

 **AIT**
Asian Institute of Technology

ED82.09 Climate Change Seminar

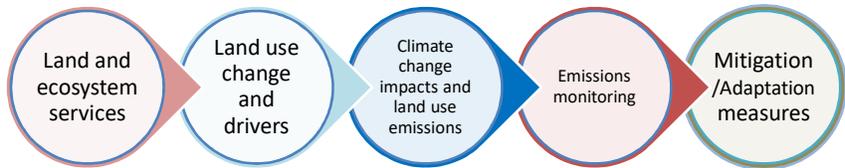
Role of Land Use in Climate Change

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2

Contents



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graph LR; A((Land and ecosystem services)) --> B((Land use change and drivers)); B --> C((Climate change impacts and land use emissions)); C --> D((Emissions monitoring)); D --> E((Mitigation /Adaptation measures));
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Definitions

3

<p>Land: an area of the earth's surface including all elements of the physical and biological environment that influence land use. Thus it refers to landforms, climate, hydrology, vegetation and fauna. <i>Urban, Water, Wetland, Barren land, Tundra (shrub/bush), Agriculture, Range land, Forest</i></p>	<p>Land cover: observed (bio)physical cover on the earth's surface.</p>	<p>Land use: management of land to meet human needs. This includes arrangements, activities and inputs people undertake in a certain land cover type to produce, change or maintain it.</p>
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Land use/cover change: also known as land change is a general term for the human modification of Earth's terrestrial surface.

Major changes	<ul style="list-style-type: none"> ▪ Infrastructure development ▪ Energy production ▪ Mining and quarrying
<ul style="list-style-type: none"> ▪ Agriculture and Forestry ▪ Urbanization 	

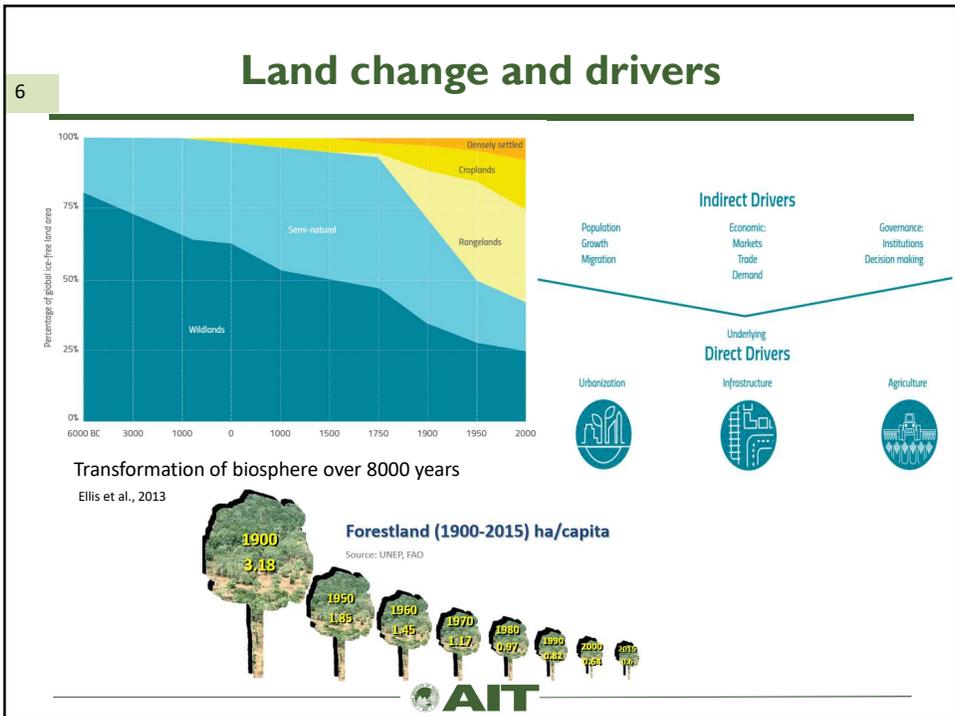
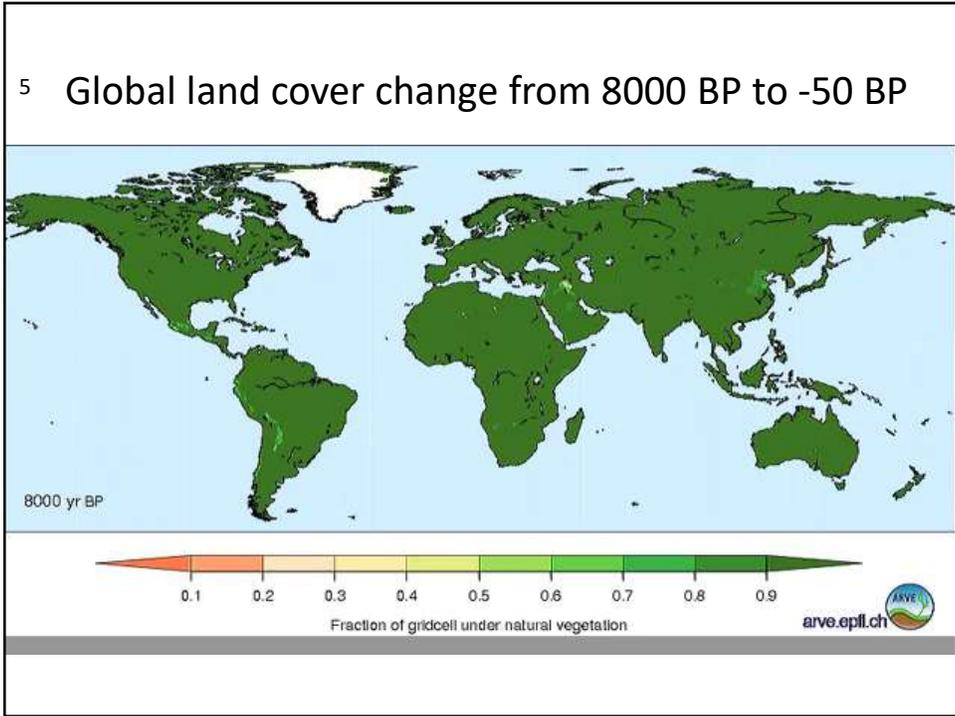


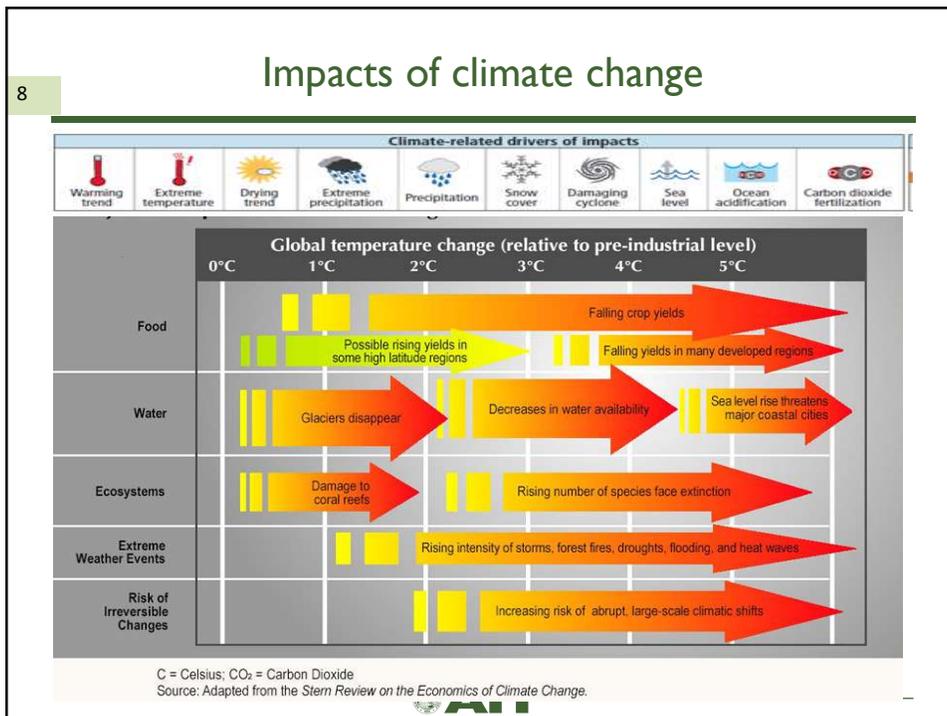
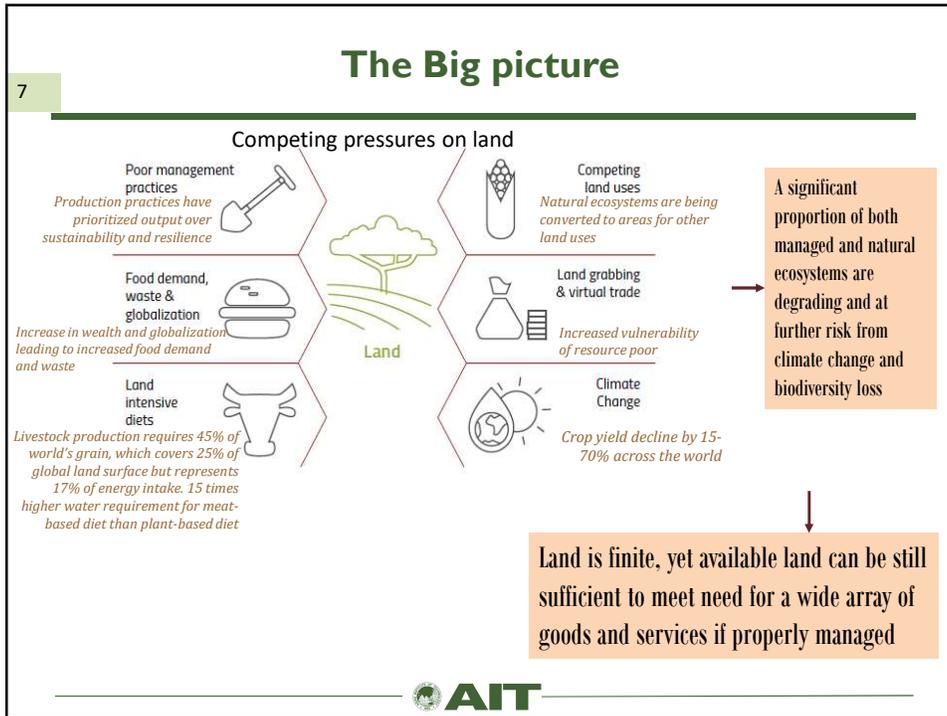
Ecosystem services from Land

4

<p>Provisioning services</p> <p>Food Fibre Water Energy Biodiversity</p>	<p>Supporting services</p> <p>Primary production Decomposition Soil formation, Nutrient cycling Water cycle Evolutionary processes</p>
Land	
<p>Regulating services</p> <p>Climate regulation Pollution control Air, soil and water quality Pollination</p>	<p>Cultural services</p> <p>Recreation Tourism Spiritual Religious</p>





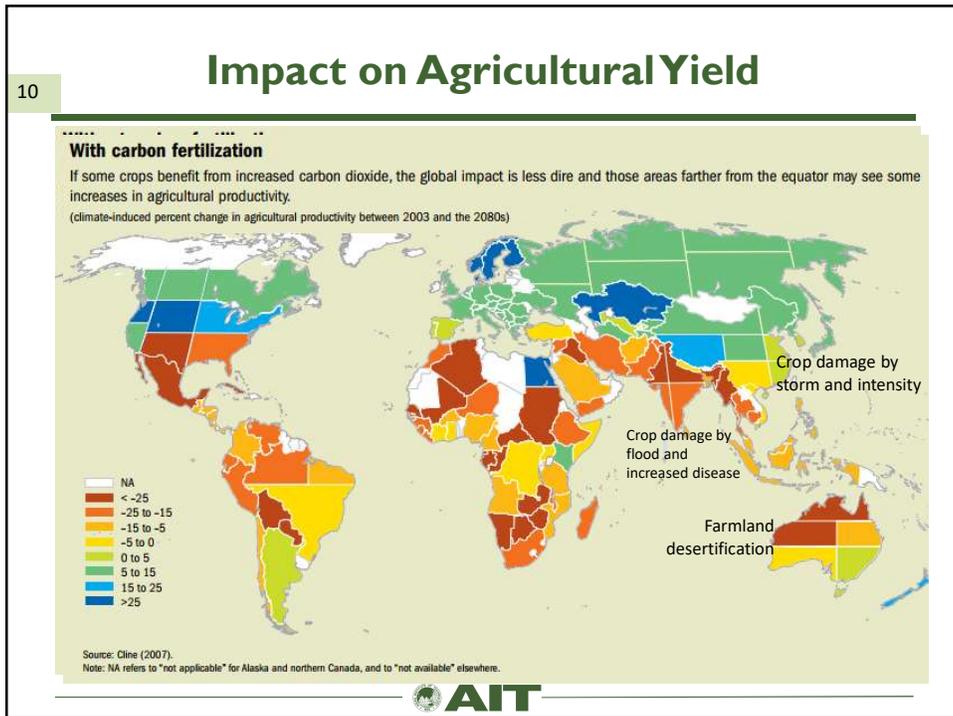


9

Impacts in Asian ecosystem

Asia	
Snow & Ice, Rivers & Lakes, Floods & Drought	<ul style="list-style-type: none"> Permafrost degradation in Siberia, Central Asia, and Tibetan Plateau (<i>high confidence</i>, major contribution from climate change) Shrinking mountain glaciers across most of Asia (<i>medium confidence</i>, major contribution from climate change) Changed water availability in many Chinese rivers, beyond changes due to land use (<i>low confidence</i>, minor contribution from climate change) Increased flow in several rivers due to shrinking glaciers (<i>high confidence</i>, major contribution from climate change) Earlier timing of maximum spring flood in Russian rivers (<i>medium confidence</i>, major contribution from climate change) Reduced soil moisture in north-central and northeast China (1950–2006) (<i>medium confidence</i>, major contribution from climate change) Surface water degradation in parts of Asia, beyond changes due to land use (<i>medium confidence</i>, minor contribution from climate change) <p>[24.3-4, 28.2, Tables 18-5, 18-6, and SM24-4, Box 3-1; WGI AR5 4.3, 10.5]</p>
Terrestrial Ecosystems	<ul style="list-style-type: none"> Changes in plant phenology and growth in many parts of Asia (earlier greening), particularly in the north and east (<i>medium confidence</i>, major contribution from climate change) Distribution shifts of many plant and animal species upwards in elevation or polewards, particularly in the north of Asia (<i>medium confidence</i>, major contribution from climate change) Invasion of Siberian larch forests by pine and spruce during recent decades (<i>low confidence</i>, major contribution from climate change) Advance of shrubs into the Siberian tundra (<i>high confidence</i>, major contribution from climate change) <p>[4.3, 24.4, 28.2, Table 18-7, Figure 4-4]</p>
Coastal Erosion & Marine Ecosystems	<ul style="list-style-type: none"> Decline in coral reefs in tropical Asian waters, beyond decline due to human impacts (<i>high confidence</i>, major contribution from climate change) Northward range extension of corals in the East China Sea and western Pacific, and of a predatory fish in the Sea of Japan (<i>medium confidence</i>, major contribution from climate change) Shift from sardines to anchovies in the western North Pacific, beyond fluctuations due to fisheries (<i>low confidence</i>, major contribution from climate change) Increased coastal erosion in Arctic Asia (<i>low confidence</i>, major contribution from climate change) <p>[6.3, 24.4, 30.5, Tables 6-2 and 18-8]</p>
Food Production & Livelihoods	<ul style="list-style-type: none"> Impacts on livelihoods of indigenous groups in Arctic Russia, beyond economic and sociopolitical changes (<i>low confidence</i>, major contribution from climate change) Negative impacts on aggregate wheat yields in South Asia, beyond increase due to improved technology (<i>medium confidence</i>, minor contribution from climate change) Negative impacts on aggregate wheat and maize yields in China, beyond increase due to improved technology (<i>low confidence</i>, minor contribution from climate change) Increases in a water-borne disease in Israel (<i>low confidence</i>, minor contribution from climate change) <p>[7.2, 13.2, 18.4, 28.2, Tables 18-4 and 18-9, Figure 7-2]</p>

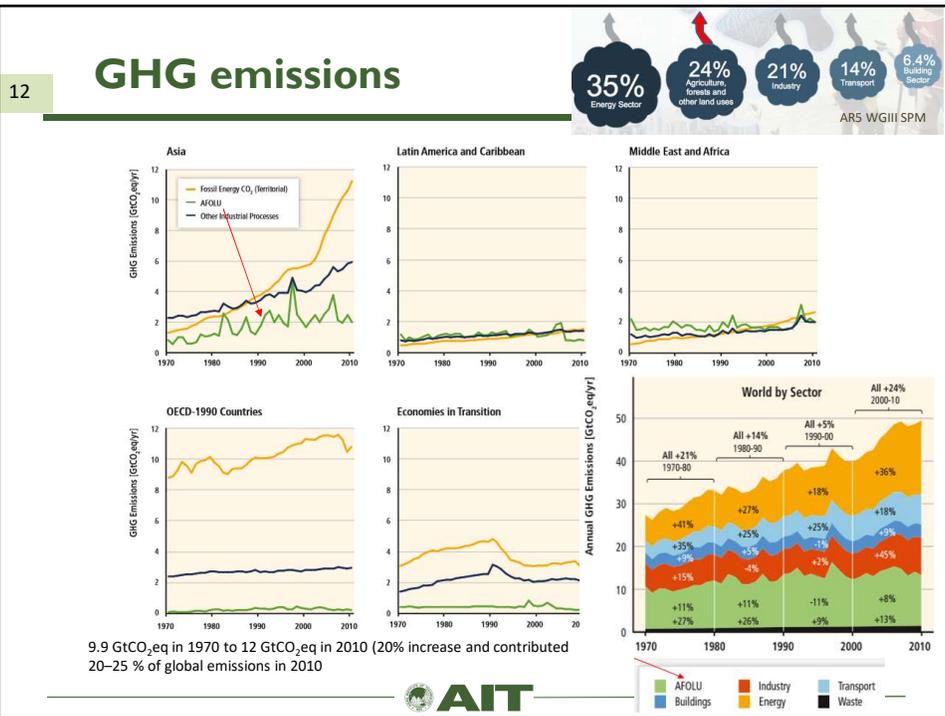
WGII-ARS Part A



11

Impact studies

Region	Sub-region	Yield impacts (%)	Scenario	Reference
World		<ul style="list-style-type: none"> (I) Maize: -4, -7 (II) Maize: -2, -12 (I) Rice: -9.5, -12 (II) Rice: -1, -0.07 (I) Wheat: -10, -13 (II) Wheat: -4, -10 	A1B CSIRO, MIROC 2050	Nelson et al. (2010)
East Asia	China	<ul style="list-style-type: none"> (I) Maize: -10.9 to -1.4 (-7.8 to -1.6), -21.7 to -8.8 (-16.4 to -10.2), -32.1 to -4.3 (-26.6 to -3.9) (II) Maize: -22.2 to -1.0 (-10.8 to +0.7), -27.6 to -7.9 (-18.1 to -5.4), -33.7 to -4.4 (-25.8 to -1.6) (I) Rice: -18.6 to -6.1 (-10.1 to +3.3), -31.9 to -13.5 (-16.1 to +2.5), -40.2 to -23.6 (-19.3 to +0.18) 	+1°C, +2°C, +3°C -CO ₂ , (+CO ₂)	Tao et al. (2011)
	Eastern China	<ul style="list-style-type: none"> Rice: -18 to +3 (+7.5 to +17.5), -26.7 to +2 (0 to +25), -39 to -6 (-10 to +25) 	2030, 2050, 2080 -CO ₂ , (+CO ₂)	Tao and Zhang (2013)
	Huang-Huai-Hai Plain, China	Wheat-maize: +4.5 ± 14.8, -5.8 ± 25.8	+2°C, +5°C	Liu et al. (2010)
	North China Plain	<ul style="list-style-type: none"> (I) Wheat: -0.9 (+23) (II) Wheat: -1.9 (+28) 	A1B 2085-2100 -CO ₂ , (+CO ₂) MIROC	Yang et al. (2013)
	Yangtze River, China	<ul style="list-style-type: none"> (I) Rice: -14.8 (-3.3) (II) Rice: -15.2 (-4.1) 	B2 2021-2050 -CO ₂ , (+CO ₂)	Shen et al. (2011)
South Asia	South Asia	<ul style="list-style-type: none"> Maize: -16 Sorghum: -11 	2050	Knox et al. (2012)
	South Asia	Net cereal production: -4 to -10	+3°C	Lal (2011)
	India	Winter sorghum: up to -7, -11, -32	A2 2020, 2050, 2080	Srivastava et al. (2010)
		<ul style="list-style-type: none"> (I) Rice: -4, -7, -10 (II) Rice: -6, -2.5, -2.5 	A1B, A2, B1, B2 2020, 2050, 2080 -CO ₂ , (+CO ₂) MIROC, PRECIS/HadCM3	Kumar et al. (2013)
		<ul style="list-style-type: none"> Monsoon maize: -21 to 0, -35 to 0, -35 to 0 Winter maize: -13 to +5, -50 to +5, -40 to -21 	A2 2020, 2050, 2080 HadCM3	Byjesh et al. (2010)
	Northeast India	<ul style="list-style-type: none"> (I) Rice: -10 to +5 (II) Rice: -35 to +5 Maize: up to -40 Wheat: up to -20 	A1B 2020 +CO ₂ PRECIS/HadCM3	Kumar et al. (2011)
	Coastal India	<ul style="list-style-type: none"> (I) Rice: -10 to +5 (II) Rice: -20 to +15 (I) Maize: -50 to -15 (II) Maize: -35 to +10 		
	Western Ghats, India	<ul style="list-style-type: none"> (I) Rice: -11 to +5 (II) Rice: -35 to +35 Maize: up to -50 Sorghum: up to -50 		
	Pakistan	Wheat: -7, -24 (Swat), +14, +23 (Chitral)	+1.5°C, +3°C	Section 24.4.4.3
		<ul style="list-style-type: none"> Wheat: -6, -8 Rice: -16, -19 	B2, A2 2080	Iqbal et al. (2009)



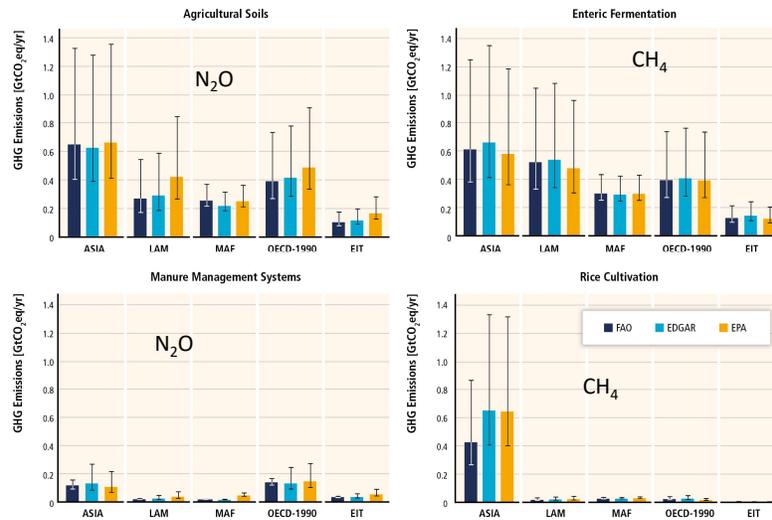
13

Emission according to country groupings



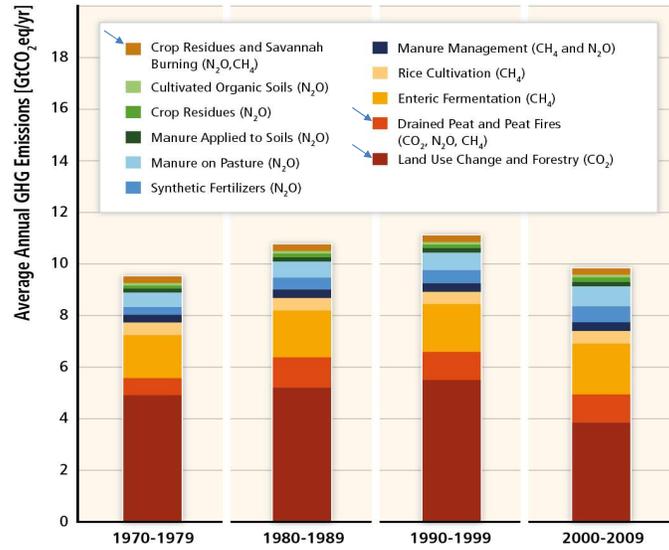
14

Emissions by Agricultural practices



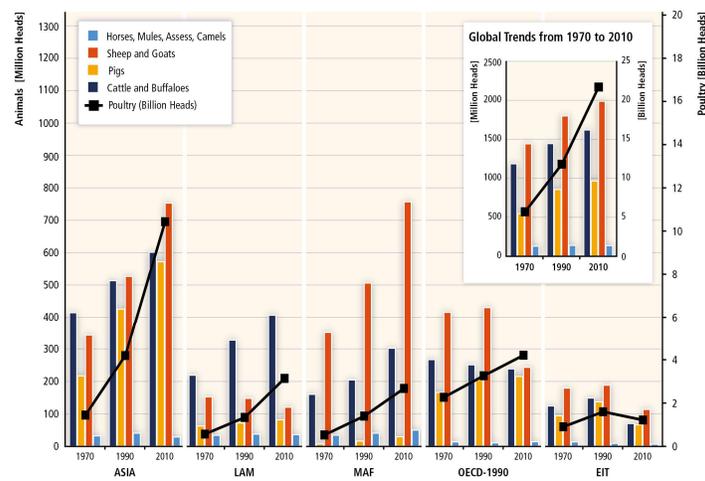
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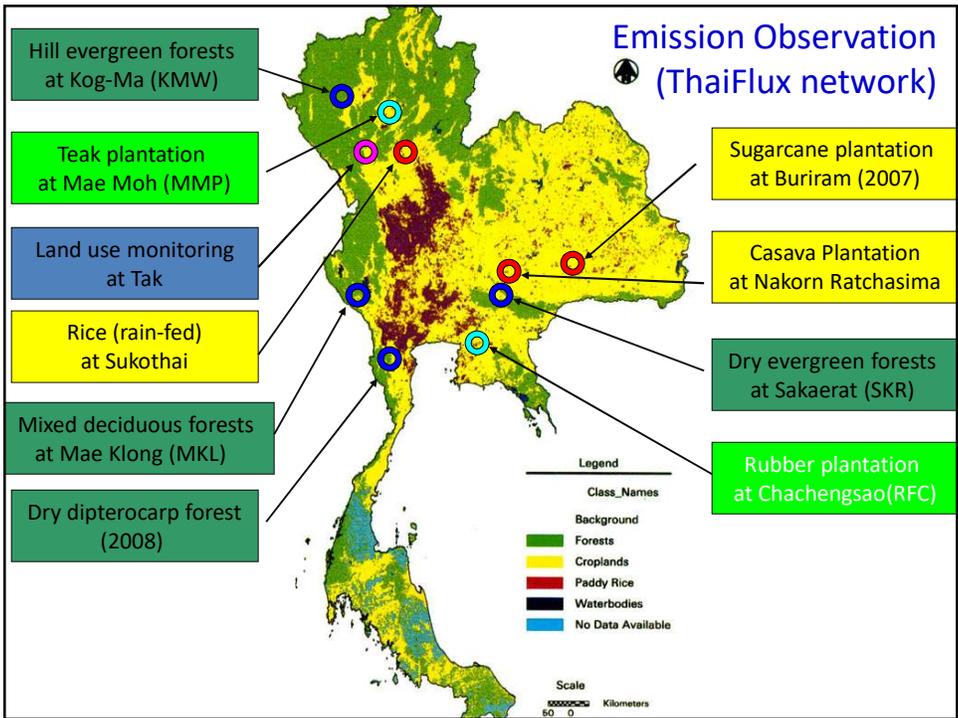
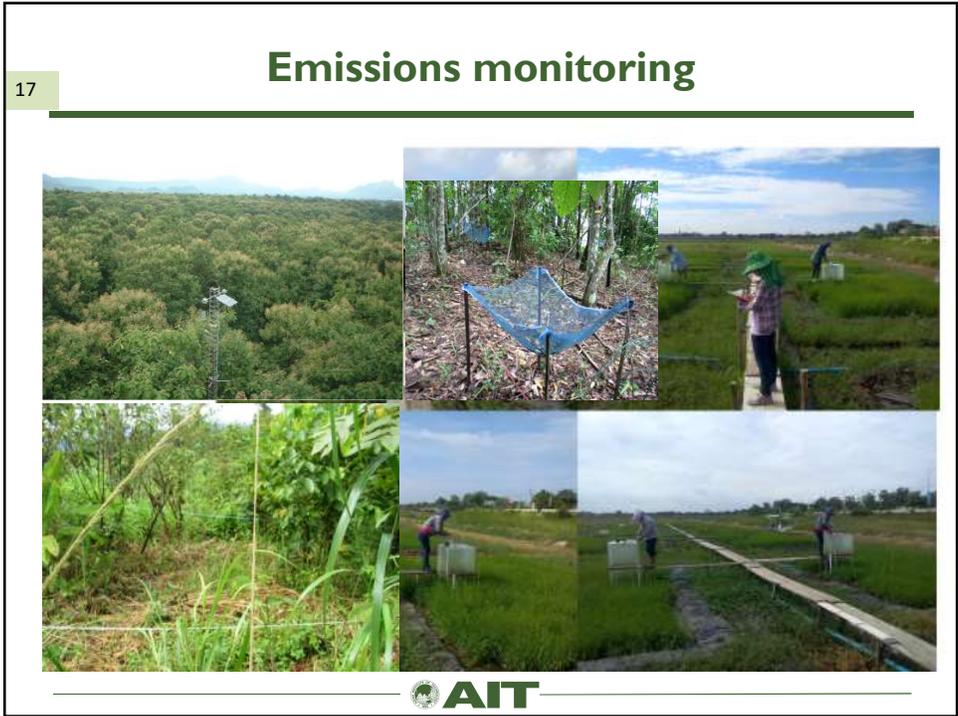
Emissions by Agricultural practices

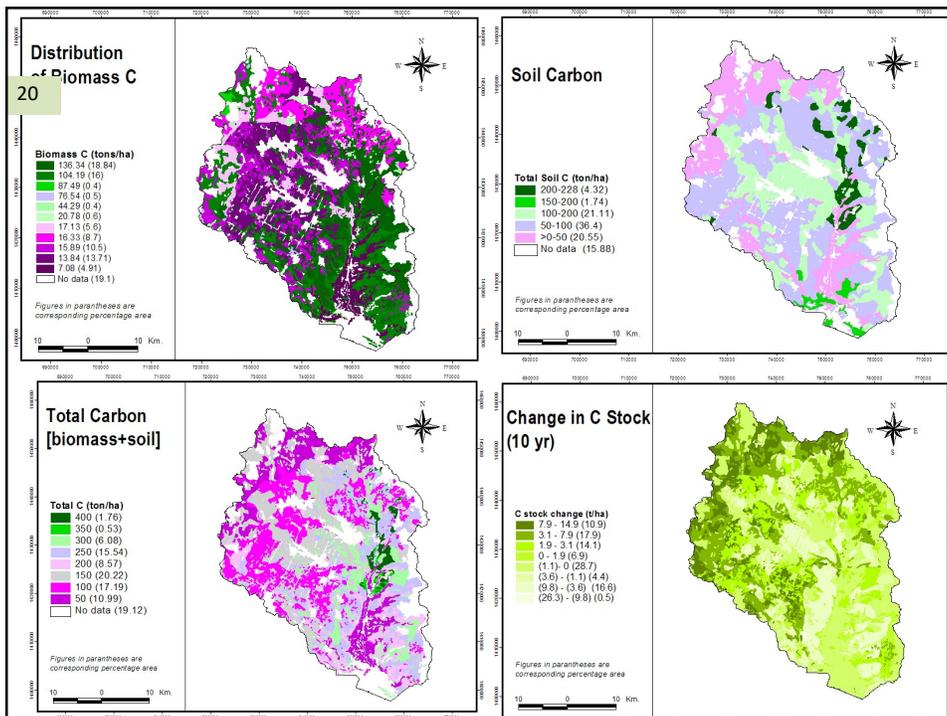
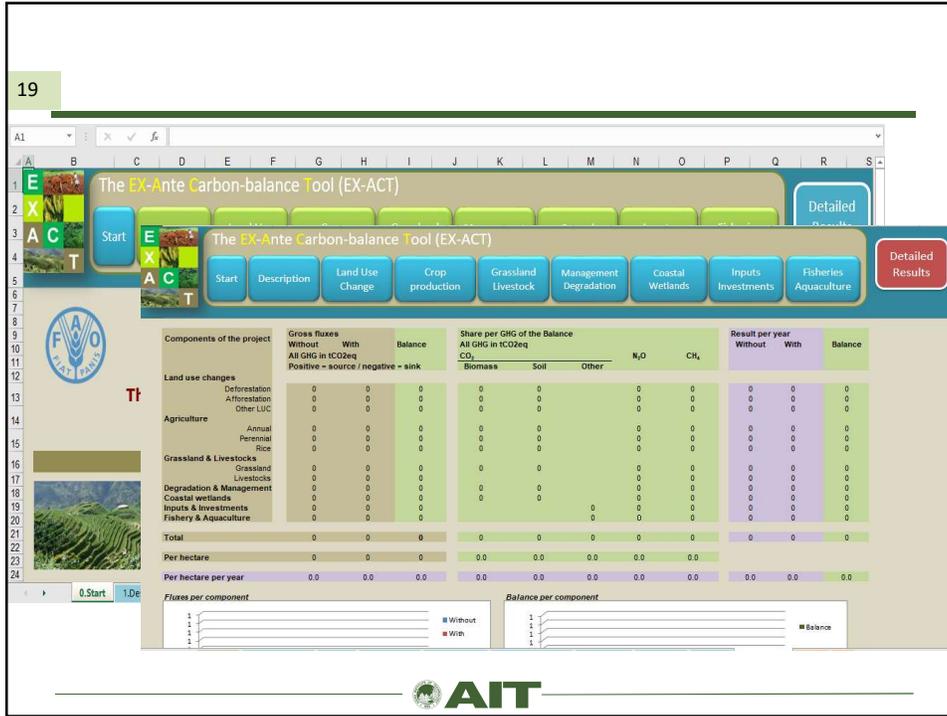


16

Animal population





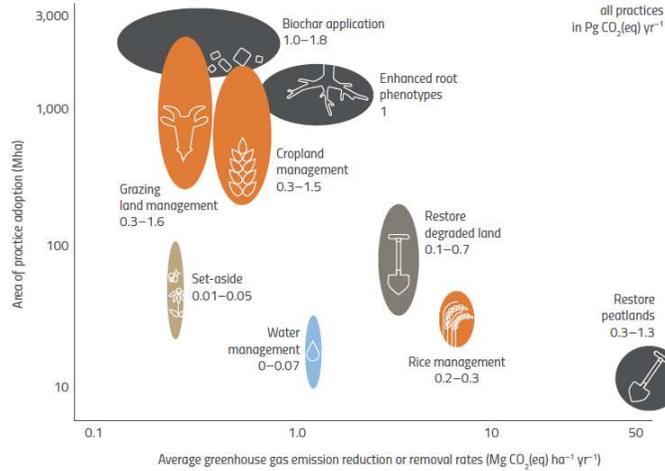


21

Mitigation potential

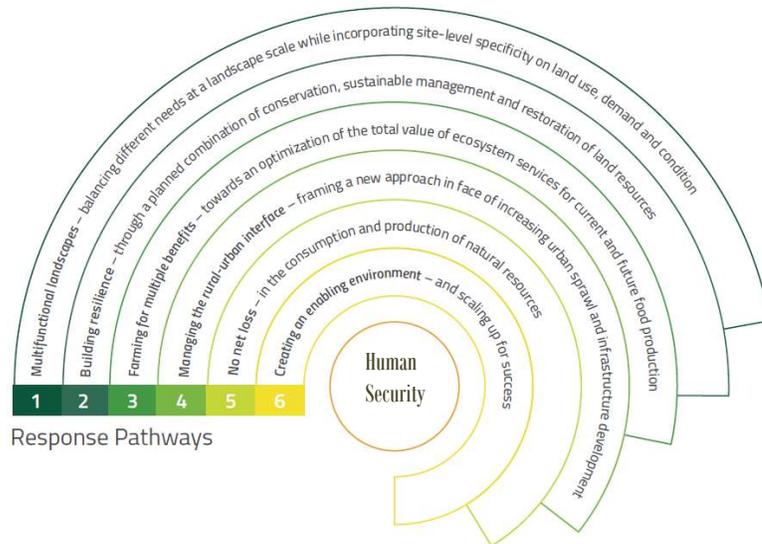


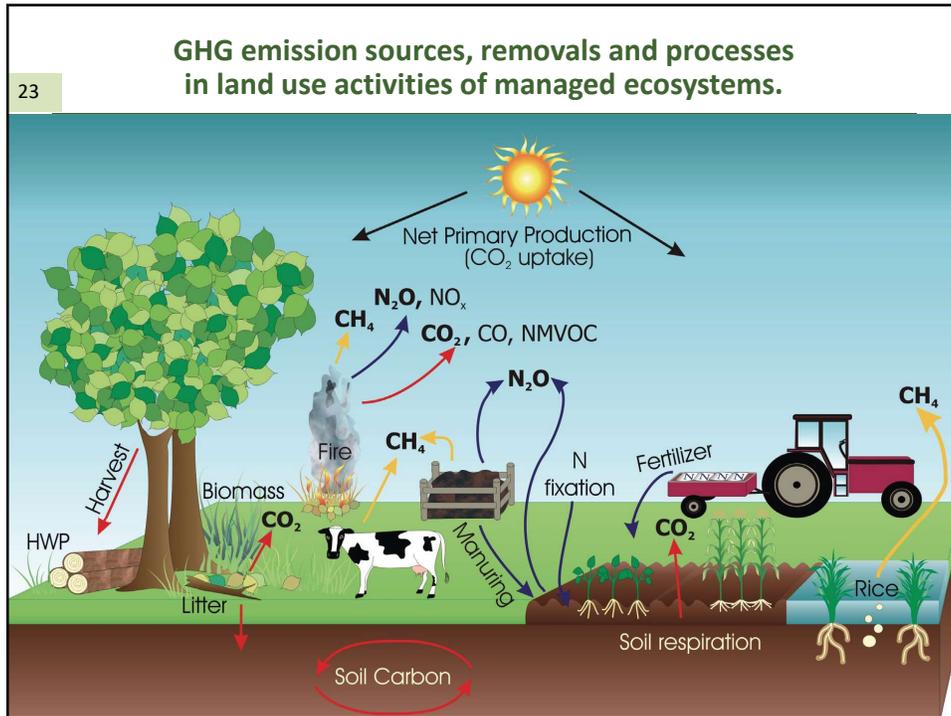
Global potential for agricultural based GHG mitigation practices



22

Response pathways





24

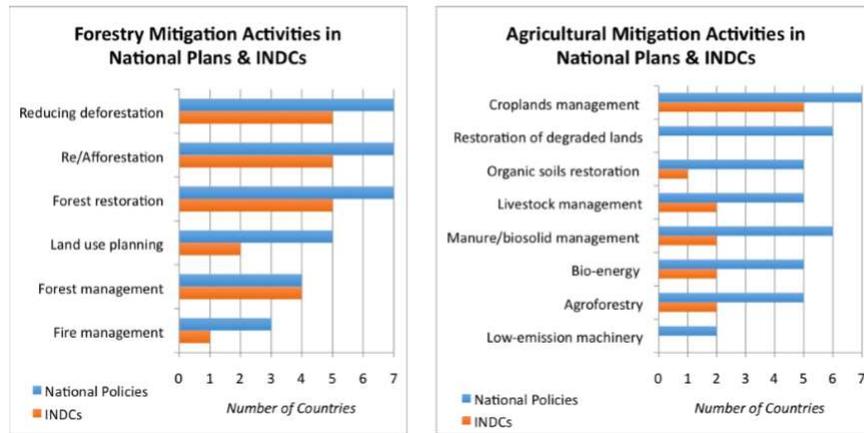
Mitigation measures in AFOLU sector

- **Supply-side improvements**
 - **Emissions reduction:** of methane (e. g., livestock management) and nitrous oxide (fertilizer and manure management) and prevention of emissions to the atmosphere by conserving existing carbon pools in soils or vegetation (reducing deforestation and forest degradation, fire prevention / control, agroforestry)
 - **Sequestration/Enhancing removals:** Increasing the size of existing carbon pools, thereby extracting CO₂ from the atmosphere (e. g., afforestation, reforestation, integrated systems, carbon sequestration in soils)
 - **Substitution/Avoiding or displacing emissions:** of biological products for fossil fuels or energy-intensive products, thereby reducing CO₂ emissions, e. g., biomass co-firing / CHP, biofuels, biomass-based stoves, and insulation products
- **Demand-side measures**
 - Reducing losses and wastes of food;
 - Changes in human diets towards less emission-intensive products;
 - Use of long-lived wood products

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25

Mitigation activities in Asian countries



26

Adaptation Technologies in Agriculture

Technology categories	Technologies	Country where used
Conservation Tillage	1. Small-scale conservation tillage	Kenya, Philippines
	2. Minimum tillage and direct planting	Ghana
	3. Conservation tillage for large scale production	Kenya, Brazil
Sustainable Water Use and Management	1. Sprinkler and Dripping Irrigation	Indonesia, Zimbabwe, Peru
	2. Fog Harvesting	Nepal
	3. Rainwater Harvesting	Paraguay, Philippine and India, Niger, Zambia
	4. Smallholder irrigation management	Senegal, Eritrea, Niger
Soil Management	1. Slow-forming Terraces, cross-slope barriers	Ecuador, Philippines, Cape Verde, Kenya, Ethiopia
	2. Integrated Nutrient Management	Uganda, India, Nicaragua
Sustainable Crop Management	1. Crop Diversification and New varieties	Uganda, India
	2. New Varieties through Biotechnology	India, Africa
	3. Ecological Pest Management	Indonesia, Africa, India
	4. Seed and Grain Storage	Afghanistan, Kenya
Integrated crop-livestock Management	1. Grazing land improvement and management	Niger, Ethiopia, Togo
	2. Selective breeding and livestock Disease Management	Peru, Madagascar
Sustainable Farming Systems	1. Mixed Farming	Bangladesh, Laos, Honduras
	2. Agro-forestry and sustainable forest management	India, Mexico, Tanzania, Togo, Kenya, Niger, Burkna Faso, Senegal, Eritrea, Burkina Faso, Madagascar

27

Conservation -Tillage Cropping

- Minimal disturbance of the soil surface is critical in avoiding soil organic matter loss from erosion and microbial decomposition.
- **No tillage** needs high-residue producing cropping system to be effective.







SOC sequestration (Virginia)
0.28 ± 0.44 Mg C/ha/yr
(without cover cropping)



0.53 ± 0.45 Mg C/ha/yr
(with cover cropping)



<http://www.climatetechwiki.org/content/conservation-tillage>

Franzluebbers (2005) Soil Tillage Res. 83:120-147.

28

Drip irrigation



Source: Courtesy of Rafael Galvão, Farm Manager Agriver SAC (2011)







Planting date adjustment of Soybean in Northern Thailand

29

- Experiments on - germination %, seed vigor, protein and oil content, yield
- 3 Varieties tested (MJ 9769-8; CM 9513-3; CM 60)
- Usual length of growing period in the area - 15 Dec - 15 Jan
- Observed changed growing period
 - For grain production (15 Nov - 5 Jan)
 - For seed production (15 Nov - 25 Dec)
- **Planting date is changed by**
 - before 10-20 days

Wannasai et. al., 2011



Irrigation Management

30

CH₄ and N₂O emissions, Rice Yield in Continuous flooding and Alternate Wet and Dry

Wet season								
Water regime	Residue	Total amount of CH ₄ (kg ha ⁻¹ crop)	Total amount of N ₂ O (kg ha ⁻¹ crop)	GWPC _{H₄} (*25) kg CO ₂ eq	GWPN ₂ O (*298) kg CO ₂ eq	GWP net	yield (kg/ha)	GHGI
CF	RS _I	126.86	4.00	3171.50	1192.00	4363.50	3590.99	1.22
	RS _B	155.1	4.23	3877.51	1260.54	5138.04	4047.81	1.27
	WRS _{I-B}	72.79	4.51	1819.75	1343.98	3163.73	3490.81	0.91
AWD	RS _I	81.04	4.21	2026.00	1254.58	3280.58	4187.00	0.78
	RS _B	64.45	4.79	1611.25	1427.42	3038.67	4196.31	0.72
	WRS _{I-B}	60.96	4.39	1524.00	1308.22	2832.22	4459.69	0.64

Dry season								
Water regime	Residue	Total amount of CH ₄ (kg ha ⁻¹ crop)	Total amount of N ₂ O (kg ha ⁻¹ crop)	GWPC _{H₄} (*25) kg CO ₂ eq	GWPN ₂ O (*298) kg CO ₂ eq	GWP net	yield (kg/ha)	GHGI
CF	RS _I	118.49	3.18	2962.19	947.64	3909.83	3855.88	1.01
	RS _B	85.11	3.32	2127.82	989.36	3117.18	4048.77	0.77
	WRS _{I-B}	33.18	3.21	829.44	956.58	1786.02	3824.71	0.47
AWD	RS _I	74.80	3.39	1870.06	1010.22	2880.28	4270.13	0.67
	RS _B	51.56	3.57	1289.08	1063.86	2352.94	4142.25	0.57
	WRS _{I-B}	34.50	3.75	862.39	1117.50	1979.89	4172.92	0.47

31

Concluding remarks

The diagram is a flowchart with five main components connected by dashed arrows. At the top is 'Land Use Planning' (Integrated Landscape Approach). An arrow points down to 'Land Management Practices' (Conservation, SLM & Restoration), which is circled in purple. To the right of this box is the text 'Rural, Urban, Energy, Infrastructure'. An arrow points down from 'Land Management Practices' to 'Soil, Water & Biodiversity'. To the left of this box is the text 'Governance' and 'Climate Change'. An arrow points down from 'Soil, Water & Biodiversity' to 'Land Health & Productivity'. An arrow points down from 'Land Health & Productivity' to 'Human Security' (food, water, energy, livelihoods).

- Information and Knowledge
- Public awareness
- Economic, financial, and policy instruments
- Non-permanence/Reversibility
- Displacement/Leakage

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32

The End

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