

**DEPARTMENT OF BOTANY, BIOINFORMATICS & CLIMATE CHANGE IMPACTS
MANAGEMENT, SCHOOL OF SCIENCE, GUJARAT UNIVERSITY, AHMEDABAD-
380 009**

SYLLABUS: M. Sc. CLIMATE CHANGE IMPACTS MANAGEMENT

Effective from June 2022

Four papers (Three hour duration) and two practical (Six hour duration) of hundred marks at the semester examination.

1. Field visit is essential for understanding natural systems. There shall be at least one such visit every year. Tour report including observations and learnings will be given due weight age.
2. Candidates shall be required to submit at the time of practical examination at the end of each semester. The laboratory journal, assignment, project work and diary of field work (field visit report) duly signed by the teachers concerned also need to be submitted.

CLI-401: Basics of Climate science

CLI-402: Climate and climate change

CLI-403: Global warming and climate change

CLI-404: Observed climate change and international responses

CLI 405PR: Practical – I: Based on topics covered in CLI 401 and 402

CLI 406PR: Practical – II: Based on topics covered in CLI 403 and 404

CLI- 407: Effects of climate change

CLI-408: Tools and techniques for impacts assessment

CLI -409: Policy and legislation: national and international scenarios

CLI -410: Future climate scenarios

CLI 411PR: Practical – III: Based on topics covered in CLI 407 and 408

CLI 412PR: Practical – IV: Based on topics covered in CLI 409 and 410

CLI-501: Climate change adaptation

CLI-502: Climate change mitigation

CLI-503: Issues need attention

CLI-504: International Response and Individual Responsibility

CLI 505PR: Practical – V: Based on topics covered in CLI 501 and 502

CLI 506PR: Practical – VI: Based on topics covered in CLI 503 and 504

CLI-507: Project

Climate Change Impacts Management

Course Name: Climate Change Impacts Management. School of Sciences			Semester 1				
Course		Name of the Course	No of Hours Per Week				
No.	Type		Lectures	Others	Practical	Total	Credit
CLI 401	Core	Basics of Climate Change	3	1	—	4	4
CLI 402	Core	Climate and Climate Change	3	1	—	4	4
CLI 403	Core	Global Warming & Climate Change	3	1	—	4	4
CLI 404	Core	Observed CC & its Intl Responses	3	1	—	4	4
CLI 405	Core	Practical 1	—	1	3	4	4
CLI 406	Core	Practical 2	—	1	3	4	4
		Total	12	6	6	24	24
			Semester 2				
Course		Name of the Course	No of Hours Per Week				
No.	Type		Lectures	Others	Practical	Total	Credit
CLI 407	Core	Effects of CC	3	1	—	4	4
CLI 408	Core	Tools & Tech. for Impacts Assessment.	3	1	—	4	4
CLI 409	Core	P&L: Ntnl.& Intl. Scenarios	3	1	—	4	4
CLI 410	Core	Future Climate Scenarios	3	1	—	4	4
CLI 411	Core	Practical 3	—	1	3	4	4
CLI 412	Core	Practical 4	—	1	3	4	4
		Total	12	6	6	24	24
			Semester 3				
Course		Name of the Course	No of Hours Per Week				
No.	Type		Lectures	Others	Practical	Total	Credit
CLI 501	Core	CC Adaptation	3	1	—	4	4
CLI 502	Core	CC Mitigation	3	1	—	4	4
CLI 503	Core	Issues Need Attention	3	1	—	4	4
CLI 504	Core	Intl Response & Intl Responsibility	3	1	—	4	4
CLI 505	Core	Practical 5	—	1	3	4	4
CLI 506	Core	Practical 6		1	3	4	4
		Total	12	6	6	24	24
CLI 507		Dissertation (Project)	Semester 4				24

SEMESTER – I

CLI- 401: BASICS OF CLIMATE SCIENCE

Unit-1: Atmosphere and Hydrosphere

- Formation, composition of Earth's atmosphere, mass and layering of atmosphere , electromagnetic radiation, solar and terrestrial radiation, variation with latitudes and seasons, Adiabatic temperature changes, air stability and instability, Ozone layer, Temperature measurements and controls, Dry and Wet adiabatic lapse rate, inversion of temperature.
- Atmospheric pressure and winds, Pressure measurements and distribution, Wind observations, Factors affecting wind, Gradient and Geostrophic winds, local winds and Jet streams.
- Natural and man-made water bodies-types, significance and constraints, humidity, condensation, cloud formation, precipitation and fog, Acid rain, evaporation and transpiration, infiltration
- Soil water storage, surface runoff and hydrologic cycle, Surface and subsurface ocean currents, ocean tides and currents
- Research stations for atmosphere and hydrosphere study, Research Journals on atmosphere and hydrosphere.

Unit-2: Lithosphere and pedosphere

- Structure of earth, Geological Timescales, Big bang theory and Continental Drift theory and plate tectonics, Earthquake and volcanic activity - Theories, occurrences, physical processes and types
- Types of rocks and soils, composition of rocks and soils, role of climate in soil formation,
- Soil classification, erosion, deposition and conservation,
- Physical and chemical properties of soil, degradation and reclamation
- Research stations for lithosphere and pedosphere study, Research Journals on lithosphere and pedosphere.

Unit-3: Biosphere

- Biological classification of organisms, Species diversity and biodiversity
- Ecosystems, nutrients in ecosystem, food chain and food web, Biodiversity- in various ecosystems, Ecosystems, nutrients in ecosystem, food chain and food web, Carbon cycle, nitrogen cycle, sulfur cycle and other mineralization processes
- Principles of Conservation Biology including Planning, Legislation and Implementation of Conservation programmes
- Biomes- terrestrial and aquatic, classification, maps of biomes, anthropogenic biomes, Flora-fauna, status, *in-situ* and *ex-situ* conservation, RET species.
- Research stations for biosphere study, Research Journals on biosphere.

Unit-4: Techniques and methods

- Principle and use of tools to study atmosphere and hydrosphere
- Principles and Methods to study physicochemical properties of soil and water

- Documentation of biodiversity and methods to study ecosystems
- Techniques to enumerate RET species
- Techniques to identify RET species

CLI-402: CLIMATE AND CLIMATE CHANGE

Unit-1: Climate and Weather

- Definition of weather and climate, meteorology and climatology, elements, types of classification systems- empirical, applied and genetic systems, Koeppen classification system,; three basic climate groups: low latitude, mid-latitude, high latitude
- Aridity index, drought, Holdridge life zones system: global bioclimatic scheme for the classification of land areas.
- Weather and climate change, Geological time scale, ice ages, record of past 1000 years, human influences, Climate feedback
- Internal forcing mechanisms and external forcing mechanisms, The Milankovitch Cycle theory, Solar variation,
- Weather station in Gujarat and Ahmedabad, Weather maps

Unit-2: Atmospheric chemistry

- Measures of atmospheric composition: Mixing ratio, number density and partial pressure
- Atmospheric transport: Geostrophic flow, General circulation, Vertical transport, turbulence
- Atmospheric lifetime and time-scales: Definition, Box models, Source and Sinks mechanism, Atmospheric lifetime of Kyoto gases and sink mechanisms.
- Trace Gases: Current Observations, Trends, and Budgets: Non-CO₂ Kyoto gases, Montreal protocol gases, reactive gases
- Projections of Future Emissions: The Adjusted/Augmented IPCC/SRES Emission Scenarios, Shifting Regional Emissions of NO_x CO, and VOC in 2100
- Projections of Atmospheric Composition for the 21st Century
- Atmospheric chemistry facility in India

Unit-3: Physical evidences of climate change

- Evidence of rapid Climate Change
- Introduction to Paleoclimatology : Major events : Oceanic Anoxic Events , Holocene climatic optimum , Paleocene–Eocene Thermal Maximum , Younger Dryas / The Big Freeze, Little ice age and Faint young Sun paradox.
- Tree ring analysis, Palynology and Sclerochronology : Principles , Applications and Drawbacks.
- Polar ice, Isotopes, Ice melting and Ice core analysis, glaciers and arctic sea loss
- Sea level changes and Shore line changes (Strand lines) and Temperature changes

Unit-4: Climate indices and extreme events

- Measurement of various climate indices, aridity index,
- Seismic activity, Remote sensing data for temperature and precipitation
- Formation, structure, types and impacts of Cyclone , Thunderstorms, winterstorms, summer storms, Tornadoes and Hurricanes
- Formation, structure, types and impacts of Floods , droughts, precipitation, El nino and arctic circulation, Heat waves, Wild fires, Health effects, Heinrich events and Daansgard-Oeschger (D-O) events
- Blizzard, Hail storm, ecological importance of extreme events

CLI 403: GLOBAL WARMING AND CLIMATE CHANGE

Unit-1: Greenhouse gases and Global warming

- Greenhouse gases and its sources
- Enhanced greenhouse gas effect
- Global warming and Greenhouse gases policy issue
- Effects and causes of global warming and Science of 1.5°C
- Tipping points and feedback effects
- UN report on global warming 2021, IPCC assessment reports on global warming 2021

Unit-2: Aerosols

- Sources of aerosols, Aerosol Science and Interaction ,Direct and indirect effects, uncertainty in the aerosols, Significance of Aerosol Research
- Radiative forcing and GHGs-Definition, concept and processes
- Forcing –response relationship, Radiative forcing by tropospheric ozone, Radiative forcing of tropospheric aerosols
- Research journals on aerosols and air quality studies

Unit-3: Indian industry and global warming

- Role of Indian industry – petroleum products and chemicals, pharmaceuticals, engineering, Gems and jewellery, textile, iron and steel, defence, pulp and paper, in production of CFC products
- Role of services- aviation, banking and financial ,information technology, tourism, education, entertainment, construction, healthcare, telecommunication, printing in global warming
- Corporate social responsibility, role of corporate houses in Gujarat and India
- Innovative approaches& Biological modulation, NGO, Startups.
- UNEP suggested six-sector solution to climate crisis

Unit 4: Measurement and procedures to assess global warming

- GHG, aerosols, Anaesthetic gases-desflurane, isoflurane and sevoflurane
- Portfolio manager ,CRIS, MLOST-NOAA, HadCRUT4, GISTEMP-GISS, JMA.
- Photoacoustic spectroscopy ,mass spectrometer,
- AGAGE,ADS GC-MS, MEDUSA GC-MS
- Measuring Global warming potential (GWP)

CLI-404: OBSERVED CLIMATE CHANGE AND INTERNATIONAL RESPONSES

Unit-1: Observed climate variability and change

- Evidences of warming and change in atmosphere/ ocean circulations
- Climate extremes, thunderstorms, Tornadoes, Heat waves
- Energy balance of the earth, Human induced climate variations
- Sea level rising, Ice melting, temperature rising, Floods and droughts
- Climate variability

Unit-2: Human ecology of climate change

- Anthropogenic activities responsible for climate change: Source activities :Burning of fossil fuel, Industrial activity, Urbanization, Agriculture, transportation, waste generation, Removals of Sinks and LULUCF
- Population and its environmental impact: Population, Population growth, Variation among nations, Population explosion, Family welfare programs, Environment and human health risk.
- Climate change and food security: Food systems: Agriculture, Animal husbandry, Fisheries, impacts of Climate Change on Food systems, Population and food security
- Energy supply: History of energy, Role of energy in development of human civilization, Energy Production, Emissions from energy generation. Role of energy in current climate change.
- Climate literacy

Unit-3: International response to climate change

- IPCC -Overview, History, Structure, assessment reports, Task Groups, Principles procedures, and scholarships. UNEP, WMO, Structure, IPCC bureau
- UNFCCC-The convention, Sites and Platforms, Kyoto Protocol, Paris agreement, 2021 ambition, Talanoa, Documents and decisions,
- National and local government responses: NAPCC,
- Adaptive response and mitigation activity
- CITES, CBD, World Heritage Convention

Unit-4: Physical climate processes and feedbacks

- Atmospheric processes and feedbacks: Physics of the Water vapor and cloud feedbacks: cloud processes, precipitation processes, radiative processes, stratospheric dynamics and atmospheric circulation regimes, convection processes
- Ocean processes and feedbacks: Surface Mixed Layer, Convection, Interior Ocean Mixing, Mesoscale Eddies, Horizontal Circulation and Boundary Currents
- Land surface processes and feedbacks: land surface change, Land hydrology, runoff and surface atmosphere exchange
- Cryosphere processes and feedbacks: Snow cover and permafrost, sea ice, land ice
- Positive climate feedback, Negative Climate Feedback

Proposed Reference material

1. Anonymous:http://unfccc.int/resource/docs/publications/infokit_2002_en.pdf

2. J. Oliver and J. Hidore (2001): *Climatology-An Atmospheric Science* (second edition).
3. M. Maslin (2004): *Global Warming- A very short introduction*, Oxford publication.
4. *Climate Change: What it means for us, our children and our grandchildren* by Joseph F.C. DiMento and Pamela Doughman, MIT press
5. IPCC Third Assessment Report (2001)
6. *Climate and Global Environmental Change* by L.D. Danny Harvey, Prentice Hall publication
7. *Climate Change- An Indian Perspective* by S.K.Das , Foundation books
8. *Global Warming- A very short introduction* by Mark Maslin, Oxford publication
9. <http://www.physicalgeography.net/fundamentals/contents.html>
10. *Climatology-An Atmospheric Science* (second edition) by John Oliver & John Hidore– Indian edition
11. *Climate and Global Environmental Change* by L.D. Danny Harvey, Prentice Hall publication
12. *Global Warming: the complete briefing* by John Theodore Houghton
13. *Climate change: Biological and Human aspects* by Jonathan Cowie

CLI 405PR: PRACTICALS BASED ON CLI 401 AND CLI 402

CLI 406PR: PRACTICALS BASED ON CLI 403 AND CLI 404

SEMESTER-II

CLI- 407: EFFECTS OF CLIMATE CHANGE

Unit-1: Climate change impacts on water

- Impacts on Water Cycle and Water Demand
- Impacts on Water Supply
- Impacts on Water Quality
- Impacts of Changes in Water Resources on Other Sectors
- Sustainable development Goal on Water (Goal 6)
- Climate Ready Estuaries, Climate Ready Water Utilities, Green Infrastructure, Healthy Watersheds, Sustainable Infrastructure in Water sense
- Researches on climate change impacts on water availability and water crisis

UNIT -2: Climate change impacts on agriculture and health

- Impacts on Crops, crop cycles, soil quality and soil organic carbon
- Impacts on Livestock, fodder production and availability, livestock crisis management
- Impacts on Fisheries, fishing cycles and local community impacts due to change in fishing cycles
- Innovative Financial mechanisms for crop/livestock/fisheries loss insurances, state government policies and aids, central government policies and aids
- Researches on climate change impacts on agriculture and food supply

Unit-3: Climate change impacts on forests and transportation

- Forest dispersion and shifting, Forest fires
- Ecophysiological Responses, Tree Responses to Temperature and Water Availability
- Tree Responses to Increased CO₂ Concentration, Carbon Storage and Nutrient Availability
- Species Distributions, Transient Responses in Species Compositions, Potential Biome Distributions, Past and Future Species Migration Rates
- Biodiversity and related Adaptation mechanisms and strategies
- Climate Change and Transportation, transportation, pollution and human health, sustainable transportation, reducing transportation footprint
- Researches on Climate change impacts on Forests

Unit -4: Climate change impacts on energy and socioeconomic issues, methods of evaluation and/or assessment

- Temperature, Energy Demand, and Energy Supply, Water Availability and Energy, energy security and Climate Change
- Climate and Energy Systems and its relevance to various stakeholders in the energy sector
- The effects of climate change on power & heat plants – assessing the risks and opportunities
- Renewable sources, production mechanisms, project planning for solar pv, wind generation farms
- Forest biomass for fuel production – potentials, management and risks under warmer climate
- Researches on Climate change impacts on energy crisis

CLI-408: TOOLS AND TECHNIQUES FOR IMPACTS ASSESSMENT

Unit-1: Methods of impacts and vulnerability assessment

- Approaches: sensitivity, adaptability and vulnerability,
- Sector wise vulnerability assessment methodology
- Key determinants of impacts: magnitude of change, rate of change, transient scenarios, climate variability and extreme events, thresholds
- Effect of complexities of analysis: climate uncertainties, socio-economic uncertainties, low-probability catastrophic events, risk and uncertainties, valuation methods-monetary measures, discounting, validation
- Anticipating effects of climate change: scale of analysis for impact assessment, the Baseline for Comparison, Integrated Scenarios of Climatic and Socioeconomic Change, assessing the impacts of Climatic Extremes and variability
- UNFCCC report on assessing climate change impacts and vulnerability

Unit-2: GIS & Remote Sensing

- Introduction to Remote Sensing and GIS techniques : Satellites , Sensors, Platforms and Resolutions, Infrared and Microwave Remote Sensing : Principles and Applications, Interpreting Optical Remote Sensing Images
- Projection of climate change scenarios and Tools for mapping and monitoring
- GIS applications based on models outputs and GIS databases, softwares
- Remote sensing technologies to monitor climate change processes -vegetation, biomass, monitoring flooding, soil moisture and depth, surface micro topography etc.
- Remote sensing datasets and satellite based monitoring systems, parameters of oceanography
- Prediction, Monitoring and evaluation of natural disasters , Temporal change study by GIS and remote sensing

Unit-3: Climate Modeling

- Significance and need of climate modeling, theory of climate models.
- Types of models-Box models, Zero dimensional models, Radiative convection models, Earth systems models, Global climate models
- Emission scenarios, scenario families, baseline scenarios-factors affecting,
- Projections of global warming under different scenarios
- Research institutes for climate modeling in Ahmedabad

Unit-4: Statistical Tools and Techniques for Impact Prediction

- Definitions of future characterization, Artificial experiments, Sensitivity analysis
- web – GIS- CLIMATE,
- Analogues, storylines in 2017, epidemiology,
- Social science research methodologies- case studies, content analysis, Narrative method, Focussed group discussion, social survey methods, data collection tools etc.
- GROUNDS tool for hydrology

CLI -409: POLICY AND LEGISLATION: NATIONAL AND INTERNATIONAL SCENARIOS

Unit-1: UNFCCC and Montreal Protocol (MULTILATERAL ENVIRONMENTAL AGREEMENTS –MEA)

- United Nations Conference on the Human Environment and United Nations Conference on Environment and Development (UNCED)
- Scientific and implementation bodies, actors in negotiation process
- Decisions of COP and MOP
- Subsidiary bodies of CDM (Designated National Authority, CDM-EB Executive board)
- Status of ratification and Links with Montreal Protocol and Gothenburg Protocol to Abate Acidification, Eutrophication and Ground-level Ozone
- Enhanced transparency framework (ETF)

Unit 2: The Kyoto mechanisms

- Kyoto protocol: Objective , Status of Ratification, Flexible mechanisms- emission trading, clean development mechanism, Joint implementation
- Economic potential: Economics of market mechanisms : CDM , JI and ET
- Environmental problems-sustainable development
- Political barriers and Amendments to the Kyoto Protocol
- Current status and reasons for the failure of Kyoto protocol

Unit-3: Other national, regional and international legislative framework

- National action plans of countries, India and Gujarat
- Reporting systems of countries, India and Gujarat
- GHG reduction initiatives of countries, India and Gujarat
- Clean energy and energy efficiency related regulations and Forestry regulations
- Climate change laws around the world, Environmental Laws and Climate Action: A

- Case For Enacting A Framework Climate Legislation In India
- Government of Gujarat initiatives to combat climate change

Unit-4: Climate Change Policy

- Climate change policy of countries, India and Gujarat
- Uncertainty and climate change policy
- Policy implications-case studies of successful implementations
- Cost-benefit analysis in the context of climate change
- Climate change policy 2021

CLI -410: FUTURE CLIMATE SCENARIOS

Unit-1: Decisions based on emissions

- Integrated Assessment Modeling- Country-wise Case studies (Example of Case study of Acid rain, Canada)
- Decision making processes: Three methods (eco-efficiency, environmental priority strategy (EPS) system, and certified emission reduction (CER) price, Considering cost and CO₂ emission
- Policy makers : Speculators
- Analysis and decision support tools in mitigation of Climate change.
- UNEP -Emissions Gap report 2021

Unit-2: Load sharing

- Burden and Equity
- Developed countries-MEDC, Characteristics, GDP, HDI, OECD members
- Developing countries-LMIC, LEDC, Characteristics, common challenges and opportunities
- Sandbag-thinktank in London : case study of reports-coal to clean, EU-ETS, Effort Sharing Regulation (ESR)
- Ember -global think tank

Unit -3: Ethics

- The perfect moral storm and its relevance on Climate Change (S. Gardiner)
- Scepticisms, past emissions, future emissions
- Environmental risk, impacts and direct interventions
- Collaborative Program on the Ethical Dimensions of Climate Change ,Climate Justice.
- Climate Diplomacy
- Ethical challenges of climate change

Unit-4: Sustainable Development

- Concept: Definition, Pillars of sustainability. Sustainable development and Ecosystem, Agriculture, forestry and others sectors
- Stake holder: Defining stake holders, stake holder engagement and role of stake holders

- Ecological foot-print: Concept, definition, methodology and case studies.
- Indicators/Determinants: population dynamics and SD, integrative vs sectorial perspective of SD
- The Triple Bottom Line of sustainability.
- SDG 2021

Proposed Reference material

- a. Climate change policy – A survey by Stephen Schneider, Armin Rosencranz and John Neils
- b. Climate change policy by Dieter helm, Oxford
- c. UNFCCC Handbook
- d. IPCC Third Assessment Report
- e. Climate Change: What it means for us, our children and our grand children by By Joseph F. DiMento, Pamela Doughman
- f. IPCC Technical Guidelines for Assessing Climate change Impacts and Adaptations
- g. An Introduction to Simple Climate Models used in the IPCC Second Assessment Report – IPCC Technical paper II
- h. Climate change: Causes, Effects and Solutions by John T. Hardy. Willey publication
- i. Climate change and technological options: basic facts, evaluation and practical solutions by Konrad Soyez and Hartmut Grabi, SpringerWien New York publication
- j. The complete guide to climate change by Brian Dawson and Matt Spanngle

CLI 411PR: Practical – III: Based on topics covered in CLI 407 and 408

CLI 412PR: Practical – IV: Based on topics covered in CLI 409 and 410

SEMESTER –III

CLI-501: CLIMATE CHANGE ADAPTATION

Unit-1: Concepts and strategies

- Definition and issues: Definition, Types of adaptation (Anticipator, reactive, human, natural), Systems, Scales, and Actors
- Methods of adaptation:
- Vulnerability and resilience: Concept, definition, methodology and case studies
- Sector –wise adaptation strategy (agriculture, animal agriculture, forests, water resources, coastal resources, fisheries, human health), adaptation potential and challenges
- CARE project for south asia

Unit-2: Costs and Benefits

- Framework for estimating benefits and cost to adaptation
- Linking variability to climate changes
- Case examples
- Economic and policy instruments to promote adaptation
- Economics of Adaptation by IPCC

Unit-3: Adaptive Capacity

- Introduction to Adaptive Capacity: Definition, concept and issues
- Determinants of adaptive capacity: Economic resources, Technology, Information and skills, Infrastructure, Equity and Institution.
- Methods of enhancing adaptive capacity in sectors: Agriculture, Forestry
- Methods of enhancing adaptive capacity in sectors: Social, Rural, Urban, Coastal.
- Assessment of adaptive capacity

Unit-4: Adaptation and Development

- Tools to address climate risks in development activities
- Tools and approaches to incorporate vulnerability and adaptation in development projects
- NAPAs, CBA, ALM, APF,SEA,CC-DARE
- Disaster risk reduction-policy and plans
- Developing an effective adaptation development plan

CLI-502: CLIMATE CHANGE MITIGATION

Unit-1: Mitigation strategies and options for various sectors

- Basic concepts , methodology and Structure of mitigation assessment
- Improved energy efficiency, fuel substitution, hydropower, carbon capture and sequestration, land based carbon sinks, Carbon farming
- General and technology specific barriers and The rebound effect
- Equity and sustainability issues, issues of biodiversity
- Assessment of mitigation costs and benefits
- GEF-7climate change mitigation strategy

Unit-2: Emission trends and mitigation policies

- Sector-wise measures and instruments to mitigate climate change : Short term and Long term Mitigation action
- New and clean technologies
- Emission standards : Vehicle emission performance standard : CARB, EURO and Bharat Stage
- Sustainable development and climate change mitigation
- IPCC -Climate change mitigation pathways

Unit-3: Carbon Market

- Carbon Markets :Emission trading ,Carbon accounting, Carbon Offsets, Tradable Permits and Leakage
- Structure of international carbon market ,allowance and project based markets : Chicago Climate Exchange, European Climate Exchange, European Energy Exchange, NASDAQ OMX Commodities Europe , Power Next, Commodity Exchange Bratislava,
- Pricing structures and Formulation : Fixed, Floating, Combination of the two ,Buyers and sellers of carbon assets
- Transactions and trends and Voluntary carbon market
- International Carbon Action Partnership (ICAP)

Unit-4: Renewable and alternative energy technologies

- Technology options: Biomass, Solar, Hydro, Geothermal and Wind.
- Technology transfer, Current Transfer of Climate Change Mitigation Technology, Methodological and Technological Issues in Technology Transfer, Barriers to Technology Transfer.
- Stakeholders and pathways for energy supply technology transfer
- Case examples : Transfer of technologies between countries , Programmes and Policies for Technology Transfer between Countries.
- Appropriate technologies to reduce climate change

CLI-503: ISSUES NEED ATTENTION

Unit-1: Sustainable forest management

- Criteria and indicators approach for sustainable forest management, The Indian and International initiatives
- Modern Technology for Sustainable Forest Management in India, Innovative Forest Management Models, Forest Certification
- Reduction
- Strategies
- Adaptation
- Prevent forest conversion and protect high conservation value forests

Unit-2: Coastal zone management

- Notification
- Ocean development
- Mangrove ecosystem
- Initiative and mitigation of coastal hazards
- Research Institutes working on ICZM projects in Gujarat

Unit-3: Land use and cover management

- Change
- Degradation
- Socio- ecological system
- Impacts

- Significance of studying LULC

Unit-4: Public awareness

- Methods and ecology, economics and ethics: the missing links
- Life cycle analysis
- Role environmentalist
- Interface of science and policy
- Need of behavioral change to address awareness in public

CLI-504 INTERNATIONAL RESPONSE AND INDIVIDUAL RESPONSIBILITY

Unit-1: Environmental Risk Assessment

- Concept hazard identification, dose-response evaluation, exposure assessment, risk characterization
- Risk evaluation
- Public perception of risk
- Risk communication
- Qualitative Risk Assessment, Quantitative Risk Assessment, Generic Risk Assessment, site specific Risk Assessment, and Dynamic Risk Assessment

Unit-2: Environmental Impact Assessment

- Concept
- Screening, scoping, prediction and mitigation, management and monitoring
- Preparing an Environmental Statement, Making a planning application and consultation
- Projects considered within the town and country planning regime. Local planning authorities, Environment Justice
- EIA Draft 2020

Unit-3: Environmental Audit

- Overall environmental management
- Procurement policy, Energy management, Materials management, Water and wastewater management, Waste management, Noise monitoring and control, Air quality monitoring and control, Emergency response procedures
- Transportation and travelling, Staff awareness and training, Publicity of environmental information, Response to public enquiries and complaints, Setting, process and carrying out an audit, Benefits of environmental audit
- Environmental audit programme in India
- Environmental Auditing

Unit-4: Individual responses

- Footprint and Handprint concept
- Awareness programs
- Case studies

- Youth participation and engagement activities, youth organization and membership opportunities, interventions and conferences and guideline development for regular participation
- Street theatre, Photography, Short video making

Proposed References Material

- a. The Earthscan reader on adaptation to climate change By Lisa Schipper, Ian Burton
- b. Climate change, adaptive capacity and development by Joel B. Smith, Richard J. T. Klein, SaleemulHuq, Potsdam-InstitutfürKlimafolgenforschung
- c. Mainstreaming Adaptation to Climate Change in Least Developed Countries (Ldcs) by SaleemulHuq, Atiq Rahman, International Institute for Environment and Development
- d. Climate Change and India: Vulnerability Assessment and Adaptation by P.R Shukla, Subodh Sharma, N.H. Ravindranath , Amit Garg and Sumana Bhattacharya
- e. Technologies, policies and measures for mitigating climate change- IPCC Technical paper I
- f. Climate change and sustainable development By Anil Markandya, Kirsten Halsnaes
- g. Climate change and carbon markets - A Handbook of emission reduction mechanisms By FarhanaYamin
- h. Voluntary Carbon Markets By Ricardo Bayon, Amanda Hawn, Katherine Hamilto
- i. State and Trends of the Carbon market- 2004, World Bank working paper no.44
- j. Carbon markets- an international business guide By Nick Eyre, Arnaud Brohé, Nicholas Howarth
- k. Handbook of Climate change mitigation options- USAID
- l. Climate change and developing countries by N.H.Ravindranath and Jayant Sathaye
- m. Primer on Climate change and Sustainable Development: Facts, policy analysis and applications by Mohan Munasinghe and Rob Swart
- n. New and Renewable technologies for sustainable development by Naim Hamdia Afgan and Maria da Graca Carvalho
- o. Renewable energy: Technology, Economics and Environment by Martin Kaltschmitt, Wolfgang Streicher, Andreas Wiese

CLI 505PR: Practical – V: Based on topics covered in CLI 501 and 502

CLI 506PR: Practical – VI: Based on topics covered in CLI 503 and 504

SEMESTER-IV

Dissertation

The dissertation is an independent research work relating to the cutting edge of climate change and management research. It develops skills in formulating research questions, and analysis/evaluation of results using appropriate techniques.