Canvi Climàtic 2013/2014

Codi: 43056
Crèdits: 6

Titulació	Tipus	Curs	Semestre
4313784 Estudis Interdisciplinaris en Sostenibilitat Ambiental, Econòmica i Social	OT	0	1

Professor de contacte

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Utilització d´idiomes

Llengua vehicular majoritària: anglès (eng)

Prerequisits

Students should preferably hold an undergraduate degree with relevance to physical sciences and engineering, including geography and environmental sciences. Students with a background in social sciences are also welcome, and should be able to follow the course provided they are acquainted with basic principles of Earth and physical sciences. A reasonable level of English speaking and writing skills are necessary to follow the course.

Objectius

The module is designed to provide the basic foundations and interdisciplinary knowledge of climate change science and policy for students wishing to engage in PhD research, or employment in private or public organisations, working in climate change related issues.

At the end of the course the student is expected to have a good understanding of:

- the basic science of climate change;
- the current impacts of climate change and vulnerability of natural and social systems;
- international approaches to adaptation and mitigation.

The aim is thus to develop:

- an inter-disciplinary understanding of climate change science, societal interactions and policy;
- a critical perspective on the impacts of climate change and the challenges associated with tackling them;
- an understanding of climate change within the context of broader anthropogenic environmental change.

Competències

Estudis Interdisciplinaris en Sostenibilitat Ambiental, Econòmica i Social

- Analitzar el funcionament del planeta a escala global per comprendre i interpretar els canvis ambientals a escala global i local.
- Aplicar la metodologia de recerca, les tècniques i els recursos específics per a investigar i produir resultats innovadors en l'àmbit dels estudis ambientals.
- Buscar informació en la literatura científica fent servir els canals apropiats i integrar aquesta informació per plantejar projectes de recerca en ciències ambientals.
- Comunicar oralment i per escrit en anglès
- Que els estudiants siguin capaços d'integrar coneixements i enfrontar-se a la complexitat de formular judicis a partir d'una informació que, tot i ser incompleta o limitada, inclogui reflexions sobre les responsabilitats socials i ètiques vinculades a l'aplicació dels seus coneixements i judicis

- Que els estudiants sàpiguen comunicar les seves conclusions, així com els coneixements i les raons últimes que les fonamenten, a públics especialitzats i no especialitzats d'una manera clara i sense ambigüitats
- Que els estudiants tinguin les habilitats d'aprenentatge que els permetin continuar estudiant, en gran manera, amb treball autònom a autodirigit
- Tenir coneixements que aportin la base o l'oportunitat de ser originals en el desenvolupament o l'aplicació d'idees, sovint en un context de recerca
- Treballar en un context internacional i multidisciplinari

Resultats d´aprenentatge

1. Analitzar i interpretar registres i resultats climàtics basats en diferents tècniques.
2. Aplicar la metodologia de recerca, les tècniques i els recursos específics per a investigar i produir resultats innovadors en l'àmbit dels estudis ambientals.
3. Avaluar i raonar les diferents realitats del canvi climàtic i les seves evidències, i les conseqüències futures de la seva existència.
4. Buscar informació en la literatura científica fent servir els canals apropiats i integrar aquesta informació per plantejar projectes de recerca en ciències ambientals.
5. Comunicar oralment i per escrit en anglès
6. Demostrar que es comprèn el concepte de canvi climàtic a causa de causes naturals o antròpiques.
7. Identificar els camps daplicació del clima en les diferents problemàtiques ambientals.
8. Que els estudiants siguin capaços d'integrar coneixements i enfrontar-se a la complexitat de formular judicis a partir d'una informació que, tot i ser incompleta o limitada, inclogui reflexions sobre les responsabilitats socials i ètiques vinculades a l'aplicació dels seus coneixements i judicis
9. Que els estudiants sàpiguen comunicar les seves conclusions, així com els coneixements i les raons últimes que les fonamenten, a públics especialitzats i no especialitzats d'una manera clara i sense ambigüitats
10. Que els estudiants tinguin les habilitats d'aprenentatge que els permetin continuar estudiant, en gran manera, amb treball autònom a autodirigit
11. Tenir coneixements que aportin la base o l'oportunitat de ser originals en el desenvolupament o l'aplicació d'idees, sovint en un context de recerca
12. Treballar en un context internacional i multidisciplinari

Continguts

The course contents are generally organised in three parts that follow the structure of previous and forthcoming reports of the Intergovernmental Panel on Climate Change (IPCC - www.ipcc.ch). Each of these parts translates in turn into a series of topical lectures (see Section 8 below for lectures and bibliography).
Part 1. Introduction to the climate system and Earth System Science

- Dynamics and variability of climate
- Climatic trends of the distant and near past
- Extreme phenomena and natural hazards
- Climate tipping points
- Quantitative approaches for understanding the functioning of the climatic system
- Global and regional modelling

Part 2. Impacts, vulnerability and adaptation

- Future scenarios
- Climate impacts and risk assessment · Science-policy interfaces
- Vulnerability and adaptation: concepts, policy and research

Part 3. Mitigation options and policy

- Carbon markets
- Renewables and bioenergy options
- Geo-engineering

- Land-use based mitigation: REDD+

Metodologia

The module will be divided into 12 classes of three hours.

Lecturers will present the topic in question and leave time for questions and discussion. Some lectures will involve the presentation/discussion of provided articles. Each session will be allocated two / three required readings, as well as optional readings (see Section 8 below).

Activitats formatives

Títol	Hores	ECTS	Resultats d´aprenentatge
Tipus: Dirigides			
Lectures	36	1,44	1, 3, 6, 7, 10, 12
Tipus: Supervisades			
Final exam	3	0,12	5, 9
Tipus: Autònomes			
2 short essays	20	0,8	2, 4, 5, 8, 9
Compulsory and optional reading	68	2,72	1, 4, 11

Avaluació

Students will be assessed on the basis of:
- A final exam that will last 2.5 hours and cover most aspects of the course. Students will have limited space to answer each of these questions and will have to prove that they have understood and master key concepts and ideas introduced during the course.
- Two written 1000-words essays corresponding to two topics addressed during the course. The teachers will assess the essay following their own marking criteria, taking chiefly into account ability to identify and synthesize relevant literature for a given topic and grasp the correspondent ideas and arguments; agumentative abilities and writing skills.
- Their assistance and participation in class.
The final mark will be the weighted average of the following assessments:
Final exam 50%
Written essays 35% (17.5% each)
Assistance and participation in class 15%

Activitats d´avaluació

Títol	Pes	Hores	ECTS	Resultats d´aprenentatge
2 essay writings	35%	20	0,8	2, 3, 4, 5, 8, 9
Final exam	50%	3	0,12	5, 9
Participation in class	15%	0	0	1, 3, 6, 7, 10, 12

Bibliografia

The references provided below are indicative and the student is encouraged to search for more articles and books under each topic. However, the articles or movies marked (**) must be read or watched prior to each lecture as they will be discussed or used in class.

Recommended general climate science textbook and preliminary reading:

- Earth's Climate: Past and Future (2nd edition). W.F. Ruddiman. W.H Freeman and Co., NY (2007).
- IPCC, 2007: Climate Change 2007: Synthesis Report, eds Pachauri, RK and Reisinger, A., Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, Cambridge University Press, 104 pp. (see: <http://www.ipcc.ch/publications_and_data/ar4/syr/en/contents.html>)

1. History of global warming. Dynamics and variability of climate

Introduction to the science of climate from an Earth Systems Science perspective and the natural and anthropogenic processes driving climate change. Discussion of the debate on the existing evidence of current global warming. Compulsory and suggested readings and movies to watch include:

(**) An inconvenient truth (2006). Movie. http://vimeo.com/16335777

(**) The great global warming swindle (2007). Documentary. http://vimeo.com/14089163

Arrhenius S. (1896). On the influence of carbonic acid in the air upon the temperature of the ground. Philosophical Magazine, 41, 237-76.

Bard, E. ((2004). Greenhouse effect and ice ages: Historical perspective. Comptes Rendus - Geoscience 336, 603-638.

Claussen et al. (2003). Climate Change in Northern Africa: The Past is Not the Future. Climatic Change, 57, 99-118.

Keeling, C.D., (1998). Rewards and penalties of monitoring the Earth. Annu. Rev. Energy Environ., 23, 25-82.

Hulme M (2007). Understanding climate change: the power and the limit of science (viewpoint article). Weather, 62, 243-244.

Hansen J., et al. (2006). Global temperature change. Proc. Natl Acad. Sci. USA, 103, 14288-14293.

Jansen E, et al. Palaeoclimate. In Climate Change (2007). the physical science basis. Contribution of Working Group I to the Fourth Assessment Report of Intergovernmental Panel on Climate Change. Solomon S, Qin D,Manning M, Chen Z, Marquis M, Averyt K.B, Tignor M, Miller H.L .pp.434-497. Eds. Cambridge, UK, Cambridge University Press.

McCarthy J. (2009). Reflections On: Our Planet and Its Life, Origins, and Futures. Science, 326, 1646-1655.

2. Climatic trends of the distant and near past

Review of the recent geological history of natural climate variability of the Earth at time scales from decades to million years, and its relevance to contextualize present and future changes relate to global warming.

(**). Masson-Delmotte V, et al. (2006). Past temperature reconstructions from deep ice cores: relevance for future climate change. Clim. Past. 2, 145-165.

(**). Skinner L. Facing future climate change: is the past relevant?. 366, Issue 1885, 28 December (2008)., Pages 4627-4645.

Alley R.B., et al. (1993). Abrupt increase in Greenland snow accumulation at the end of the Younger Dryas event. Nature, 362, 527-529.

Blunier T., et al. (1998). Asynchrony of Antarctic and Greenland climate change during the last glacial period. Nature, 394, 739-743.

Bond, G., et al. (1992). Evidence for massive discharges of icebergs into the glacial Northern Atlantic. Nature, 360, 245-249.

Dansgaard, W., et al. (1993). Evidence for general instability of past climate from a 250-kyr ice-core record. Nature, 364, 218-220.

Jouzel J, et al. (2007). Orbital and millennial Antarctic variability over the past 800,000 years. Science. 317, 793-796.

Lambeck K, Chappell J (2001). Sea level change through the last glacial cycle. Science. 292, 679-686.

Mann, M.E., R.S. Bradley, and M.K. Hughes, (1998). Global-scale temperature patterns and climate forcing over the past six centuries.Nature, 392, 779-787.

Paillard D (2006). What drives the ice age cycle? Science.313, 455-456.

Petit J.R., J. Jouzel, D. Raynaud, N.I. et al. (1999). Climate and atmospheric history of the past 420,000 years from Vostok ice core, Antarctica. Nature, 399 (6735). 429-436.

Severinghaus, J.P., and E.J. Brook, (1999). Abrupt climate change at the end of the last glacial period inferred from trapped air in polar ice. Science, 286, 930-934.

Schmittner, A. (2011). Climate Sensitivity Estimated from Temperature Reconstructions of the Last Glacial Maximum. Science, 334, 1385-1388.

Stocker, T.F., (1998). The seesaw effect. Science, 282, 61-62.

MARGO project members (2009). Constraints on the magnitude and patterns of ocean cooling at the Last Glacial Maximum. Nature Geoscience, 2, 127-132.

Wunsch, C. (2002). What is the thermohaline circulation? Science, 298, 1179-1180.

Zachos est al. (2001). Trends, rhythms, and aberrations in global climate 65 Ma to present. Science, 292, 686 -693.

3. Global and regional modelling

Short introduction to the approaches used to model climate at different spatial scales, and validate their performance particularly to predict future climate under different scenarios.

(**).Foley, A. M. (2010). Uncertainty in regional climate modelling: A review. Progress in physical geography, 34,647 -670.

(**). A national strategy for advanced climate modelling. (2012). The National Academic Press. http://nas-sites.org/climatemodeling/index.php

Budyko M.I. (1969). The effect of solar radiation variations on the climate of the Earth. Tellus 21: 611-619.

Gates, W.L., et al. (1996). Climate models - evaluation. In: Climate 1995: The Science of Climate Change [Houghton, J.T., et al. (eds.).]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 229-284.

Joussaume, S. & Taylor, K. E. (2000). Modelling extreme climates of the past: what we have learned from PMIP and related experiments. In PAGES-CLIVAR newsletter, pp. 18-19.

Knutti R (2008). Should we believe model predictions of future climate change?. Phil. Trans. R. Soc. A. 366, 4647-4664.doi:10.1098/rsta.(2008).0169.

Knutti R. (2010). The end of model democracy?. Climatic Change, 102, 395-404.

McGuffie K., Henderson-Sellers A . 2005. A climate modelling primer (3rd edition). Wiley.

Randall, D.A. et al. (2007). Cilmate Models and Their Evaluation. In: Climate Change (2007). The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M.Tignor and H.L. Miller (eds.).]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Trenberth, K. E., J. T. Fasullo and J. Kiehl ((2009). Earth's global energy budget. Bull. Amer. Meteor. Soc., 90: 311-323.

4. Extreme phenomena and natural hazards. Climate tipping points.

Discussion of current understanding on climate change related to abrupt/rapid transitions, and the possible influence of global warming on the increased occurrence of extreme phenomena and weather.

(**). Levitan, D. (2013). Quick change planet: do global climate tipping points exist?. Scientific American. http://www.scientificamerican.com/article.cfm?id=do-global-tipping-points-exist

(**). "Chapter 3.8. Changes in extreme events" in Trenberth, K.E. et al. (2007). Observations: Surface and Atmospheric Climate Change. In: Climate Change (2007). The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon, S., D. Qin, M. Manning, Z. Chen, M. Marquis, K.B. Averyt, M. Tignor and H.L. Miller (eds.).]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

Alley et al. (2003). Abrupt Climate Change 299 (5615). 2005-(2010).

Beniston M., Stephenson D.B. (2004). Extreme climatic events and their evolution under changing climatic conditions. Global and planetary change, 44, 1-4.

Broecker, W.S., (1997). Thermohaline circulation, the Achilles heel of our climate system: will man-made CO2 upset the currentbalance? Science, 278, 1582-1588.

Cox PM , et al. (2000). Acceleration of global warming due to carbon-cycle feedbacks in a coupled climate model. Nature 408:184-187.

Grinsted A. et al. (2013). Projected Atlantic hurricane surge threat from rising temperatures. Proceedings of the National Academy of Sciences of the United States of America, 110, 5369 -5373.

Hofmann M., Rahmstorf S. (2009). On the stability of the Atlantic meridional overturning circulation. Proc. Natl. Acad. Sci. USA, 106, 20584-20589.

Huybrechts P , De Wolde J ((1999). The Dynamic Response of the Greenland and Antarctic Ice Sheets to Multiple-Century Climatic Warming. J Clim 12:2169-2188.

Lenton T.M, et al. (2008). Tipping elements in the Earth's climate system.Proc. Natl Acad. Sci. USA. 105, 1786-1793.

Lenton T.M. et al. (2012). Early warning of climate tipping points from critical slowing down: comparing methods to improve robustness. Phil Trans R Soc A. 370, 1185-1204.

Min, S.-K., Zhang, X., Zwiers, F. W. & Hegerl, G. C. (2011). Human contribution to more-intense precipitation extremes Nature 470, 378-381.

Rial et al. (2004). Nonlinearities, Feedbacks and Critical Thresholds within the Earth's Climate System Climatic Change 65, 11-38.

5. Attributing climate change. Future scenarios

In this lecture we will consider the evidence that shows the causes of the current global warming and attributes

an influence to anthropogenic activities. In a second part, we will discuss the criteria used to create future scenarios of greenhouse emissions, and the projections obtained of future climates and their uncertainties.

(**). Stone D.A. et al. (2009). The Detection and Attributionof Human Influence on Climate. Annual review of environment and resources, 34, 1 -16.

(**). van Vuuren D., Riahi K. (2008). Do recent emission trends imply higher emissions forever? Clim. Change 91 237-248.

Anderson K., Bows A. Beyond 'dangerous' climate change: emission scenarios for a new world. Phil. Trans. R. Soc. A, 369, 20-44.

Bard, E. and Frank, M. (2006). Climate change and solar variability: What's new under the sun? Earth and Planetary Science Letters 248, 1-14.

Barnett, T.P., et al. (1999). Detection and attribution of recent climate change: A status report. Bull. Am. Meteorol. Soc., 80, 2631-2660.

Betts R. et al. (2011). When could global warming reach 4°C?. Phil. Trans. R. Soc. A. (2011). 369 67-84.

Crowley, T.J. (2000). Causes of climate change over the past 1000 years. Science, 289, 270-277.

Le Quéré C., et al. (2009). Trends in the sources and sinks of carbon dioxide Nature Geosci. 2 831-836.

Mitchell, J.F.B., et al. (2001). Detection of climate change and attribution of causes. In: Climate Change (2001). The Scientific Basis. Contribution of Working Group I to the Third Assessment Report of the Intergovernmental Panel on Climate Change [Houghton, J.T., et al. (eds.).]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 695-738.

Raupach M. R., Marland G., Ciais P., Le Quéré C., Canadell J. G., Klepper G., Field C. B. (2007). Global and regional drivers of accelerating CO2 emissions Proc. Natl Acad. Sci. USA 104 10 288-10 293

Stainforth D.A, et al. 2005 Uncertainty in predictions of the climate response to rising levels of greenhouse gases. Nature. 433, 403-406.

Stott, P. A. et al. (2010). Detection and attribution of climate change: a regional perspective. Wiley Interdiscip. Rev. Clim. Change 1, 192-211.

Zickfeld K. et al. (2010). Expert judgments about transient climate response to alternative future trajectories of radiative forcing. Proc. Natl. Acad. Sci. USA, 107, 12451-12456.

6. Climate impacts and risk assessment

We will discuss the existing evidence on the negative impacts of climate change on natural and social systems throughout history, since the early XXth century and possible hazards for the future under different climate scenarios.

(**). Good P. et al. (2011). A review of recent developments in climate change science. Part I: Understanding of future change in the large-scale climate system. Progress in physical geography, 35, 281 -296.

(**). Rosenzweig C. Neofotis P., (2013). Detection and attribution of anthropogenic climate change impacts. Climate change, 4, 121 -150.

Archer D, Ganopolski A 2005 A movable trigger: fossil fuel CO2 and the onset of the next glaciation. Geochem. Geophys. Geosyst. 6, Q05003, doi:1031029/(2004).GC000891.

Berger A, Loutre M.-F (2002). An exceptionally long interglacial ahead?.Science. 297, 1287-1288.

de Menocal, P.B., (2001). Cultural responses during the late Holocene. Science, 292, 667-673.

Doney S.C. et al. (2012). Climate change impacts on marine ecosystems. Annu. Rev. Mar. Sci. 4,11-37.

Ehrlich P.R., Ehrlich A.H. (2013). Can a collapse of global civilization be avoided? Proc. R. Soc. B (2013). 280, (2012).2845.

Gosling et al. (2011). A review of recent developments in climate change science. Part II: The global-scale impacts of climate change. Progress in physical geography, 35,443-464.

Hansen J.E 2005 A slippery slope: how much global warming constitutes'dangerous anthropogenic interference'?. Clim. Change. 68, 269-279.

New M., et al. (2011). Four degrees and beyond: the potential for a global temperature increase of four degrees and its implications. Phil Trans R Soc A, 369, 6-19.

Ramanathan V, Feng Y. (2008). On avoiding dangerous anthropogenic interference with the climate system: Formidable challenges ahead. Proc. Natl. Acad. Sci. USA, 105, 14245-14250.

Rosenzweig, C., G. Et al. (2007). Assessment of observed changes and responses in natural and managed systems. Climate Change (2007). Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change, M.L. Parry, O.F. Canziani, J.P. Palutikof, P.J. van der Linden and C.E. Hanson, Eds., Cambridge University Press, Cambridge, UK, 79-131.

Salomon S. et al. (2009). Irreversible climate change due to carbon dioxide emissions. Proc. Natl. Acad. Sci. USA, 106, 1704-1709.

Smith J.B. et al. (2009). Assessing dangerous climate change through an update of the Intergovernmental Panel on Climate Change (IPCC). "reasons for concern". Proc. Natl. Acad. Sci. USA, 106, 4133-4137.

7. Evolution and architecture of international climate policy

This lecture has two parts. The first overviews the evolution and history of negotiations under the United Nations Framework Convention on Climate Change, from the Kyoto Protocol to the most recent Copenhagen Accord in 2009. It reviews the key cornerstones of international climate change architecture (i.e. carbon markets, fund-based mechanisms, for both mitigation and adaptation action) and set the conceptual foundations for the remaining lectures. The second part of the lecture analyses the implications of the Copenhagen Accord along four axis: international cooperation; climate justice; mitigation pledges; and adaptation implications. Compulsory and suggested readings include:

(**) Okereke, C. and Schroeder, H. (2009) How can justice, development and climate change mitigation be reconciled for developing countries in a post-Kyoto settlement? Climate and Development, 1: 2010-2015.

(**) den Elzen, MGJ. et al. The emissions gap between the Copenhagen pledges and the 2 degrees C climate goal: Options for closing and risks that could widen the gap. Global Environmental Change, 21:2, 733-743.

Bosello et al. (2013) Adaptation can help mitigation: an integrated approach to post 2012 climate policy. Environment and Development Economics, 18:3, 270-290.

de Araujo, MS. et al. (2012) GHG historical contribution by sectors, sustainable development and equity. Renewable and Sustainable Energy Reviews, 11:5, 988:997.

Dimitrov, R. (2010) Inside Copenhagen: The state of climate governance. Global Environmental Politics, 10:2.

Gardiner, S. (2004) Ethics and Global Climate Change. Ethics, 114: 555-600

Okereke, C. et al. (2009) Conceptualizing Climate Governance Beyond the International Regime. Global Environmental Politics, 9:1.

Ramathan, V. and Xu, YY. (2010) The Copenhagen Accord for limiting global warming: Criteria, constraints, and available avenues. Proceedings of the National Academy of Sciences of the United States, 107:18, 8055-8062.

Schroeder, H. (2010) The history of international climate change politics: Three decades of progress, process

and procrastination in Boykoff, M. (ed) The Politics of Climate Change, London: Routledge.

Sterner, T. and Damon, M. (2011) Green growth in the post-Copenhagen climate. Energy Policy, 39:11, 7165-7173.

Rogelj, J. et al. Analysis of the Copenhagen Accord pledges and its global climatic impacts-a snapshot of dissonant ambitions. Environmental Research Letters, 5:3.

8. Vulnerability, adaptation and maladaptation: concepts and policy practice

This first part of this lecture provides the theoretical fundamentals of three concepts that are critical in climate change policy and responses, i.e. vulnerability, adaptation and maladaptation. It describes how they have been addressed and considered by international climate change policy and discusses some of the articles suggested below. The second part of the lecture describes how we can assess vulnerability and adaptation in a given research context, drawing on the literature and a case study provided by the teacher.

(**) Adger, N. et al. (2012) Cultural dimensions of climate change impacts and adaptation. Nature Nov 2012 doi:10.1038/NCLIMATE1666

(**) Eakin, H. (2005) Institutional Change, Climate Risk, and Rural Vulnerability: Cases from Central Mexico. World Development, 33: 11, 1923-1938.

Adger, WN. et al. (2009) Are there social limits to adaptation to climate change? Climatic Change (2009) 93:335-354.

Agarwal, A. et al. (2012) Climate policy processes, local institutions, and adaptation actions: mechanisms of translation and influence. WIREs Clim Change 2012, 3:565-579. doi: 10.1002/wcc.193

Barnett, J. and O'Neill, S. (2010) Maladaptation. Global Environmental Change 20: 211-213.

Berkhout, F. (2012) Adaptation to climate change by organizations. WIREs Clim Change 2012, 3:91-106. doi: 10.1002/wcc.154.

climate change, WIREs Clim Change, 1: 232-242.

Eakin, H. et al. (2009) Nested vulnerability: exploring cross-scale linkages and vulnerability teleconnections in Mexican and Vietnamese coffee systems

Moser, C. and Ekstrom, JA. (2010) A framework to diagnose barriers to climate change adaptation. Proceedings of the National Academy of Sciences of the United States, 107:51, 22026-22031.

O'Brien, K. and Wolf, J. (2010) A values-based approach to vulnerability and adaptation to

Olmos, S. (2001) Vulnerability and Adaptation to Climate Change: Concepts, Issues, Assessment Methods. A report for the Climate Change Knowledge Network, www.cckn.net

Otto Naess, L. (2012) The role of local knowledge in adaptation to climate change. WIREs Clim Change 2012. doi: 10.1002/wcc.204.

Paavola, J. and Adger, WN. (2006) Fair adaptation to climate change. Ecological Economics 56 (2006) 594-609.

Parraguez, E. and Barton, J. (2012) Poverty and Dependency in Indigenous Rural Livelihoods: Mapuche Experiences in theAndean Foothills of Chile. Journal of Agrarian Change.

Pramova, E. et al. (2012) Forests and trees for socialadaptation to climate variability and change. WIREs Clim Change, 3: 581-596.

Swart, R. et al. (2009) Europe Adapts to Climate Change. Comparing National Adaptation Strategies. PEER Report No 1.

Wolf, J. and Moser, C. (2011) Individual understandings, perceptions, and engagement with climate change: insights from in-depth studies across the world. WIREs Clim Change 2011 DOI: 10.1002/wcc.120.

Ziervogel, G. and Ericksen, P. (2010) Adapting to climate change to sustain food security. WIREs Clim Change 1, 525-540.

9. Carbon markets and offsets: objectives, results and controversies

This lecture focuses on the principal economic policy instrument enacted to control global greenhouse gas emissions, i.e. carbon markets and complementary offsetting mechanisms. It reviews the fundamentals of these markets, with particular emphasis on the largest of all, the European Union Emissions Trading Scheme, shedding light on its procedural rules and its somehow contested outcomes. The lecture also reviews the functioning of the Clean Development Mechanism as the largest offsetting international mechanism, its history, performance and controversies, which range from ethical to technical arguments. Videographic material is likely to be shown.

(**) Bond, P. (2012) Emissions Trading, New Enclosures andEco-Social Contestation. Antipode Vol. 44 No. 3 2012 ISSN 0066-4812, pp 684-701.

(**) Boyd, E., Hultman, N., Timmons Roberts, J., Corbera, E., Cole, J., Bozmoski, A., Ebeling, J., Tippman, R., Mann, P., Brown, K. and Liverman, D. (2009) Reforming the CDM for sustainable development: lessons learned and policy futures. Environmental Science and Policy 12(7), 820-831

Bailey, I. (2007) Neoliberalism, climate governance and the scalar politics of EU emissions trading. Area, 39:4, 431-442.

Bodas Freitas, IM. et al. (2012) The Kyoto mechanisms and the diffusion of renewable energy technologies in the BRICS. Energy Policy, 42, 118-128.

Corbera, E. and Friedli, C. (2012) Planting trees through the Clean Development Mechanism: a critical assessment. Ephemera: theory and politics in organisation, 12(1/2): 206-241.

Lohmann, L. (2010) Uncertainty Markets and Carbon Markets: Variations on Polanyian Themes. New Political Economy, 15:2, 225-254.

Lohmann, L. (2011) Capital and Climate Change. Development and Change, 42(2): 649-668.

Lohmann, L. (2009) Toward a different debate in environmental accounting: The cases of carbon and cost-benefit. Accounting, Organizations and Society, 34:3-4, 499-534.

Newell, R. et al. (2013) Carbon Markets 15 Years after Kyoto: Lessons Learned, New Challenges. Journal of Economic Perspectives,27(1): 123-146.

Calel, R. (2013) Carbon markets: a historical overview. Wiley Interdisciplinary Reviews-Climate Change, 4(2): 107-119.

Spaargaren, G. and Mol, APJ. (2013) Carbon flows, carbon markets, and low-carbon lifestyles: reflecting on the role of markets in climate governance. Environmental Politics, 22:1, 174-193.

Lederer, M. (2012) Market making via regulation: The role of the state in carbon markets. Regulation and Governance, 6(4): 524-544.

Clo, S. (2009) The effectiveness of the EU Emissions Trading Scheme. Climate Policy, 9:3, 227-241.

10. Renewables and bioenergy policy: progress and controversies

This first part of the lecture overviews the global progress in renewable energy deployment (specifically solar thermal, photovoltaics and wind energy) and identifies current drivers and barriers to upscaling. The second part of the lecture introduces a variety of bioenergy options, but focuses on primary sourced biofuels and discusses climate mitigation potentials and implementation risks, drawing on the most recent IPCC literature.

(**) Creutzig, F. et al. (2012) Reconciling top-down and bottom-up modeling on future bioenergy deployment. Nature Climate Change, 2, 320-327.

(**) Garcia-Olivares, A. et al. (2012) A global renewable mix with proven technologies and common materials. Energy Policy, 41, 561-574.

Cherubini, F. et al. Energy- and greenhouse gas-based LCA of biofuel and bioenergy systems: Key issues, ranges and recommendations. Resources, Conservation andRecycling, 53:8, 443-447.

Chum et al. (2011) Bioenergy. In: Edenhofer, O. et al. IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, Cambridge University Press.

Creutzig, F. et al. (2012) Can Bioenergy Assessments Deliver? Economics of Energy & Environmental Policy, 1:2, 65-82.

Hill et al. (2006) Environmental, Economic, and Energetic Costs and Benefits of Biodiesel and Ethanol Biofuels. Proceedings of the National Academy of Sciences of the United States, 103:30, 11206-10.

Edenhofer, O. et al. (2011) IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, Cambridge University Press.

Fargione et al. (2008) Land Clearing and the Biofuel Carbon Debt. Science 319:29, 1235-1238.

Giampietro, M. and Mayumi, K. (2009) The Biofuel Delusion. The fallacy of large-scale agro-biofuel production. Earthscan, London.

Havlik, P. et al. (2011) Global land-use implications of first and second generation biofuel targets. Energy Policy,39:10, 5690-5702.

Jackson, ALR. (2011) Renewable energy vs. biodiversity: Policy conflicts and the future of nature conservation. Global Environmental Change, 21:4, 1195-1208.

Jänicke, M. (2012) Dynamic governance of clean-energy markets: how technical innovation could accelerate climate policies, 22:1, 50-59.

McMichael, P. (2009) The agrofuels project at large. Critical Sociology 35:6, 825-839.

Melillo et al. (2011) Indirect Emissions from Biofuels: How Important? Science 326, 1397-1399.

Negro et al. (2012) Why does renewable energy diffuse so slowly? A review of innovation system problems. Renewable and Sustainable Energy Reviews, 16:6, 3836-3846.

Pimentel, D. et al. (2009) Food Versus Biofuels: Environmental and Economic Costs. Human Ecology, 37:1, 1-12.

Scheidel, A. and Sorman, AH. (2012) Energy transitions and the global land rush: Ultimate drivers and persistent consequences. Global Environmental Change, 22:3,588-595.

van der Host, D. (2007) NIMBY or not? Exploring the relevance of location and the politics of voiced opinions in renewable energy siting controversies. Energy Policy, 35:5, 2705-2714.

Vermeylen, S. (2010) Resource rights and the evolution of renewable energy technologies. Renewable Energy, 35:11, 2399-2405.

Wolsking, M. (2010) Contested environmental policy infrastructure: Socio-political acceptance of renewable energy, water, and waste facilities. Environmental Impact Assessment Review, 30:5, 302-311.

11. Geoengineering: a public debate (invited speakers to be confirmed)

This lecture consists of a public debate on the potential and limitations of geo-engineering options, that more prominently include carbon capture and storage technologies, The speakers invited are renowned experts in

this field.

(**) de Paula Gomes and Muylaert de Araujo, MS. Artificial cooling of the atmosphere-A discussion on theenvironmental effects. Renewable & Sustainable Energy Reviews, 15:1, 780-786.

(**) Shepherd, JG. (2012) Geoengineering the climate: an overview and update. Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences, 370:1974, 4166-4175.

Kriegler, E. et al. (2013) Is atmospheric carbon dioxide removal a game changer for climate change mitigation? Climatic Change,118: 45-57.

Meadowcroft, J. (2013) Exploring negative territory Carbon dioxide removal and climate policy initiatives. Climatic Change, 118, 137-149.

Pires, JCM. et al. (2011) Recent developments on carbon capture and storage: An overview. Chemical Engineering Research and Design, 89:9, 1446-1460.

Poumadere, M. et al. Public perceptions and governance of controversial technologies to tackle climate change: nuclear power, carbon capture and storage, wind, and geoengineering. Wiley Interdisciplinary Reviews-Climate Change, 2:5, 712-727.

Rasch, PJ. et al. (2008) Exploring the geoengineering of climate using stratospheric sulfate aerosols: The role of particle size. Geophys. Res. Lett., 35:2.

Tavoni, M. and Socolow, R. (2013) Modeling meets science and technology: an introduction to a special issue on negative emissions. Climatic Change, 118, 1-14.

12. Land-use mitigation -agriculture and forestry-

This lecture overviews current approaches to land-use based mitigation, focusing principally on agriculture and the evolving UN framework of Reducing Emissions from Deforestation and Forest Degradation (REDD+). The first part of the lecture explores proposals to integrate agricultural activities more substantially in climate change mitigation, and the second part overviews the REDD+ framework, its current architecture and both its potential and limitations in regards climate mitigation, biodiversity conservation and rural development.

(**) Corbera, E. and Schroeder, H. (2011) Governing and implementing REDD+. Environmental Science and Policy, 14: 89-99.

(**) Verspecht, A. et al. Review of trade-offs and co-benefits from greenhouse gas mitigation measures in agricultural production. Journal of Integrative Environmental Sciences, 9:s1, 147-157.

Anderson, EK. and Zeriffi, H. (2012) Seeing the trees for the carbon: agroforestry for development and carbon mitigation. Climatic Change, 115:3-4, 741-757.

Bryan, E. et al. (2012) Can agriculture support climate change adaptation, greenhouse gas mitigation and rural livelihoods? insights from Kenya. Climatic Change, 118:2, 151-165.

Chhatre, A. et al. (2012) Social safeguards and co-benefits in REDD+: a review of the adjacent possible. Current Opinion in Environmental Sustainability, 4, 654-660.

Corbera, E. (2012) Problematizing REDD+ as an experiment in payments for ecosystem services. Current Opinion in Environmental Sustainability, 4: 612-619.

Corbera, E. and Brown, K. (2010) Offsetting benefits? Analysing access to forest carbon. Environment and Planning A, 42(7): 1739-1761

Corbera, E., Estrada, M. and Brown, K. (2010) Reducing greenhouse gas emissions from deforestation in developing countries: Revisiting the assumptions. Climatic Change, 100 (3-4), 355-388.

Corbera, E., Estrada, M., May, P., Navarro, G. and Pacheco, P. (2011) Rights to land, forests and carbon in REDD+: insights from Mexico, Brazil and Costa Rica. Forests, 2(1): 301-342.

De Sy, V. et al. (2012) Synergies of multiple remote sensing data sources for REDD+ monitoring. Current Opinion in Environmental Sustainability, 4, 696-706.

Eliasch, J. (2008) Climate Change: Financing Global Forests (Executive Summary). London: Office of Climate Change.

Gupta, A. et al. (2012) In pursuit of carbon accountability: the politics of REDD+ measuring, reporting and verification systems. Current Opinion in Environmental Sustainability, 4, 726-731.

Houghton, RA. (2012) Carbon emissions and the drivers of deforestation and forest degradation in the tropics. Current Opinion in Environmental Sustainability, 4, 597-603.

Hurteau, MD et al. (2013) Aligning ecology and markets in the forest carbon cycle. Frontiers in Ecology and the Environment, 11:1, 37-42.

Pistorius, T. (2012) From RED to REDD+: the evolution of a forest-based mitigation approach for developing countries. Current Opinion in Environmental Sustainability, 4, 638-645.

Putz, FE., Redford, KH. (2009) Dangers of carbon based conservation. Global Environmental Change 19: 400-401.

Smith, P. and Gregory, PJ. (2012) Climate change and sustainable food production. Proceedings of the Nutrition Society 72:1, 21-28.

Smith, LJ. and Torn MS. (2013) Ecological limits to terrestrial biological carbondioxide removal. Climatic Change (2013) 118, 89-103.

Streck, C. (2012) Financing REDD+: matching needs and ends. Current Opinion in Environmental Sustainability, 4, 628-637.