REEPS/Andong University Joint Workshop

Modelling the land use, agriculture and local pollution

E3ME

Unnada Chewpreecha

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clarity from complexity

Overview

- NEXUS and land

- E3ME and FTT-Agriculture

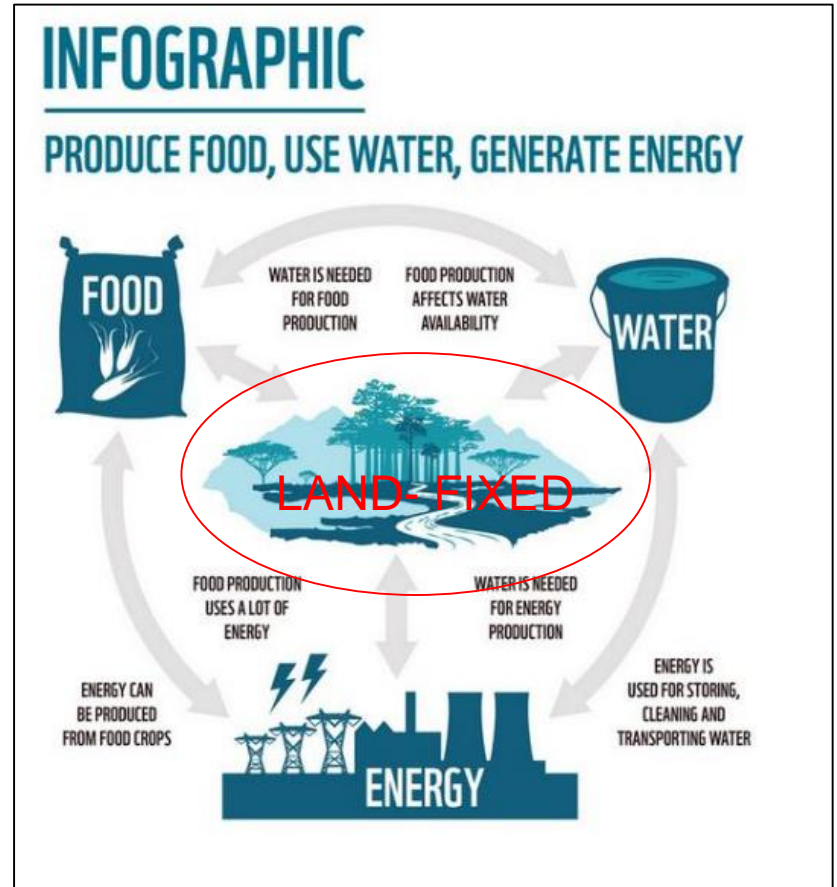- Example research questions

NEXUS Definition

nexus

/ˈnɛksəs/ ◄)

noun

1. a connection or series of connections linking two or more things.
   "the nexus between industry and political power"

2. a central or focal point.
   "the nexus of any government in this country is No. 10"

*interdependencies *trade-offs

Source(s): Water Footprint

E3ME and FTT−Agriculture

- Linkages to land-use (FTT-Agriculture) model is under development

- Ongoing NEXUS research project for Brazil https://www.camecon.com/news/brazil-food-water-energy-nexus/
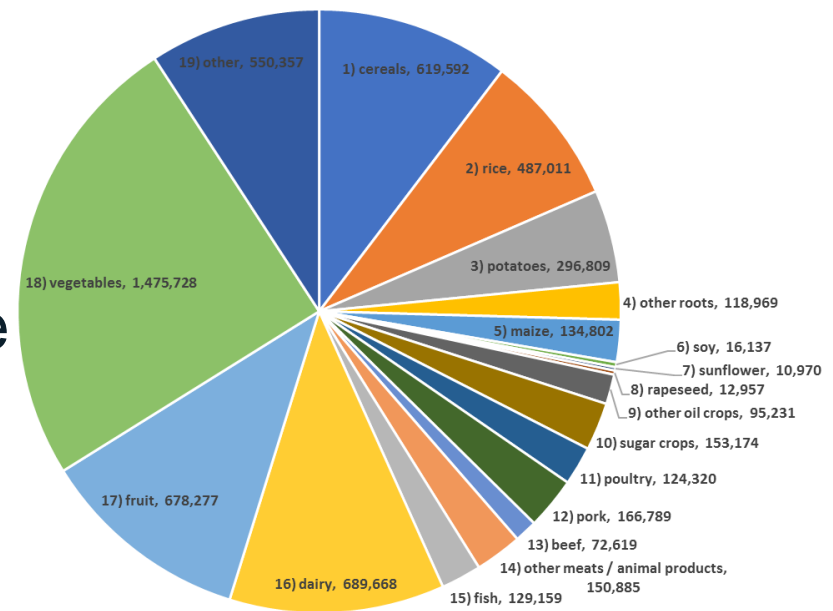
FTT–Agriculture in E3ME

Three stages

- Introducing new detailed food demand equations in E3ME

- Constructing FTT-Agriculture to allocate land used

- Linking FTT-Agriculture to E3ME and other FTTs

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Stage 1: Constructing detailed food demand equations in E3ME

- 19 different food types for each region including
  - food crops
  - bio crops
  - animal
  - fishing

- units are in physical tonne

Pie chart labels:
- 1) cereals, 619,592
- 2) rice, 487,011
- 3) potatoes, 296,809
- 4) other roots, 118,969
- 5) maize, 134,802
- 6) soy, 16,137
- 7) sunflower, 10,970
- 8) rapeseed, 12,957
- 9) other oil crops, 95,231
- 10) sugar crops, 153,174
- 11) poultry, 124,320
- 12) pork, 166,789
- 13) beef, 72,619
- 14) other meats / animal products, 150,885
- 15) fish, 129,159
- 16) dairy, 689,668
- 17) fruit, 678,277
- 18) vegetables, 1,475,728
- 19) other, 550,357

Global food consumption, 2013 (1000 tonnes), FAOSTAT2013

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Stage 1: Constructing detailed food demand equations in E3ME

- econometrics approach

- demand = function of income and price (with income converted to a log shaped curve so that demand doesn't increase indefinitely).

- corrections are put in for both spoilage and waste (i.e. non-demanded food), and also the primary-final conversion for animal feed.

- replace food and feed demand (aggregated) in existing material demand modelling (further feedbacks via IO)

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Stage 2: Constructing FTT−Agriculture

- FTT -the technology and decision diffusion model methodology Future Technology Transformations
  - a group of sectoral models of technological change to calculate global emissions, using diffusion theory
  - micro-model of technology choice and substitution, given economic/policy context
- E3ME 'top-down' approach is supplemented by a set of 'bottom-up' engineering sub-models (FTT)
  - the current model version includes a detailed treatment of the electricity supply industry, road transport and heating (FTT)
  - recent publication "*Modelling complex systems of heterogeneous agents to better design sustainability transitions policy*", Mercure et al *(2016)* http://dx.doi.org/10.1016/j.gloenvcha.2016.02.003

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FTT−E3ME

Summary: the FTT-E3ME model in a nutshell
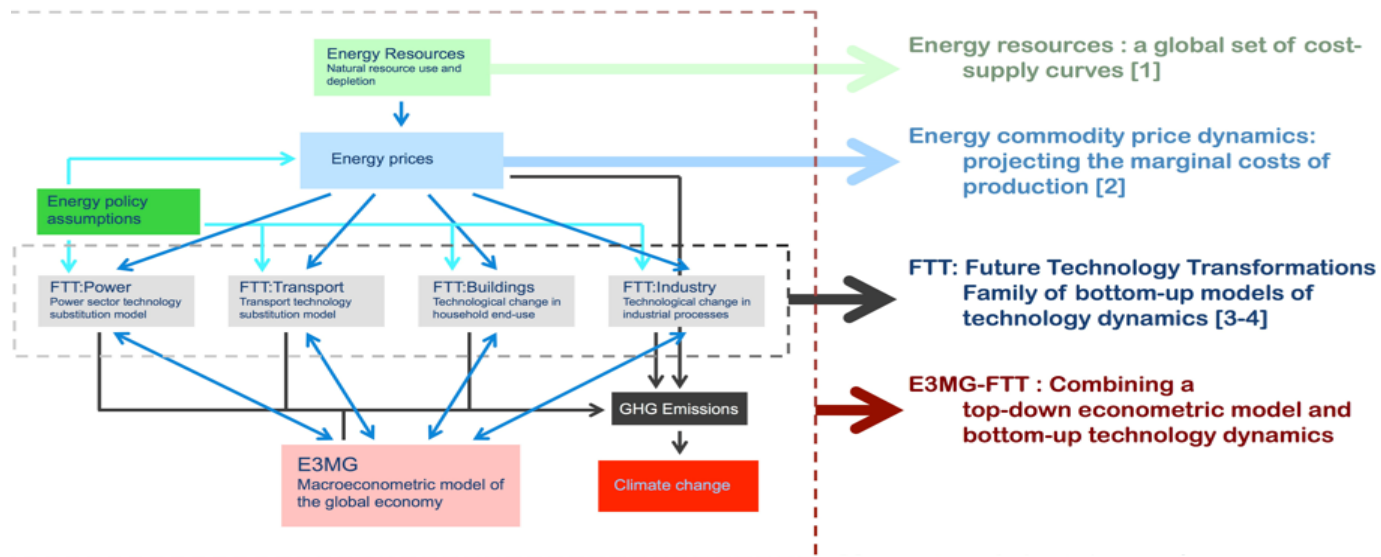
[1] Mercure & Salas, *Energy*, DOI 10.1016/j.energy.2012.08.018
[2] Mercure & Salas, *Energy Policy*, DOI 10.1016/j.enpol.2013.08.040
[3] Mercure, *Energy Policy*, DOI 10.1016/j.enpol.2012.06.025
[4] Mercure, *IST2013 papers*

Stage 2: Constructing FTT−Agriculture

- growing demand for food, bioenergy, housing all competing for land

- think of the food types as competing technologies competing on a fixed amount of land

- E3ME estimate demand for food (stage 1), FTT-Power and FTT-Transport estimate demand for bioenergy, simpler treatment of housing demand

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Stage 2: constructing FTT−Agriculture

- FTT-Agriculture allocated amount of fixed land to different used (supply) to meet demand for food and bio crops (demand) based on land productivity

- farmers are more likely to switch to what they know about, but there will be 'levelised' costs based on soil productivity and the prices for each crop.

- 'levelized costs' can be influenced by exogenous policies

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Stage 3: Feedback to E3ME

- The prices are returned to the main model and back into the equations.
  - food price paid by end users – consumer and industry demand (domestic, imports and exports)
  - biofuel price – power generation, transport energy demand

E3ME and FTT−Agriculture Overview
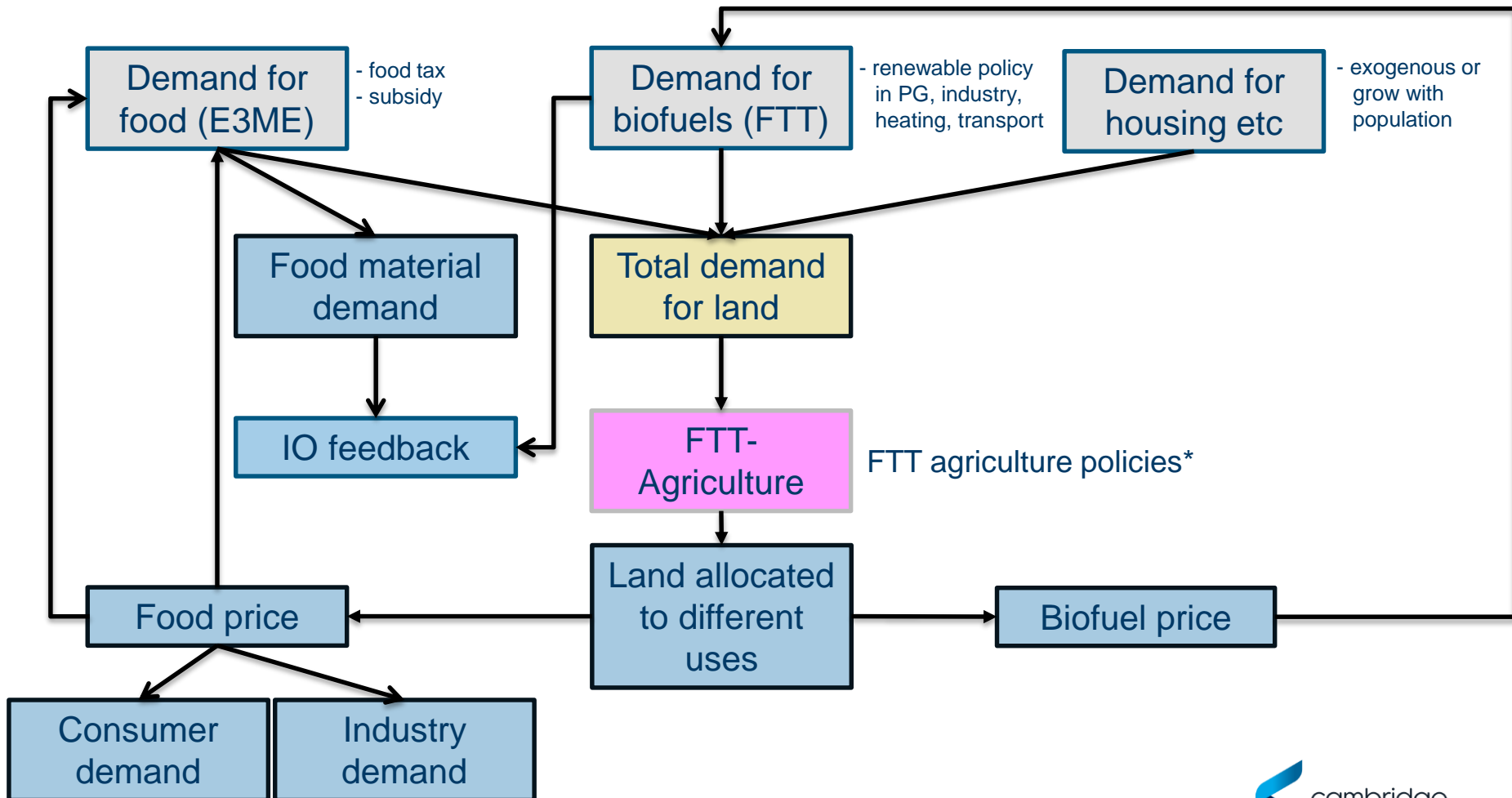
Example research questions

- trade-offs between bioenergy and food production

- social impacts of higher food prices

- potential impacts of meat/vegetarian dietary trends

- restrictions on available land and rates of deforestation

- impacts on pollutions from different land uses

Timetable

- Brazil – end of 2017
- Rest of world early 2018

Thank you!

- Contact(s)
  - Unnada Chewpreecha, Principal Economic Modeller uc@camecon.com
  - Hector Pollitt, Director hp@camecon.com
  - Jean-Francois Mercure, Professor, Radboud University Nijmegen J.Mercure@science.ru.nl