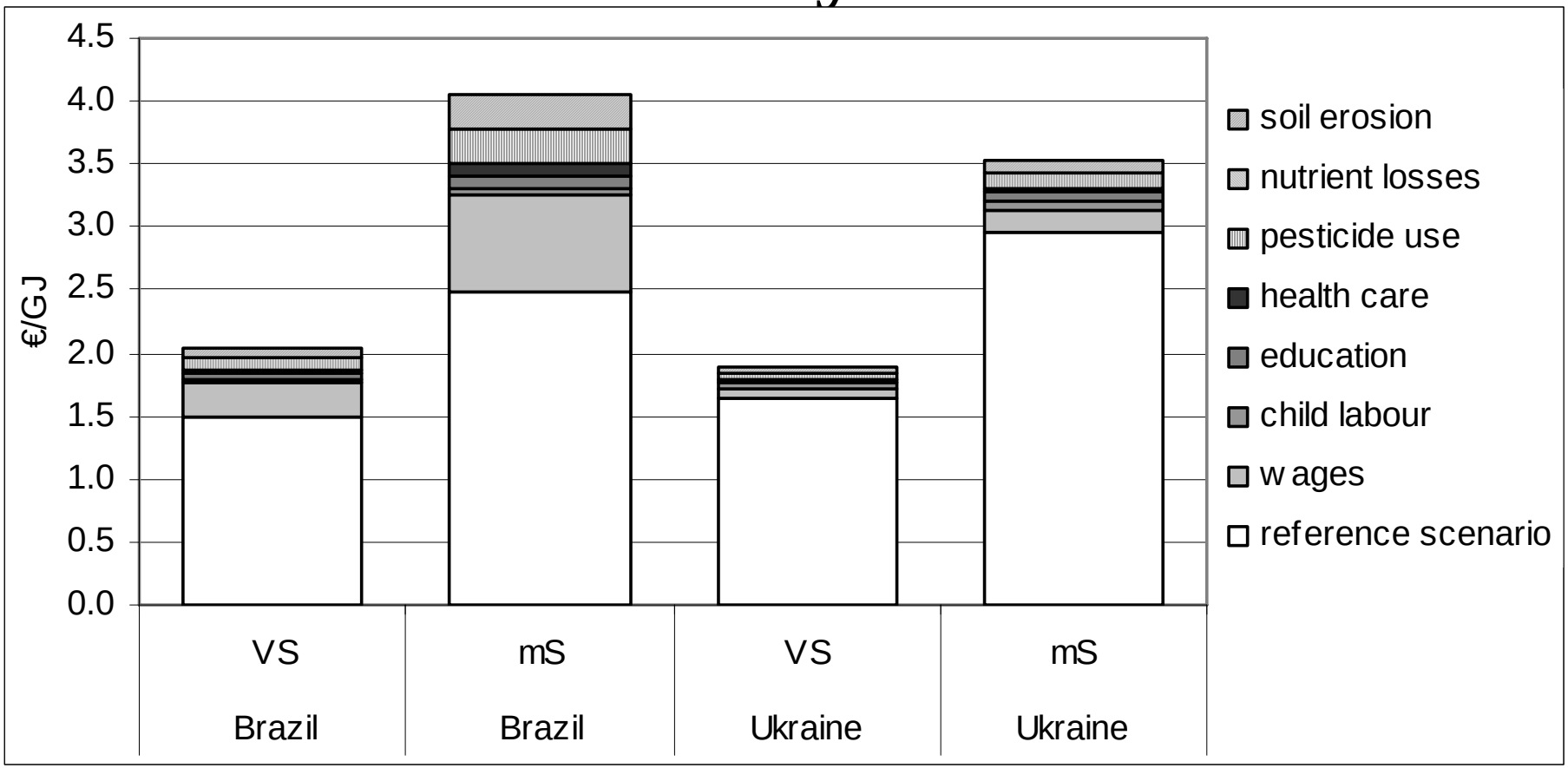


[Smeets et al., 2005]

Indicative cost impacts of applying sustainability criteria…



[Smeets et al., 2005]

Quickscan of PROALCOOL-Brazil

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Issue		Remarks
Water use		Dependant on local situation
Water pollution		Dependant on local situation; criteria available
Biodiversity		Indirect impacts?; research required
Erosion		Dependant on local situation
GM cane		No GM cane is used
Cane burning		Complex issue: link with employment, erosion, GHG
GHG/emission		Soil carbon is crucial
Competition with food		Indirect impacts?; research required
Employment		Indirect impacts?; research required
Wages/working conditions		
Child labour		Easy to check; limited impact

 Big impact and/or important issue and/or difficult to tackle and/or no indicators present

 Limited impact and/or unimportant issue and/or easy to tackle and/or indicators present

Closing remarks (I)

- Large, economic, biomass potentials (but needs complex, sustainable, development and a working international market; 1/3 of global energy demand seems feasible!)
- Integration of biomass production into agriculture (implying integrated rural development schemes targeting traditional agriculture)
- Competitive biomass-technology combinations within reach for the world market (but needs serious, consistent development and market introduction).

Closing remarks (II)

- Sustainable biomass production achieving multiple benefits is possible (but needs strong frameworks and control of market forces).
- Diversity in ecological and socio-economic conditions to be recognized (asking for regional approaches in a global setting; stakeholder approaches (PIA) seem best model).
- Sense of urgency is needed; market forces are already steering development of international bio-energy markets.

Closing remarks (III)

- Flagship projects (to demonstrate multiple benefits and framework(s) under different conditions; solid fuels… multiple markets with international focus…
- Promising future; but policy needs to choose and coordinate (agriculture, trade, climate, energy and development are interlinked here).
- Strong need for international collaboration and action: IBEP, Biofuels Init., IEA, G8 partnership, WTO, etcetc.

Internat. network: IEA Task 40

- **Members:** Netherlands (T.L.; Copernicus & Essent), Sweden, Norway, Brazil, Finland, Canada, UK, Italy, Belgium; Germany just came on board
- **Affiliated international bodies**
  - FAO, World Bank; (interest: UNCTAD, WWF int., UNEP)

www.bioenergytrade.org:

- Detailed activities
- Results (e.g. country reports, analyses)
- Events
- Partner for collaboration