



Bhutan and Climate Change



Sonam Dagay
National Environment Commission
Royal Government of Bhutan



Outline ∞

- ❖ Bhutan in brief
- ❖ Bhutan's Vulnerability
- ❖ Potential Impacts and adaptation needs
- ❖ National GHG Inventory (SNC)

Bhutan in brief



- ✓ LDC with a very fragile mountainous terrain
- ✓ Total Area of 38, 394 Sq. Km
- ✓ Approx. 779,666 people
- ✓ Constitutional mandate: 60% of total area under forest cover for all times
- ✓ Current Forest Cover 80.9 %
-42.7 % Protected Area
- ✓ Approx. 69% of population dependent on agriculture
- ✓ Hydropower, agriculture, tourism- economy

Bhutan's Vulnerability to Climate Change



fragile mountainous landscape



landlocked & least developed country

Heavy dependence on climate sensitive sectors
Low level of economic diversification



Agrarian society
(69% of population)



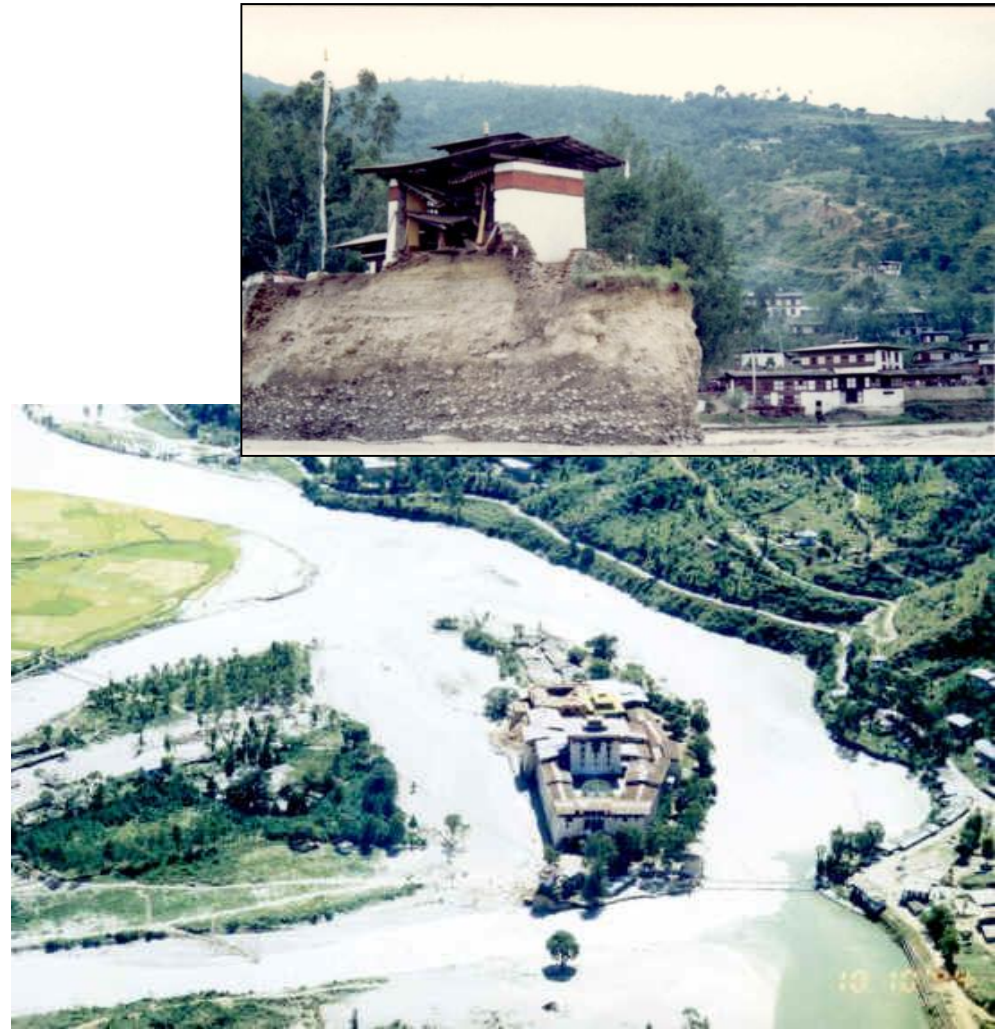
Large investments in
hydropower

Large areas of glaciers and glacial lakes



Current Vulnerabilities

- Glacial Lake Outburst Floods
 - due to temperature rise
- Land Degradation
 - Landslides, erosion due changes in to weather patterns, high intensity rainfall, cyclones
- Flashfloods
 - Intense rainfall periods, cyclones



Current Vulnerabilities

- Droughts
 - Drying water sources due to temperature rise, longer intervals between rains
- Wind and Thunder storms
- Pests and diseases



Potential areas impacts of climate change in Bhutan



Human Health

Rising Temperatures may cause the spread of tropical diseases and heat stress into higher altitudes.



Natural Disasters

Rapidly retreating alpine glaciers is increasing the risk of 'glacial lake outburst floods' endangering life and property downstream. Increasing flash floods may also be caused by intensifying



Agriculture

80% of the Bhutanese practice subsistence farming. Climate Change can cause changes in temperature and precipitation patterns and increase the vulnerability of a large group of this population.



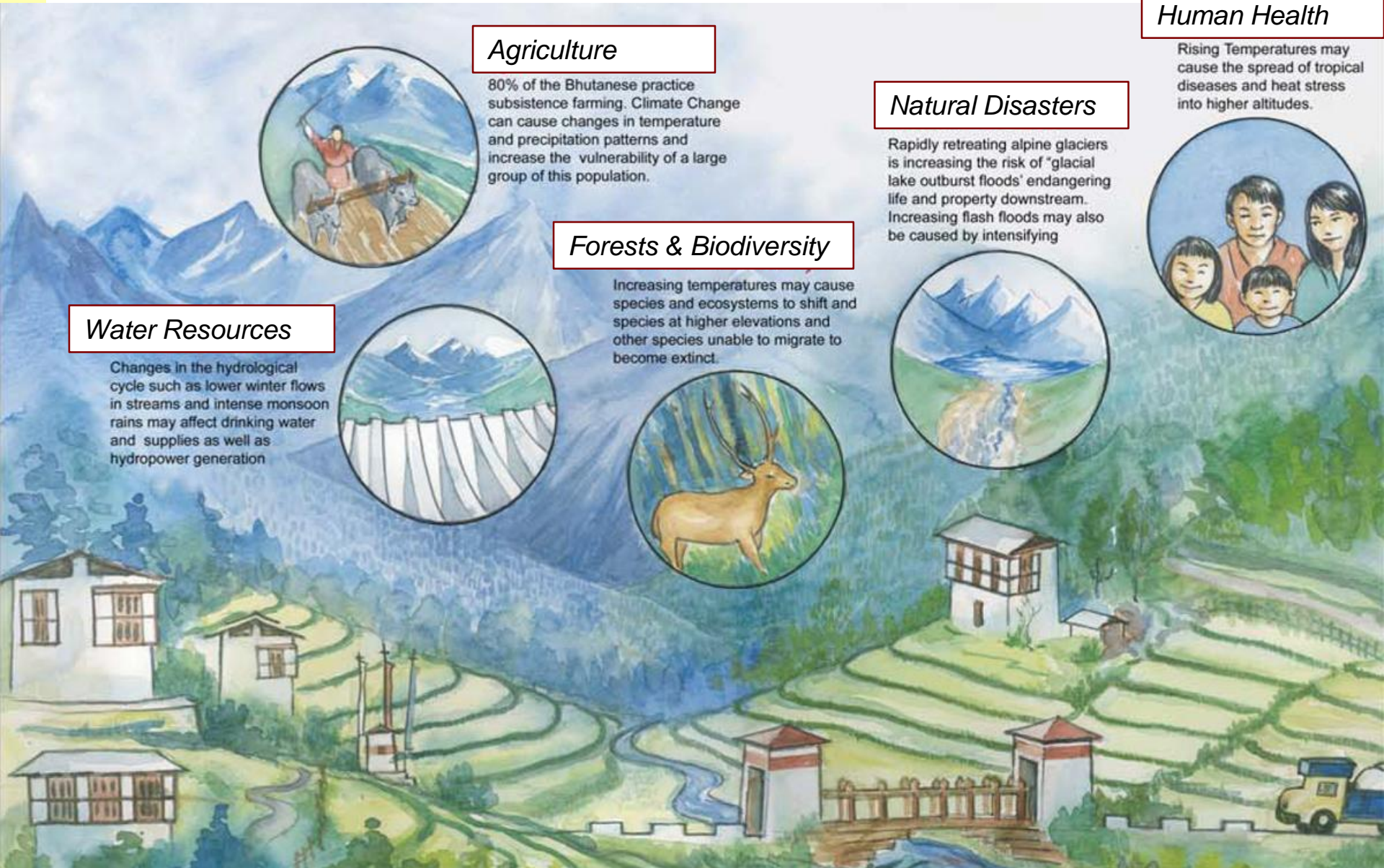
Forests & Biodiversity

Increasing temperatures may cause species and ecosystems to shift and species at higher elevations and other species unable to migrate to become extinct.



Water Resources

Changes in the hydrological cycle such as lower winter flows in streams and intense monsoon rains may affect drinking water and supplies as well as hydropower generation



Climate Change Scenarios and potential adverse impacts





Climate Change Projections: summary

Temperature changes by 2069 compared to present

- average annual temperature +3.5 C
- monsoon season average temperature +3.0 C
- winter season average temperature +3.5 - 4.0 C

Rainfall changes by 2069 compared to present

- change in the amount (increase in annual precipitation)
- slightly wetter conditions in the warm monsoonal months
- slightly drier conditions in the dry winter months.



Potential Impacts based on Scenarios

Water Resources (using WEAP + model results)

- At gross level (main river and rainfall), enough water in the country
- However local shortages and droughts (above rivers)

Agriculture (case studies using DSSAT + model results),

- Maize (Kanglung) moderate decrease in potential production
- Rice (Bhur) moderate decrease in potential production
- Potatoes (Phobjikha) significant increases in potato yields in the future

Forests (using Holdridge classification + model results)

- general northward migration of major forest classes
- subtropical species invading the southern margins and alpine species decreasing on the northern margins.



Adaptation Priorities

Short term Immediate Actions

1. Disaster Risk Reduction and Management
2. Landslide Management and Flood Prevention
3. Application of Environment Friendly Road Construction
4. Enhancing National Capacity for Weather and Seasonal Forecasting
5. Increasing climate Resilience in Vulnerable Communities
6. Flood Protection of Infrastructure (industrial and agricultural)
7. Rainwater Harvesting
8. Community Based Forest Fire Management & Prevention



Adaptation Priorities

Long term Actions

- Economic Diversification
- Climate proofing of hydropower and infrastructure
- Agriculture research and diffusion of appropriate varieties and techniques
- Water resources management
- Diversification of energy mix
- Protection of forests and parks
- Scaling up of GLOF Risk Reduction
- Mainstreaming climate change into development
- ...



First NAPA Project funded by LDCF

*Reducing Climate Change-induced Risks and Vulnerabilities
from Glacial Lake Outburst Floods
in the Punakha-Wangdi and Chamkhar Valleys*

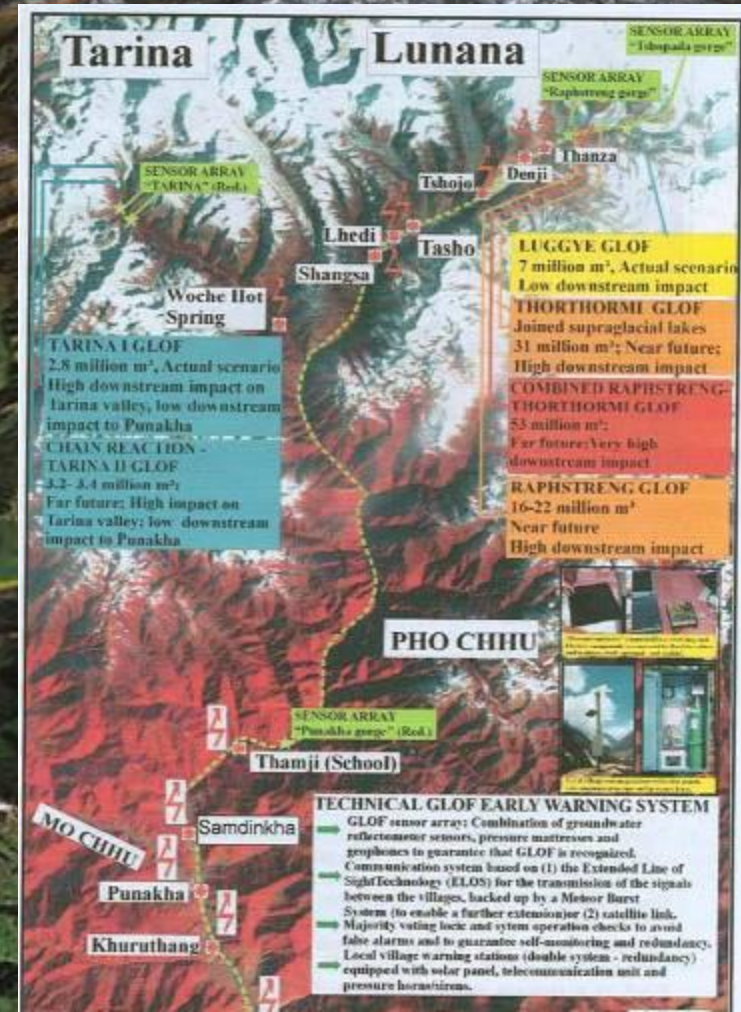
Three Components

1. Artificial lowering of water level in Thorthormi Lake
2. Increase capacity for disaster risk management in affected valleys
3. Installing Technical Early Warning System for glacial lake outburst floods

Lowering water level of Thorthormi Lake



Early Warning System & Disaster Preparation



2nd NAPA Project



- Landslide stabilization
- Community Based adaptation
 - Disaster Management
 - Forest Fire management
 - Water harvesting
- Water inventory
- Flood Management
- Climate & Weather forecasting

Greenhouse Gas Inventory





Per capita Emissions in 2005 (tons CO₂ Eq)

Bhutan	2.88
Bhutan (with sinks)	-7.06
<i>World average</i>	<i>4.0</i>
<i>Developed</i>	<i>11.4</i>
<i>Developing</i>	<i>2.1</i>
India	1.9
China	3.9
Japan	10.4
USA	24.5

Source:

- *Bhutan emissions data from 2nd National GHG Inventory, NEC*
- *World data from World Resources Institute*
- *Bhutan population in 2005 = 635,000 (National Census)*

2nd National Greenhouse Gas inventory



- ✓ National multi-sectoral task force
 - ✓ 30 Members in 5 working groups

- ✓ IPCC 1996 Revised Guidelines
 - Indirect through activity/consumption data
 - Emission = Activity x Emission Factor

- ✓ UNFCCC GHG Inventory Software (MS Excel)

- ✓ Base year for reporting: 2000





Bhutan's Emissions in 2000

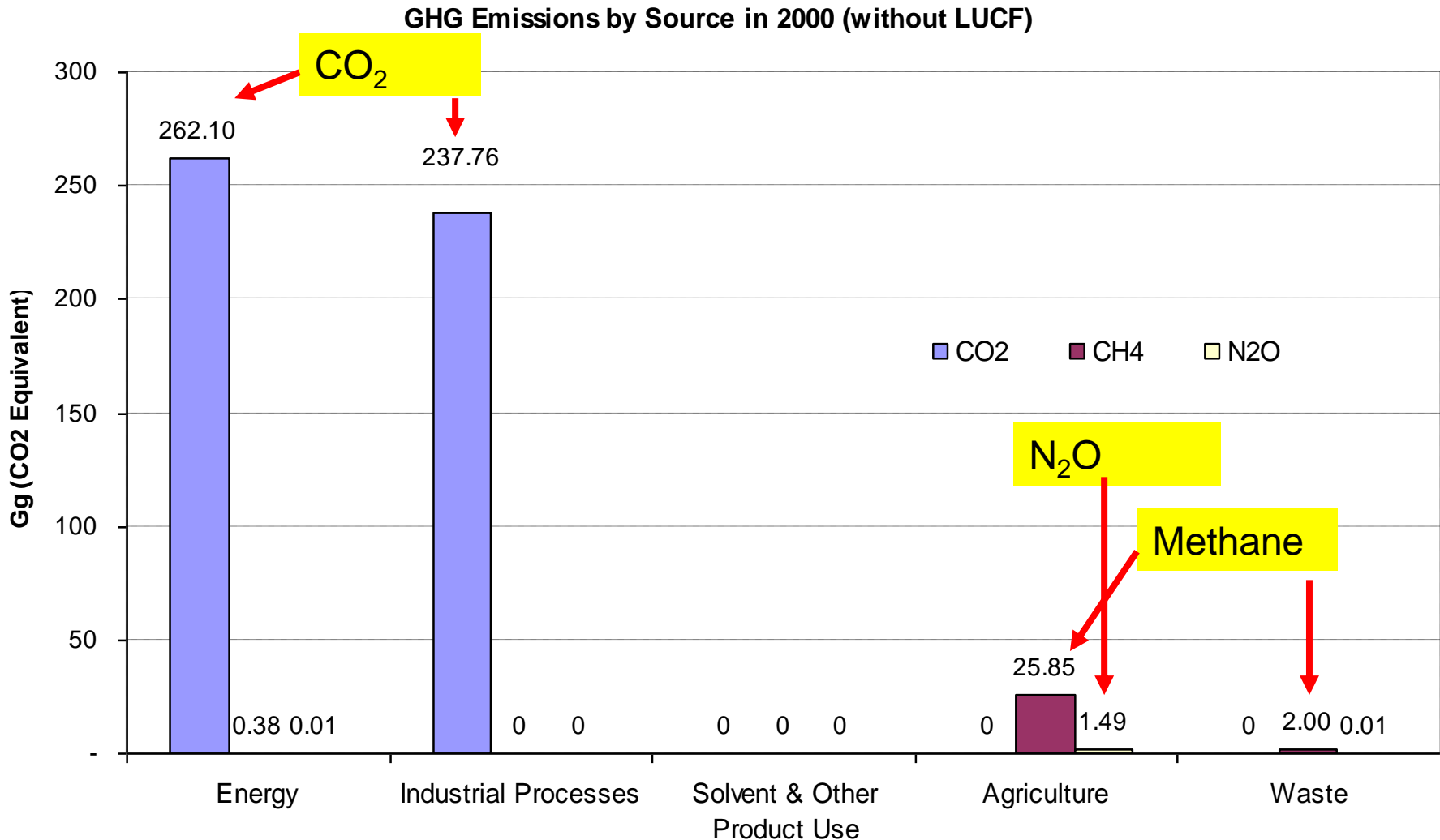
GHG Sources & Sinks	CO ₂ -equiv	CO ₂	CH ₄	N ₂ O	NO _x	CO	NM _{VOC}	SO ₂
Energy	272.31	262.10	0.38	0.01	1.79	8.99	1.29	0.97
Industrial Processes	237.76	237.76	0	0	0	0	1.69	0.10
Solvent & Other Product Use	-	0	0	0				
Agriculture	1,005.30	0	25.85	1.49	0.02	0.41		
Waste	46.27	0	2.00	0.01				
Land-Use Change & Forestry	(6,309.60)	-6309.6	0	0	0	0		
Total National Emissions	1,561.64	534.5	27.3	1.5	1.82	9.40	2.98	1.07
Net National Emissions	(4,747.96)	-5775.1	27.3	1.5				

All figures in giga grams

(1 Giga gram = 1 billion grams = 1 million kg)

Bhutan GHG Emissions in Year 2000

(Primary GHGs without Land Use Change and Forestry)



Converting all GHG to one common unit

Global Warming Potentials (GWP) in CO₂ equivalent

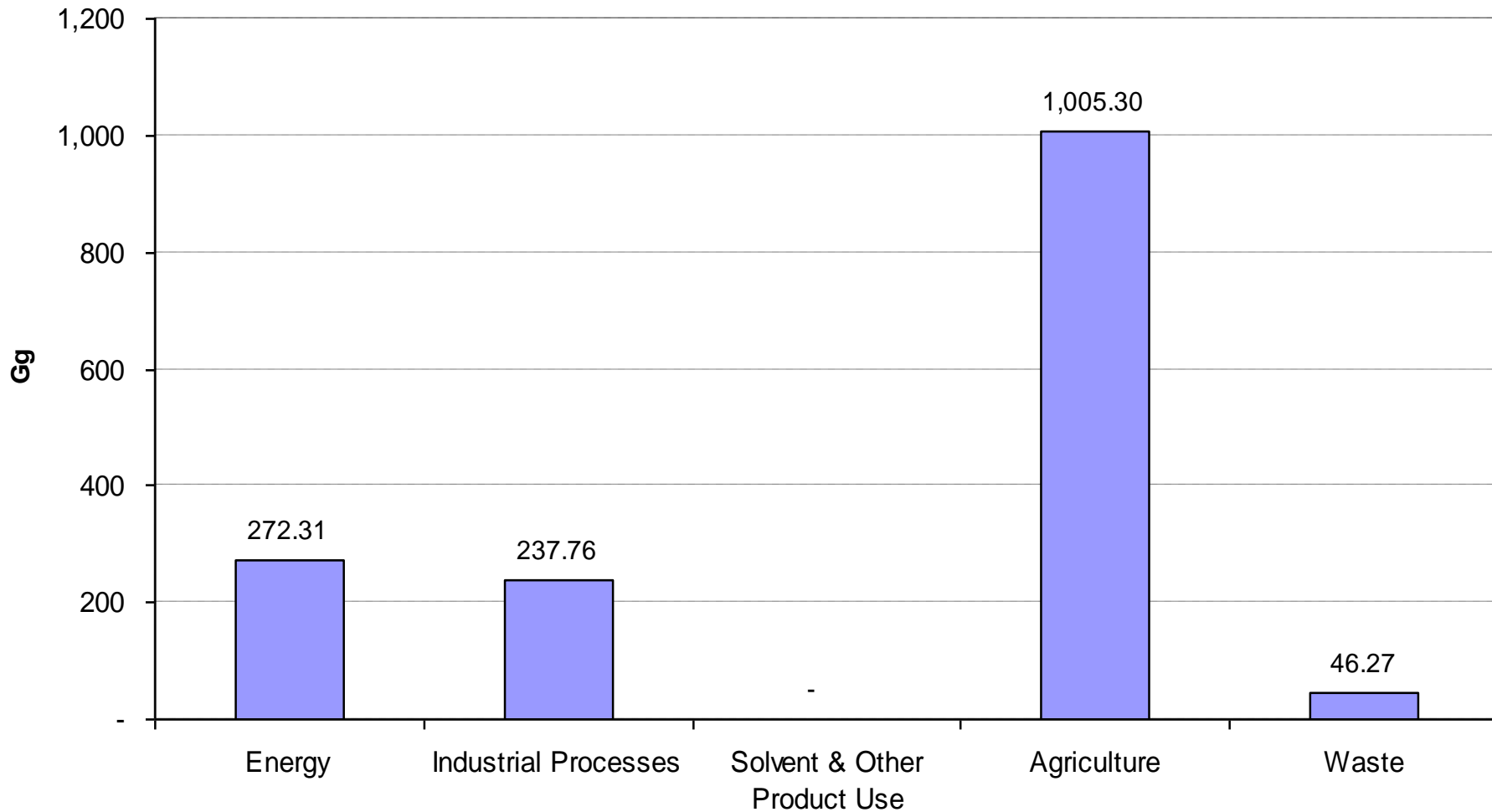
GHG	GWP in CO₂ equiv (100 years)
Carbon dioxide (CO ₂)	1
Methane (CH ₄)	21
Nitrous oxide (N ₂ O)	310

Bhutan GHG Emissions in Year 2000

(CO₂ equivalent without Land Use Change and Forestry)



GHG Emissions CO₂ Equivalent in 2000 (without LUCF)

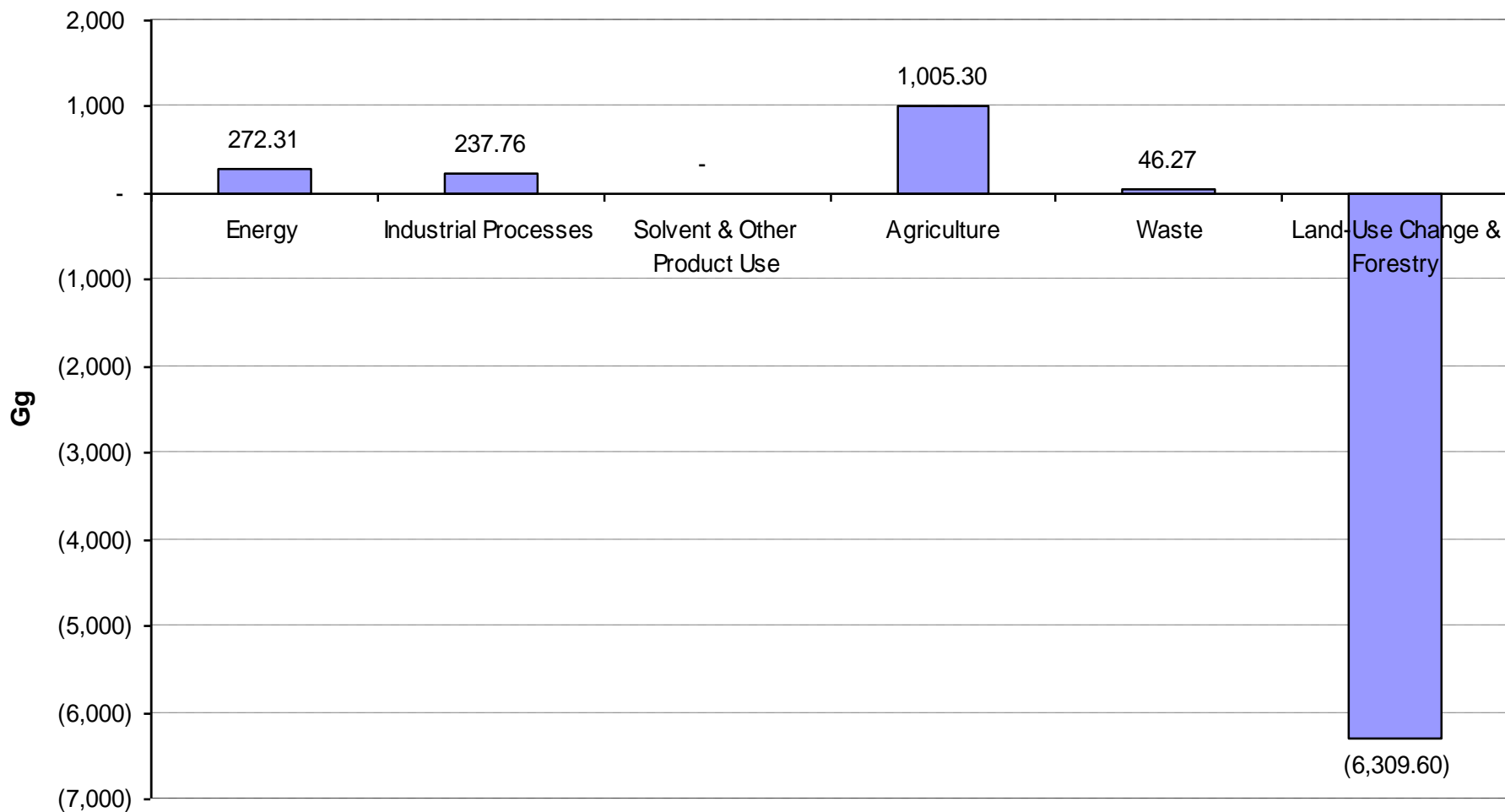


Bhutan GHG Emissions in Year 2000

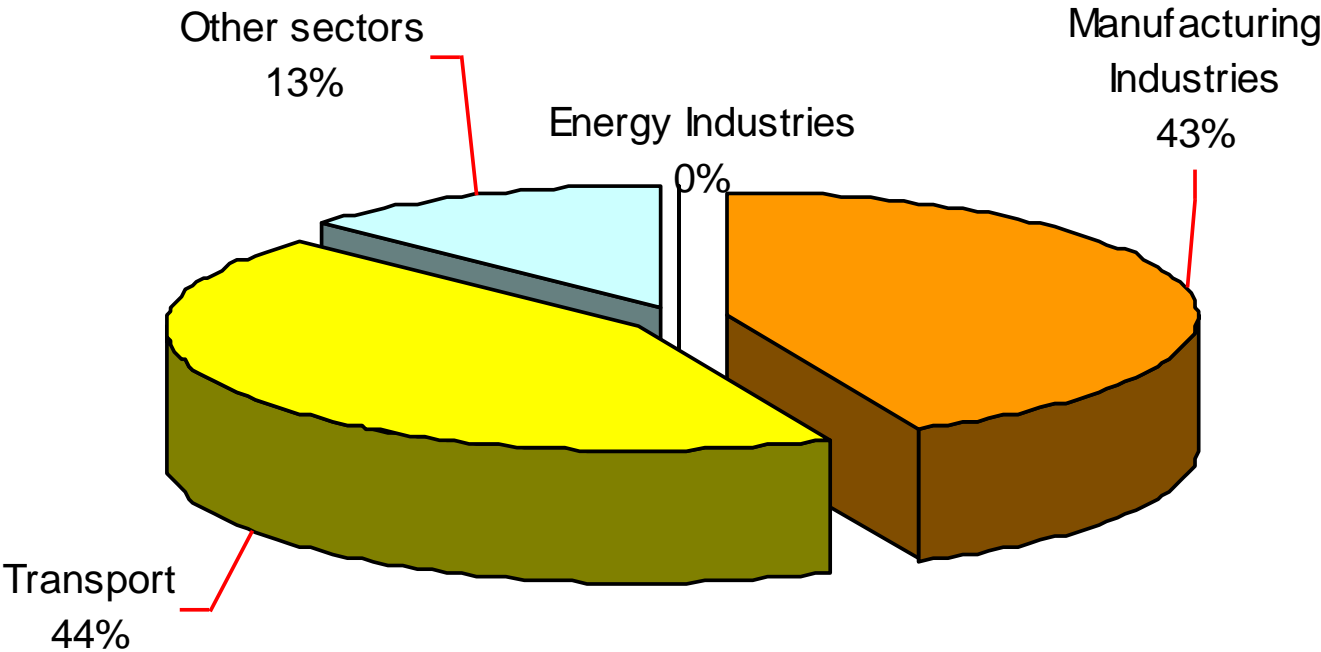
(CO₂ equivalent including Land Use Change and Forestry)



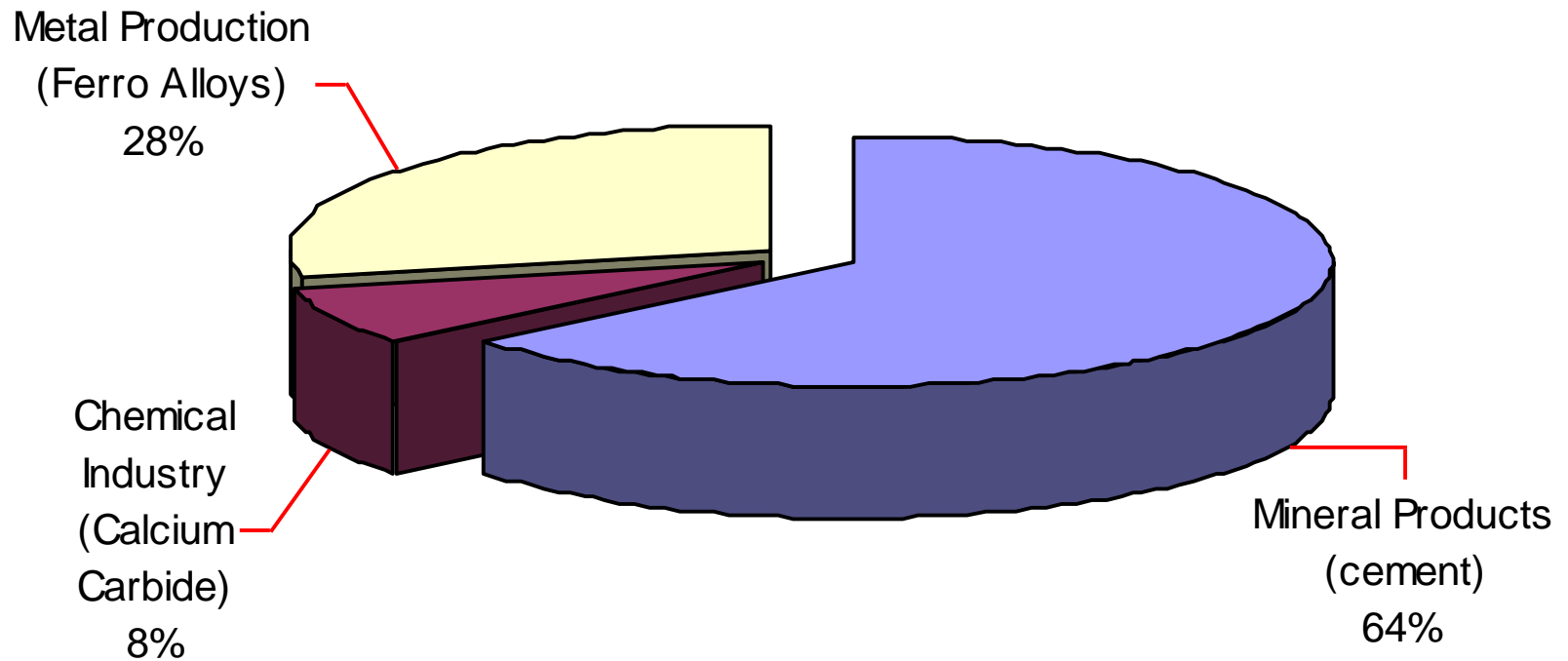
GHG Emissions CO2 Equivalent in 2000 (with LUCF)



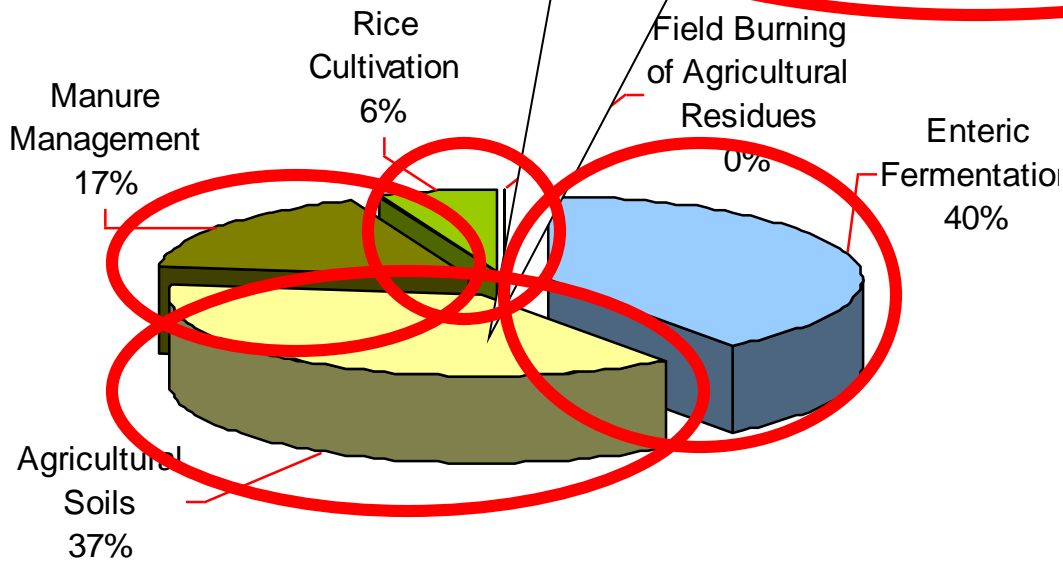
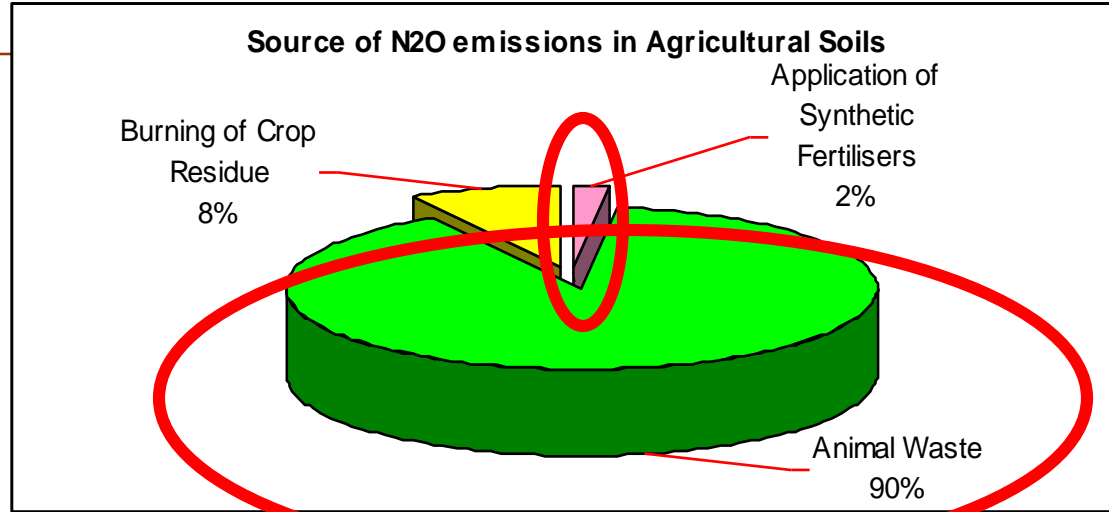
Breakup of Emissions from Energy Use (2000)



Breakup of Emissions in Industrial Production (2000)

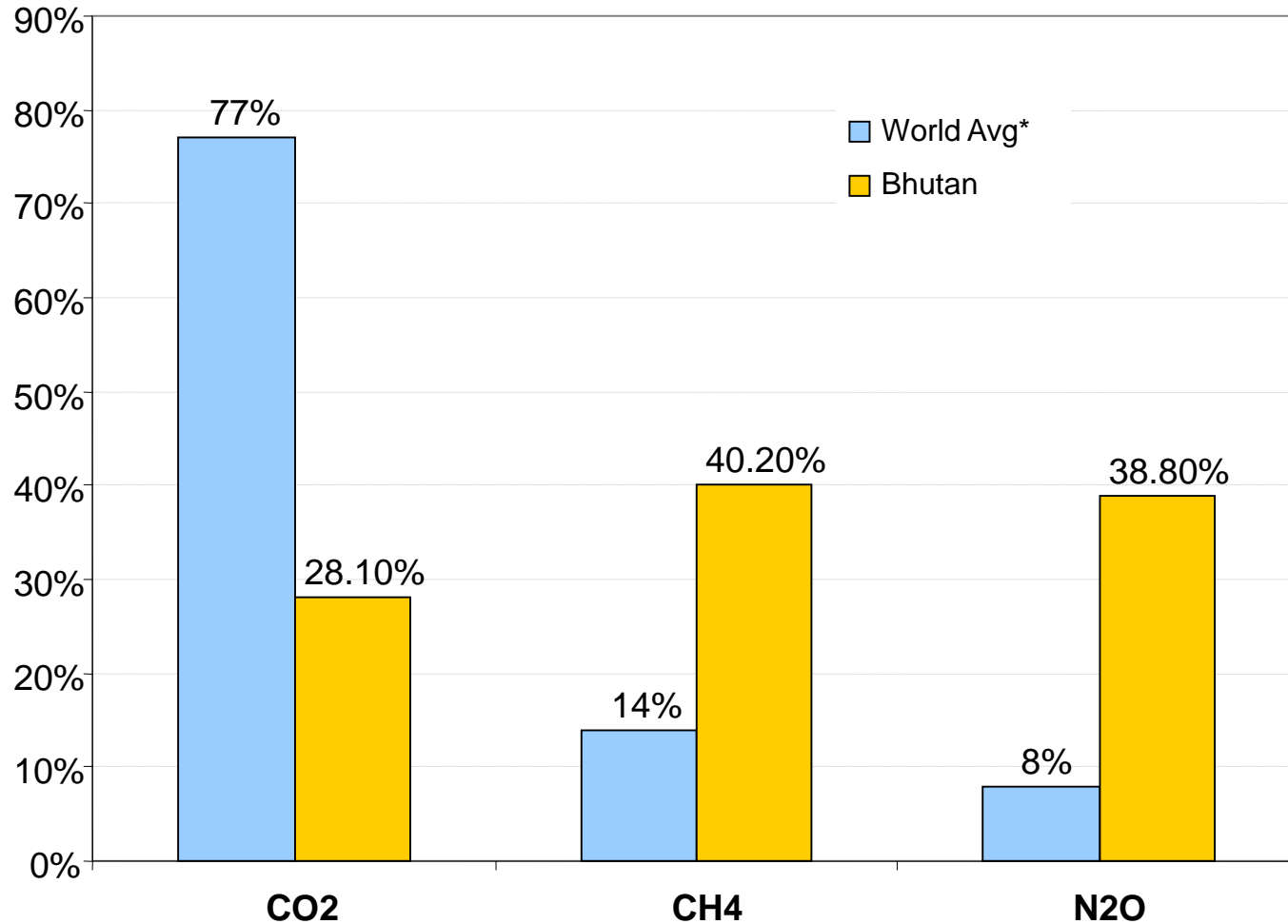


Breakup of Emissions from Agriculture (2000)



Survival Emissions!

Comparison of Bhutan vs. World Avg. *Total GHGs*



* Source: World Resources Institute

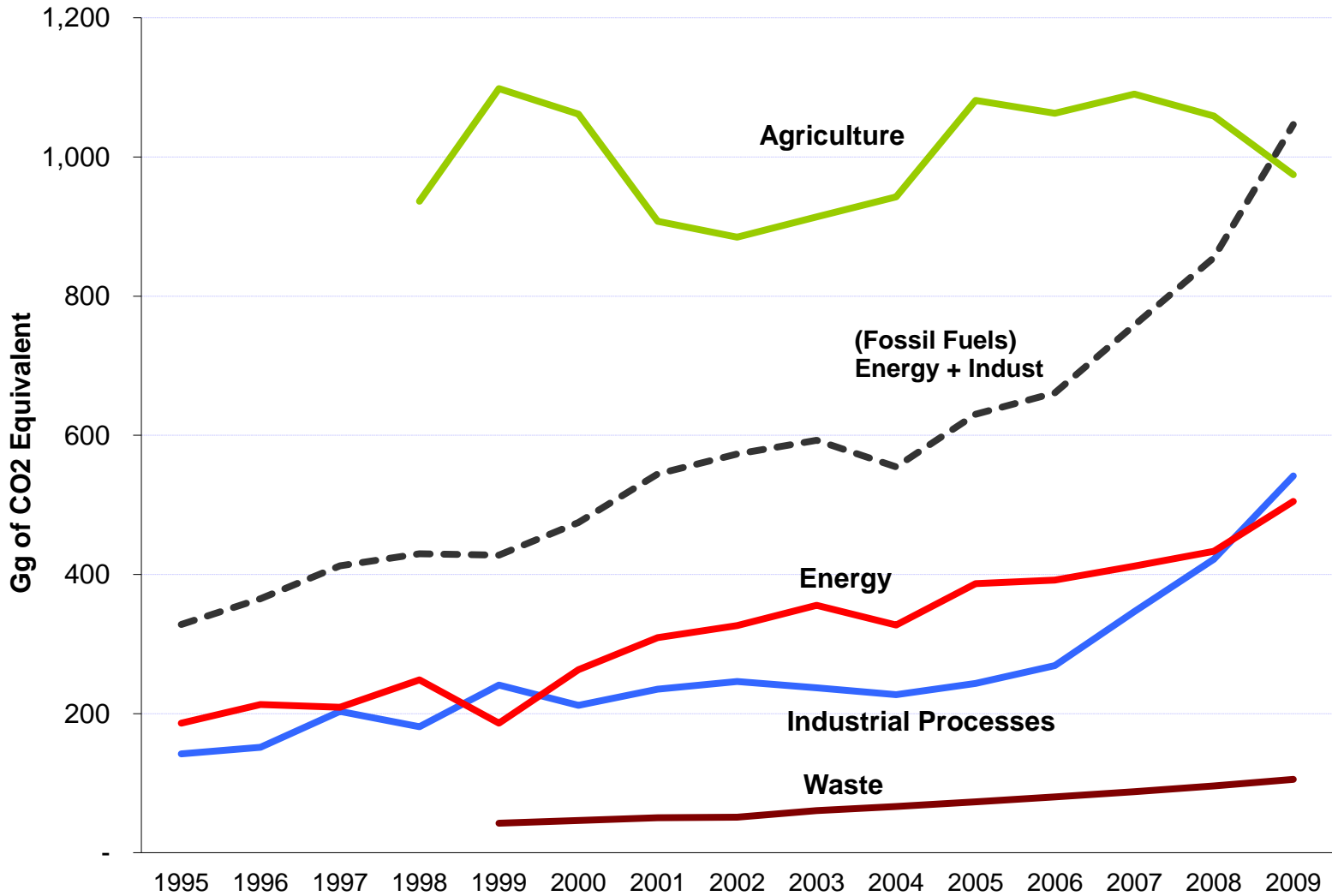
Comparison of Bhutan vs. World Avg.

Sources of GHG

Sector	World Avg*	Bhutan
Energy	61.4%	18.3%
<i>Transport</i>	13.5%	7.8%
<i>Electricity and Heat</i>	24.5%	0%
<i>Other Fuel Combustion</i>	9%	2.8%
<i>Industry</i>	10.4%	7.7%
<i>Fugitive Emissions</i>	3.9%	0%
Industrial Processes	3.4%	10.3%
LUCF	18.2%	0%
Agriculture	13.5%	68.1%
Waste	3.6%	3.1%

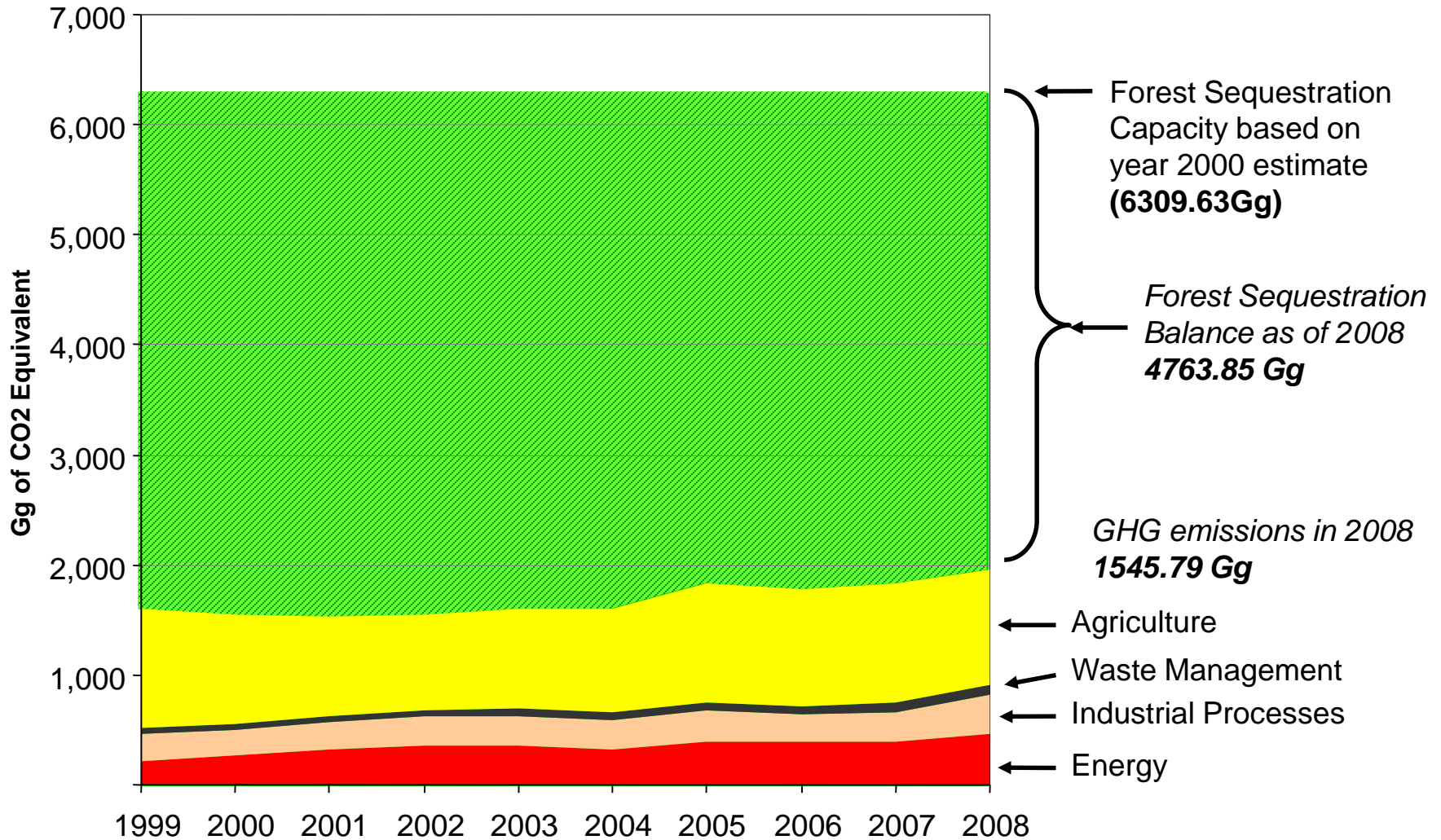
* Source: World Resources Institute

Trends in GHG Emissions





Trends in Bhutan's Carbon Budget





Bhutan's Commitment to Combating Climate Change

Bhutan's declaration to remain Carbon Neutral

- Declaration at 15th Conference of Parties to UNFCCC (2009)
- National strategy to remain carbon
- Requires support of international community

Constitution of the Kingdom of Bhutan requires 60% forest cover to be maintained for all times & Environmental Protection

Economic Development Policy emphasises “green growth”

- LEDS (Transport, Industries, Human settlement)
- NAMAs (Waste, Transport, Energy Efficient buildings)
- 11 & 12FYP- Carbon neutral & Climate resilient



Conclusions

- Bhutan is not responsible to causing climate change
 - Emissions are negligible from survival emissions
 - Sinks provide global service
- Yet Bhutan is one of most vulnerable countries
 - Due to geography, economic development,
- Bhutan is still committed to doing its part as a responsible member of global community to combat climate change