How much biofuel can we produce in the world?

15th August 2011

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[Round Table 1- BBEST Conference Campos do Jordão]

Increasing bioenergy will require increased supplies of biomass

Four fundamental ways to increase biomass supplies:

1. Expanding cropped area
   - nationally / globally
2. Increase yields
3. Reduce losses
4. Increase efficiency of production, conversion and use
   - Integration benefits

Understanding potentials

Jayant Sathaye (Lawrence Berkley and IPCC) outlines the following progression from theoretical to practical / realisable potentials:

1. Biological/theoretical potential
2. Technological potential
3. Economic potential
4. Ecological potential
5. Realistic potential/implementation
    1. Doing stuff e.g. mobilising capital, takes time!

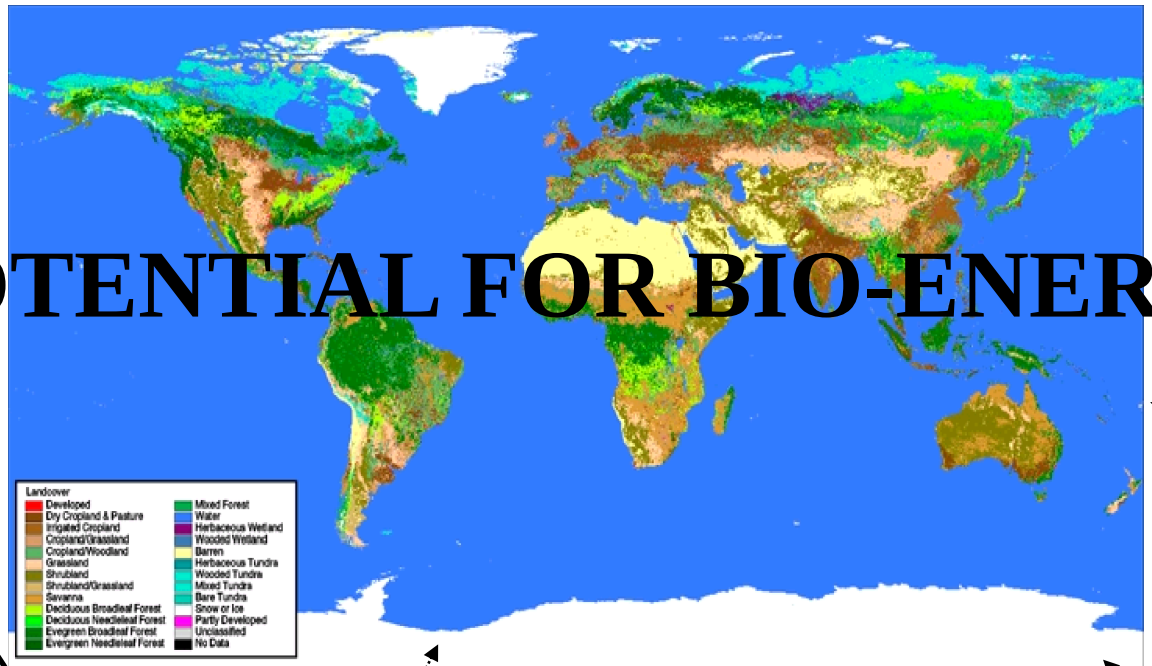
population

energy consumption

trade

future land use patterns

biotechnology



POTENTIAL FOR BIO-ENERGY?

GDP

agricultural system irrigation, breeding, mechanization, chemicals

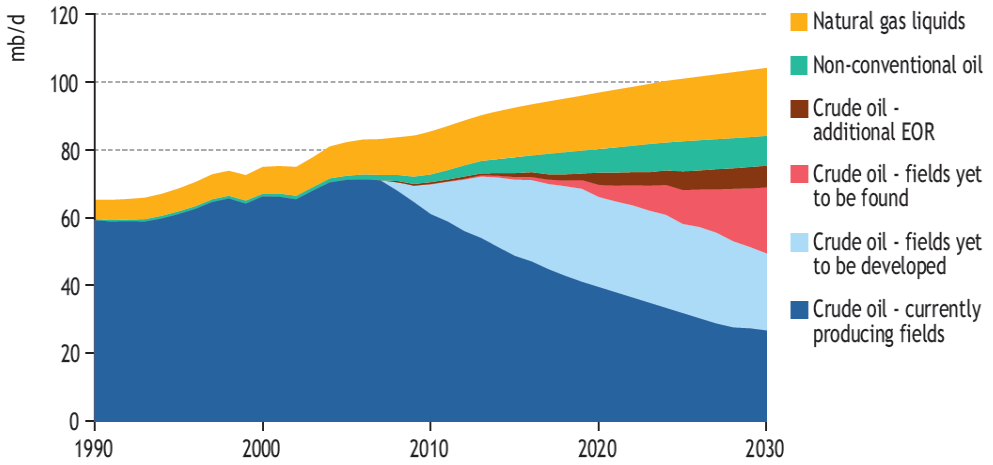
Competition from food and fibre sectors

land productivity

agricultural policy

Adapted from Smeets, Faaij, and Lewandowski (2004)

Future World oil production and price?

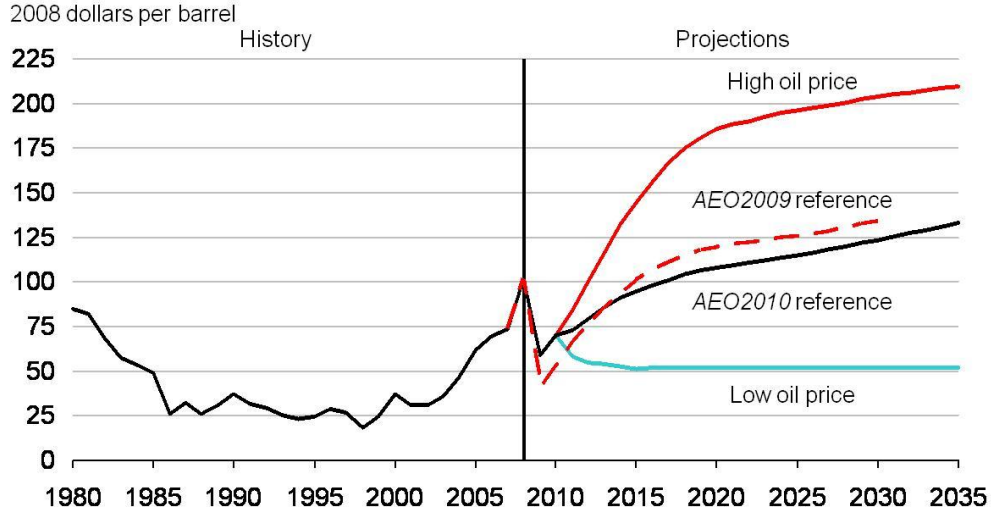


World oil production by source in WEO Reference Scenario:

64 mb/d of gross capacity needs to be installed between 2007 & 2030 – six times the current capacity of Saudi Arabia – to meet demand growth & offset decline

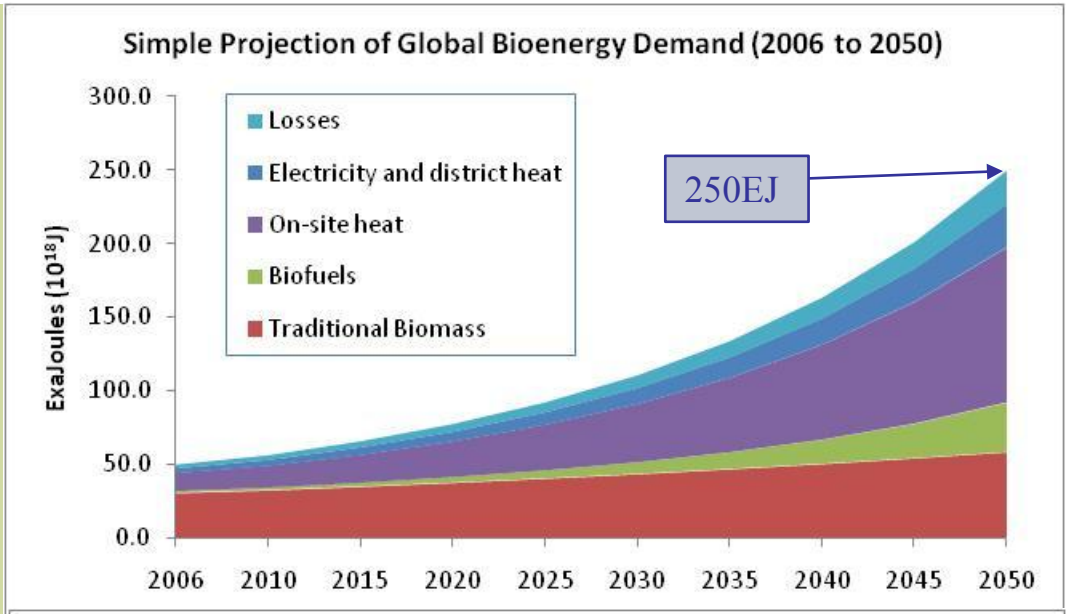
Oil prices in the US EIA reference case rise steadily; the full *AEO2010* will include a wide range of prices

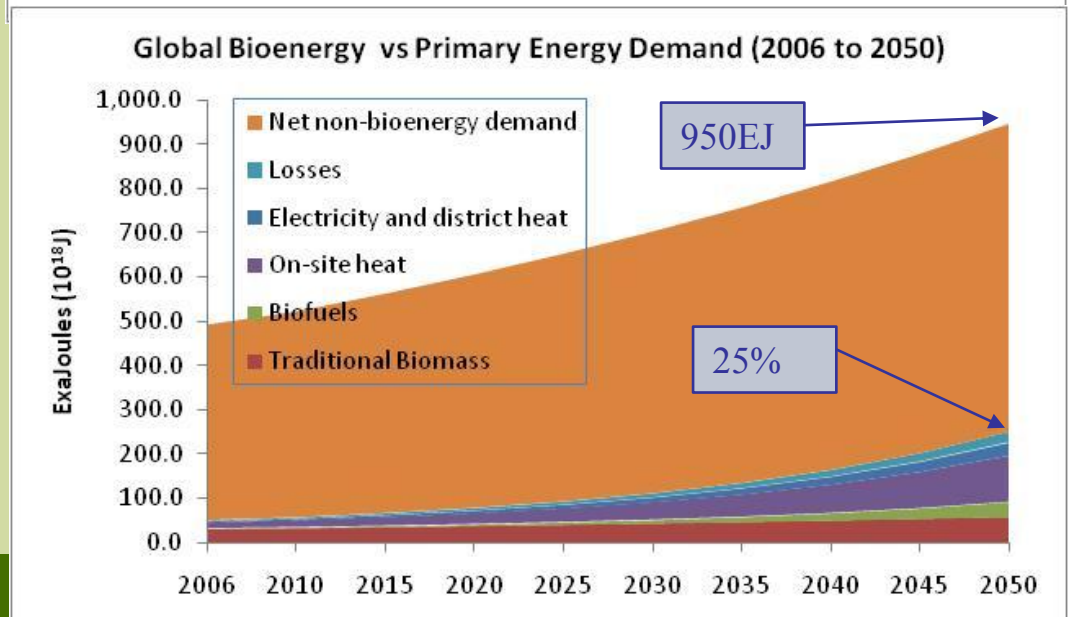
Source: *Annual [US] Energy Outlook 2010*



Really simple projections

- Global primary energy grows at 1.5% CAGR (WEO, 2009)
- 5% CAGR for:
  - Electricity + district heat
  - On-site heat
  - Biofuels
- c. 1.2% CAGR for Traditional Biomass
  - Depends primarily on balance between rural and urban population projections in developing countries



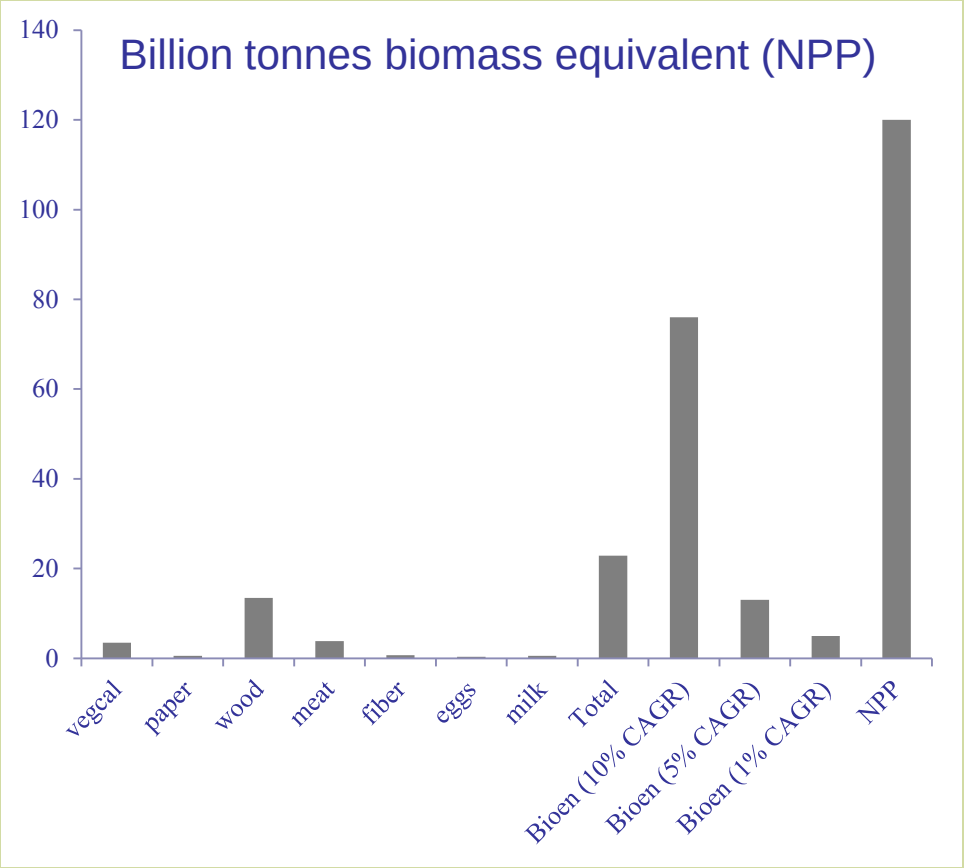


Going to need more carbon and energy from photosynthesis

- At 5% CAGR bioenergy provides 250EJ of primary energy:
  - 13 billion tonnes of dry biomass
  - Equivalent to 10% of current NPP (assumed to be 120 Bt biomass)
- At 10% CAGR provides 1 370 EJ
  - 76 billion tonnes dry biomass
  - 63% of NPP
- At 1% CAGR provides 90 EJ
  - 5 billion tonnes dry biomass
  - 4% of NPP

Going to need more carbon and energy from photosynthesis

- To supply future food needs (including animal feed)
- To supply future energy needs: heat, electricity and mobility
- To ensure the provisioning of biodiversity (for heterotrophic respiration as per Janzen, this meeting)

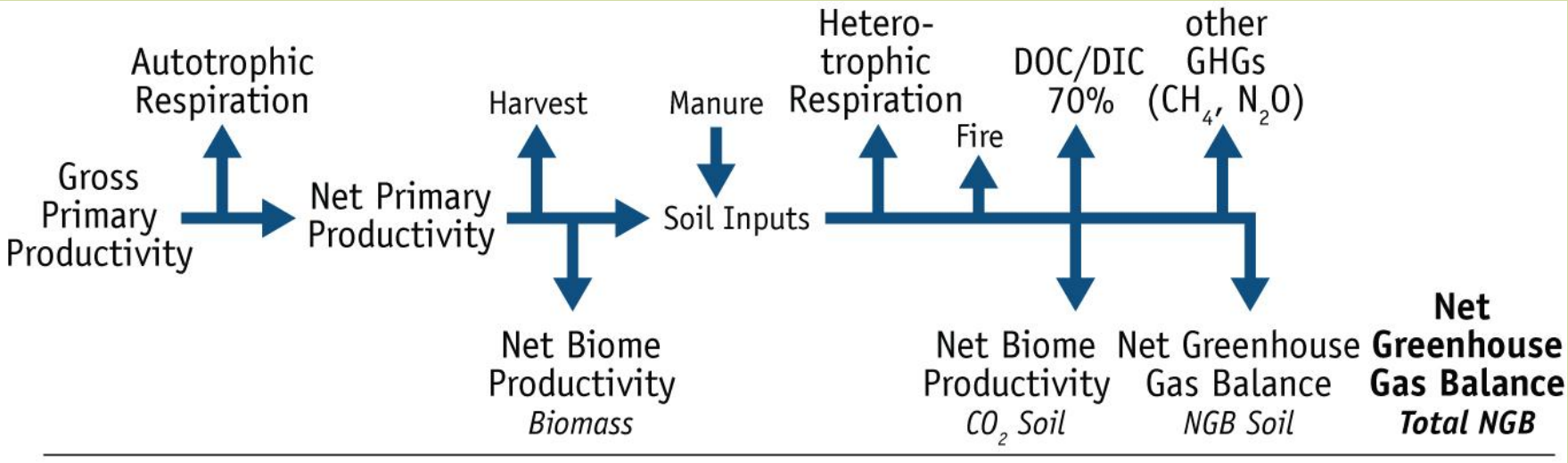


HANPP from; Imhoff, Marc L., Lahouari Bounoua, Taylor Ricketts, Colby Loucks, Robert Harriss, and William T. Lawrence. 2004. **Human Appropriation of Net Primary Productivity (HANPP) by Country and Product.** Data distributed by the Socioeconomic Data and Applications Center (SEDAC): http://sedac.ciesin.columbia.edu/es/hanpp.html. [Accessed 14th August 2011]

Reconciling future global supply and demand?

- Using simple projections (1, 5 or 10% CAGR), total bioenergy demand might range between 90 and 1000 EJ by 2050
  - High estimate v unlikely but not impossible AND would imply substantial increase in global gross and net primary production!
  - Lower estimate might be possible mostly through more efficient use of biomass
- = 10 and 75 billion tonnes dry biomass
- 20 to 140% of current global NPP!
  - Traditional biomass currently 1-2% of NPP
  - Need to account multiple lives of biomass; recycling (closed loop) and multiple fates

Will not all be a direct draw-down of NPP



Schulze et al., 2009

Humans, animals and crops are 'leaky' and so much biological carbon (and nutrients) can be recycled and reused

Where will the biomass come from?

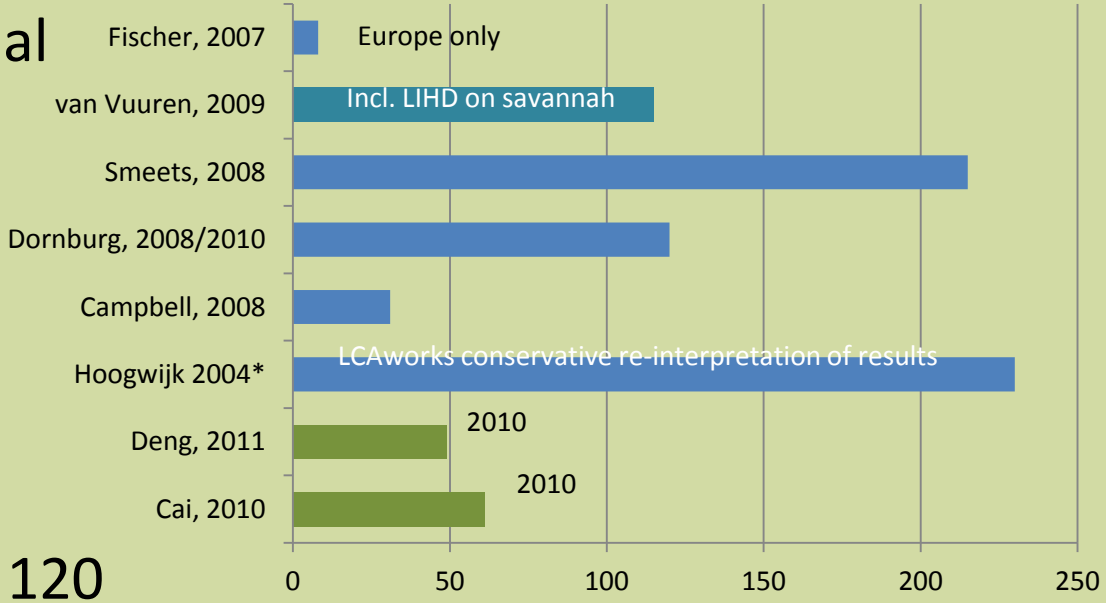
Meta-assessment of 30 studies (Akhurst et al, 2011) including:

- Abandoned Land Potential
- Surplus Forest Products
- Wastes and Residues
- Abandoned / surplus land

Where will the biomass come from?

Abandoned Land Potential (EJ)

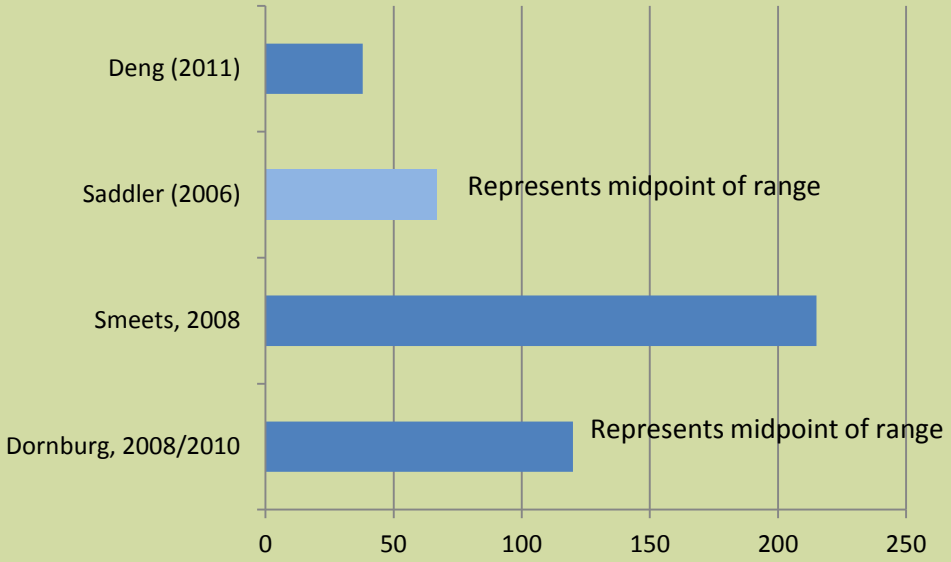
- Cai, 2010 61
- Deng, 2011 49
- Hoogwijk 2004* 230
- Campbell, 2008 31
- Dornburg, 2008/2010 120
- Smeets, 2008 215
- van Vuuren, 2009 115
- Fischer, 2007 8



Where will the biomass come from?

Surplus Forest Products (EJ)

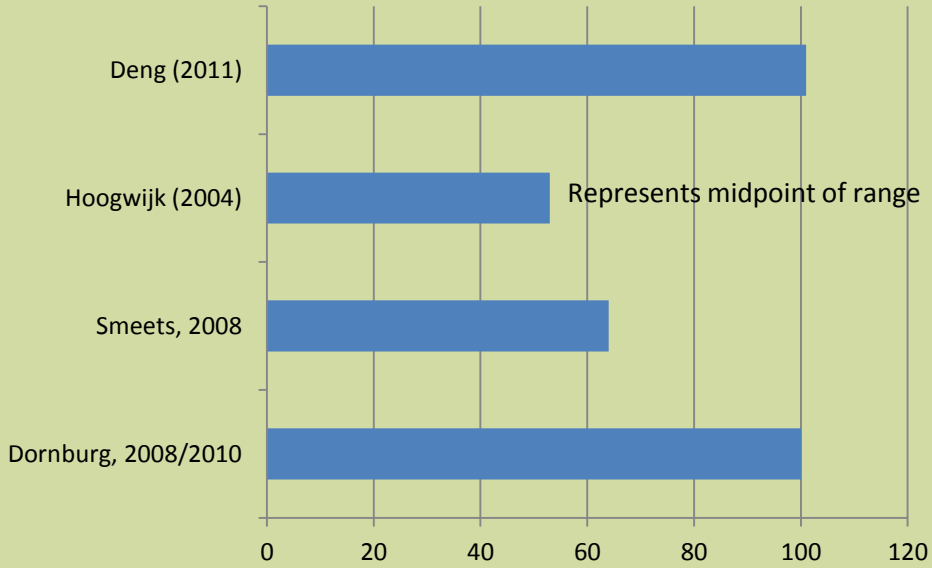
- Dornburg, 2008/2010 120
- Smeets, 2008 215
- Saddler (2006) 67
- Deng (2011) 38



Where will the biomass come from?

Wastes and Residues; 250 (EJ)

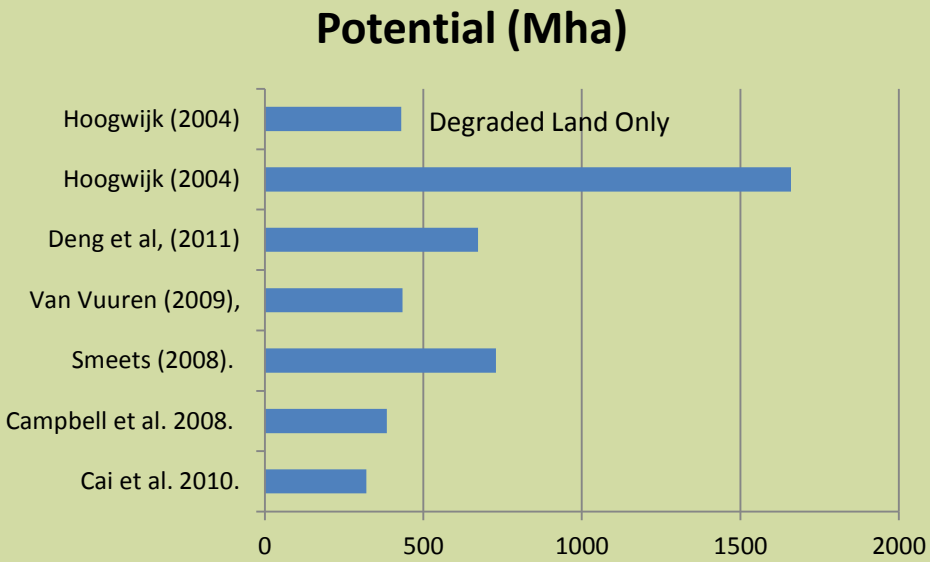
- Dornburg, 2008/2010 100
- Smeets, 2008 64
- Hoogwijk (2004) 53
- Deng (2011) 101



Where will the biomass come from?

Surplus / Abandoned land (Mha)

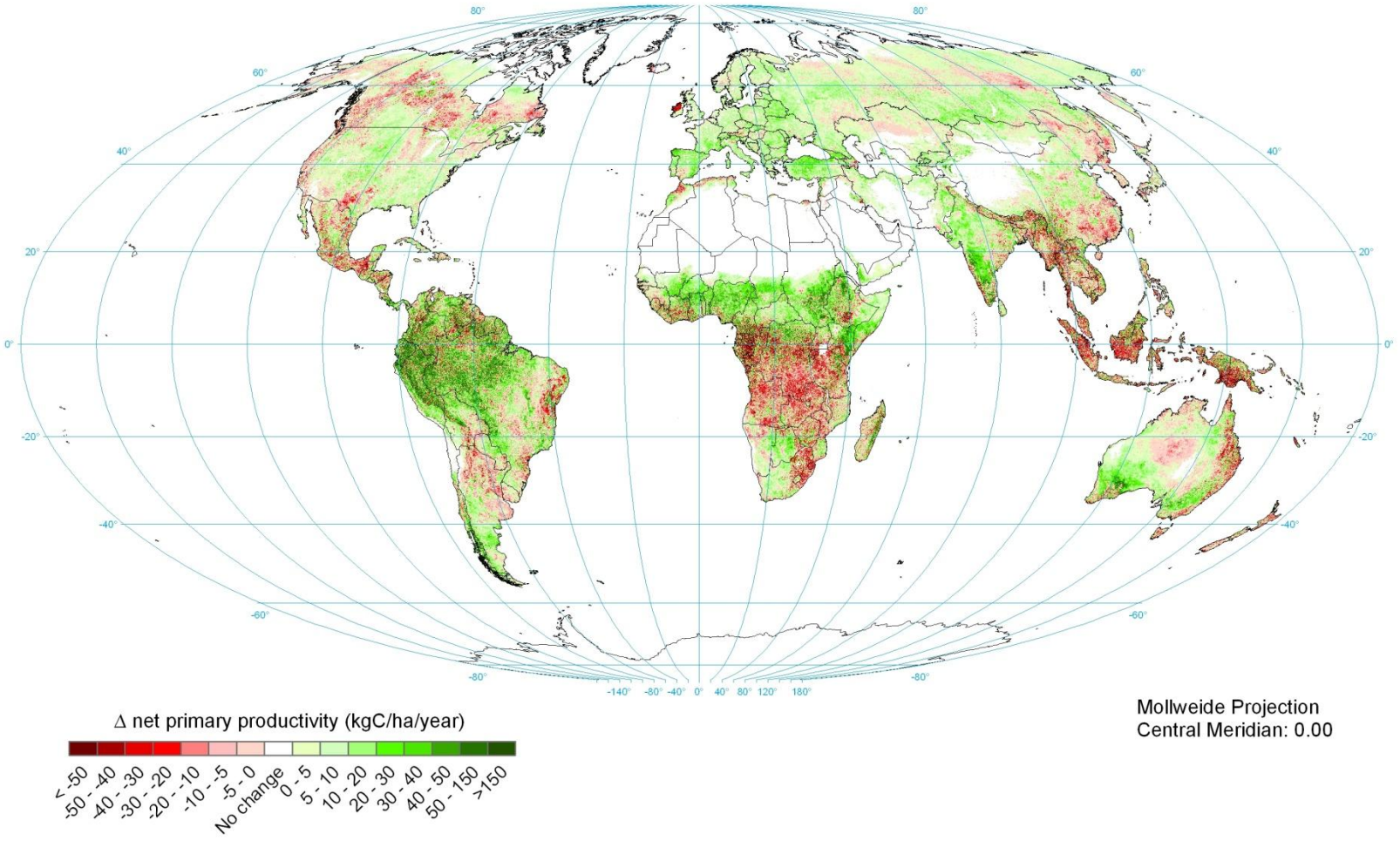
- Cai et al. 2010. 320
- Campbell et al. 2008. 385
- Smeets (2008). 729
- van Vuuren (2009), 435
- Deng et al, (2011) 673
- Hoogwijk (2004) 1660
- Hoogwijk (2004) 430



Enhancing Photosynthesis

Global change in net primary productivity between 1981 and 2003

FAO / ISRIC, 2008



Conclusions

- The global biomass resource base is currently under-utilised
- The scale of the biomass resource is significant in terms of current global energy consumption
- Fuller exploitation of this resource has major implications for energy, climate and food security
- It will also have significant impacts on the global bio-physical cycles e.g. water, nitrogen, phosphorous, potassium; and also on social factors
- Some positive outcomes can occur by default i.e. without substantive policy intervention e.g. energy security, others will require enhanced policies and regulation

So- what is the potential?

- Current trends in fossil fuel prices mean that a reliance on status-quo is not tenable and intervention coupled to support for innovation is required
- Lignocellulosic technologies will enable more of the biomass resource to be accessed- this brings with it many benefits but also a number of threats
- A very recent IPCC WGIII (2011) report estimates the global bioenergy potential to be in the range of <50 to >1,000 EJ
- Through this meta-analysis we derive a rough estimate of the technical potential for bioenergy up to 350 EJ, or roughly 2/3 of the current global primary energy demand.

Source: Akhurst, Woods and Kalas, 2011. Meta-analysis of Biomass Potentials for Biofuel Production. Science Business Insights.

Is there enough biomass?

Wood harvesting for cricket bats (Sharnbrook, October 2010)

Before

After

Thank you!

Old Jatropha Tree

Northern Zambia

22nd November 2010

(picture courtesy of Eric Laurenz)

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