Assessing the sustainability of using biofuels for Transport

Table ronde n°1 : Biocarburants pour le transport vs production d'électricité

Conference: Biocarburants pour L'Afrique

Ouagadougou

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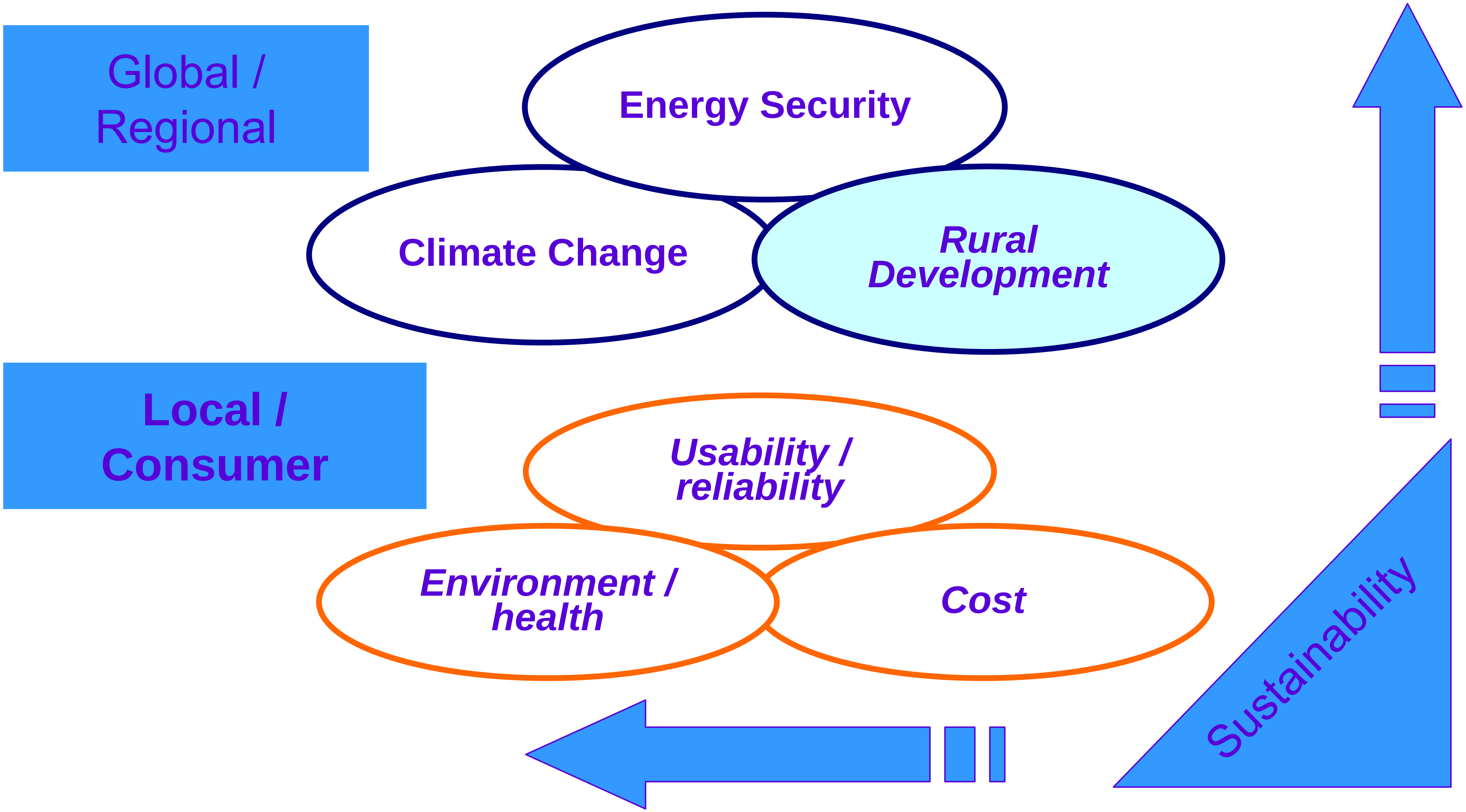
Basic Questions

- Is Africa fundamentally constrained in its ability to increase biomass production for food, fuel, fibre, environmental services, etc?
  - Is there really a competition for resources?
- Can we use existing flows of biomass more efficiently?
  - Economically
  - Physically
- What are the likely social, economic and environmental impacts of increase biomass production for energy?
- What are the consequences of increased local supplies of modern energy services?
  - Transport, electricity and heat!

Drivers and obstacles for bioenergy
Conflicts and synergies are inevitable



What is driving the biofuels?

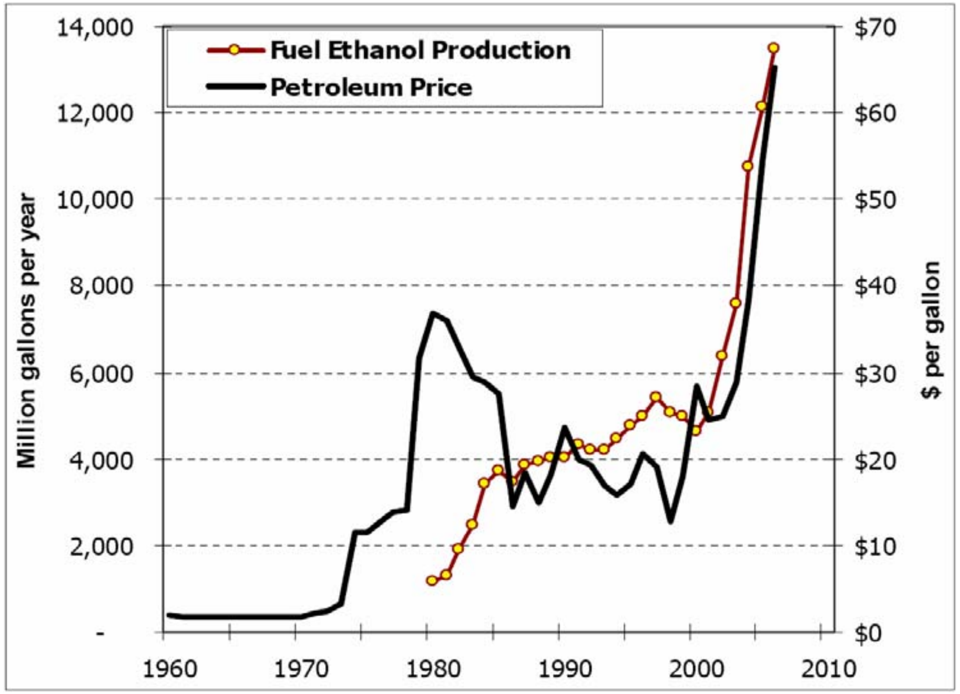
Zambia Gasoline Price (March 2006)

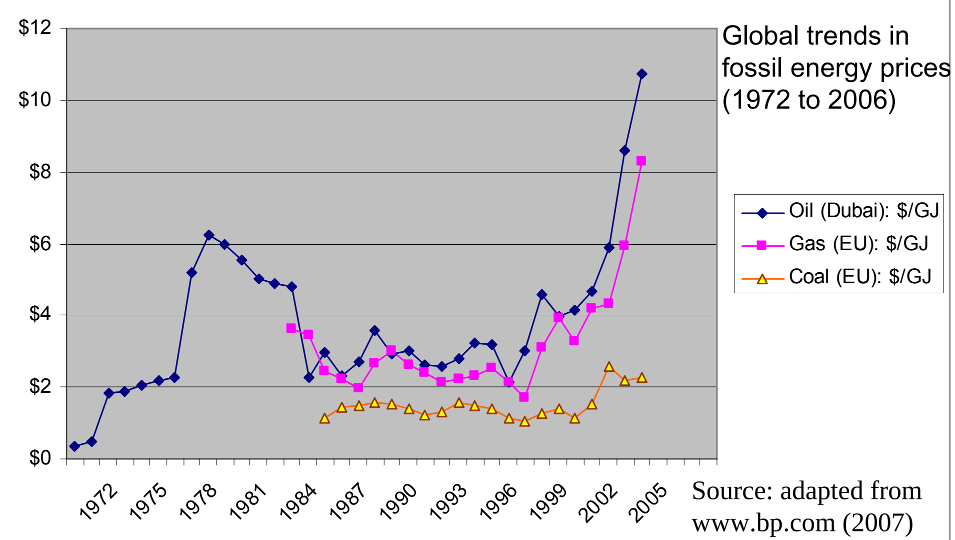
- Wholesale petrol = $18/GJ
- Pump purchase = $44/GJ

Zambia projected ethanol production costs

- $16 to $38/GJ (no taxes)
  - C-molasses to straight juice used
- Assumes no value for co-products e.g. electricity

Global petroleum prices ($/barrel) and ethanol production (Mgal/yr. 1960 to 2006; Kammen et al, 2007)

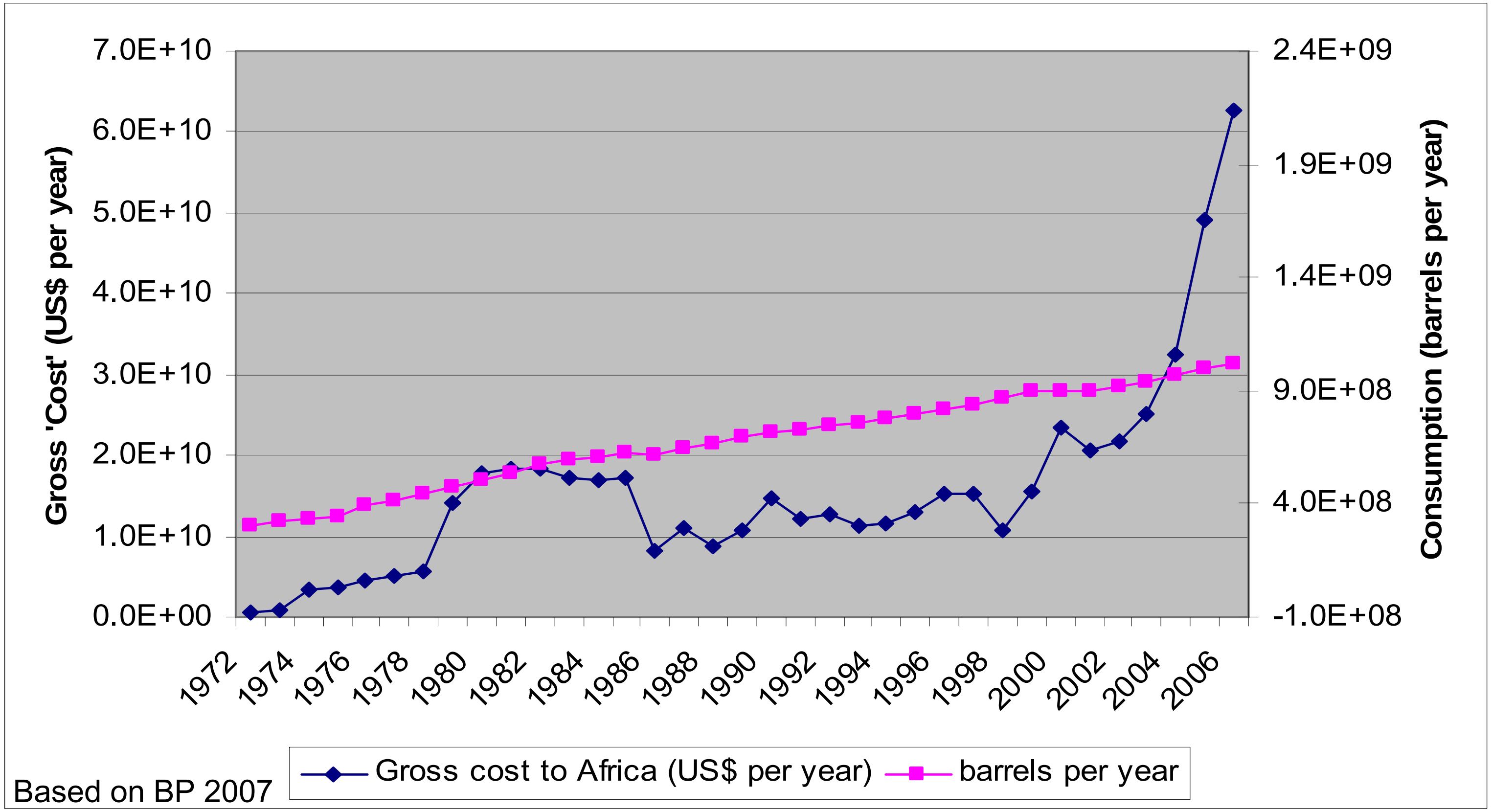




Global trends in fossil energy prices (1972 to 2006)

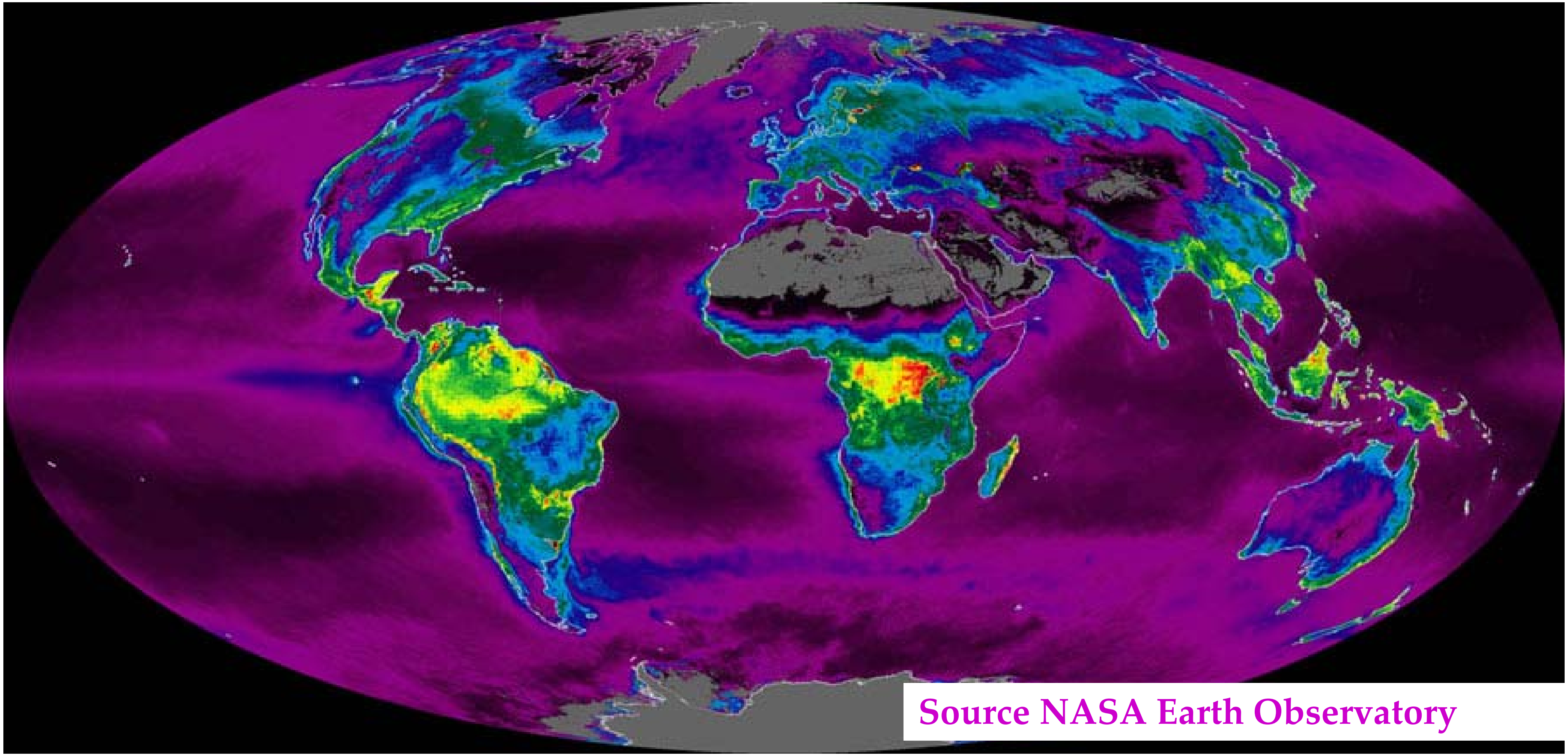
Source: adapted from www.bp.com (2007)

Costs of Oil provision to Africa



- Estimated ‘oil expenditure’ for Africa = US$62 billion in 2006
  - In Tanzania and Senegal c. 40% of foreign exchange earnings are spent on purchasing oil products
- Estimated expenditure has tripled since 2002
- Consumption has increased by 10%

The Earth's carbon "metabolism"- productivity vs location



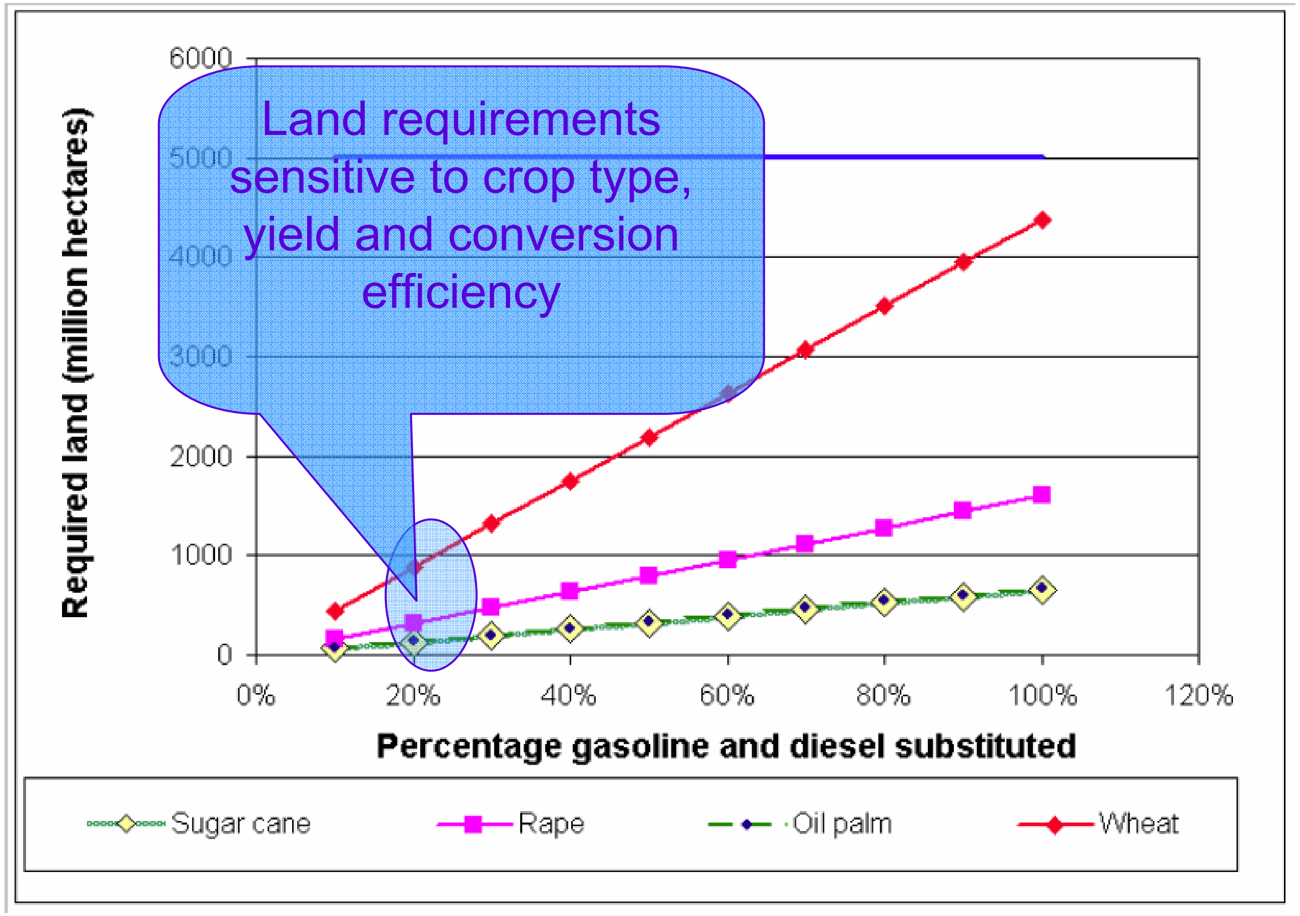
- Rate at which plants absorbed C out of the atmosphere during 2002
- Global annual average of net productivity of vegetation on land and in ocean.
- Yellow and red areas show the highest rates, (2 to 3 kg C taken in per $m^{2/}$yr (~44t_{DM}/ha.yr)
- Green, blue, and purple shades show progressively lower productivity.

Land requirements for biofuels (2020)

- To meet Total 2020 Transport Energy demand (105EJ; SMMT 2006) would require c. **600 Mha** using conventional technology (8kl/ha)
- Using advanced crops and technologies would require c. **250 Mha** (16kl/ha)
- 30% of Transport energy (2020) would require between **80 and 200 Mha**

Figure 10 source: Bergsma et al 2007 (Delft Rpt to Unilever)

Figure 10 Land requirements for substitution of gasoline and diesel by biofuels at current crop yields and technology, in 2020



Potential Land?

UNEP, 2002:

- 440 Mha land 'potentially available for bioenergy
- 2Bha currently 'abandoned or degraded'
  - Nearly 500Mha in Africa alone

EEA, 2006:

- Bioenergy potential in 2030 represents around 15–16 % of the projected primary energy requirements of EU-25 in 2030, and
- 17 % of current energy consumption, cf a 4 % share of bioenergy in 2003.

Source: taken from Doornbosch and Steenblik (2007) – background paper for OECD Roundtable on Sustainable Development

Table 1. Potentially available land for energy biomass production in 2050 (in Gha)

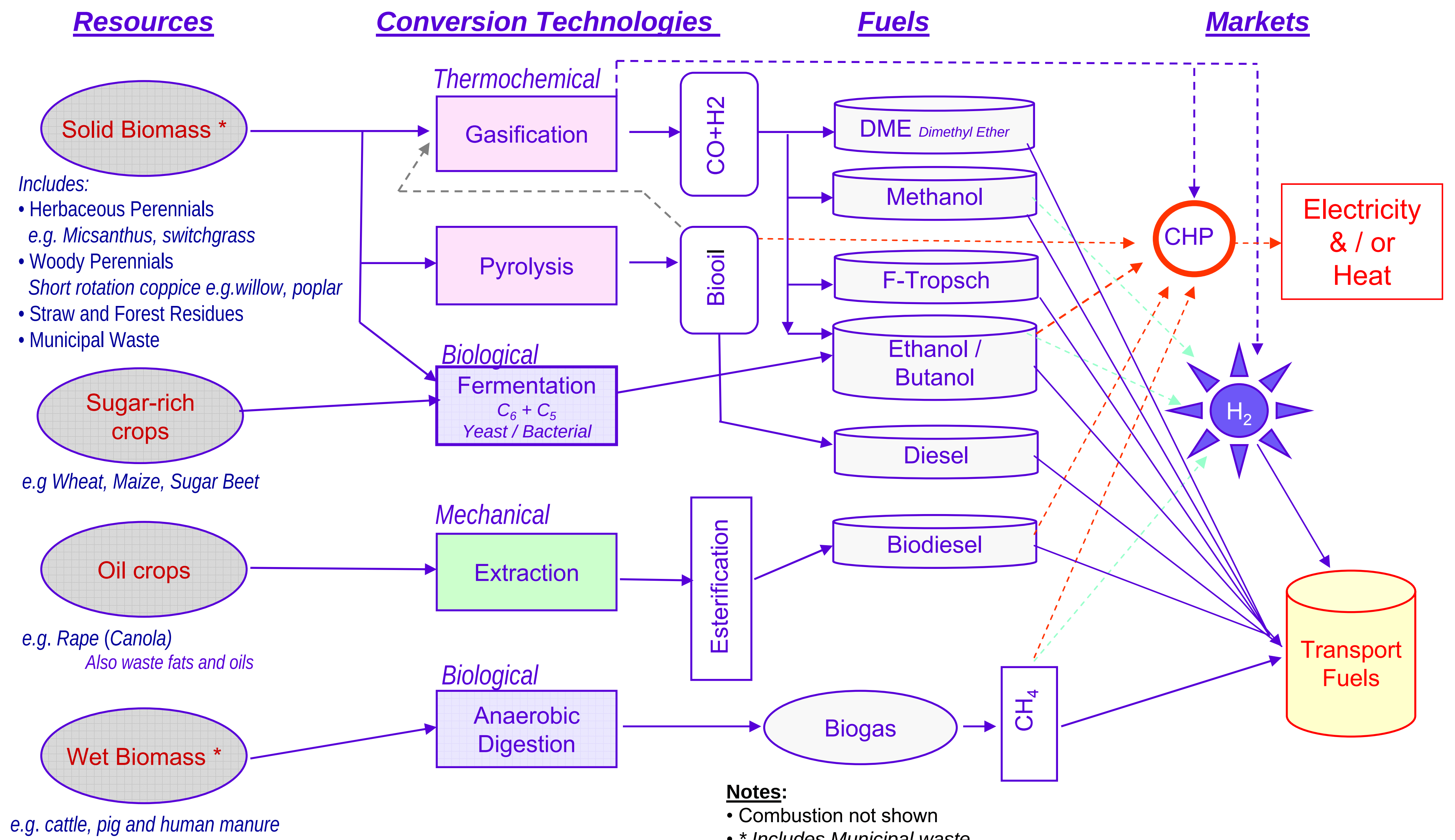
	Total land surface	Land with potential for Rain-fed cultivation	Potential land under forest	Land already in use for agriculture (arable land)	Additional land needed for food, housing and infrastructure until 2030/50[a]	**Gross Additional land available**	**Additional land potentially available**
	(-)	(1)	(2)	(3)	(4)	**(5) =(1)-(2)-(3)-(4)**	**(5) * (1 - % needed for grassland)**
North America	2.1	0.4	0.1	0.2	0.0	0.00	0.00 (0%)
South & Central America	2.0	0.9	0.3	0.1	0.1	0.25	0.25 (0%)
Europe and Russia	2.3	0.5	0.1	0.2	0.0	0.08	0.04 (50%)
Africa	3.0	0.9	0.1	0.2	0.1	0.44	0.18 (60%)
Asia	3.1	0.5	0.0	0.6	0.1	-0.07[b]	-0.07 (n/a)
Oceania	0.9	0.1	0.0	0.1	0.0	0.04	0.04 (0%)
World Total	**13.4**	**3.3**	**0.8[c]**	**1.5[c]**	**0.3**	**0.74**	0.44

a. Most studies assume that only a small fraction of additional land is needed to feed the world's growing population — from 6.5 billion people at present to 9 billion people in 2050 — and that most of the increase in food requirements will be met by an increase in agricultural productivity.[6] Here it is assumed that 0.2 Gha is needed for additional food production (based on Fisher and Schrattenholzer, 2001 where a yearly increase in agricultural productivity of 1.1% is assumed); the remainder (roughly 0.1 Gha) is needed for additional housing and infrastructure.

b. A negative number is shown here as more land is cultivated than potentially available for rain-fed cultivation because of irrigation. The negative land available has not been rounded to zero because food imports are likely to be needed from other region with implications on their land use.

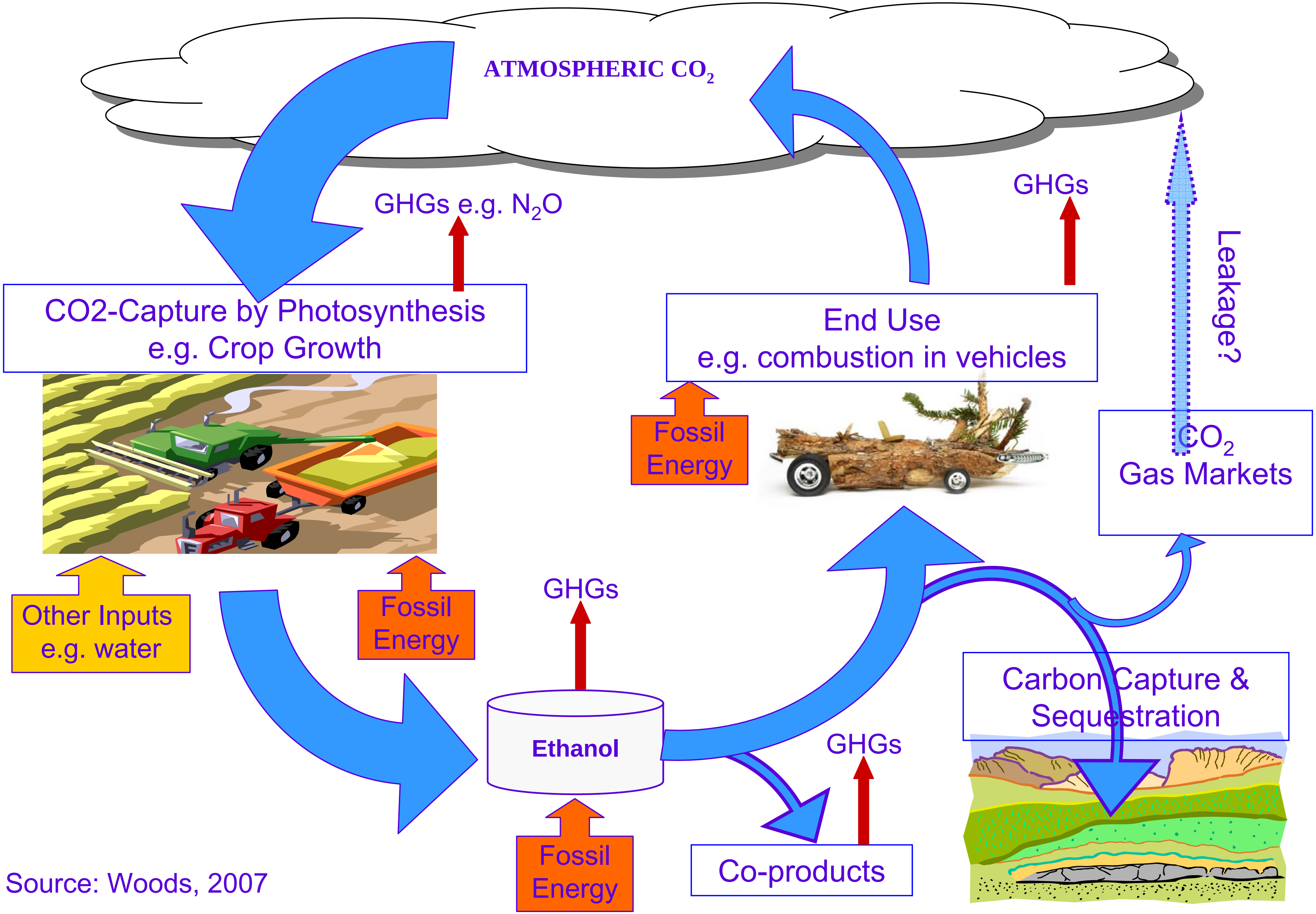
c. Numbers in this column don't add up because of rounding.

Overview of Bifouel Conversion Pathways *(biomass and co-products e.g. Wastes)*



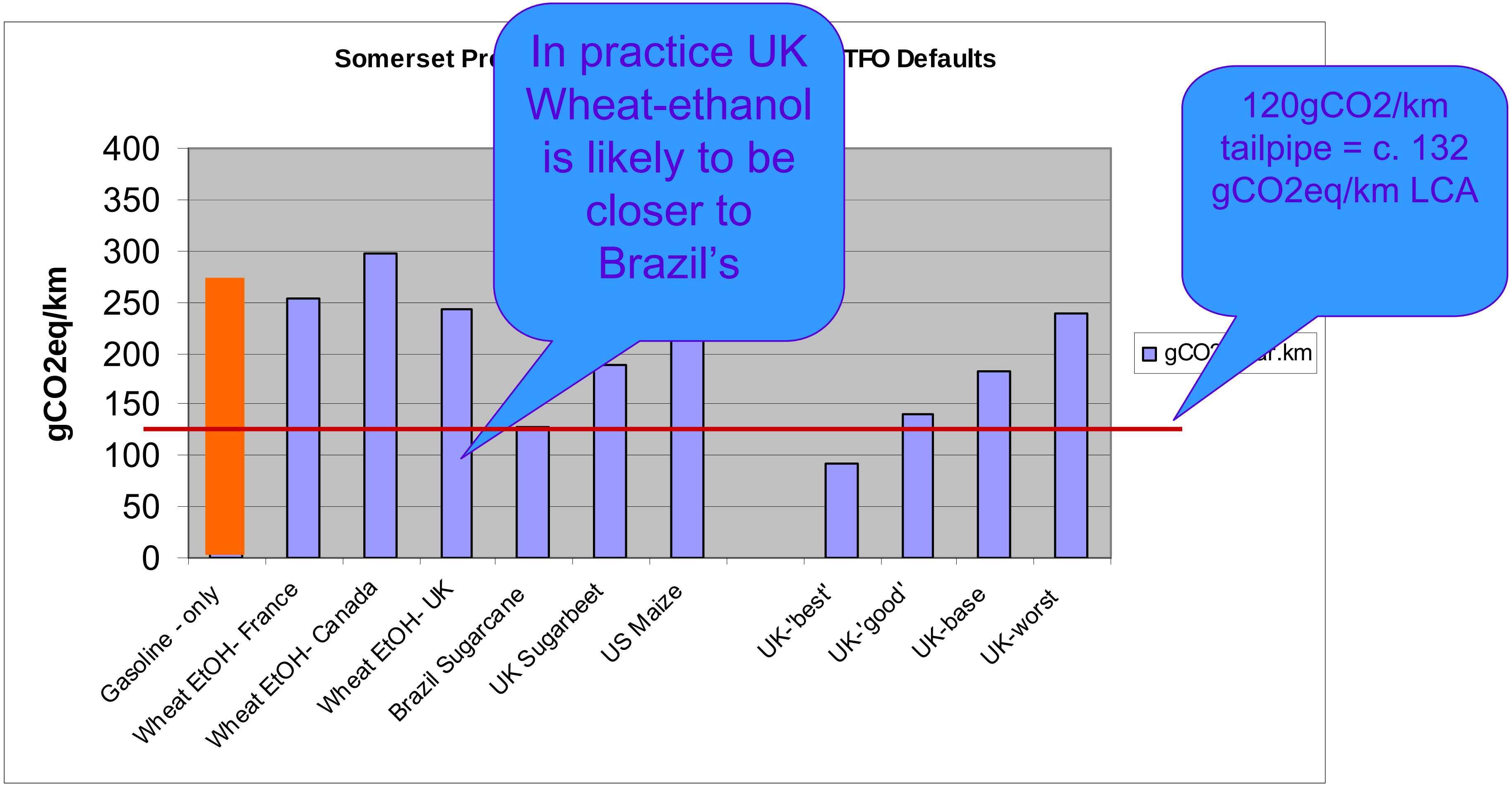
Notes:
- Combustion not shown
- ** Includes Municipal waste*
- Synthesis gas requires catalysts for upgrading
- *Indicates requirement of reformer*

Source: Revised from DG TREN (Maniatis, 2003; Woods, 2003)



Source: Woods, 2007

UK- RTFO implications for E85 use in Somerset



- Worst case GHG savings between 53% to -25%
- Using 'country level default factors' as defined by the UK-Renewable Transport Fuel's Obligation Reporting Requirements (RTFO, 2007)

Efficient use of resources – polygeneration e.g. sugarcane co-generation

Could keep 15 (20W) light bulbs running for 20 hours

Electricity production Factors depending on technology

Sugar Mill Technology	BAR	°C	Surplus Electricity ($kWhe/t_{cane}$)		Technology
Old	20	350	20	1.0	Back Pressure Turbine
Conventional	45	440	92	4.6	CEST
Conventional - advanced	82	525	143	7.2	CEST
Advanced - developmental			280	14.0	Gasif-CC

+ 11 to 75 litres ethanol per tonne cane processed
+ / or 0 to 15 kg sugar per tonne cane processed

It is dangerous to generalise

Assurance reporting

Research & Demonstration

Scale & Location

e.g. Regional and local levels

Data & indicators

Environmental

- Net emissions to air, water and land
- Climate change mitigation & adaptation
  - Inc GHGs
- Above and below-ground carbon balances
- Biodiversity
- Good agricultural practice & soil management
- Waste
- Direct & Indirect Land Use

Social

- LCA Social impacts
- health & safety
  - environmental quality
  - Labour conditions
- Welfare / happiness
- Equitable access to local resources
  - e.g. land tenure
- Barriers

Economic

- Competitiveness
  - Market breakthrough
- Incentives
- Barriers & Regulations
- Taxes
- IP rights and ownership
- Value chains and value retention

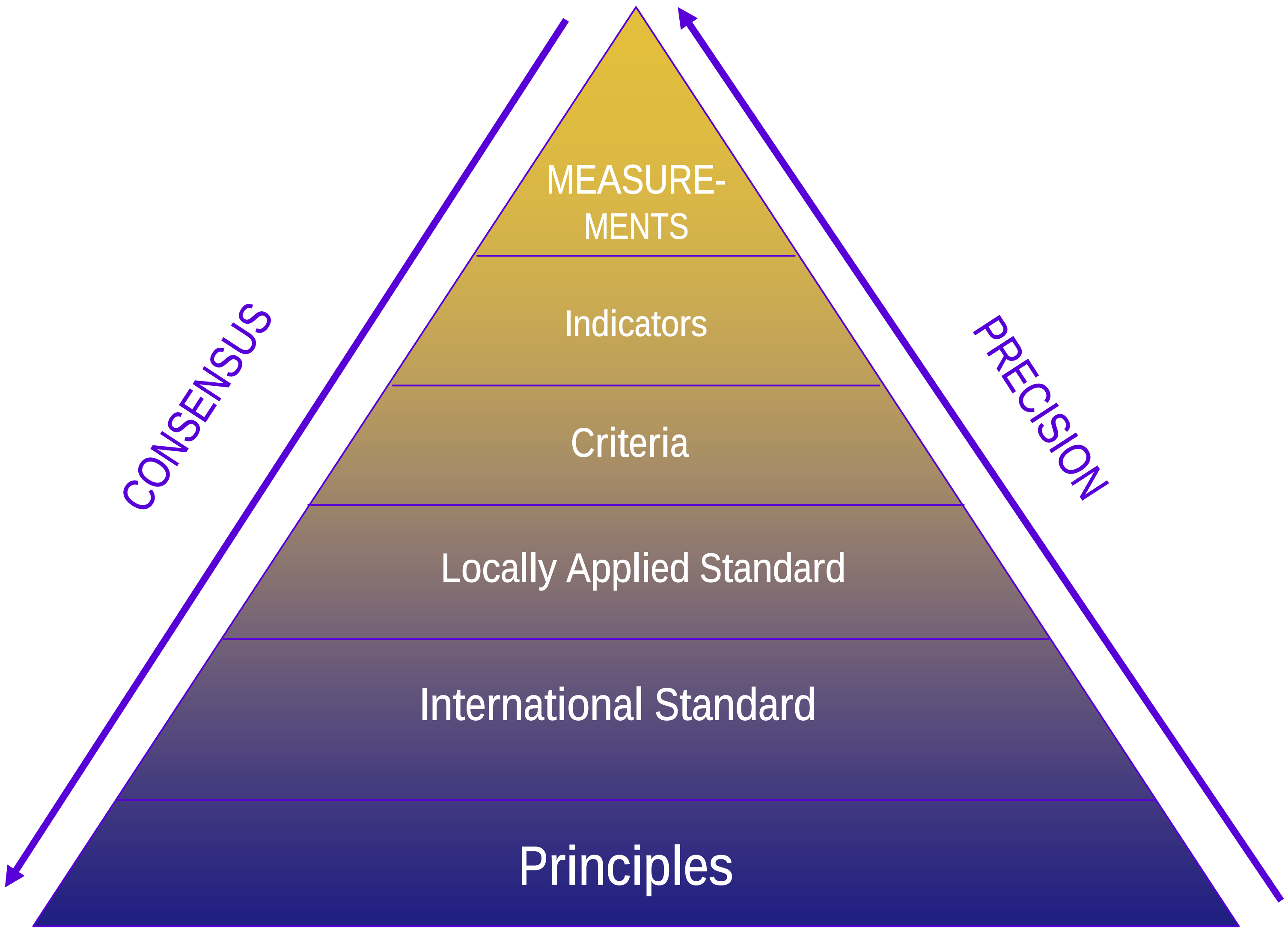
Policy & Institutions

- New policies & plans
- Directives
- Incentives
- Barriers
- Institutional capacity
- Technology neutral options

Regional Strategic Drivers e.g. EU's Lisbon Criteria

Diaz-Chavez, 2007

Assurance Pyramid: credibility and complexity



Adapted from: Jim Smith, BSI Professional Standards Services (his presentation to LCVP on 18Feb05)

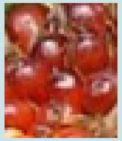
Dealing with Uncertainty and Complexity

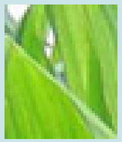
- Land-use change:
  - Changes in Biomass Stock (deforestation)
  - Changes in soil carbon (e.g. grassland)
  - Changes in water requirements / hydrology
  - Indirect LUC
  - ‘reference system,’ e.g. what replaces what?
- N_2O emissions from agriculture
- CH_4 emissions from agriculture
- Transport logistics

- Farm vs Field accounting…

What are the components of a credible [sustainability] scheme?

- **Standards** or set of criteria which defines ‘sustainable’
- Independent **certification** or verification to confirm standard is implemented
- **Accreditation** to control certification bodies
- Product **traceability** / supply chain control



See Nusbaum, Pro-forests, 2007: www.ProForest.net

Standards → Principles → Criteria → Indicators

- Principles

  'general tenets of sustainable production'

- Criteria

  'Conditions to be met to achieve these tenets'

- Indicators

  How a farm, producer or company could prove that a particular criterion is met

Need to distinguish between '**direct**' and '**in-direct**' impacts

Principles and Criteria for Biofuel Crops

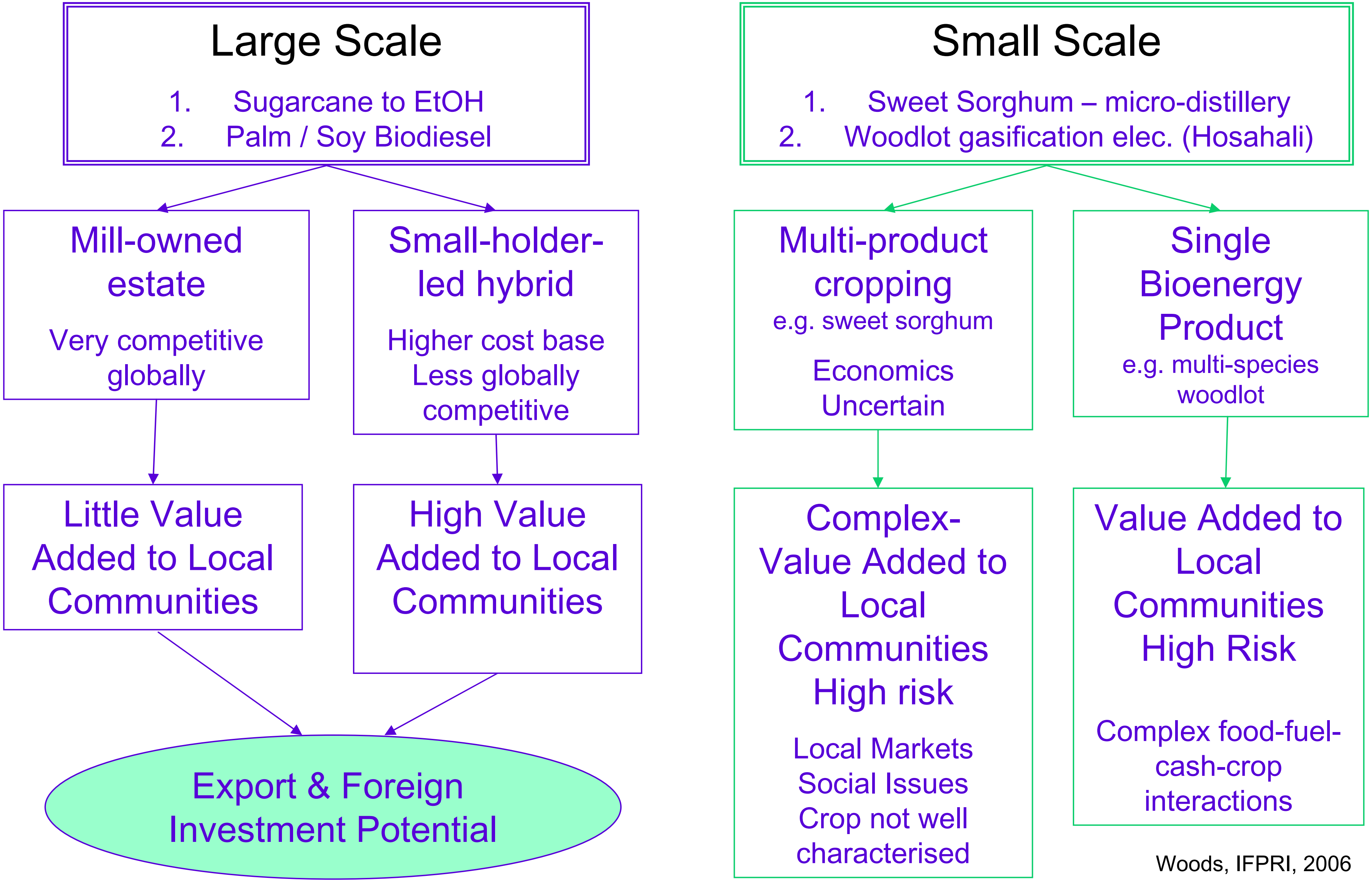
Environmental standards for **biofuel crops** production comprise the following "Principles", "*Criteria*.":

- Conservation of carbon stocks
  - *Protection of above-ground carbon*
  - *Protection of soil carbon*
- Conservation of biodiversity
  - *Conservation of important ecosystems & species*
  - *Basic good biodiversity practices*
- Sustainable use of water resources
  - *Efficient water use in water critical areas*
  - *Avoidance of diffuse water pollution*
- Maintenance of soil fertility
  - *Protection of soil structure and avoidance of erosion*
  - *Maintain nutrient status*
  - *Good fertiliser practice*
- Good agricultural practice
  - *Use of inputs complies with relevant legislation*
  - *Use of inputs justified by documented problem*
  - *Safe handling of materials*
- Waste management
  - *Waste management complies with relevant legislation*
  - *Safe storage and segregation of wastes*

Conclusions

- Bioenergy and biofuels will play a minor (possibly pivotal) role in the way the world tries to feed 9-10 billion people by 2100
- Food vs fuel needs to be seen as food AND fuel.
- Without integration and efficiency gains serious conflicts for resources are likely
- New land-management-based GHG accounting tools needed:
  - Ditto biodiversity
  - Ditto social / rural development
- New thinking that takes a balanced view of 'sustainability' (economic, social and environmental) urgently needed

Bioenergy Development Options - scale matters



Woods, IFPRI, 2006

Emerging sustainability conclusions - COMPETE

- Economic:
  - Supply of affordable energy
  - Local value retention
  - Impact of ‘Carbon finances’?
- Scale:
  - Local Value Retention (export of indigenous production)
    - How to harness foreign direct investment in a beneficial way?
    - How to value local markets and production systems – inherently small scale?
    - How to manage a transition from traditional to modern bioenergy without harming access to traditional energy resources by the poor?
- Spatial:
  - Where to locate what?
  - Impacts of climate change
- Communication:
  - How to develop strong and effective links between national and local authorities and local populations who will host the bioenergy production
- Sustainability ‘criteria’:
  - What criteria can help to achieve sustainable bioenergy pathways?

Conclusions

- Globally, 30% of transport energy (2020) would require **80 to 200 Mha**
  - C.f. 1.97 Bha of degraded land (Lal, 2006; 2002, UNEP)
  - C. 500 Mha in Africa alone?
- How that land is chosen and how the biomass is produced will define the sustainability (social, environmental and economic)
  - Need ensure that an equitable share of value is retained 'locally'
- This requires systems which are able to monitor and encourage sustainable development from the local to the global levels
- Land use
  - Pervasive vs hotspot biodiversity
  - Soil-C hotspots
  - In-direct land use – how to account for this?

THANK YOU!

Further work on biofuels in the BioEnergy Group- Imperial:

Cereals 2007 (HGCA) – including farm audits
RTFO-related (multiple strands)
TSEC-Biosys

COMPETE
NILE
QUEST
BEST

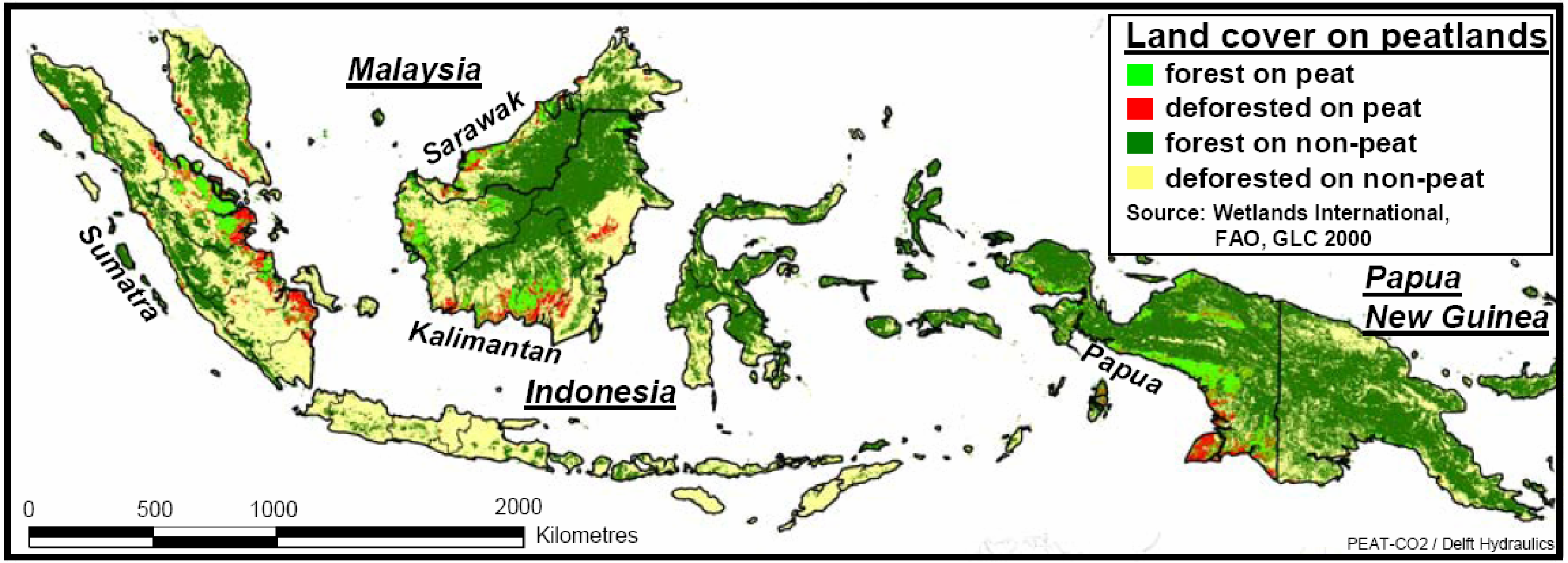


Figure 5 Forest status on peatland and non-peatland, in the year 2000.