FOODSHEDS, FOOTPRINTS AND FOODMILES

…a few tools to work with

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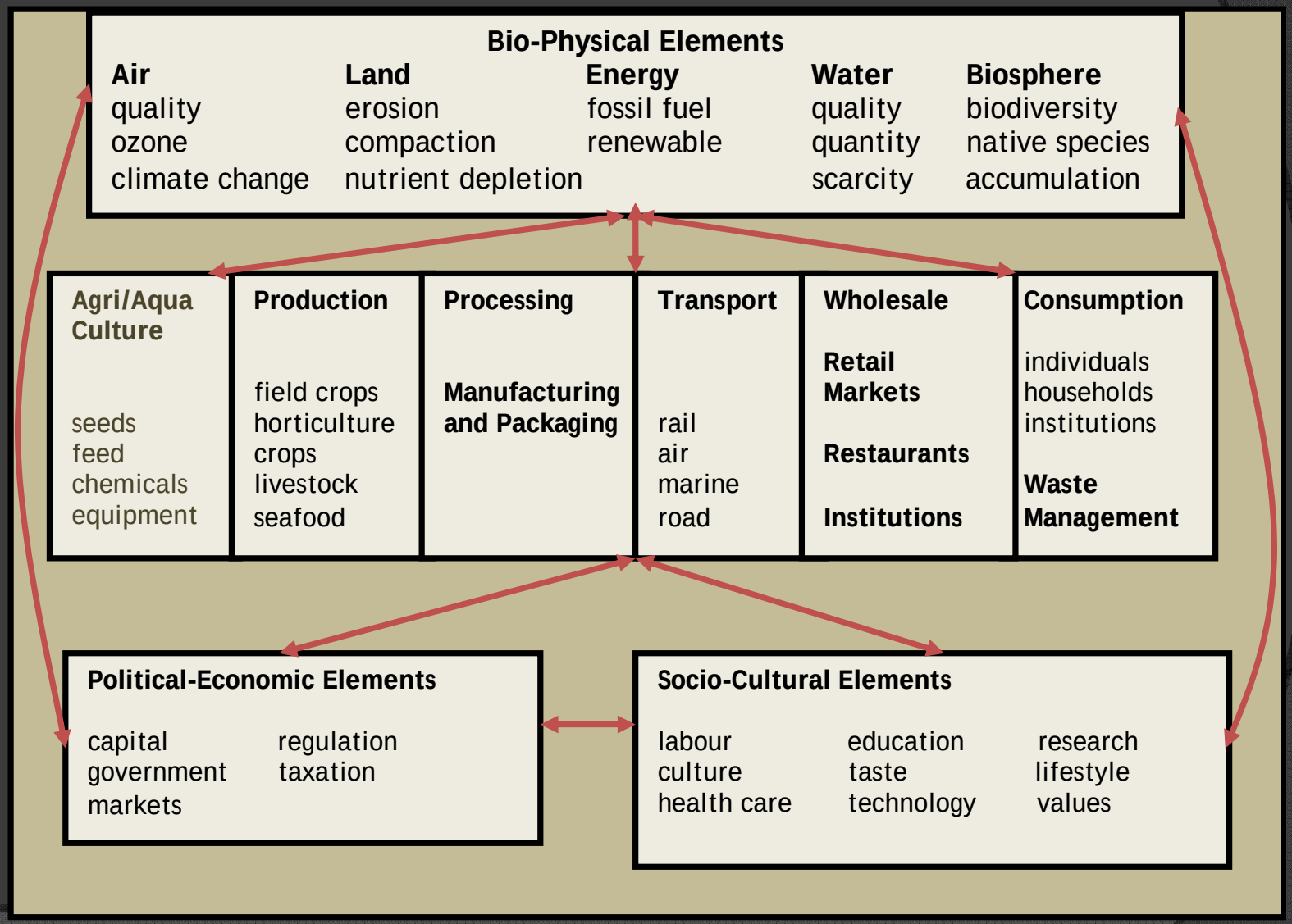
food systems and the environment



the big question

How sustainable is the food system that feeds

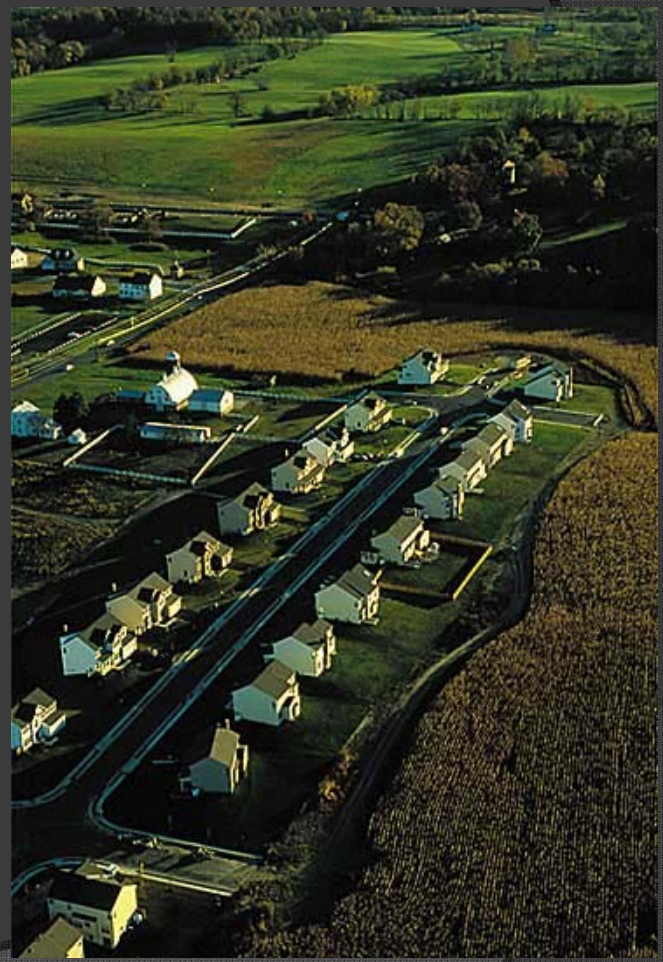
Me…Toronto…GTA…Ontario

…Canada…the whole Earth?

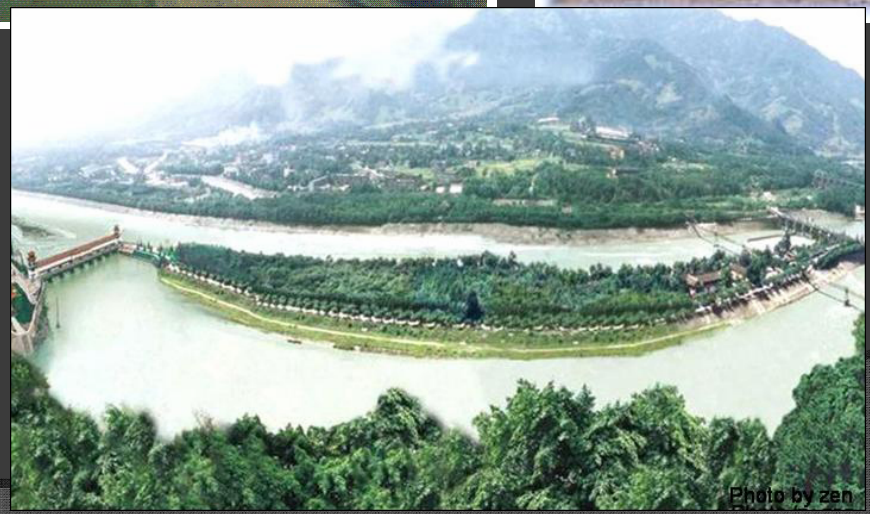
agro-ecological approach

- 5 key “ingredients” in agriculture

loss of crop and pasture land



overpumping of groundwater



declining soil fertility
disrupted nutrient cycles
eutrophication

fossil fuel consumption
greenhouse gas emissions

drought
heat waves
sea level rise

Foodshed: metaphor and analytical tool

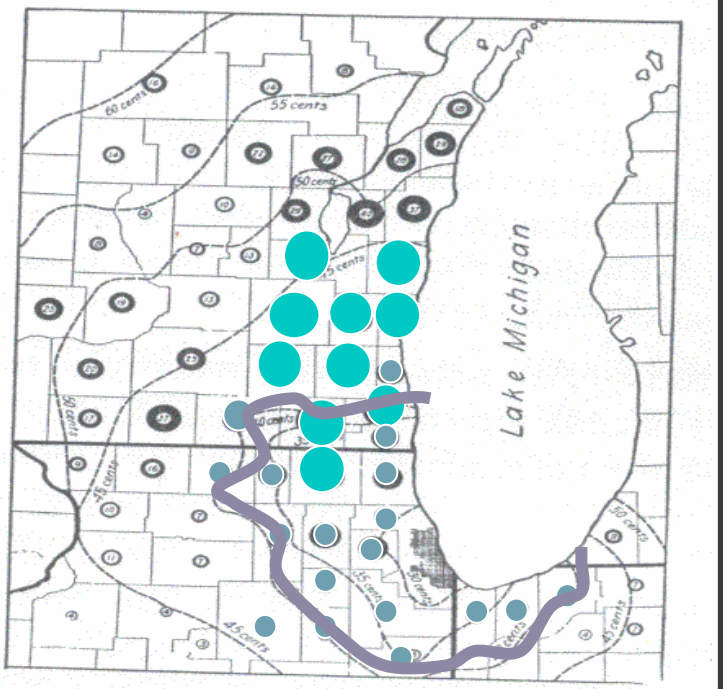


FIG. 6. — THE CHICAGO MILKSHED

Showing in thousands of gallons the milk produced per square mile within each freight-rate zone. Most of the fluid milk coming to the Chicago market originates within the forty-cent line, but in the next zone production almost doubles the inner district production. Courtesy of H. A. Ross.

10 gallons/acre

25 gallons/acre

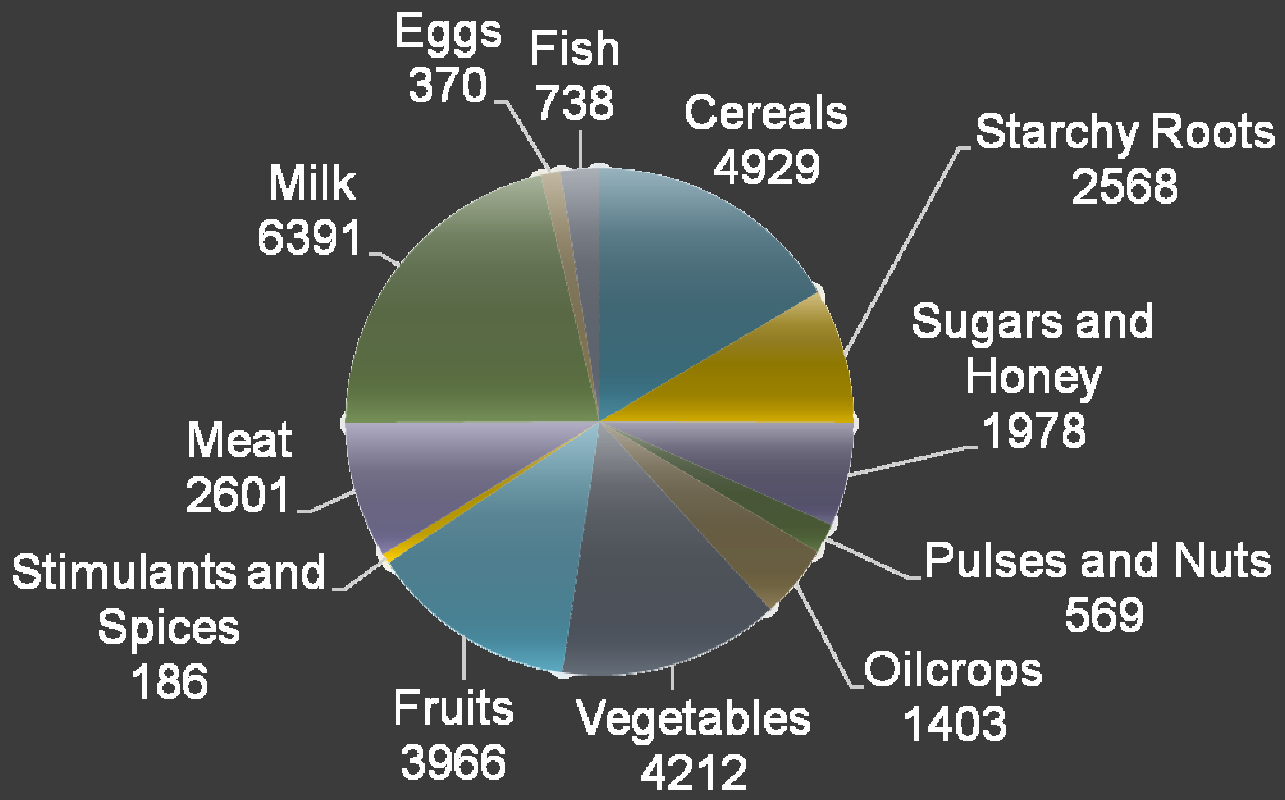
"The drainage basin from which a river outlined by heights of land, making a continuous watershed…

By analogy, the flow of foodstuffs to consuming markets as determined by foodsheds.

The barriers are more often economic than physical. The dams and dikes are railroad freight rates, protective tariffs, and inspection standards."

W.P Hedden, 1929:17

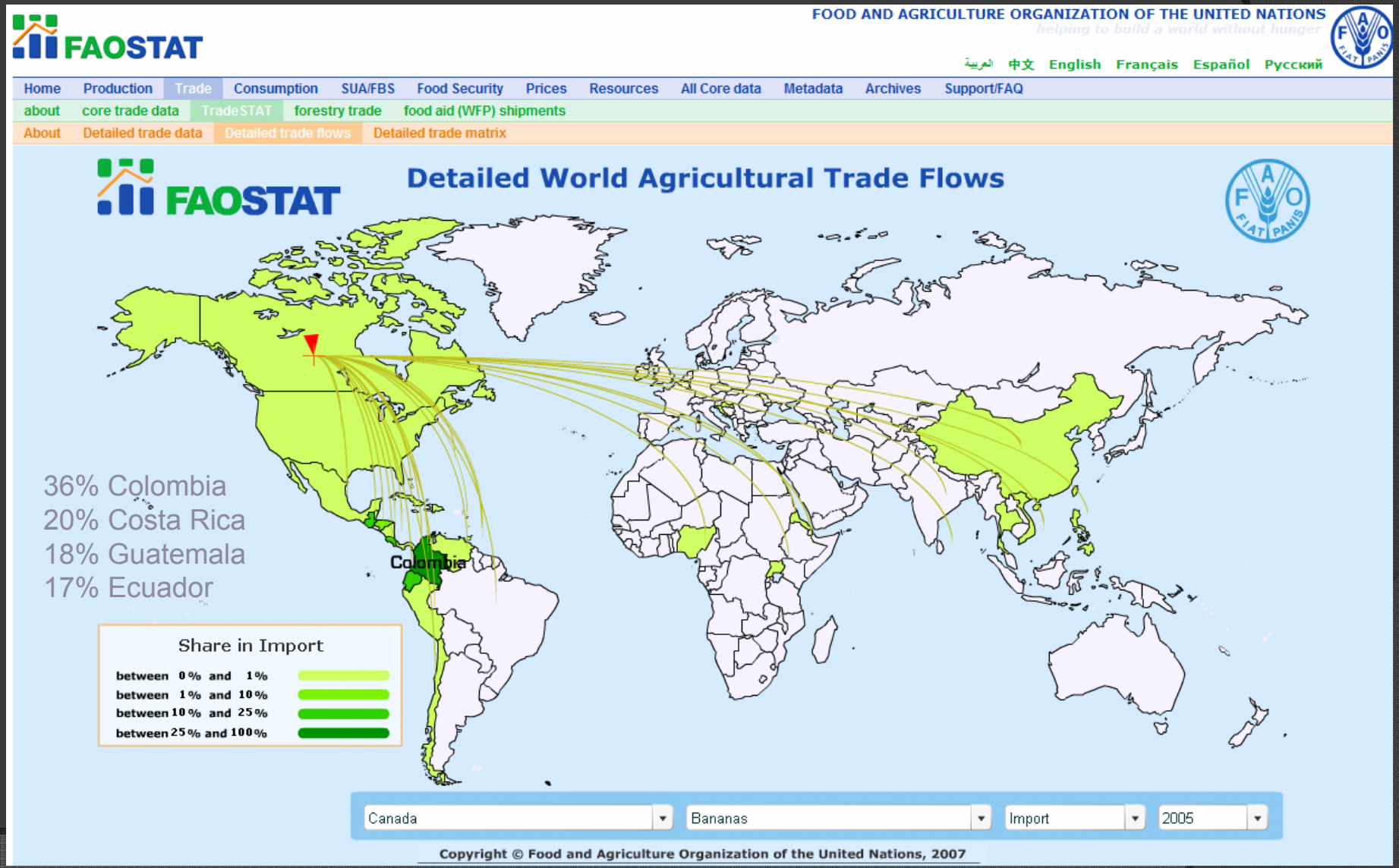
Food available for consumption ‘000 tonnes, ave 2001-2005



FAO, 2007

production + imports – exports – other uses – wastes = food available for consumption

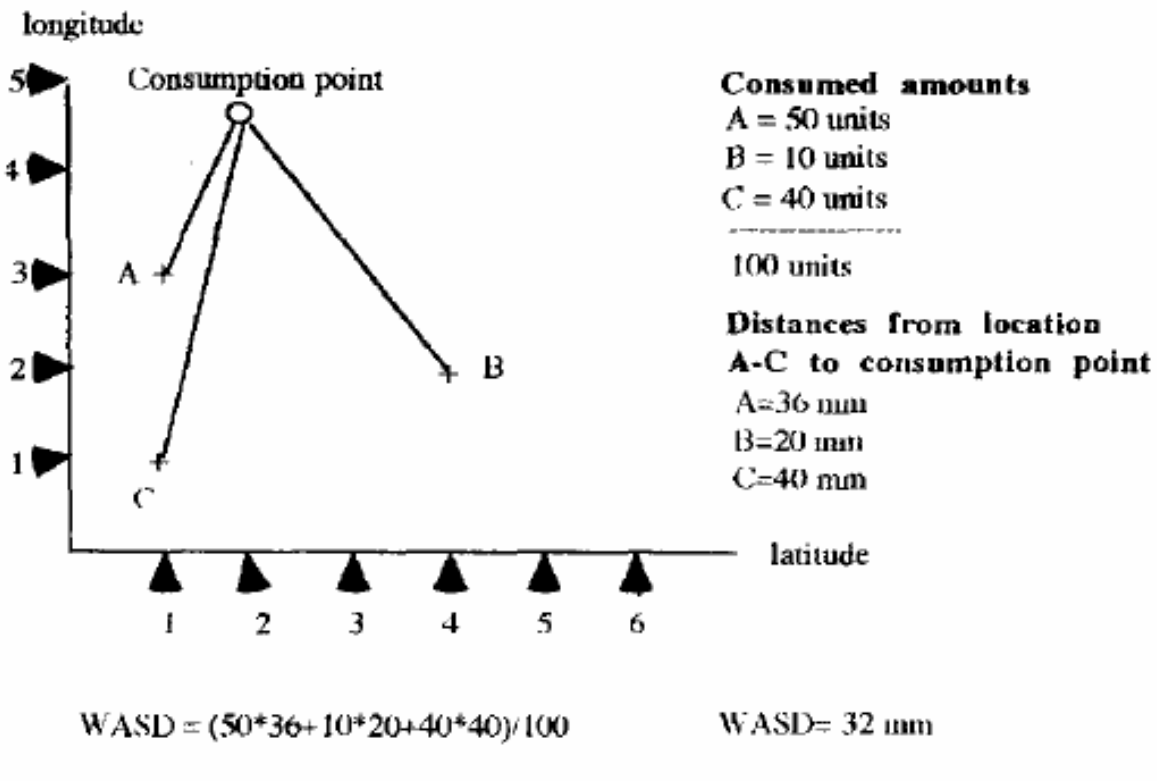
Detailed Trade Flows (FAO)



Weighted Average Source Distance

- Most common method of calculating

$$WASD = \frac{\sum_{k=1}^{n} m_k * d_k}{\sum_{k=1}^{n} m_k}$$



Carlsson-Kanyama, 1997

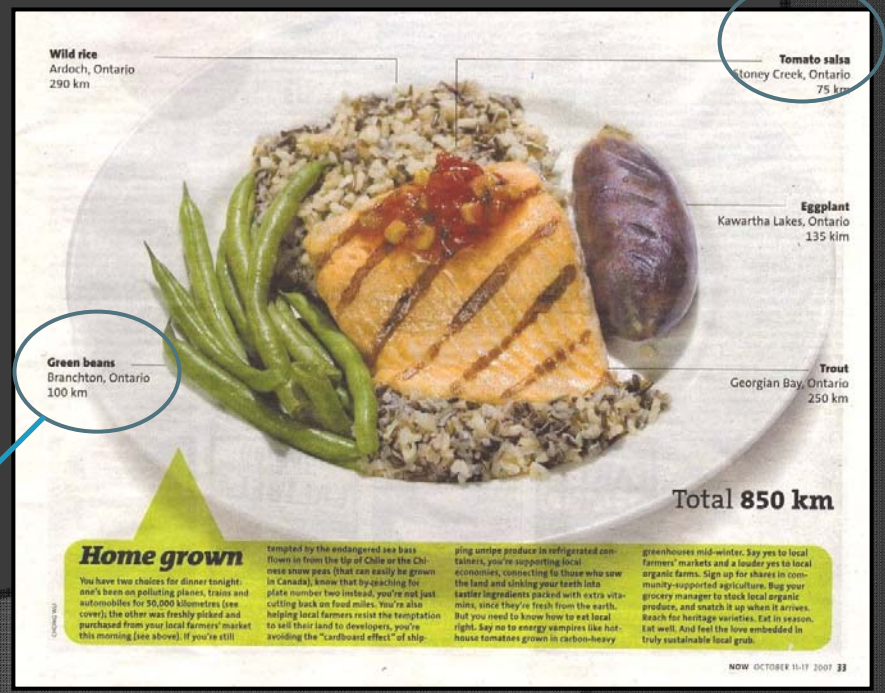
questions about foodmiles

- Challenges - how specific is necessary?
  - Start and end points
    (Colombia → Canada; Bogotá → Ottawa?)
  - “as the crow flies” vs. actual shipping and land routes
- Consistency for illustration
- Accurate data (?) needed for evaluation
- What does it *mean*?

where does it come from? how far *is* that?

Mango salsa
Brazil
9,000 km

Tomato salsa
Stoney Creek, Ontario
75 km



Snow Peas
China
11,500 km

Green Beans
Branchton, Ontario
100 km

how big is the foodshed?
*Food*print

$$\text{Foodprint (hectares)} = \frac{\text{Food Item (kg)}}{\text{Yield (kg/hectare)}}$$

Application #1 – compare dietary choices

Vegan Diet vs Omnivore Diet ?

- On average 10g of vegetable protein are needed to produce 1 g of animal protein
- Meat protein requires 6-17 X more land than protein based on soybeans

Application #2 – calculate actual land use for consumption patterns

- For any food item:

$$\text{Foodprint (ha)} = \frac{\text{Domestic (t)}}{\text{Yield (t/ha)}} + \sum_{h\ldots2}^{n} \frac{\text{Import (t)}_h}{\text{Yield (t/ha)}_h}$$

h= trade partner country

- Similar to Ecological Footprint
- Supply is a mix of import and domestic
- Yields vary from location to location
- Actual land used based on real yields in trade partner countries

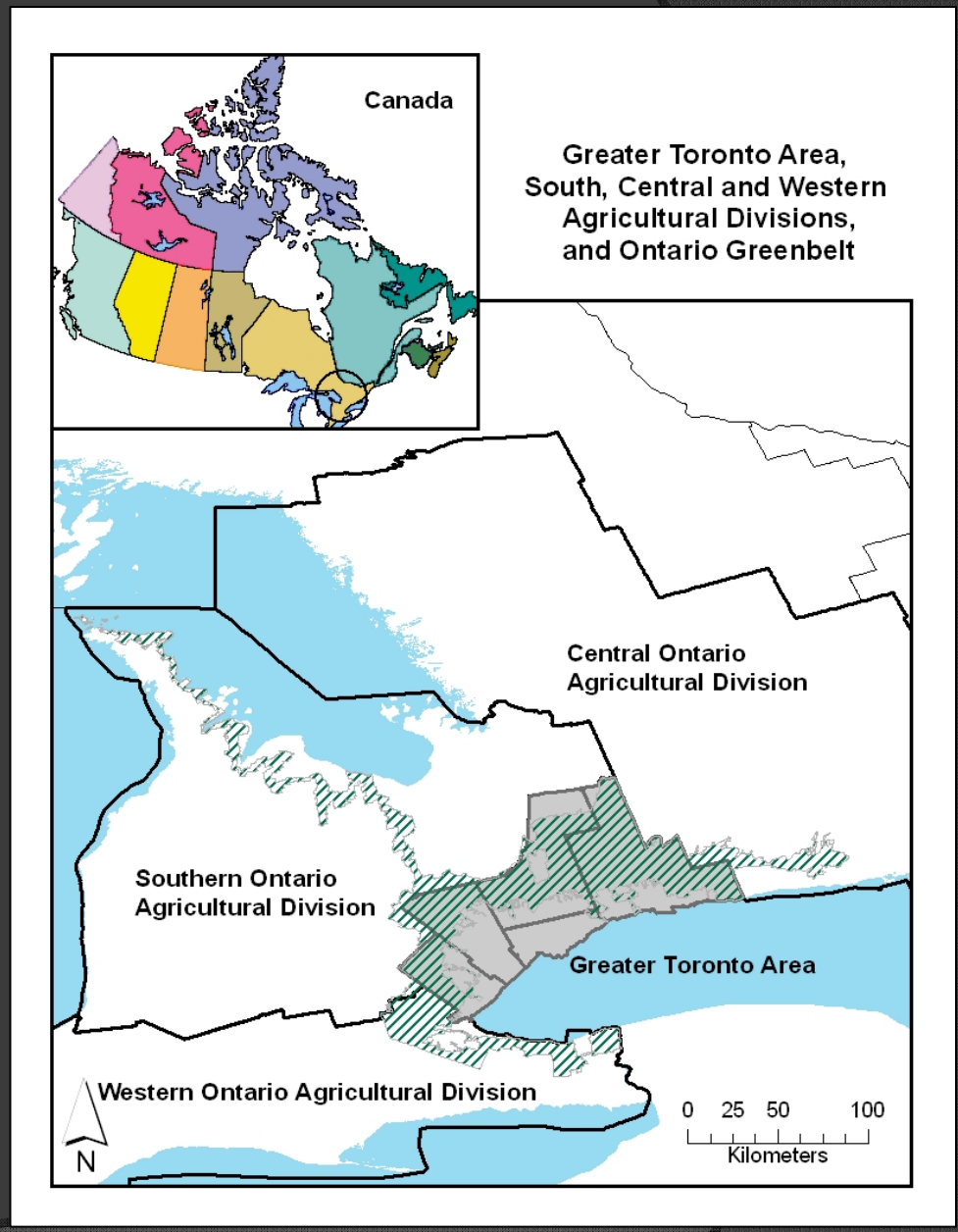
Application #3 – evaluate trade patterns

Food item	Foodprint total (ha)	Foodprint Domestic (ha)	Foodprint if 100% Canadian content (ha)	Total dometic land under cultivation (ha)
Cereals, nec	78000	28000	45000	387000
Maize	164000	145000	203000	1189000
Soybeans	46000	32000	57000	1097000
Potatoes	85000	81000	113000	169000
Tomatoes	18000	10000	16000	9000
Grapes	72000	8000	146000	9000
Lettuce	10000	3000	14000	3000

- More than enough land, domestic yields are higher
- More than enough land, domestic yields are lower
- Not enough land, domestic yields are higher
- Not enough land, domestic yields are lower

GTA population

Crop	Land needed for 100% "local" (ha)	Current cultivation SWC Ont (ha)
Oats	109	35249
Apples	3841	7792
Carrots	1680	4014
Tomatoes	2764	8107
Potatoes	19879	14464
Lettuce	2481	370
Grapes	25692	8317



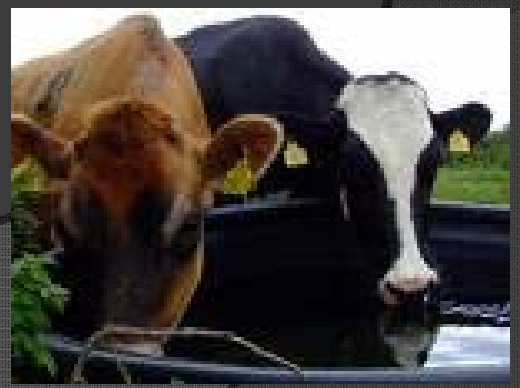
Virtual Water Content

- Food is primary mode of international water trade

Crop water content = evapo-transpiration demand

Livestock water content = feed water content +
drinking water + servicing water





water consumption in agriculture

- Global water use for crop production 6390 Gm^3/yr PLUS 1590 Gm^3/yr irrigation loss
- 1/3 irrigation
- 2/3 soil water (rainfall and storage)
- Virtual water content increases with processing →

Product	Virtual Water Content (m^3/tonne)
Wheat (USA)	849
Wheat (India)	1654
Beef (USA)	13,193
Beef (Mexico)	37,762
Soybeans (USA)	1869
Soybeans (China)	2617
Paddy Rice (USA)	1275
Paddy Rice (India)	2850
Broken Rice (India)	4254

Hoekstra and Chapagain, 2007

One Gm^3 or giga-cubic metre is one billion cubic metres.
This contains one trillion (1,000,000,000,000 or 1×10^{12}) litres.

virtual water content of “products”

- Majority of water is in production but also used in processing

Green coffee
17,373 m^3/t

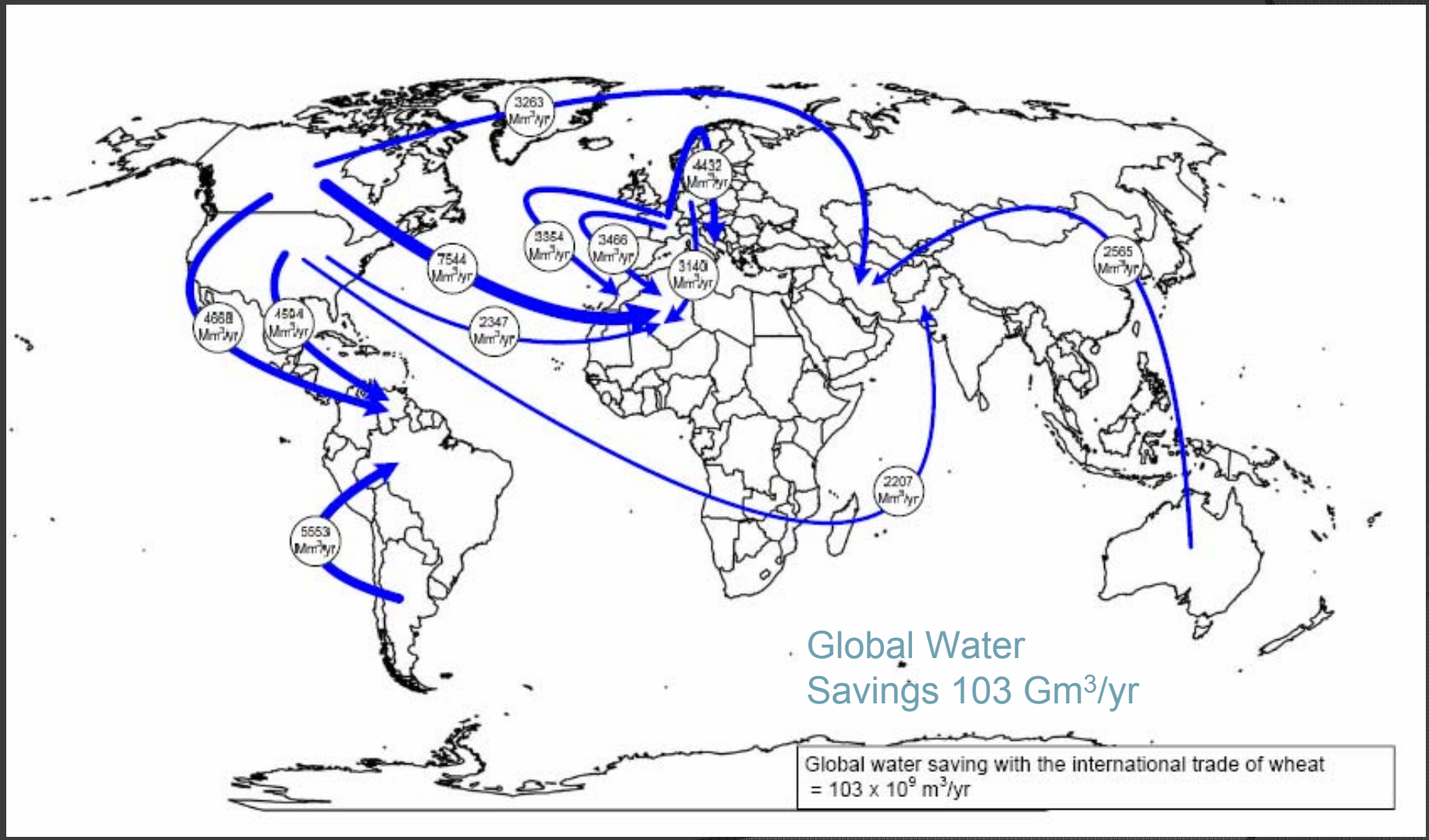
Roasted coffee
20,682 m^3/t

Brewed tea
9,205 m^3/t

Product	Virtual Water Content (L) *
1 beer (250ml)	75
1 coffee (125ml)	140
2 slices of bread + 10g cheese	130
1 bag of potato chips (200g)	185
1 hamburger (250g)	2400
1 tomato (30g)	13
1 glass of wine (125 ml)	120
1 cotton t-shirt	2000
1 pair of leather shoes	8000
1 tea (250ml)	35

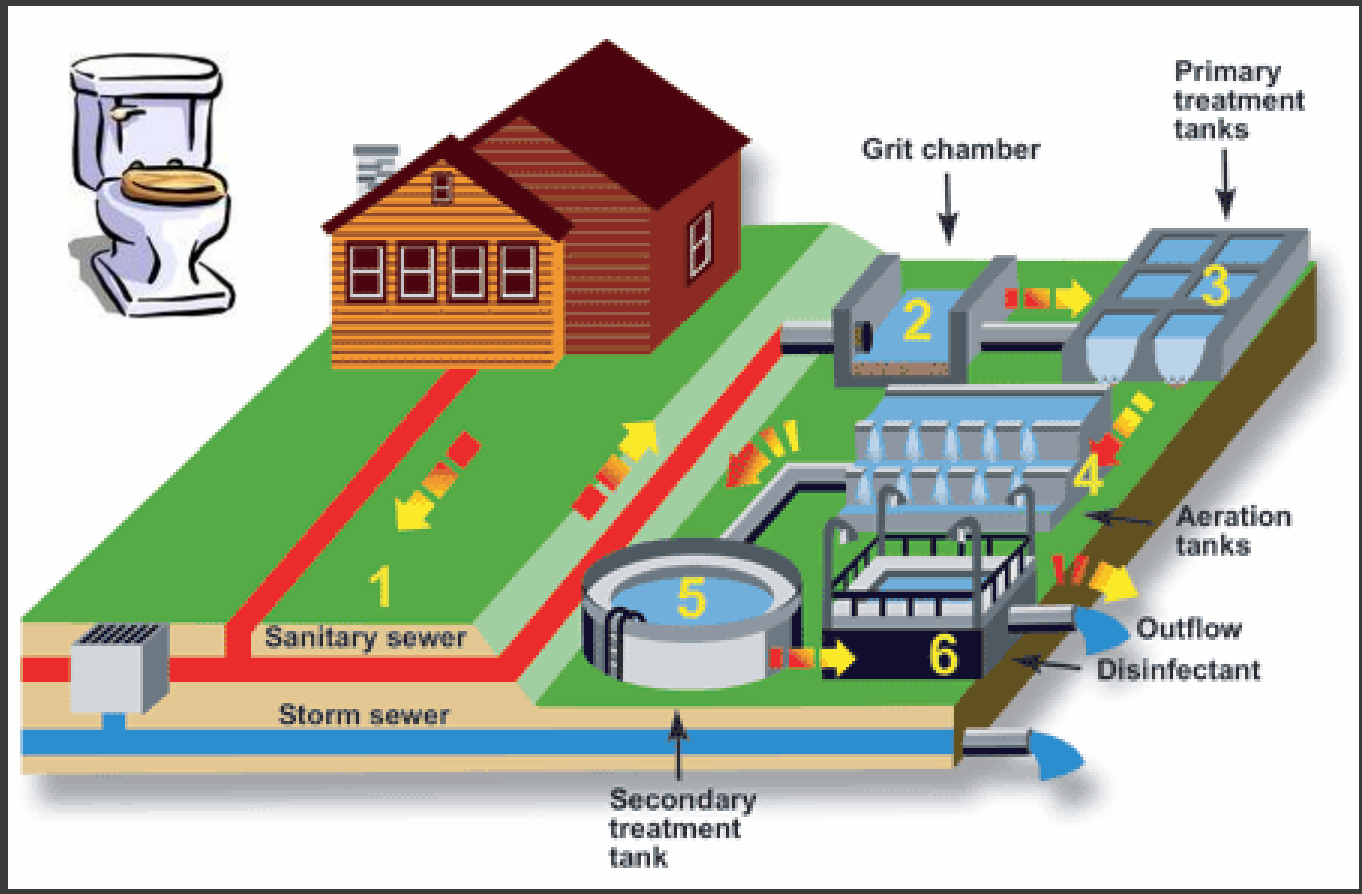
* global averages, Hoekstra and Chapagain, 2007

conserving water through trade



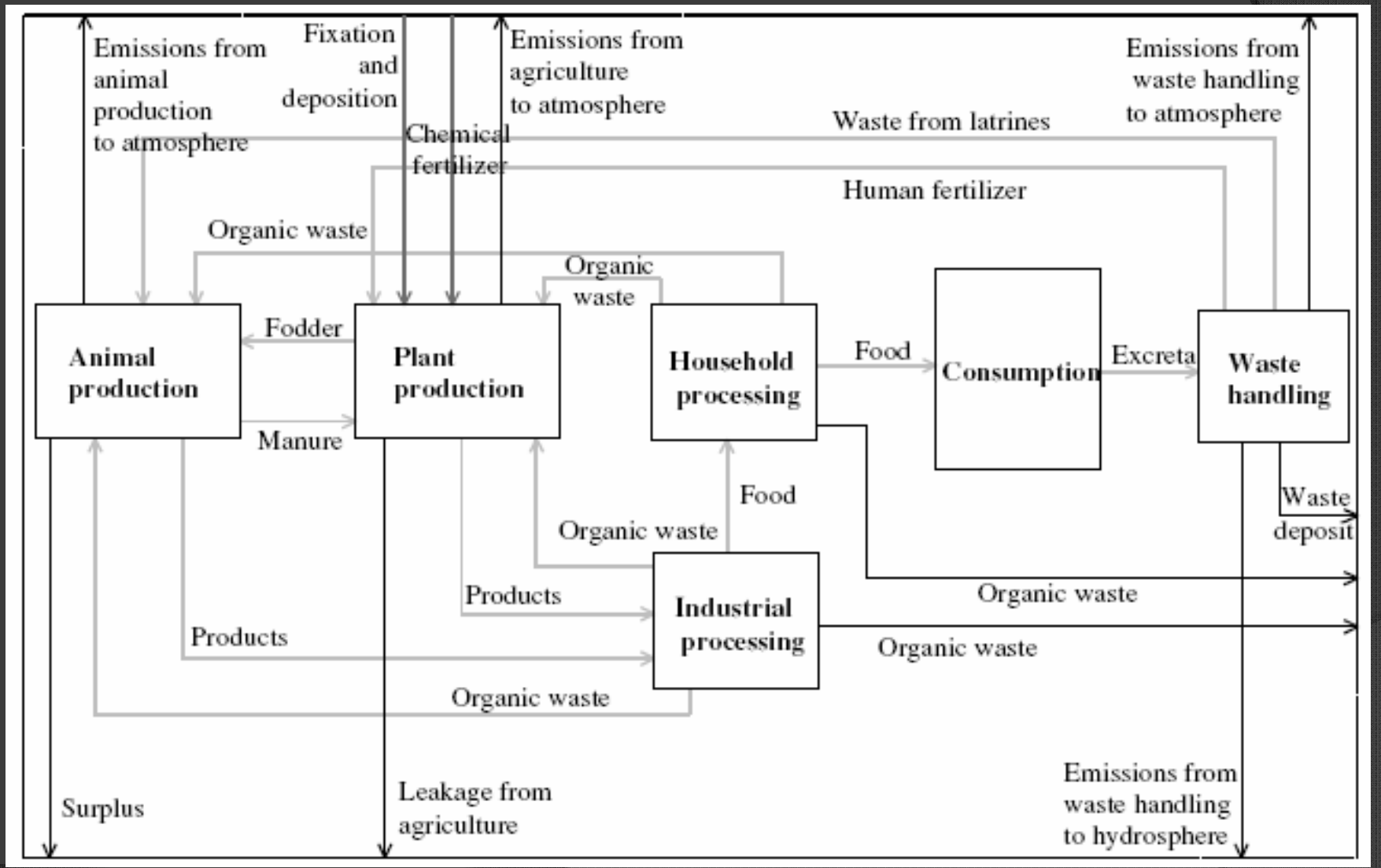
Chapagain et al., 2006

water use continues after the plate



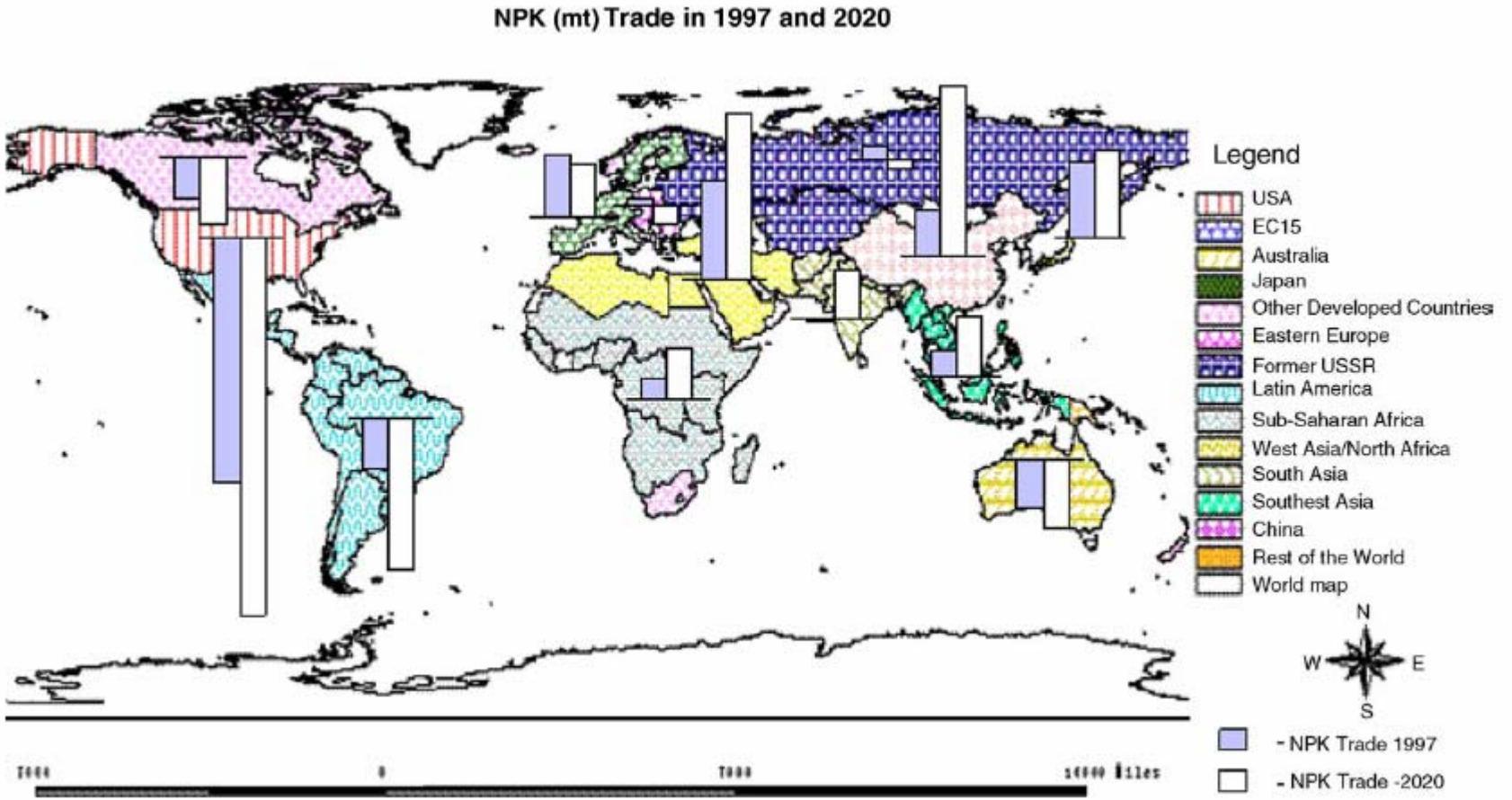
- Canadians average five flushes **per person per** day
- How to account for it in measurement of whole system?

Nutrient balance – full cycle approach



Neset et al., 2006

global trade in nutrients (NPK)



Grote et al., 2005

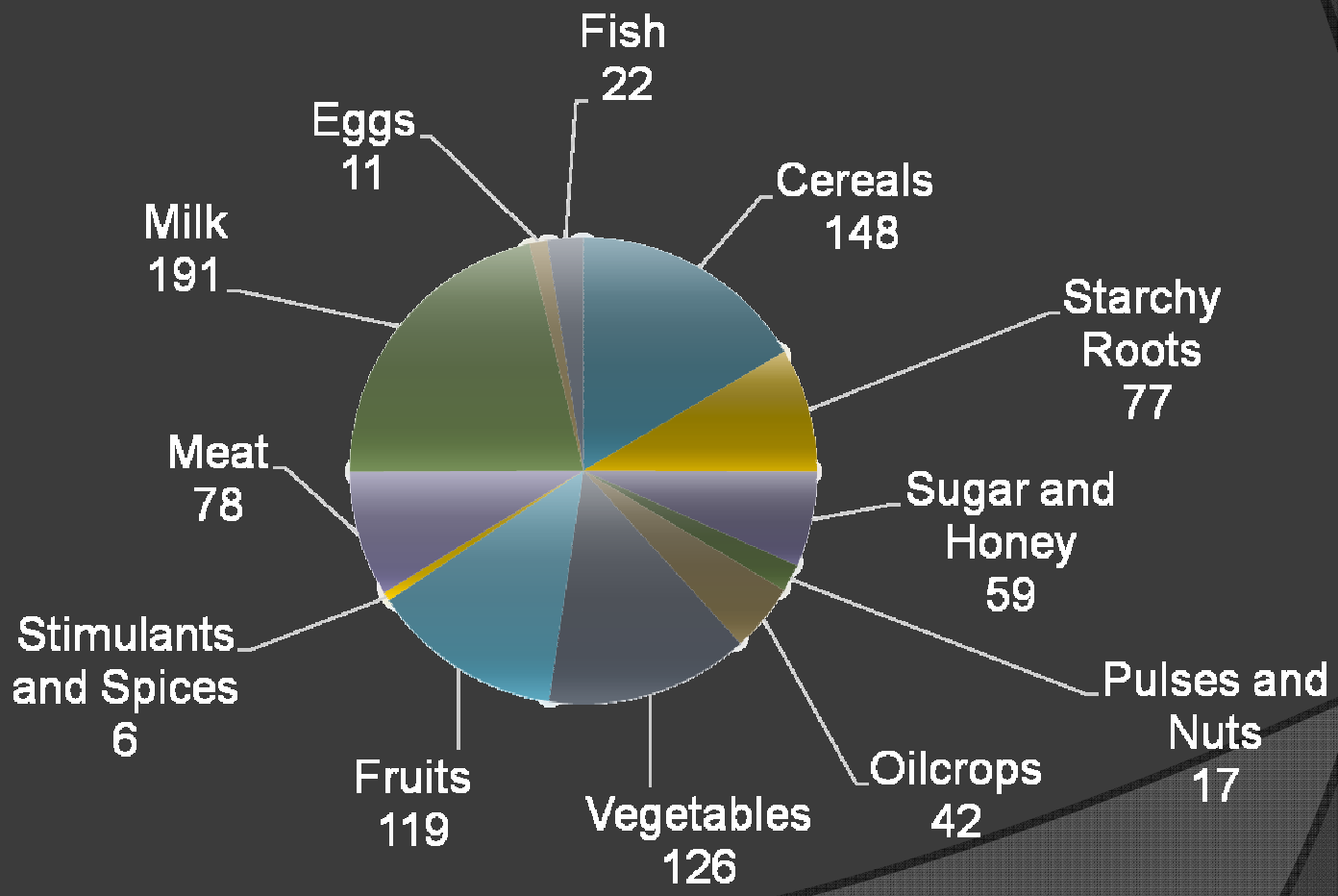
nutrient content in food items (kg/t)

Product	Nitrogen	Phosphorous	Potassium
Beef	25	2.1	3.5
Poultry	24	1.5	2.7
Wheat	21	2.3	3.2
Maize	11.7	2.1	2.4
Rice	9.2	2.1	2.6
Potatoes	3	0.4	4.4
Soybeans	17	20	16.4

Grote et al., 2005

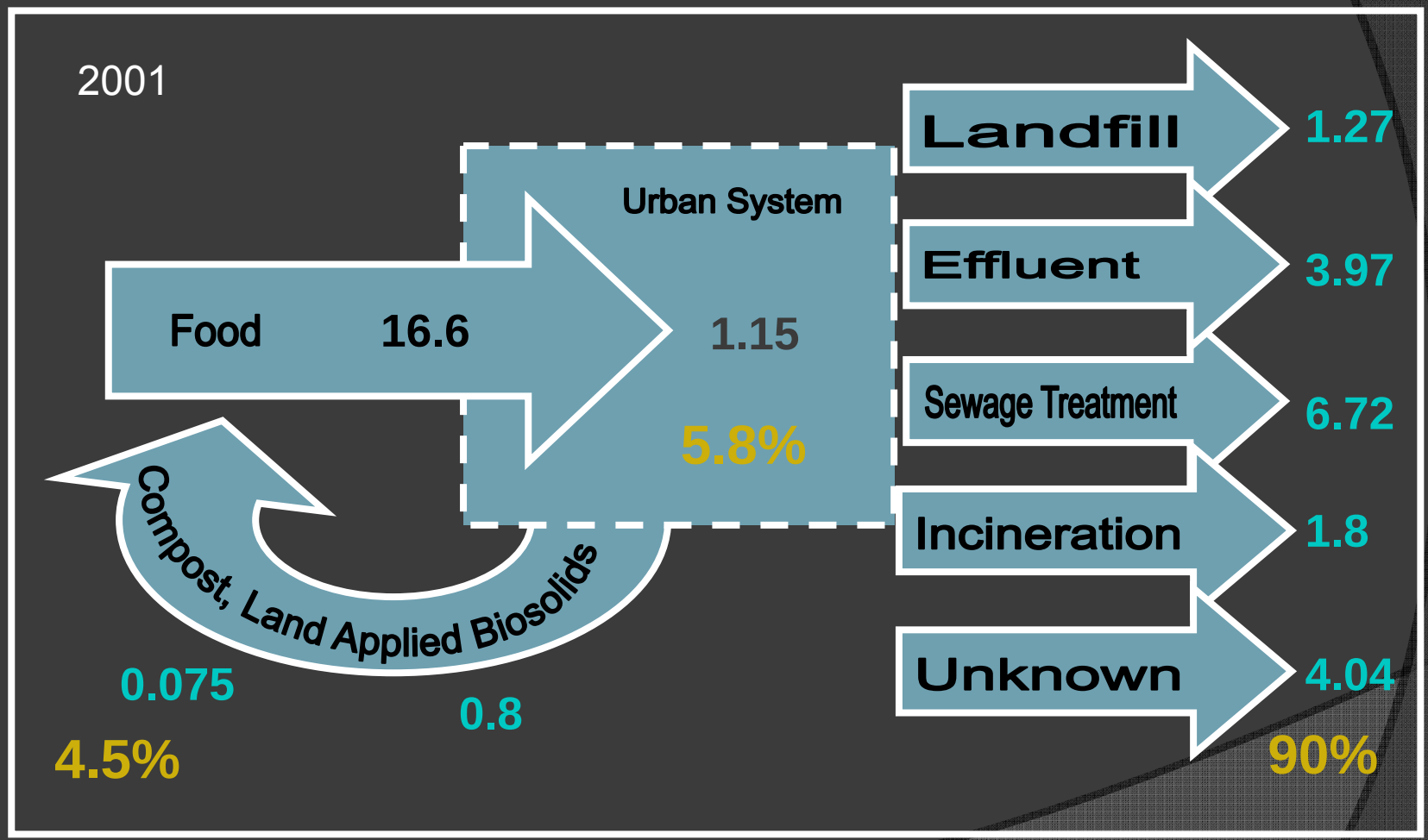
Virtual nutrients? On average 10g of vegetable protein are needed to produce 1g of animal protein

Food available per capita - Canada kg, ave 2001-2005



FAO, 2007

Toronto – Nitrogen Balance Example



10^3 tonnes of N

the big question, again

How sustainable is the food system that feeds

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…Canada…the whole Earth?

TOOLKIT

- Foodprint – land use
- Virtual Water – water use
- Nutrient Balance – nutrient use and recycling
- Foodmiles – useful heuristic


Energy
Land
Water
Technology
Nutrients
FOOD