Incorporating Land Use and Greenhouse Gases Emissions into the GTAP Data Base

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Global Trade Analysis Project

GTAP Land Use and GHG Data (1)

- **VFM("AEZ_Land", PROD_COMM, REG)**
  - AEZ_Land = {18 AEZs}
- **Global Land Cover Area Data**
  - 18 AEZs
  - 7 land cover types
- **Global Cropland Data**
  - Harvested area and yield
  - 18 AEZs
  - 19 crop types
- **Global Timberland Area Data**
  - 18 AEZs
  - Up to 14 tree types
  - 10 10-year cohorts of trees

GTAP Land Use and GHG Data (2)

- **Global CO_2 Emissions from Combustion**
  - Sectoral

- **Global forest carbon stock**
  - 18 AEZs
  - Up to 14 tree types
  - 10 10-year cohorts of trees

- **Global CH_4, N_2O, Fluorinated Gases Emissions**
  - Sectoral

- **Global Cropland Data**
  - Harvested area and yield
  - 18 AEZs
  - 19 crop types

- **Global Timberland Area Data**
  - 18 AEZs
  - Up to 14 tree types
  - 10 10-year cohorts of trees

Land Use: The AEZ concept

- **IIASA/FAO Pioneer Project on Agro-ecological Zoning**
  - **Function of temperature (T) and adequate soil moisture (S)**
    - **LGP = F(T, S)**
  - **Soil moisture: a function of rainfall, soil type, topography, …, etc.**
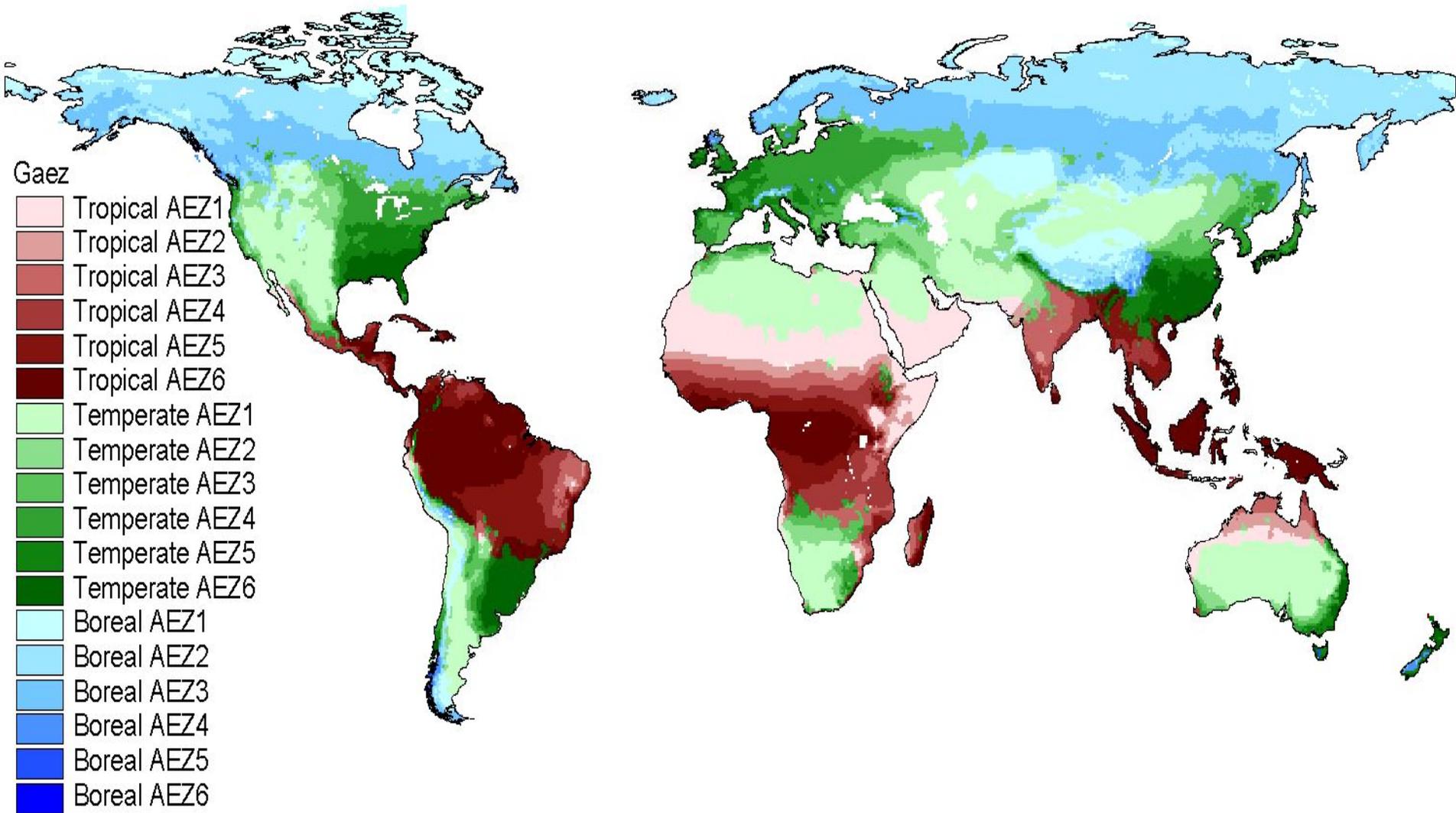- **We Adopted the AEZ Concept Developed by IIASA/FAO.**

VFM("AEZ_Land", SEC , REG)

AEZs	Land use types in region r								
	$Crop_1$	....	$Crop_N$	$Livestock_1$	....	$Livestock_H$	$Forest_1$	....	$Forest_V$
AEZ_1									
....									
....									
....									
AEZ_M									
Total									

Availability of Agriculture AEZ Land Data

- **Data provider:**
  - Dr. Navin Ramancutty, University of Wisconsin-Madison, SAGE

- **18 agro-ecological zones (AEZs) for 160 countries**
  - 6 AEZ: by FAO definition, 0.5 degree GIS map
  - 3 climate zones: boreal, temperate, tropical

- **19 crop types**

- **Acreage data by AEZ**

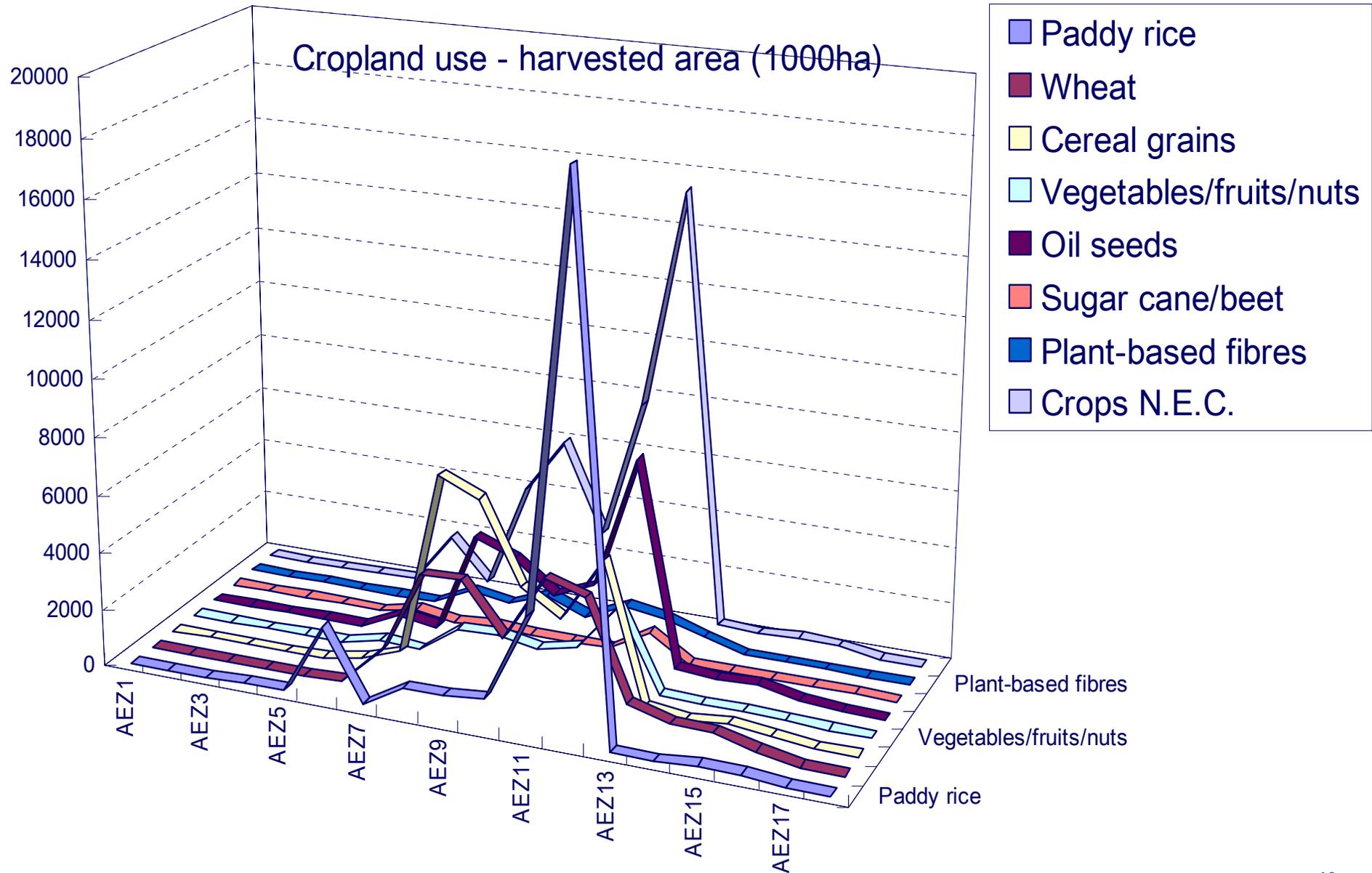- **Yield by AEZ estimated based on FAO data**

The 18-AEZ Map

Gaez

- Tropical AEZ1
- Tropical AEZ2
- Tropical AEZ3
- Tropical AEZ4
- Tropical AEZ5
- Tropical AEZ6
- Temperate AEZ1
- Temperate AEZ2
- Temperate AEZ3
- Temperate AEZ4
- Temperate AEZ5
- Temperate AEZ6
- Boreal AEZ1
- Boreal AEZ2
- Boreal AEZ3
- Boreal AEZ4
- Boreal AEZ5
- Boreal AEZ6

LGP v.s. AEZ

LGP in days	Moisture regime	Climate zone	GTAP class
0-59	Arid	Tropical	AEZ1
		Temperate	AEZ7
		Boreal	AEZ13
60-119	Dry semi-arid	Tropical	AEZ2
		Temperate	AEZ8
		Boreal	AEZ14
120-179	Moist semi-arid	Tropical	AEZ3
		Temperate	AEZ9
		Boreal	AEZ15
180-239	Sub-humid	Tropical	AEZ4
		Temperate	AEZ10
		Boreal	AEZ16
240-299	Humid;	Tropical	AEZ5
		Temperate	AEZ11
		Boreal	AEZ17
>300 days	Humid; year-round growing season	Tropical	AEZ6
		Temperate	AEZ12
		Boreal	AEZ18

SAGE's 18 crops v.s. GTAP's 8 crop sectors

SAGE No.	SAGE code	GTAP No.	GTAP code	Description
1	barley	3	gro	Cereals grain n.e.c.
2	cassava	4	v_f	Vegetables, fruit, nuts
3	cotton	7	pfb	Plant-based fibres
4	groundnuts	5	osd	Oil seeds
5	maize	3	gro	Cereals grain n.e.c.
6	millet	3	gro	Cereals grain n.e.c.
7	oilpalm	5	osd	Oil seeds
8	others	8	ocr	Crops n.e.c.
9	potato	4	v_f	Vegetables, fruit, nuts
10	pulses	4	v_f	Vegetables, fruit, nuts
11	rape	5	osd	Oil seeds
12	rice	1	pdr	Paddy rice
13	rye	3	gro	Cereals grain n.e.c.
14	sorghum	3	gro	Cereals grain n.e.c.
15	soy	5	osd	Oil seeds
16	sugar beet	6	c_b	Sugar cane, sugar beet
17	sugar cane	6	c_b	Sugar cane, sugar beet
18	sunflower seeds	5	osd	Oil seeds
19	wheat	2	wht	Wheat

Cropland Use (Harvested Area): China, 2001

Cropland use - harvested area (1000ha)

Legend:
- Paddy rice
- Wheat
- Cereal grains
- Vegetables/fruits/nuts
- Oil seeds
- Sugar cane/beet
- Plant-based fibres
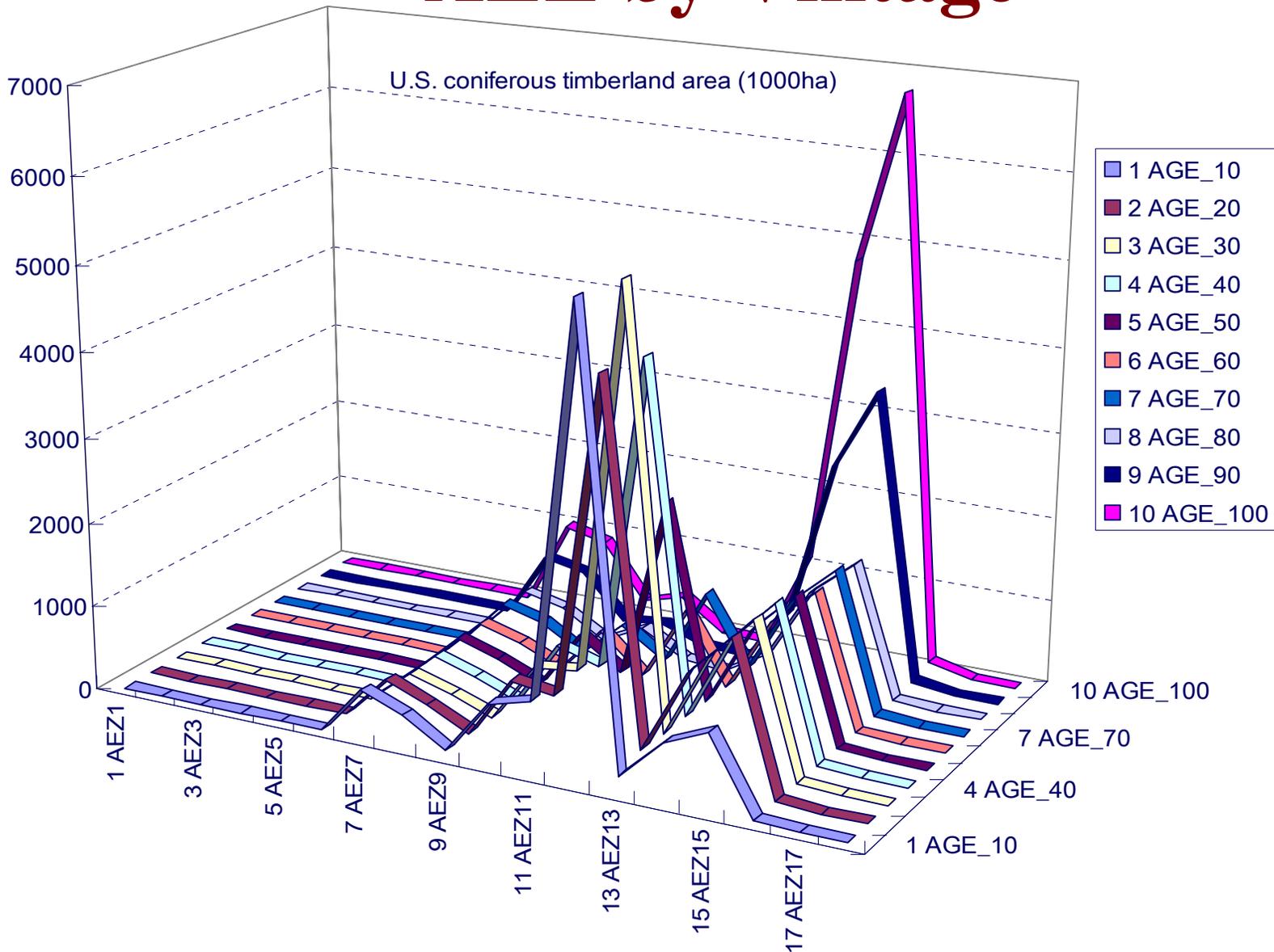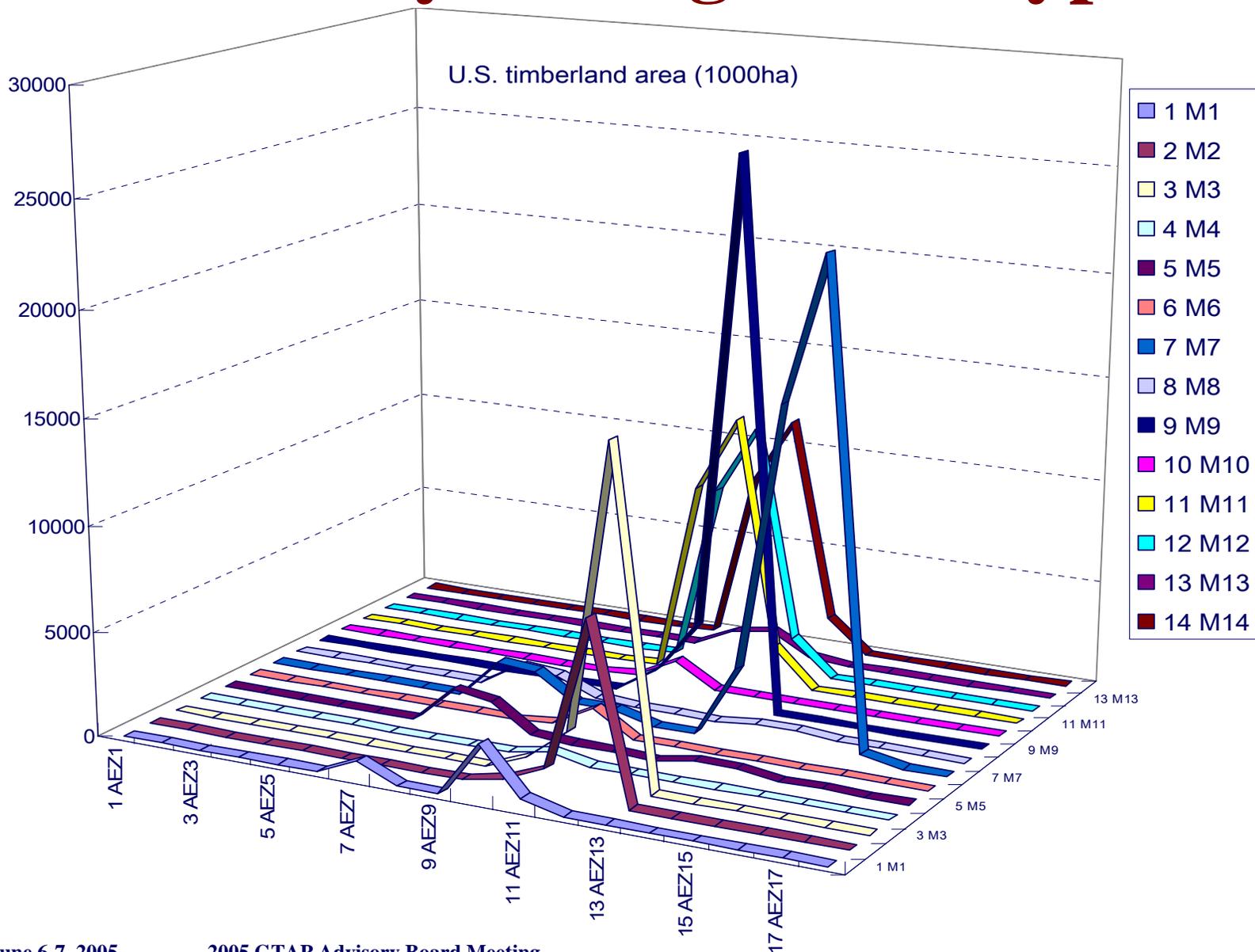- Crops N.E.C.

Availability of Timberland Data

- **Data Provider:**
  - **Dr. Brent Sohngen, Ohio State University**
- **18 AEZs for GTAP's 215 world regions**
  - **Same AEZ map as SAGE's**
- **3 Species: Coniferous, Broadleaf, Mixed**
- **Acreage, Timberland Rent Data: by management type**
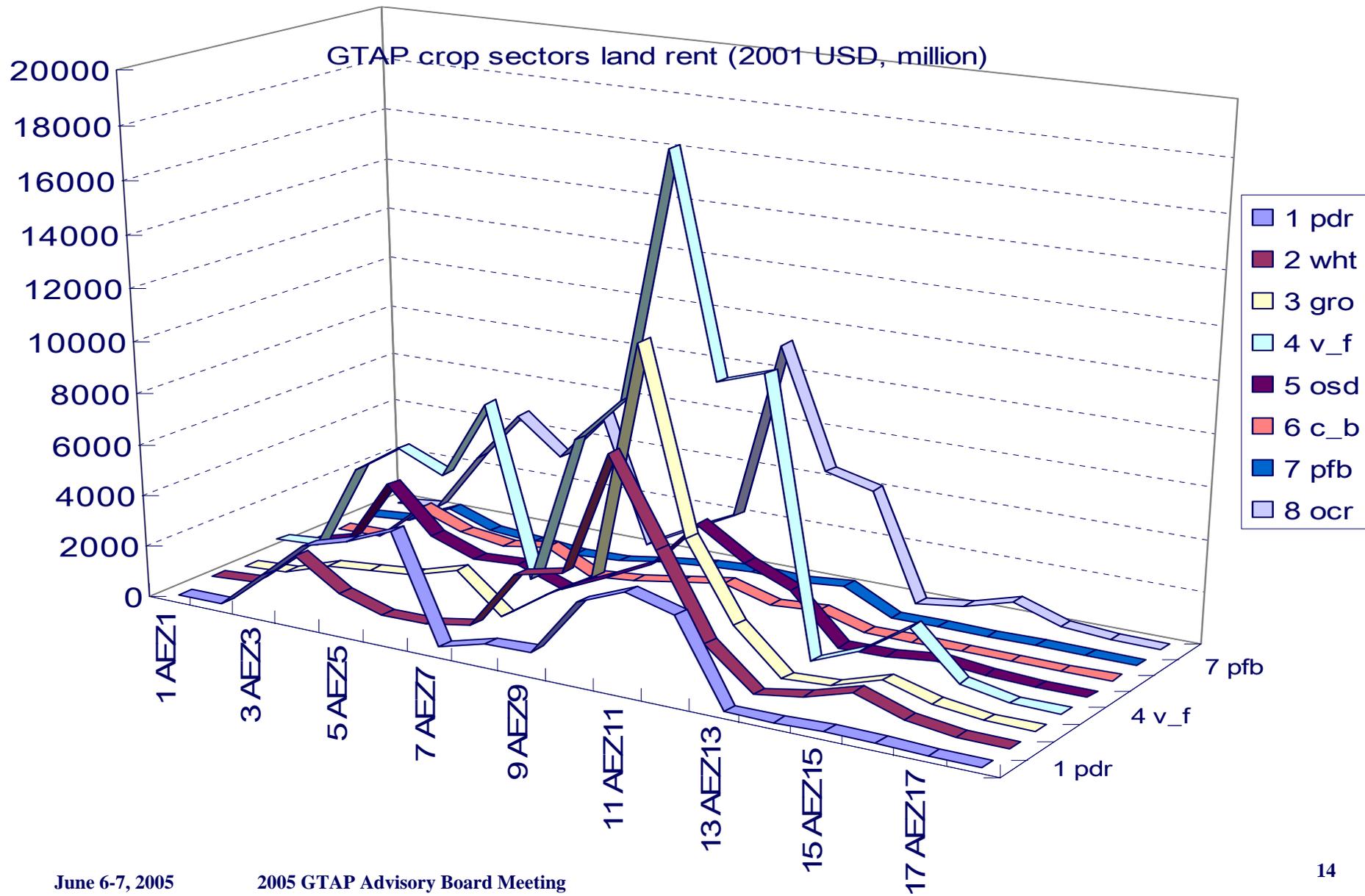- **10 10-year Cohorts of Trees**
- **Forest Carbon Stock**
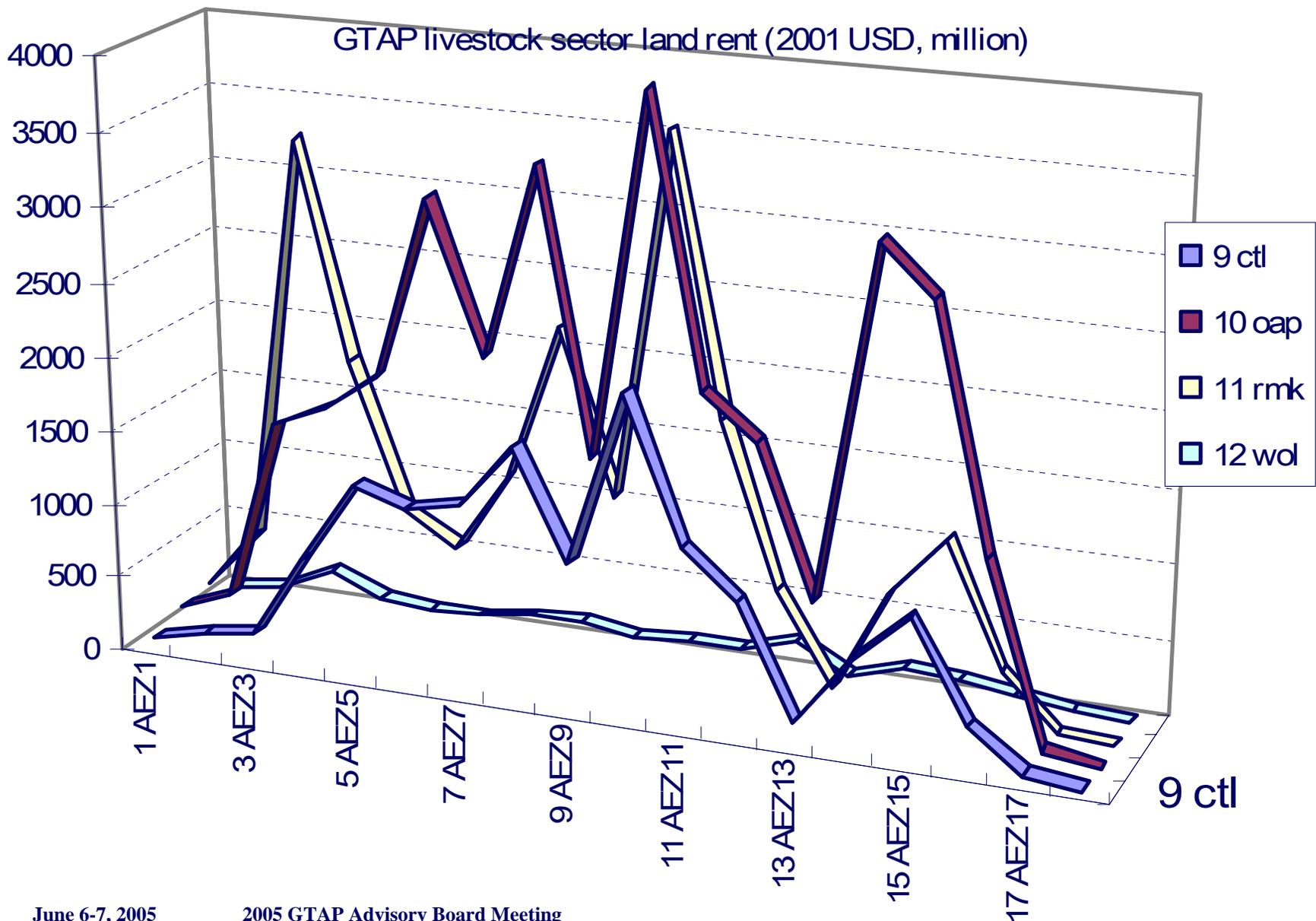
U.S. Coniferous Timberland Area: AEZ by Vintage


U.S. coniferous timberland area (1000ha)

Legend:
- 1 AGE_10
- 2 AGE_20
- 3 AGE_30
- 4 AGE_40
- 5 AGE_50
- 6 AGE_60
- 7 AGE_70
- 8 AGE_80
- 9 AGE_90
- 10 AGE_100

U.S. All-species Timberland Area: AEZ by Management Types

U.S. timberland area (1000ha)

Legend:
- 1 M1
- 2 M2
- 3 M3
- 4 M4
- 5 M5
- 6 M6
- 7 M7
- 8 M8
- 9 M9
- 10 M10
- 11 M11
- 12 M12
- 13 M13
- 14 M14

GTAP Crop Sector Land Rent: World

GTAP crop sectors land rent (2001 USD, million)

Legend:
- 1 pdr
- 2 wht
- 3 gro
- 4 v_f
- 5 osd
- 6 c_b
- 7 pfb
- 8 ocr

GTAP Livestock Sector Land Rent: World

GTAP livestock sector land rent (2001 USD, million)

Legend: 9 ctl, 10 oap, 11 rmk, 12 wol

GTAP Forest Sector Land Rent: World

GTAP forest sector land rent (2001 USD, million)

■ 13 frs
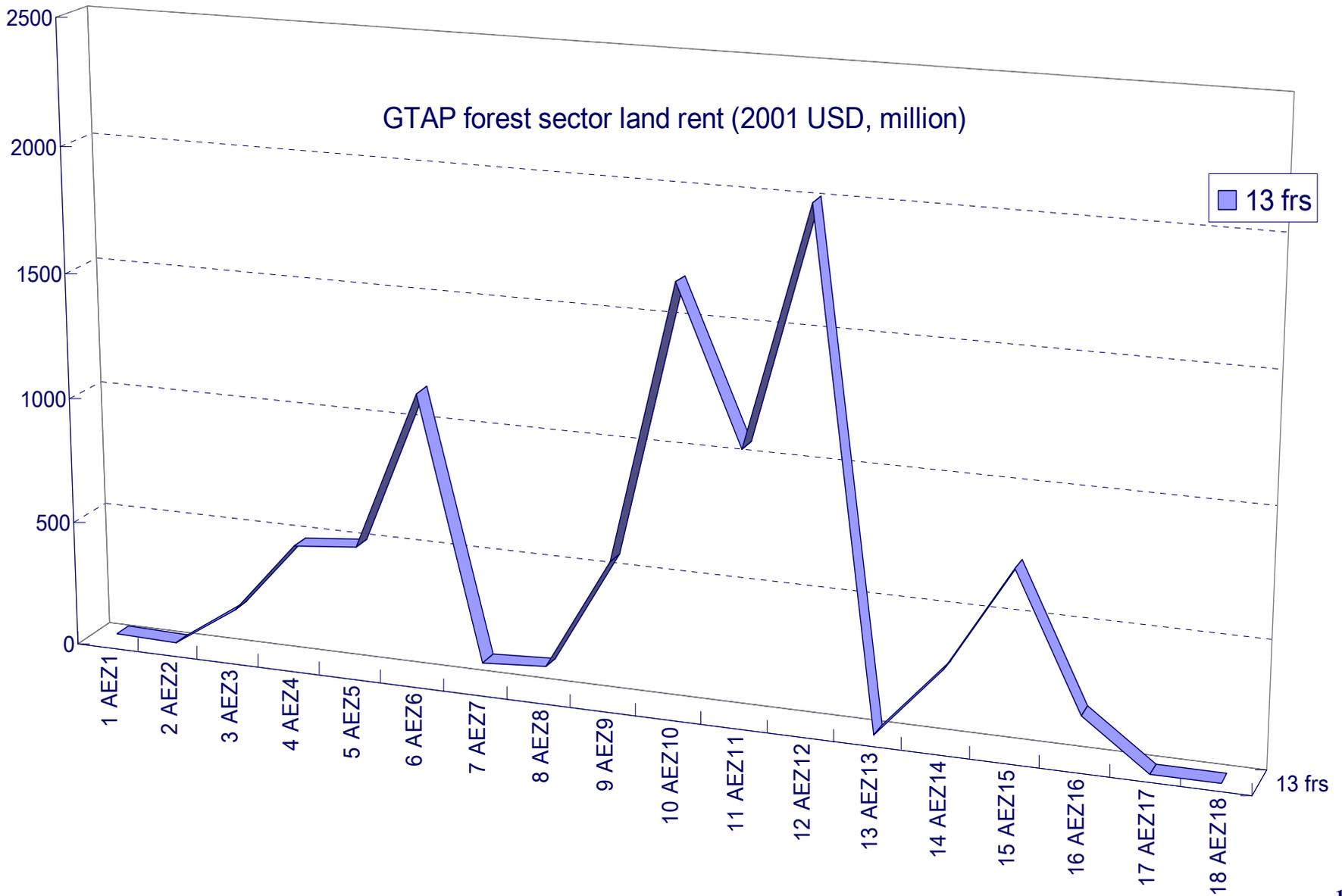
Greenhouse Gases Emissions Data

- ## CO_2 emissions:
  - **Tier 1 method of the revised 1996 IPCC Guideline**
  - **Special treatment for non-emitting activities**
    - **Country-specific sectoral feedstock use ratios**
    - **Energy transformation: e.g., coal used to produce coal products**

- ## CH_4, N_2O, and F-gases emissions:
  - **IPCC Tier 1 and Tier 2 methods**
  - **Mapping emissions sources to GTAP sector activities**

CO$_2$ Emissions Data: Share of World Total, by Activity and Fuel

GTAP sectors	Coal	Crude oil	Natural gas	Petroleum products	Gas	Activity Total
Petroleum, coal products	0.00	0.00	0.01	2.58	0.00	2.60
Chemical, rubber,	1.39	0.19	0.91	1.31	0.65	4.44
Mineral products n.e.c.	1.97	0.00	0.19	0.55	0.22	2.93
Ferrous metals	2.29	0.00	0.27	0.31	0.32	3.20
Electricity	27.13	0.33	4.15	3.98	4.26	39.85
Trade	0.05	0.00	0.06	3.47	0.26	3.84
Transport n.e.c.	0.06	0.00	0.12	6.99	0.03	7.21
Water transport	0.00	0.00	0.00	1.10	0.00	1.10
Air Transport	0.00	0.00	0.01	2.77	0.00	2.78
Household consumption	1.50	0.00	0.63	11.65	2.62	16.41
Other sectors	3.27	0.04	1.58	6.44	4.31	15.65
Fuel Total	37.66	0.56	7.93	41.17	12.68	100.00

CO$_2$ Emissions Intensity: Selective Big Emitting Countries
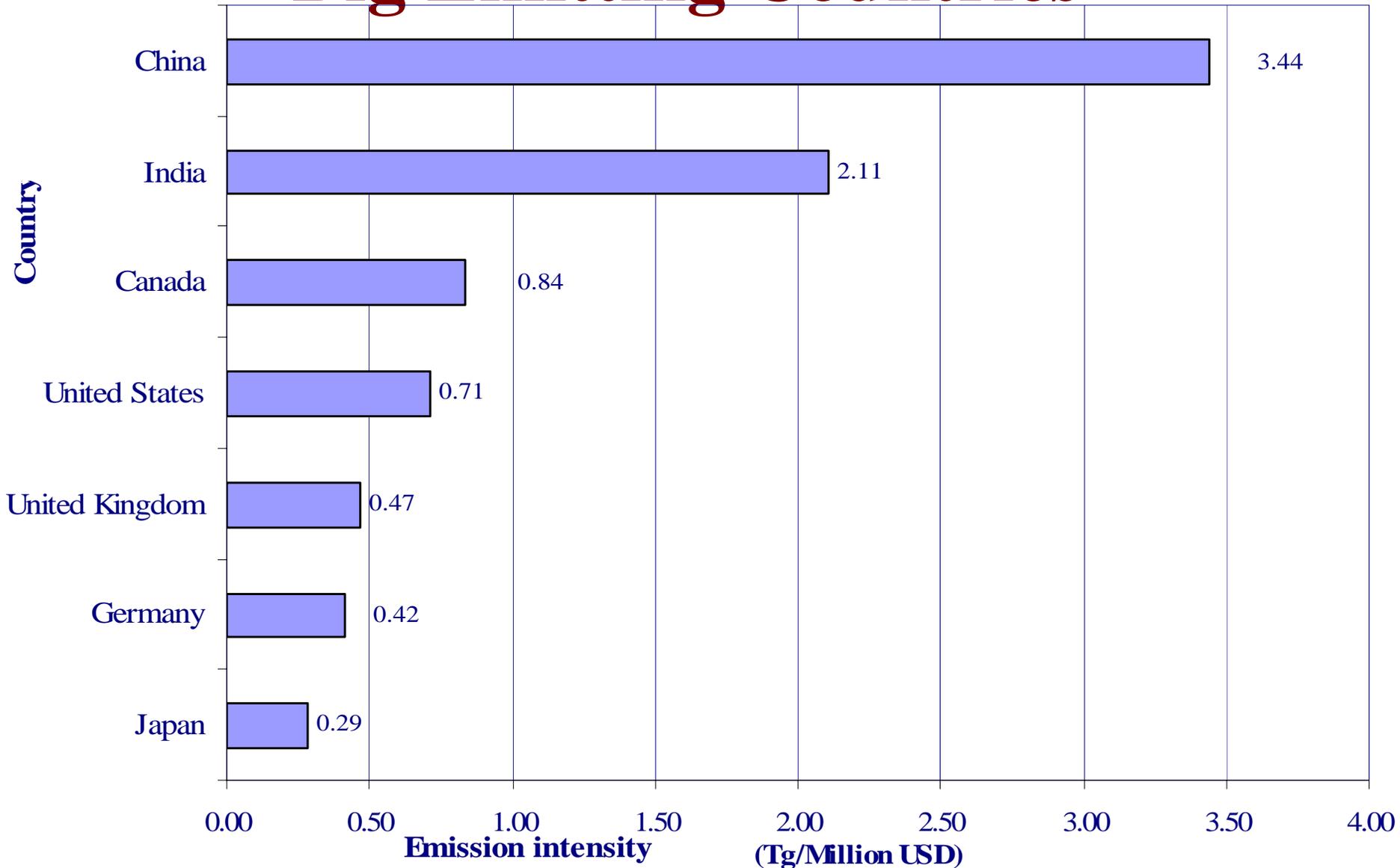
Mapping of CH_4 Emission Sources to GTAP Sectors

Sources of CH_4 emissions	Activities/drivers	Mapping to GTAP sectors
Stationary Sources	Households burning wood	Households
Mobile Sources	Driving (vehicles running on gasoline/diesel fuel)	Households and transport sector
Coal Mining	Coal production	"15 COL": coal sector
Natural Gas Systems (exploitation/mining)	Natural Gas production	"17 GAS": natural gas sector
Petroleum Systems (exploitation/mining)	Crude Oil production	"16 OIL": crude oil sector
Waste Water treatment	Sanitary service sector output	"56 OSG": sanitary service sector
Rice Cultivation	Harvested area of flooded rice paddies	"1 PDR": paddy rice sector
Enteric Fermentation	Population of ruminants	"9 CTL": cattle, horses, sheep sectors "11 RMK": dairy sector
Ag Residue/Biomass Burning	Crop production	"1 PDR": paddy rice "2 WHT": wheat "3 GRO": other grains "6 C_B": sugar cane and beet
Manure Management	Population of animals	"9 CTL", "10 OAP" ,"11 RMK"
Land-fills	Sanitary service sector output	"56 OSG": sanitary service sector

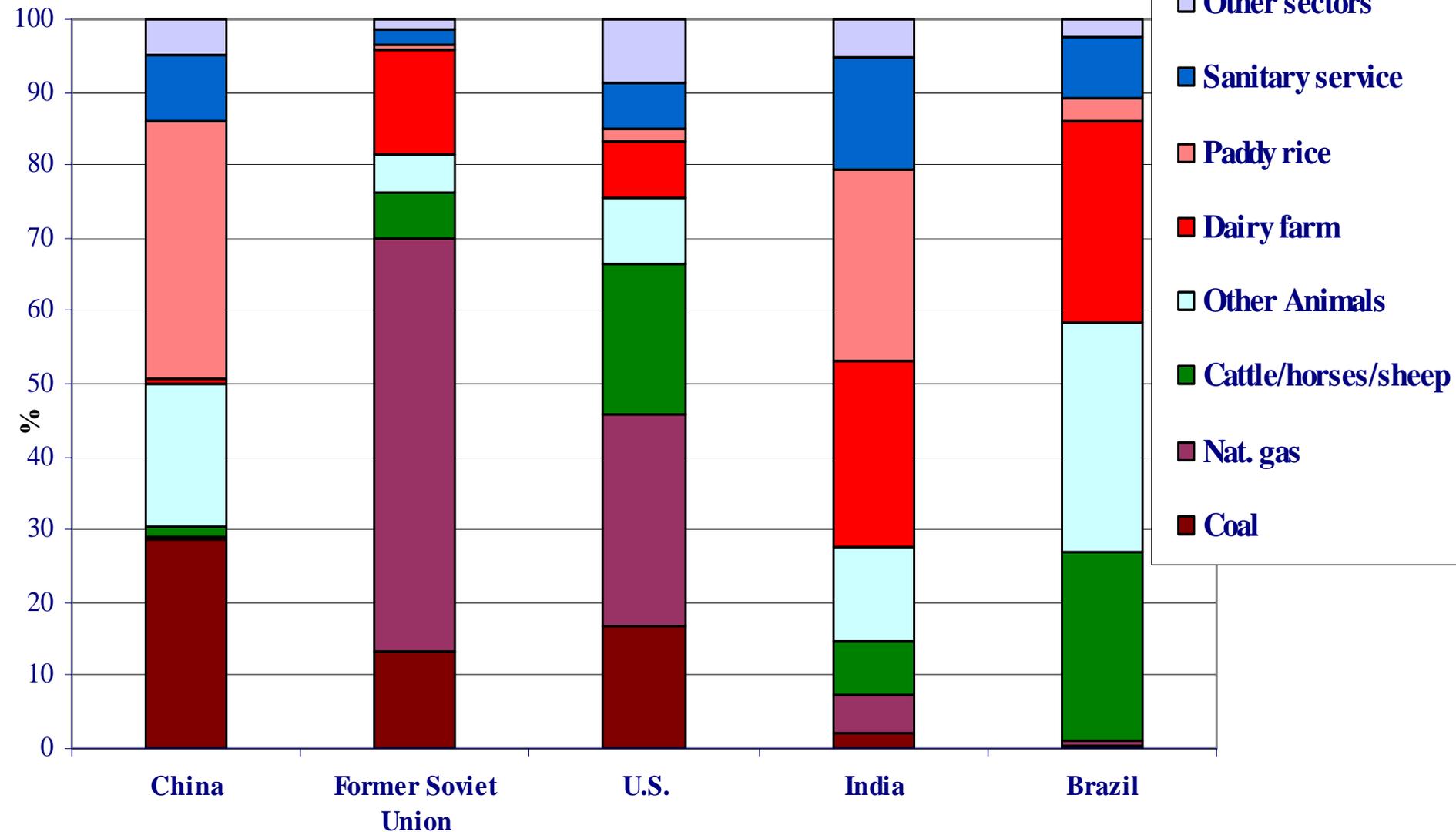# Mapping of N_2O Emission Sources to GTAP Sectors

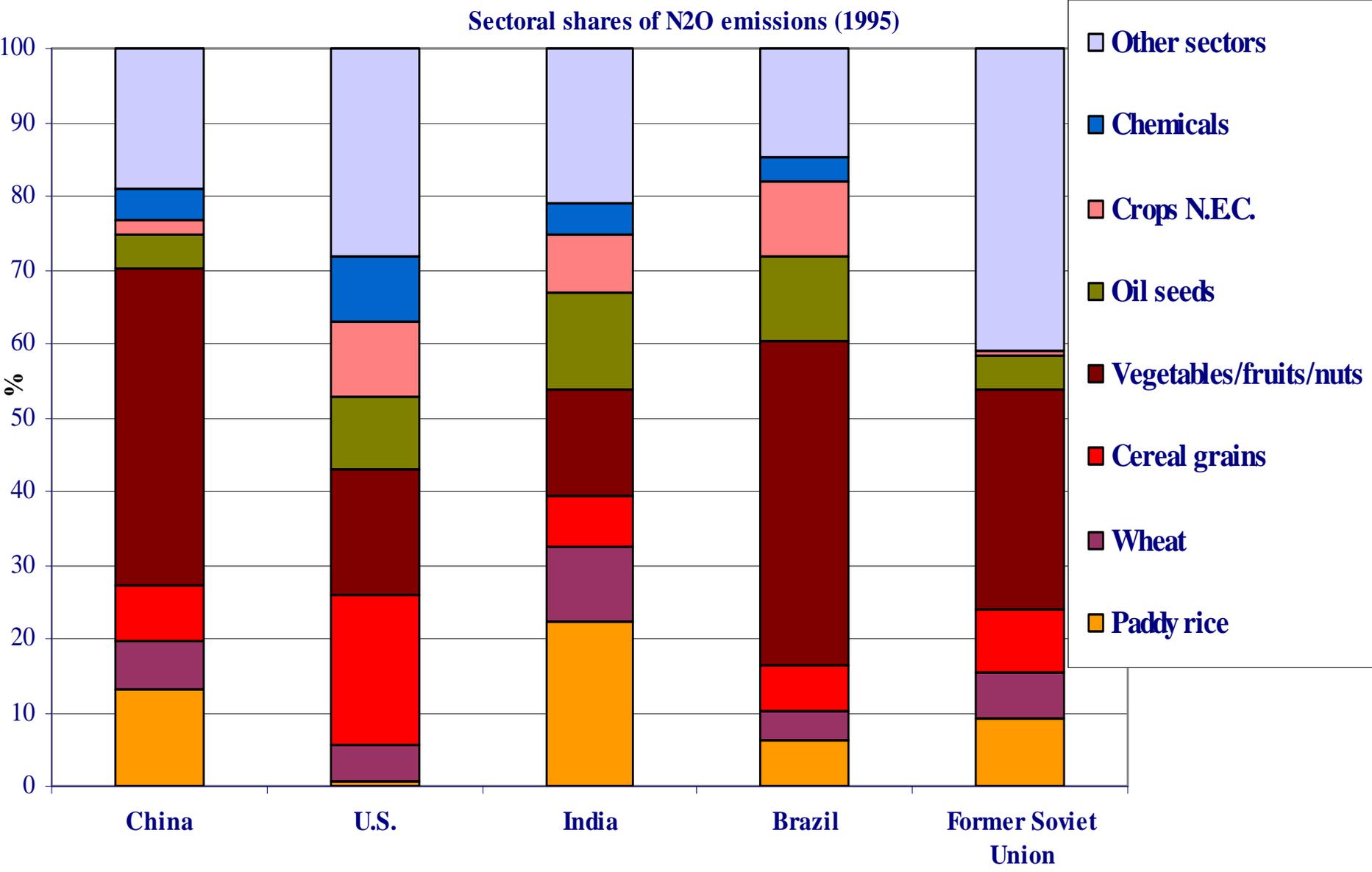| Sources of N_2O emissions	Activities/drivers	Mapping to GTAP sectors
Stationary Sources	Fuel combustion	All sectors that burn fuels
Mobile Sources	Driving (vehicles running on gasoline/diesel fuel)	Households and transport sector
Industrial Process	Chemical production	"33 CRP": chemicals sector
Ag. Soils Management	Agriculture production (fertilizer application)	GTAP sector 1 to 8 (crop sectors)
Manure Management	Population of animals	"9 CTL": cattle, horse, sheep sector "10 OAP": other animals sector "11 RMK": dairy sector
Ag. Residue Burning	Crop production	"1 PDR": paddy rice sector "2 WHT": wheat sector "3 GRO": other grains sector "6 C_B": sugar cane and beet
Human Sewage	Sanitary service output	"56 OSG": sanitary service sector

Mapping of F-gases Emission Sources to GTAP Sectors

		F-gases			
		HFC-134a	CF4	HFC-23	SF6
A. Emissions are released due to use of "inputs" which contain ODS substitutes					
Emissions of F-gases due to use of refrigeration application					
1	Refrigeration/AC (Gg HFC-134a Eq)	HH; IND's			
Emissions of F-gases due to use of ODS substitutes as INPUTs to industrial production					
2	Aerosols (MDI) (Gg HFC-134a Eq)	33 crp			
3	Aerosols (Non-MDI) (Gg HFC-134a Eq)	33 crp			
4	Solvents (Gg HFC-134a Eq)	33 crp			
5	Foams (Gg HFC-134a Eq)	33 crp			
6	Fire Extinguishing (Gg HFC-134a Eq)	33 crp			
7	Semiconductors				
8	*CF4 (PFC) (Gg CF4 Eq)*		40 ele		
9	*C2F6 (PFC) (Gg CF4 Eq)*		40 ele		
10	*C3F8 (PFC) (Gg CF4 Eq)*		40 ele		
11	*NF3 (PFC) (Gg CF4 Eq)*		40 ele		
12	*HFC-23 (Gg CF4 Eq)*		40 ele		
13	*SF6 (Gg CF4 Eq)*		40 ele		
16	Magnesium (Gg SF6 Eq)				36 nfm
17	Electric Trans. & Dist. (Gg SF6 Eq)				43 ely
18	Electric GIS Manufact. (Gg SF6 Eq)				
B. Emissions are proportional to sectoral "output".					
Emissions of F-gases as by-product of industrial production					
14	HCFC-22 Production (Gg HFC-23 Eq)			33 crp	
15	Aluminum (Gg CF4 Eq)		36 nfm		

Region-specific Sectoral Shares of CH$_4$ Emissions: 1995

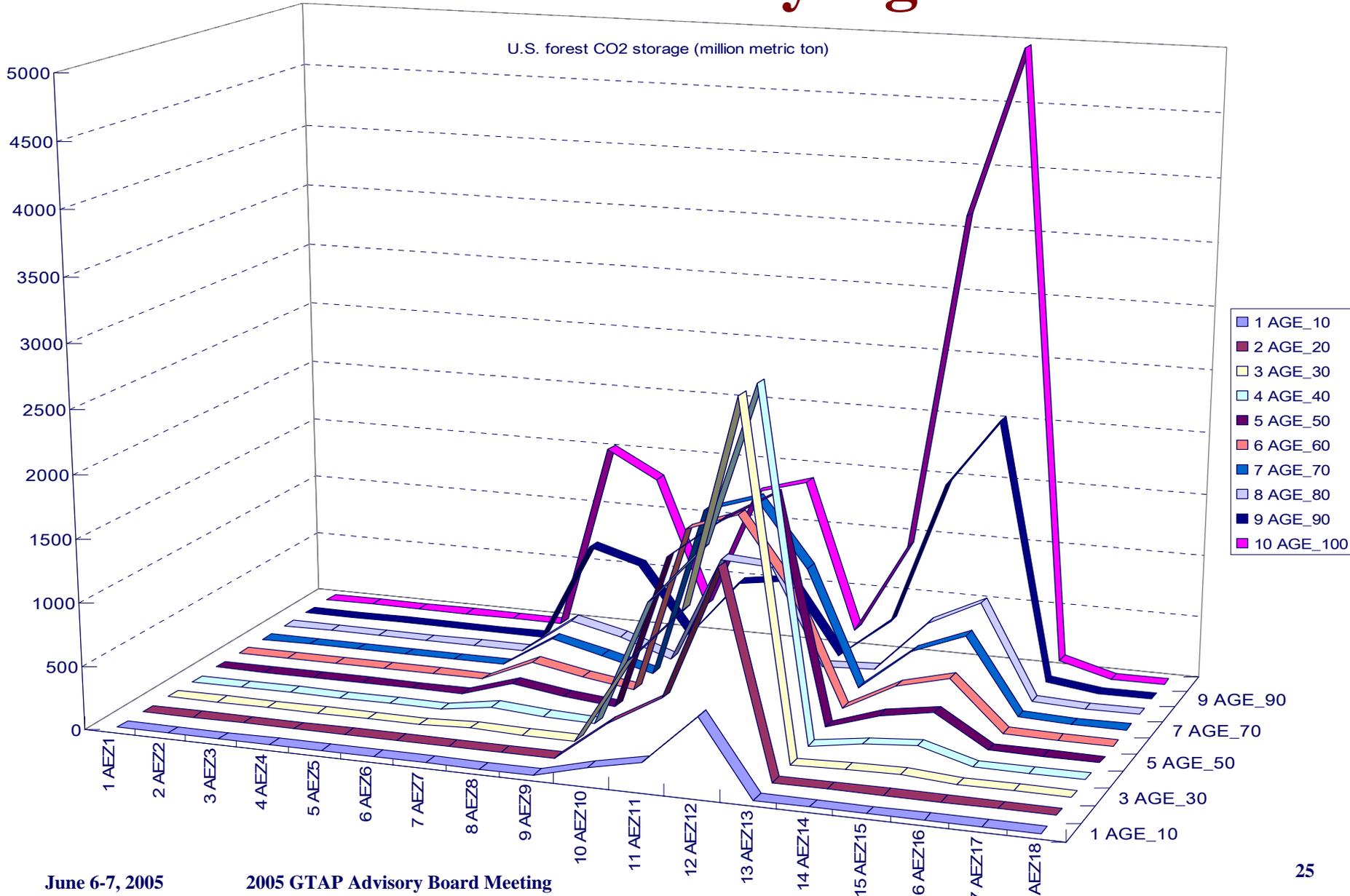Sectoral Shares of CH4 emissions (1995), by country

Legend:
- Other sectors
- Sanitary service
- Paddy rice
- Dairy farm
- Other Animals
- Cattle/horses/sheep
- Nat. gas
- Coal

Countries: China, Former Soviet Union, U.S., India, Brazil

Region-specific Sectoral Shares of N₂O Emissions: 1995

Sectoral shares of N2O emissions (1995)

U.S. All-species Timberland CO₂ Stock Data: AEZ by Age

U.S. forest CO2 storage (million metric ton)

Legend:
- 1 AGE_10
- 2 AGE_20
- 3 AGE_30
- 4 AGE_40
- 5 AGE_50
- 6 AGE_60
- 7 AGE_70
- 8 AGE_80
- 9 AGE_90
- 10 AGE_100

GTAP Project on Developing Land-use and GHG Emissions Data for use in a Computable General Equilibrium Framework

Suggestions and Comments ?!