Theme Based Multidisciplinary Course

Climate Change, Adaptation and Prediction

Course Teachers:

Dr. Binita Pathak, Assistant Professor, Department of Physics
Dr. Bikash Deka, Assistant Professor, Department of Sociology
Dr. Shukla Acharjee, Assistant Professor, Centre for Studies in Geography
Dr. Rizwan Rehman, Assistant Professor, Centre for Computer Science and Applications
Dr. Palash Dutta, Assistant Professor, Department of Mathematics

About the course:

The Earth's climate has inevitable impacts on life and on human activities. The vegetation type and thus the overall agriculture in a particular region of the globe is determined by the temperature and precipitation of that region. Similarly, the climatic conditions and probabilities of natural calamities, acts as major factors that influence the locations and designs of residences and other infrastructures in a region. Since the beginning of human civilization, the human race has been adapting to various changes in climatic conditions. Due to the sustaining observation and consequent understanding of the climate variations, it evolved as science over time, elaborating sophisticated representations of the observed phenomena. Such a description of climate involves a very broad range of expertise, corresponding to different domains of the sciences including physics, mathematics, statistics, chemistry, biology and geology.

Climate change is unprecedented and has emerged as one of the complex environmental challenges of the present time. It is a global problem, but experienced on local scales, that will persist for decades and centuries to come and jeopardize the security of water, food and energy systems. People all around the globe are experiencing the irreversible negative effects of human intervention on the climate system, especially by releasing carbon dioxide, one of the heat-trapping greenhouse gases. This year's (2021) Nobel prize in Physics was awarded to Syukuro Manabe, Senior Meteorologist at Princeton University, USA and Klaus Hasselmann, Professor, Max Planck Institute for Meteorology, Hamburg, Germany, for the foundation of our knowledge of the Earth's climate and how humanity influences it. Hence, the Nobel prize of 2021 is a great acknowledgement to climate science and the scientists working in this area across the globe. It is high time now to involve each and every human being in the climate-change related issues, such as the cause-and-effects to the adaptation, mitigation and clean air strategies of a nation. The preparedness for Climate Change in terms of Adaptation with changing climate for improvement of quality of life of all living creatures, is of utmost importance. Climate change involves many dimensions – science, economics, society, politics and moral and ethical issues.

This multidisciplinary course is designed to bring awareness among the target students about the causes, impacts, vulnerability and adaptation of climate change, at first stage. They are expected to take part in bringing awareness among people in their own locality and beyond about the same in the next phase. In this interdisciplinary course a comprehensive analysis of all the components of the climate system - atmosphere, ocean, ice sheets, geosphere and of all the interactions between them will be dealt with in detail. Tools to study the climate system and climate change will also be included along with basics of weather and climate predictions. Societal impacts of climate change is another dimension of the course. Theories from social science disciplines will be applied to make action plans at the individual, community, or political level.

Target Students:

All disciplines.

Desirable: Motivation to work for society in bringing awareness among people on climate change and adaptation.

Method of Teaching:

This will be a hybrid course: theory and practical will be classes course materials including books, articles, research publications are available mostly on-line. Learning methods include both offline and online classes, printable lecture notes, asynchronous threaded discussions, weekly assignments, short quizzes,

Course Objectives:

The objectives of this course are to

- Familiarize students with the Earth's climate system and the Science of Climate change
- To provide a foundational insight for students to an introductory perspective and potential core contributions of sociological insights on climate change.
- To explore opportunities and obstacle that may occur with increased interdisciplinary cooperation and collaboration
- Describe the many and unequal impacts of climate change on society
- Understand the many ways that social institutions and individuals are responding to climate change
- Know more about local and regional impacts and responses to climate change.
- familiarize the students with weather and climate prediction models
- Equip with tools to handle online available data to study the past, present and future climate
- Ensure citizen participation in mitigating climate change

Student outcome:

Students are expected to be able to

- Identify factors influencing the global climate systems and climate change
- Assess impacts of climate change on global, regional and local scales
- Engage themselves towards bringing awareness on the cause and effect of climate change among the people of their own community and beyond
- Analyse and interpret climate data as well as learn prediction methods

- Examine and critique policy issues related to climate change based on their scientific knowledge gained in the course.
- Identify clean technologies for sustainable development

Semester Wise Course Distribution

Semester	Course Name	credit			Marks Distribution				
		Theory	Practical /case Study		Theory		Practical		Total
					End Sem	In Sem	End Sem	In Sem	
1	AEC I	2		2	30	20	-	-	50
2	GE I	3	1	4	45	30	15	10	100
3	GE II	3	1	4	45	30	15	10	100
3	AEC II	1	1	2	15	10	15	10	50

Detailed Syllabus

AEC I: Introduction to Climate Change and societal impacts

Credits: 2

Unit I : The Earth climate system and Climate change (Course Teacher: Dr Binita Pathak) **Marks: 15** **Lectures: 15**

The climate system, and interaction among the sub-systems, The Earth's natural greenhouse Effect and Dark Heating, radiation balance, Climates of the past: last hundred, thousands and millions years;
natural versus anthropogenic causes of climate change, enhanced greenhouse effect, climate forcing, climate forcing agents- greenhouse gases, aerosols, clouds, land use etc; global warming: role of CO_2, CH_4, water vapor etc., global warming potentials, the runaway greenhouse effect, CO_2 emissions and the Earth's carbon reservoirs, The Intergovernmental Panel on Climate Change (IPCC)

Weather and climate, Global wind systems, importance of monsoons, El-nino and southern oscillations, general circulation,

Unit II: Social theories and Methodological approaches to Climate Change (Course Teacher: Dr Bikash Deka) **Marks: 15** **Lectures: 15**

Addressing the Social Theory of Climate Change: The Value of Sociology, Opportunities and Obstacles for Interdisciplinary Collaborations in Climate Change, Bridging social and natural sciences in understanding and addressing the climate change, Social Structure and Processes: The forces Driving Climate Change

GE I: Vulnerability of Climate Change in twenty-first century Credits: 4

Unit I: Current state of the climate (Course Teacher: Dr Binita Pathak, Dr Palash Dutta)

Marks: 15 **Lectures: 15**

Recent Climate change-human intervention, emission scenarios/pathways, Changes in climate extremes, long and short term climate changes, regional patterns of climate change, temperature response, air quality response, irreversibility, tipping point and abrupt changes, drivers of Regional Climate Variability and Change- global and regional monsoons response to climate change

Hazardous Emissions- Risk Assessment Process- Hazard identification, Dose response assessment, Exposure- assessment, Exposure Pathways and Risk Assessment Models-EPA model

Unit II: Climate change impacts on Ecology (Course Teacher: Dr. Shukla Acharjee)

Marks: 15 **Lectures: 15**

Climate change impacts on: fresh water resources-surface and groundwater, drought and soil moisture, wetlands, glaciers melting, terrestrial ecosystem-geographic shifts in terrestrial habitats, vegetation-climate interaction, loss of biodiversity, agriculture and food supply, marine environment- sea level rise, ocean current and circulation, ocean acidification, coastal lives, marine ecosystem

Unit III: Sociological Analysis of the Causes of Global Climate Change (Course Teacher: Dr Bikash Deka)

Marks: 15 **Lectures: 15**

Individual and Technology- Human Settlement and Infrastructure, Culture, Capitalism

Unit IV: Socio-Economic Climate Impacts (Course Teacher: Dr Bikash Deka)

Marks: 15 **Lectures: 15**

Climate impacts on Economic, Political and Human Security; Physical and Mental Health, Indigenous People and Climate Justice, Gender and Justice across Time and Space

GE II: Climate change: adaptation, mitigation and sustainability

Credit : 4

Unit I: Adaptation, Mitigation, Response, and Resilience to Climate Change (Course Teacher: Dr Bikash Deka)

Marks: 15 **Lectures: 15**

Public opinion on Climate Change, Consumption Patterns and global climate Change, Strategies for Equitable Mitigation and Adaptation

Unit II: Global Climate Politics and the Role of Civil Society and Social Movements (Course Teacher: Dr Bikash Deka)

Marks: 15 **Lectures: 15**

Global inequality and Climate justice, Climate Change and denial Counter-movements, Economic and Government Responses, Social Movements and Location

Unit III: Climate change and sustainability (Course Teacher: Dr. Shukla Acharjee)

Marks: 15 **Lectures: 15**

Adaptive capacity, adaptation to climate change, Carbon sequestration, Mitigation technologies and potential in 2030, Zero carbon future, temperature stabilization, mitigation- carbon dioxide removal (CDR), reduction of global warming by geoengineering, carbon free renewable energy technology- alternative energy, efficient use of energy and its conservation, Global Village, climate change preparedness

Unit IV: Application of Remote sensing and GIS in Climate Change studies (Course Teacher: Dr. Shukla Acharjee, Binita Pathak)

Marks: 15 **Lectures: 15**

Application of GIS for land use and land cover change study- Land use, land cover, landscape pattern, landscape condition; Scenario Development - land-use impacts on greenhouse gas emissions and climate change, forest ecosystem and biodiversity, and hydrologic change and water availability, Driving-Force Analysis; satellite remote sensing of atmospheric parameters- trace gases, aerosols, temperature, pressure, wind, humidity etc.

AEC II: Climate Data Handling and Prediction

Credit: 4

Unit I: Machine Learning in Climate Science (Course Teacher: Dr Rizwan Rehman)

Marks: 15 **Lectures: 15**

Basics of Python Programming, Introduction to machine learning, Understanding Climate Data, Similarity-based Learning, Regression Analysis, Decision Tree Learning, Bayesian Learning, case study on a climate dataset.

Unit II: Prediction of weather and climate (Course Teacher: Dr Binita Pathak)

Marks: 15 **Lectures: 15**

Modeling the weather- Weather analysis-gathering data and analysing weather maps; Weather forecasting- range, methods-Numerical Weather Prediction-seasonal forecasting

Basics of climate model -introduction, types, components-Earth system models; Governing Equations of a climate model- dynamical core, Parameterizations: microphysics, boundary layer, convection, radiation, land surface, etc; Post processing using various tools like NCO, CDO, NCL, Python etc., Models for climate prediction, Understanding the past, present and future climate - Coupled Model Intercomparison Project (CMIP) models, European Centre for Medium-Range Weather Forecasts (ECMWF) - Integrated Forecasting System.

Suggested Readings

1. The Atmosphere: An Introduction to Meteorology, Frederick K. Lutgens, Edward J. Tarbuck, PHI Learning
2. Global Warming-The complete briefing, John Houghton, Cambridge University Press
3. Climate Changes: Causes, Effects and Solutions, John T. Hardy, Wiley
4. Basics of Atmospheric Science, A Chandrasekar, PHI Learning
5. Climate Change Impact, Adaptation and Mitigation in Agriculture: Methodology for Assessment and Application, *Editors:* H. Pathak P.K. Aggarwal S.D. Singh
6. Remote Sensing and Land Cover: Principles and Applications, Chandra Giri, Taylor and Francis CRC Press
7. Introduction to climate dynamics and climate modeling, Goosse H., P.Y. Barriat, W. Lefebvre, M.F. Loutre, and V. Zunz (2010). Online textbook available at http://www.climate.be/textbook.
8. Climate Change and Sustainable Development: Prospects for Developing Countries, Anil Markandya, Routledge, 2002
9. Interpreting Sustainability, in Sustainability: Dynamics and Uncertainty, Heal, G. M., Kluwer Academic Publ., 1998
10. Climate Change Policy – Facts, Issues and Analysis, Jepma, C.J., and Munasinghe, M., Cambridge University Press, 1998

11. Sustainable Energy Development: Issues and Policy in Energy, Environment and Economy: Asian Perspective, Munasinghe, M., Kleindorfor P. R. et. al (ed.), Edward Elgar, 1996
12. Climate Change – An Indian Perspective, Sushil Kumar Dash, Cambridge University Press India Pvt. Ltd, 2007
13. An Introduction to Atmospheric Radiation, K N Loiu, Academic Press
14. Adaptive capacity is intimately connected to social and economic development but is unevenly distributed across and within societies." IPCC, Climate Change 2007: Synthesis Report, Summary for Policymakers, p. 14.
15. Intergovernmental Panel on Climate Change, Climate Change 2007: Synthesis Report, Summary for Policymakers, Allan Schnaiberg (2007), Cambridge University Press, 2007.
16. Climate Change and Society: Sociological Perspectives, Dunlap, R.E.; Brulle, R.J. (2015), Oxford University Press, New York, NY, USA, 2015
17. Decision Making for the Environment: Social and Behavioral Science Research Priorities, Garry Brewer and Paul Stern (2005) (eds.), National Research Council of the National Academies, p.1.
18. Marx's Theory of Metabolic Rift: Classical Foundations for Environmental Sociology, John Bellamy Foster(1999), American Journal of Sociology 105, 2:366-405.
19. The Treadmill of Production: Injustice and Unsustainability in the Global Economy, Kenneth Gould, David Pellow, Allan Schnaiberg (2008), Paradigm Publishers, 2008.
20. Marina Fischer-Kowalski and H. Haberl (2007), Socioecological Transitions and Global Change. Trajectories of Social Metabolism and Land Use (Edward Elgar).
21. A Climate of Injustice: Global Inequality, North South Politics, and Climate Change; Robert, J. T; Parks, B.C (2006): The MIT Press: UK, Cambridge
22. From Metabolic Rift to Metabolic Value: Reflections on Environmental Sociology and the Alternative Globalization Movement, Salleh, A., Organ. Environ. 2010, 23, 205-219
23. The Environment: From Surplus to Scarcity (1980), Oxford University Press.
24. Radiation Risks in Perspectives, Kenneth L. Mossman, CRC Press, 2019.
25. Machine Learning, S Sridhar and M. Vijayalakshmi, Oxford University Press.

Some useful Links

https://www.ipcc.ch/
https://nas-sites.org/climate-change/climatemodeling/page_1_1.php
https://www.wcrp-climate.org/wgcm-cmip
https://www.ecmwf.int/en/research/modelling-and-prediction
https://climate.nasa.gov/
https://climate.nasa.gov/solutions/resources/
https://www.nobelprize.org/prizes/physics/2021/popular-information/