Lecture 12 - ADAPTATION

From AR4 (IPCC)

SECTOR	ADAPTATION OPTION/STRATEGY	UNDERLYING POLICY FRAMEWORK	KEY CONSTRAINTS AND OPPORTUNITIES TO IMPLEMENTATION
Water	• Expanded rainwater harvesting; • water storage and conservation techniques; • water re-use; • desalination; • water-use and • irrigation efficiency	• National water policies and integrated water resources management; • water-related hazards management	• Financial, human resources • And physical barriers; • integrated water resources • management; • synergies with other sectors
Agriculture	• Adjustment of planting dates and crop variety; • crop relocation; • improved land management, e.g. erosion control and soil protection through tree planting	• R&D policies; institutional reform; • land tenure and land reform; training; • capacity building; • crop insurance; • financial incentives, e.g. subsidies and tax credits	• Technological and financial constraints; • access to new varieties; • markets; • longer growing season in higher latitudes; • revenues from 'new' products

SECTOR	ADAPTATION OPTION/STRATEGY	UNDERLYING POLICY FRAMEWORK	KEY CONSTRAINTS AND OPPORTUNITIES TO IMPLEMENTATION
Infrastructure / settlement (including coastal zones)	• Relocation; • seawalls and storm surge barriers; • dune reinforcement; • land acquisition and creation of marshlands/wetlands as buffer against sea level rise and flooding; • protection of existing natural barriers	• Standards and regulations that integrate climate change considerations into design; • land-use policies; • building codes; • insurance	• Financial and technological barriers; • availability of relocation space; • integrated policies and management; • synergies with sustainable development goals
Human Health	• Heat-health action plans; • emergency medical services; • improved climate-sensitive disease surveillance and control; • safe water and improved sanitation	• Public health policies that recognise climate risk; • strengthened health services; • regional and international cooperation	• Limits to human tolerance (vulnerable groups); • knowledge limitations; financial capacity; • upgraded health services; • improved quality of life

SECTOR	ADAPTATION OPTION/STRATEGY	UNDERLYING POLICY FRAMEWORK	KEY CONSTRAINTS AND OPPORTUNITIES TO IMPLEMENTATION
Tourism	• Diversification of tourism attractions and revenues; • Shifting ski slopes to higher altitudes and glaciers; • artificial snow-making	• Integrated planning (e.g. carrying capacity; linkages with other sectors); • financial incentives, e.g. subsidies and tax credits	• Appeal/marketing of new attractions; • financial and logistical challenges; • potential adverse impact on other sectors (e.g. artificial snow-making may increase energy use); • revenues from 'new' attractions; • involvement of wider group of stakeholders
Transport	• Realignment/ relocation; • design standards and planning for roads, rail and other infrastructure to cope with warming and drainage	• Integrating climate change considerations into national transport policy; • investment in R&D for special situations, e.g. permafrost areas	• Financial and technological barriers; • availability of less vulnerable routes; • improved technologies and integration with key sectors (e.g. energy)

SECTOR	ADAPTATION OPTION/STRATEGY	UNDERLYING POLICY FRAMEWORK	KEY CONSTRAINTS AND OPPORTUNITIES TO IMPLEMENTATION
Energy	• Strengthening of overhead transmission and distribution infrastructure; • Underground cabling for utilities; • Energy efficiency; • Use of renewable sources; • Reduced dependence on single sources of energy	• National energy policies, regulations, and fiscal and financial incentives to encourage use of alternative sources; • incorporating climate change in design standards	• Access to viable alternatives; financial and technological barriers; • Acceptance of new technologies; • stimulation of new technologies; • use of local resources

Note:
Other examples from many sectors would include early warning systems.

MITIGATION TECHNOLOGIES

MITIGATION POTENTIAL

- The concept of '**mitigation potential**' has been developed to assess the scale of GHG reductions that could be made, relative to emission baselines, for a given level of carbon price (expressed in cost per unit of carbon dioxide equivalent emissions avoided or reduced).
- Mitigation potential is further differentiated in terms of 'market mitigation potential' and 'economic mitigation potential'.
- **Market mitigation potential** is the mitigation potential based on private costs and private discount rates (reflecting the perspective of private consumers and companies), which might be expected to occur under forecast market conditions, including policies and measures currently in place, noting that barriers limit actual uptake.
- **Economic mitigation potential** is the mitigation potential that takes into account social costs and benefits and social discount rates (reflecting the perspective of society; social discount rates are lower than those used by private investors), assuming that market efficiency is improved by policies and measures and barriers are removed.

MITIGATION POTENTIAL

- Mitigation potential is estimated using different types of approaches.
- **Bottom-up studies** are based on assessment of mitigation options, emphasising specific technologies and regulations. They are typically sectoral studies taking the macro-economy as unchanged.
- **Top-down studies** assess the economy-wide potential of mitigation options. They use globally consistent frameworks and aggregated information about mitigation options and capture macro-economic and market feedbacks.

MITIGATION POTENTIAL …

- No single technology can provide all of the mitigation potential in any sector. The economic mitigation potential, which is generally greater than the market mitigation potential, can only be achieved when adequate policies are in place and barriers removed (Table SPM.5). *{4.3}*
- Bottom-up studies suggest that mitigation opportunities with net negative costs have the potential to reduce emissions by around 6 GtCO2-eq/yr in 2030, realising which requires dealing with implementation barriers. *{4.3}*

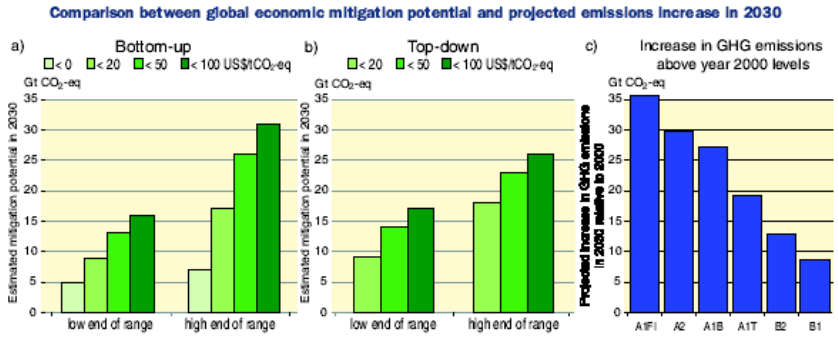

Figure SPM.9. Global economic mitigation potential in 2030 estimated from bottom-up (Panel a) and top-down (Panel b) studies, compared with the projected emissions increases from SRES scenarios relative to year 2000 GHG emissions of 40.8 GtCO$_2$-eq (Panel c). Note: GHG emissions in 2000 are exclusive of emissions of decay of above ground biomass that remains after logging and deforestation and from peat fires and drained peat soils, to ensure consistency with the SRES emission results. {Figure 4.1}

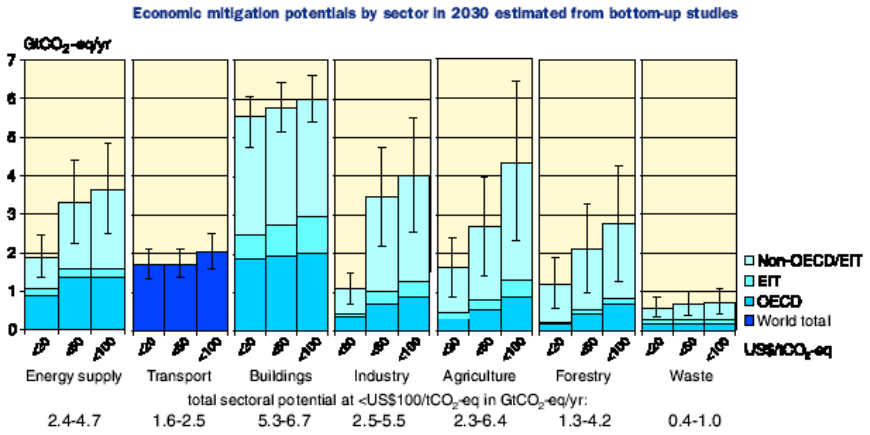

Figure SPM.10. Estimated economic mitigation potential by sector in 2030 from bottom-up studies, compared to the respective baselines assumed in the sector assessments. The potentials do not include non-technical options such as lifestyle changes. {Figure 4.2}

Sector	**Key mitigation technologies and practices currently commercially available.** ***Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.***	**Policies, measures and instruments shown to be environmentally effective**	**Key constraints or opportunities** (Normal font = constraints; italics = opportunities)
Energy supply {WGIII 4.3, 4.4}	• Improved supply and distribution efficiency; • fuel switching from coal to gas; nuclear power; • renewable heat and power (hydropower, solar, wind, geothermal and bioenergy); • combined heat and power; • early applications of carbon dioxide capture and storage (CCS) (e.g. storage of removed CO2 from natural gas); • *CCS for gas, biomass and coal-fired electricity generating facilities; advanced nuclear power;* • *advanced renewable energy, including tidal and wave energy, concentrating solar, and solar photovoltaics.*	• Reduction of fossil fuel subsidies; taxes or carbon charges on fossil fuels • Feed-in tariffs for renewable energy technologies; • renewable energy obligations; producer subsidies	• Resistance by vested interests may make them difficult to implement • *May be appropriate to create markets for low emissions technologies*

Sector	**Key mitigation technologies and practices currently commercially available.** ***Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.***	**Policies, measures and instruments shown to be environmentally effective**	**Key constraints or opportunities** (Normal font = constraints; italics = opportunities)
Transport {WGIII 5.4}	• More fuel-efficient vehicles; hybrid vehicles; cleaner diesel vehicles; biofuels; • Modal shifts from road transport to rail and public transport systems; • non-motorised transport (cycling, walking); land-use and transport planning; • *second generation biofuels;* • *higher efficiency aircraft;* • *advanced electric and hybrid vehicles with more powerful and reliable batteries*	• Mandatory fuel economy; biofuel blending and CO2 standards for road transport • Taxes on vehicle purchase, registration, use and motor fuels; road and parking pricing • Influence mobility needs through land-use regulations and infrastructure planning; investment in attractive public transport facilities and non-motorised forms of transport	• Partial coverage of vehicle fleet may limit effectiveness • Effectiveness may drop with higher incomes • *Particularly appropriate for countries that are building up their transportation systems*

Sector	**Key mitigation technologies and practices currently commercially available.** ***Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.***	**Policies, measures and instruments shown to be environmentally effective**	**Key constraints or opportunities** (Normal font = constraints; italics = opportunities)
Buildings {WGIII 6.5}	• Efficient lighting and daylighting; more efficient electrical appliances and heating and cooling devices; • improved cook stoves, improved insulation; • passive and active solar design for heating and cooling; alternative refrigeration fluids, recovery and recycling of fluorinated gases; • *integrated design of commercial buildings including technologies, such as intelligent meters that provide feedback and control;* • *Solar photovoltaics integrated in buildings*	• Appliance standards and labelling • Building codes and certification • Demand-side management programmes • Public sector leadership programmes, including procurement • Incentives for energy service companies (ESCOs)	• Periodic revision of standards needed • *Attractive for new buildings*. Enforcement can be difficult • Need for regulations so that utilities may profit • *Government purchasing can expand demand for energy-efficient products* • *Success factor*: Access to third party financing

Sector	**Key mitigation technologies and practices currently commercially available.** ***Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.***	**Policies, measures and instruments shown to be environmentally effective**	**Key constraints or opportunities** (Normal font = constraints; italics = opportunities)
Industry {WGIII 7.5}	• More efficient end-use electrical equipment; heat and power recovery; material recycling and substitution; control of non-CO2 gas emissions; and a wide array of process-specific technologies; • *advanced energy efficiency; CCS for cement, ammonia, and iron manufacture; inert electrodes for aluminium manufacture*	• Provision of benchmark information; performance standards; subsidies; tax credits • Tradable permits • Voluntary agreements	• *May be appropriate to stimulate technology uptake*. Stability of national policy important in view of international competitiveness • Predictable allocation mechanisms and stable price signals important for investments • Success factors include: clear targets, a baseline scenario, third-party involvement in design and review and formal provisions of monitoring, close cooperation between government and industry

Sector	**Key mitigation technologies and practices currently commercially available.** ***Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.***	**Policies, measures and instruments shown to be environmentally effective**	**Key constraints or opportunities** (Normal font = constraints; italics = opportunities)
Agriculture {WGIII 8.4}	• Improved crop and grazing land management to increase soil carbon storage; • restoration of cultivated peaty soils and degraded lands; • improved rice cultivation techniques and livestock and manure management to reduce CH4 emissions; • improved nitrogen fertiliser application techniques to reduce N2O emissions; • dedicated energy crops to replace fossil fuel use; • improved energy efficiency; • *improvements of crop yields*	• Financial incentives and regulations for improved land management; • maintaining soil carbon content; • efficient use of fertilisers and irrigation	• *May encourage synergy with sustainable development and with reducing vulnerability to climate change, thereby overcoming barriers to implementation*

Sector	**Key mitigation technologies and practices currently commercially available.** ***Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.***	**Policies, measures and instruments shown to be environmentally effective**	**Key constraints or opportunities** (Normal font = constraints; italics = opportunities)
Forestry/ forests {WGIII 9.4}	• Afforestation; reforestation; forest management; reduced deforestation; harvested wood product management; • use of forestry products for bioenergy to replace fossil fuel use; • *tree species improvement to increase biomass productivity and carbon sequestration;* • *improved remote sensing technologies for analysis of vegetation/soil carbon sequestration potential and mapping land-use change*	• Financial incentives (national and international) to increase forest area, to reduce deforestation and to maintain and manage forests; • land-use regulation and enforcement	• Constraints include lack of investment capital and land tenure issues. • *Can help poverty alleviation*.

Sector	**Key mitigation technologies and practices currently commercially available.** ***Key mitigation technologies and practices projected to be commercialised before 2030 shown in italics.***	**Policies, measures and instruments shown to be environmentally effective**	**Key constraints or opportunities** (Normal font = constraints; italics = opportunities)
Waste {WGIII 10.4}	• Landfill CH4 recovery; • waste incineration with energy recovery; • composting of organic waste; • controlled wastewater treatment; recycling and waste minimisation; • *biocovers and biofilters to optimise CH4 oxidation*	• Financial incentives for improved waste and wastewater management • Renewable energy incentives or obligations • Waste management regulations	• *May stimulate technology diffusion* • Local availability of low-cost fuel • Most effectively applied at national level with enforcement strategies

SELECTED EXAMPLES IN THE AREA OF MITIGATION

Selected sectors	Non-climate change policy instruments and actions	Potentially affects:
Macro-economy	Implement non-climate taxes/subsidies and/or other fiscal and regulatory policies that promote sustainable development	Total global GHG emissions
Forestry	Adoption of forest conservation and sustainable management practices	GHG emissions from deforestation
Electricity	Adoption of cost-effective renewables, demand-side management programmes, and transmission and distribution loss reduction	Electricity sector CO2 emissions
Petroleum imports	Diversifying imported and domestic fuel mix and reducing economy's energy intensity to improve energy security	Emissions from crude oil and product imports
Insurance for building, transport sector	Differentiated premiums, liability insurance exclusions, transport sectors improved terms for green products	Transport and building sector GHG emissions
International finance	Country and sector strategies and project lending that reduces emissions	Emissions from developing countries

CONCLUSIONS

- Current warming trends are unequivocal. It is very likely that greenhouse gases released by human activities are responsible for most of the warming observed in the past fifty years.
- Climate change already has a measurable impact on many natural and human systems.
- Effects are projected to increase in the future and to be more severe with greater increases in temperature. Adaptation measures are already being implemented, and will be essential in order to address the projected consequences.
- Mitigation measures that aim to reduce greenhouse gas emissions can help avoid, reduce or delay many impacts of climate change. Policy instruments could create incentives for producers and consumers to significantly invest in products, technologies and processes which emit less greenhouse gases.

Review questions

- Suggest the possible adaptations measures for food security in Nepal.
- What are the possible means of reducing fossil fuel use in transportation?