THEMES

THEMES, UAB-ICTA, 7-17 June 2006

Session: Urbanisation and water use in the Metropolitan Region of Barcelona

Lecturer: Elena Domene, David Sauri

Short description

Urban sprawl is eroding the traditionally compact, diverse, and mixed Southern European cities. Besides the rise in land and energy consumption, the expansion of low density urban forms also affects water, a critical resource in the region. The main purpose of the presentation is to examine how physical, but also economic, social and cultural processes are behind the current urban transformation of the Metropolitan Region of Barcelona. We intend to shed some light on the driving forces and consequences of process of urbanization of the MRB, particularly in what refers to water management and water consumption. In order to do so, we will first introduce briefly the water context in the Region of Barcelona. We will use garden irrigation to illustrate the importance of outdoor water use in the urbanization process, and, following the insights provided by urban political ecology, to highlight the differences in garden types and water spending according to power relations derived from income levels. Our results indicate that, generally, higher income households prefer and can afford more water-consuming Atlantic gardens whereas lower income households have to resort to more climate-adapted species. These differences produce in turn different urban natures based on who can and who cannot afford water costs.

Recommended reading: Domene E., Sauri D., Parés M. 2005, 'Urbanization and Sustainable Resource Use: The Case of Garden Watering in the Metropolitan Region of Barcelona', Urban Geography, Vol.26, Number 6, pp.520-535.

Session: The Ethno-Ecology Lab at ICTA

Lecturer: Victoria Reyes-Garcia

Short description

Ethnoecology is the interdisciplinary study of dynamic relationships among peoples, biota, and environments. Ethnoecology is a rapidly-growing field of research, gaining recognition from professionals, students, researchers, and the public. From April 2006, the Institute for Environmental Sciences and Technology (ICTA) at the Universitat Autònoma de Barcelona (UAB) is setting up an Ethnoecology Laboratory oriented to strengthen the development of ethnoecology in Europe.

The activities of the Ethnoecology Lab will be oriented to link expertise across disciplines and to provide hands-on training of students. The activities of the Ethnoecology Laboratory will include 1) four specialized seminars in ethnoecology; 2) two field courses on methods in ethnoecology, one from the social and one from the natural sciences; 3) an information centre and facilities for the analysis of ethnoecological data; 4) at least three international research projects offering fieldwork possibilities to students; 5) internships in local and international NGOs and research centres; and 6) a monthly e-newsletter to be distributed to participants in the Ethnoecology Network.

Compulsory reading previous to the course: Berkes F., Colding J., Folke C. 2000, 'Rediscovery of traditional ecological knowledge as adaptive management', *Ecological Applications*, 10, pp. 1251-1262.

Session: Ethno-Ecology: Bolivian case study

Lecturer: Victoria Reyes-Garcia

Short description

Quantitative ethnoecology can help testing hypotheses about the causes of transmission and loss of traditional ecological knowledge. We draw on information from Tsimane' Amerindians –a foraging-horticultural society in the Bolivian Amazon– to test hypotheses about the distribution of traditional ecological knowledge. Results from our study show that 1) indigenous people share traditional ecological knowledge widely; 2) market exposure affects the distribution of traditional ecological knowledge, people living farther from market towns share more traditional ecological knowledge than people living closer to market towns; 3) only economic activities that take people out of their cultural context are associated to the loss of traditional ecological knowledge; and 4) traditional ecological knowledge protects short-run nutritional status more than schooling and is negatively associated with the clearance of tropical rainforest for farming.

Compulsory reading previous to the course: Reyes-García V., Vadez V., Huanca, T., Leonard W., McDade T., 'Indigenous knowledge and clearance of tropical rainforest for agriculture: A case study in lowlands Bolivia', Ambio, Submitted Nov 2005.

Further recommended readings: Reyes-García V., Godoy R., Vadez V., Apaza L., Byron E., Huanca T., Leonard W., Pérez E., Wilkie D. 2003, 'Ethnobotanical Knowledge Shared Widely Among Tsimane' Amerindians, Bolivia', *Science*, 299, pp. 1707.
Reyes-García V., Vadez V., Huanca T., Leonard W., McDade T., 'Economic development and local ecological knowledge: a deadlock? Data from a native Amazonian society', *Human Ecology*, In press.

Session: Dealing with the Complexity of Agricultural Systems

Lecturers: Mario Giampietro, Kozo Mayumi, Jesus Ramos-Martin

Short description

PART 1 - the challenges faced by integrated assessment of development of agricultural systems.
This section starts with a general overview of the challenges of Integrated Assessment which uses the complexity of agricultural systems as a case study. In particular, this introduction will discuss three major problems faced by integrated assessment of sustainability: (1) technical incommensurability: the need of using non-equivalent descriptive domains to address the issue of sustainability in relation to different dimensions of analysis - e.g. economic, ecological, social, demographic, technical - and different levels of analysis - e.g. household, village, province, national and global level; (2) social incommensurability: the need of adopting legitimate but contrasting perspectives expressed by relevant social actors about the meaning of development in a given context; (3) the unavoidable presence of large doses of uncertainty/genuine ignorance about the future, when dealing with evolution. This entails that when making an integrated analysis it is necessary to make a distinction between: (1) what refers to the characteristics of the story-teller - the chosen narratives about development, the definition of goals and taboos, the chosen criteria of performance, the selection of the possible alternatives; (2) what refers to the characteristics of what is observed - the data used to build indicators using variables which are associated with the criteria of

performance. That is, an integrated analysis has to be able to generate a integrated package of indicators characterizing the performance of a system in relation to a selection of criteria which has to be chosen "à la carte" by the social actors.

PART 2 - several examples of multi-scale integrated analysis of the sustainability of farming system are provide including examples from cases study in China, Vietnam and Laos. These examples are based on the application of a method called Multi-Scale Integrated Analysis of Societal Metabolism (MSIASM) - whose theoretical basis will be discussed more in details in session 2 - which makes it possible to characterize agricultural systems on different levels (household, village, province, etc) and in relation to different dimensions of analysis. Another interesting feature of the MSIASM approach is the possibility of studying changes in the Metabolism of a social system (metabolism of flows of energy, food and added value) in relation to both the profile of allocation of human activity and profile of allocation of land uses over the different tasks associated with production and consumption.

Compulsory reading previous to the course: see below

Session: Multi-Scale Integrated Analysis of Societal Metabolism (MSIASM): theory and applications

Lecturers: Mario Giampietro, Kozo Mayumi, Jesus Ramos-Martin

Short description

PART 1 presenting the MSIASM approach.
This section provides an overview of the rationale of the approach - MSIASM builds on the Bioeconomics concept of Georgescu-Roegen which describes the socio-economic process in terms of flows-funds elements. Several additional ideas derived from the complexity revolution have been mixed together to develop this tool. In particular three concepts are the building block of MSIASM: (1) mosaic effect across levels and scales - the chosen representation of the metabolism of elements described at different levels of analysis (household, economic sector, whole economy) must result congruent when aggregated across scales; (2) Impredicative Loop Analysis - the definition of 3 funds element (human activity, colonized land and technical capital) requires the definition of different set of categories for defining compartments across hierarchical levels. The identities of these categories define/are defined by each other, within the option space provided by the relation of congruence among flows and funds elements over the multilevel matrix of compartments; (3) surfing in complex time and space - the semantic definition of performance and sustainability has to be tailored in relation to the continuous emergence of novelties (due to the process of becoming) and to the specificity of the local context in which the analysis is applied.

PART 2 examples of applications of MSIASM.
These examples include: (i) a multi-scale integrated analysis of the trajectory of development of countries (Spain, Ecuador, China); (ii) an overview of the characteristics of the metabolism of world countries; (iii) a scenario analysis in relation to the development of China (CO2 emission, energy demand, and implications for the feasibility of Kyoto protocol).

Compulsory readings previous to the course: Giampietro M., Ramos-Martin J. 2005, 'Multi-scale integrated analysis of sustainability: a methodological tool to improve the quality of narratives', *Int. J. Global Environmental Issues*, Vol. 5, Nos. 3/4, pp. 119-141.

Giampietro M., Mayumi K., Munda G. 2006, 'Integrated assessment and energy analysis: Quality assurance in multi-criteria analysis of sustainability', *Energy*, 31, pp. 59-86.
Mayumi K., Giampietro M. 2006, 'The episemological challenge of self-modifying systems: Governance and sustainability in the post-normal science era', *Ecological Economics*, article in press.

Further recommended readings: Ramos-Martin J., Giampietro M. 2005, 'Multi-scale integrated analysis of societal metabolism: learning from trajectories of development and building robust scenarios', *Int. J. Global Environmental Issues*, Vol. 5, Nos. 3/4, pp. 225-263.
Ramos-Martin J., Giampietro M., Mayumi K., 'On China's exosomatic energy metabolism', *Ecological Economics*, manuscript draft.

Session: Social Metabolism and Time-Use

Lecturer: Marina Fischer-Kowalski

Short description

There are at least three linkages between social metabolism and time-use, linkages that are explored in very different research traditions. There is one linkage between human time use and the production side of social metabolism: as already Marx stated, human labour (and labour time) is the means to provide for social metabolism. This, as I will show, is historically very variable, though. There is another linkage between time-use and consumption; it may work directly (fast time rhythms in life generating higher energy demand), or indirectly, via income: I will try to demonstrate the stability or increase of paid working time in combination with efficiency gains to be responsible for a rebound effect of material and energy consumption. Finally, I will discuss the linkage of demography, life time time-use distributions and quality of life from a sustainability perspective. Basic reading, a reference list and training examples will be distributed.

Compulsory reading previous to the course: see below

Session: Social Metabolism, MFA – Spain, Catalonia, Mexico

Lecturer: Cristina Sendra, Ana Citlalic Gonzalez, Marina Fischer-Kowalski

Short description

There is burgeoning literature on the topic of environmental Kuznets curve, a hypothesis based on the idea that economic and technological development allows for the reduction of environmental impact of societies (Rothman, 1998). If verified, this hypothesis would lead to important political consequences, in the sense that following the present development path will lead to a more sustainable economic system. This would mean that environmental measures are not necessary, and that instead, the environment would benefit from policies that aim at stimulating the economic growth.

An interesting way to test this hypothesis is to analyse the amount of material used by a country in physical terms through the Material Flow Accounting (MFA) methodology (EUROSTAT, 2001; Bringezu and Schütz, 2001). The material used cannot be taken as a direct measure of sustainability: many materials, used in small quantities, such as mercury, can have highly negative effects on the environment. Nevertheless, the total amount of material used by an economy can give insights into its 'social metabolism' (Fischer-Kowalski, 1998a; 1998b) and can be applied as an indirect measure of the environmental

impact. In fact, materials must be extracted and processed in order to produce goods that are then transported, exchanged, used and finally, discharged. All these activities have environmental impacts.

The objective of this session is two-fold. On the one hand, it aims at providing a rough overview of the MFA methodology and its main indicators. On the other hand, it will test the Kuznets curve hypothesis with three case- studies, that is, Mexico, Spain and Catalonia.

Bibliography

Bringezu, S. and Schütz, H. (2001) 'Total material requirement of the European Union', in European Environmental Agency (Ed.): *Technical Report No 55*, EEA, Copenhagen.
EUROSTAT (2001) *Economy-Wide Material Flow Accounts and Derived Indicators – a Methodological Guide*, Office for Official Publications of the European Communities, Luxembourg.
Fischer-Kowalski, M. (1998a) 'Society's metabolism. The intellectual history of material flow analysis, Part I, 1860–1970', *Journal of Industrial Ecology*, Vol. 2, No. 1, pp.61–78.
Fischer-Kowalski, M. (1998b) 'Society's metabolism. The intellectual history of material flow analysis Part II, 1970–1998', *Journal of Industrial Ecology*, Vol. 2, No. 4, pp.107–136.
Rothman, D.S. (1998) 'Environmental kuznets curves - real progress or passing the buck? A case for consumption-based approaches', *Ecological Economics*, Vol. 25, pp.177–194.

Compulsory reading previous to the course: Cañellas S., Citlalic González A., Russi D., Sendra C., Sojo A. 2004, 'Material flow accounting of Spain', *Int. J. Global Environmental Issues*, Vol.4, No.4, pp.229-241.

Further recommended readings: Schandl H., Grünbühel C.M., Haberl H., Weisz H. 2002, 'Handbook of Physical Accounting, Measuring bio-physical dimensions of socio-economic activities, MFA – EFA – HANPP', IFF, Social Ecology Working Paper 73, available at <http://www.iff.ac.at/socec/publs/wpapers_en.php>.
European Communities 2002, 'Material use in the European Union 1980-2000: Indicators and analysis', Working Papers and Studies, Theme 2 Economy and finance, Luxembourg.
Martinez-Alier J. 2005, 'Social Metabolism and Ecological Distribution Conflicts', Australian New Zealand Society for Ecological Economics, available at <http://www.anzsee.org/anzsee2005papers/Martinez-Alier_plenary.pdf>.

Session: Deliberative innovation to different effect: consensus conferences in Denmark, France, and the United States

Lecturer: John Dryzek

Short description

Democratic theorists are attracted by the potential contribution to deliberative democratization of designed forums composed of lay citizens. Using a comparative study of consensus conferences on the issue of genetically modified food in Denmark, France, and the United States, we show that the democratic potential of such 'mini-publics' is radically different in different sorts of political system. In actively inclusive Denmark, mini-publics are deployed in integrative fashion; in exclusive France, in managerial fashion; in the passively inclusive United States, in advocacy fashion. If mini-publics are to contribute to deliberative democratization they need supportive structures and processes in government and the broader

public sphere. The kinds of structures and processes required will again vary by political system type.

Recommended readings: Dryzek J.S. 2006 'Deliberative innovation to different effect: consensus conferences in Denmark, France, and the United States', draft.

Session: Uncertainty, complexity and post-normal science

Lecturer: Silvio Funtowicz, Jeroen van der Sluijs, Roger Strand, Sigrid Muñiz San Martin

Short description

The presence of irreducible uncertainty and complexity is gradually becoming acknowledged as a fundamental condition of governance within a number of policy domains. This includes governance issues with respect to the environment, resource management, health services, novel technologies and novel foods, etc. However, existing philosophies of science and politics have tended to assume that certainty can be obtained, at least in principle, that facts and values are independent, and furthermore that models of simple systems offer suitable heuristics also for knowing and acting within complex systems.

The latter decades a number of research traditions have attended the shortcomings of existing theoretical frameworks and the need for constructing new theories on the interface between science and policy in the presence of irreducible uncertainty, the value-ladenness of facts, and emergent complexity. Of particular importance is the need to revise one's self-understanding as an expert on a complex system: It needs to be understood reflexively as an agent within the system. In this part of the course we shall present some of these theoretical and practical developments, including that of post-normal science.

Compulsory reading previous to the course: Funtowicz S.O., Ravetz J.R. 1994, 'The worth of a songbird: ecological economics as a post-normal science', *Ecol Econ,* 10, pp.197-207.
Van der Sluijs J.P., Petersen A.C., Janssen P.H.M., de Vink P.J.F., Risbey J.S. and Ravetz J.R:, 'Science-policy interface needs knowledge quality assessment', *manuscript in preparation.*

Session: Remote Sensing of environmental health: oil impact in the Peruvian Amazon as a case study

Lecturer: Agustin Lobo, Marti Orta

Short description

Remote Sensing offers a unique set of tools for studying ecosystems. First, remotely-sensed images provide information at scales ranging from landscape to global, while most ecological studies have to focus on very small plots. Second, the type of information provided by remotely-sensed imagery is inherently holistic, as it comes from the interaction of the ecosystem with electromagnetic waves. This is also a difference with most ecological tools, which are designed to measure one given property only. A third feature of remote sensing is its ability of temporally intensive sampling, which opens the way for the simultaneous study of structural and dynamical aspects of ecosystems. Finally, thermal remote sensing offers the possibility of studying ecosystems from a thermodynamic point of view, a fact that was well known and emphasized by John Kay.

Remote Sensing is thus an excellent approach for studying complex systems, kindly locating the scientist on different observatories from which synthetic views become the natural way of

approaching problems. In this talk we will review remote sensing systems and methods, from the point of view of the ecologist. We will devote particular attention to the case of oil impact in the Peruvian Amazon, a subject that we are currently studying, and present the methods that we are applying: different sorts of remote sensing, field inspection, ethnocartography and GIS. Finally, we will discuss the impactions of the impacts of oil extraction on biodiversity and human traditional cultures.

Session: Bioinvasions in Ebro River

Lecturers: Beatriz Rodriguez-Labaros, Rosa Binimelis, Iliana Monterroso

Short description

Biological invasions are human-mediated processes contributing to global change, being considered as major cause of biodiversity loss. Governance of the responses to invasion processes must handle dynamic social understanding and agency.

Mainstream policy guidelines embracing the precautionary approach advise the implementation of a hierarchical scheme starting from preventive strategies. This faces uncertainties inherent to such a socially and biologically complex phenomenon.

The cases of two aquatic species invading the low Ebro River (NE Spain) are employed as empirical support for analysing complex drivers, impacts and policy responses. The species are zebra mussel (*Dreissena polymorpha*) and Wels catfish (*Silurus glanis*) whose invasions seem to be interlinked. Through participatory methods, key uncertainties are unveiled by stakeholders thus contributing to the assessment of the process.

Recommended readings: Binimelis R., Monterroso I., Rodríguez-Labajos B. 2005, 'Assessing "global invaders" – Two participatory analyses', Paper presented in the 6th International Conference of the European Society of Ecological Economics, Lisbon, 14th – 17th June 2005, available at <http://selene.uab.es/brodriguezl>.

Rodríguez-Labajos B. 2006, 'Interlinked biological invasions in the Ebro River. A multi-scale scenario approach', Master dissertation for the Ph. D. Program of Environmental Sciencies, Autonomous University of Barcelona, Bellaterra, available at <http://selene.uab.es/brodriguezl>.

Session: Scenarios of Urban Development

Lecturers: Begum Ozkaynak

Short description

This section will first make clear that a multi-dimensional and long-term perspective, as well as a participatory and integrative approach is needed for framing and assessing urban development policies. It will then be argued that the scenario approach is a valuable analytical device, which offers a common framework for different social actors within the city to address the critical issues and concerns in a consistent and coherent way. It provides a systematic perspective—based on plurality and incommensurability principles—to evaluate the different environmental, social and economic impacts of different urban actions and policies. After a brief overview of the scenario approach and methodology, the section will focus on a real world application based on a project conducted in the province of Yalova.

Yalova's alternative futures are conceived as plausible and consistent combinations of the local factors and the two key external uncertainties: globalisation, Europe, and the future of social and environmental policies on the one hand, and Turkey's relations with the EU on the

other. For local driving forces, an empirical study was conducted in the province of Yalova during 2003. This consisted of 36 in-depth interviews, three focus groups, three workshops, and a survey administered to a total of 1,196 as respondents representative of the urban and rural population. Regarding the global, national and regional driving forces, various global scenario studies and documents related with the EU enlargement and policy were reviewed, and a literature review on Turkey was conducted with a focus on its potential accession to the EU, its economic growth prospects, and the environmental and social aspects of its economic development and urbanization. As such, four city-scale scenarios for Yalova-2020 are constructed in a descriptive and exploratory way: *Yalova within Triumphant Markets*, *Yalova within Social Europe*, *Business-as-Usual in Yalova*, and *Inward-Looking Yalova.* Overall, these alternative futures with their socio-economic and environmental implications provide a background to explore and formulate the paths that need to be taken within a multi-layered system of governance to strengthen those forces that would favor a more sustainable urban development with reference to current problem areas.

Recommended reading: Greeuw S., van Asselt M., Grosskurth J., Storms Ch., Rijkens-Klomp N., Rothmans D., Rotmas J. 2000, 'Cloudy crystal balls, an assessment of recent European and global scenario studies and models', Environmental issues series, No 17, available at <http://reports.eea.eu.int/Environmental_issues_series_17/en/envissue17.pdf>.

Session: The Precautionary Principle

Lecturer: Jeroen van der Sluijs

Short description

Over the past decades, the Precautionary Principle(PP) has become an underlying rationale for a large and increasing number of international treaties and declarations in the fields of sustainable development, environmental protection, health, trade, and food safety. In its most basic form, the PP is a strategy to cope with scientific uncertainties in the assessment and management of risks. It is about the wisdom of action under uncertainty. Precaution means taking action to protect human health and the environment against possible danger of severe damage. However, in the international arena, different views exist of what precaution is and the PP has different interpretations.

Recently, an expert group on the Precautionary Principle established by the World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) of UNESCO published a report aiming at bringing clarity in the multitude of definitions and interpretations of the PP.

This session will present and discuss major highlights from the report. The report aims to reduce the gaps in the understanding of the principle and to clarify the PP for decision-makers and scientists in order to achieve a more informed debate of the principle and to serve as reference for possible further implementations of the PP. The report sketches the history of the PP, reviews concepts and definitions of the PP and identifies common elements in the various definitions. On that basis a new working definition of the PP is presented. The ethical basis of the PP and the questions of responsibility, inter- and intra-generational equity and deliberative democracy are explored and legal issues discussed. Special focus is put on the characteristics of complex systems and the concepts of robustness and resilience as well as the multiple dimensions of uncertainty in scientific assessment. These uncertainties are at the heart of the PP. The concept of risk is dealt with and associated decision-making problems for which the PP can be helpful.

In the session we will further addresses a range of application issues of the PP: implications of the PP for science, implications for policy and governance, implications for industry and trade and social and cultural implications of the PP.

Compulsory reading previous to the course: World Commission on the Ethics of Scientific Knowledge and Technology (COMEST) 2005, *The Precautionary Principle*, United Nations Educational, Scientific and Cultural Organisation (UNESCO), Paris, available at <http://unesdoc.unesco.org/images/0013/001395/139578e.pdf>.

Session: Sustainability in the tropical forest: Philosophy, Ecology and Social analysis

Lecturer: Sharachchandra Lélé

Short description

This session explores the complexities involved in defining, measuring and explaining the presence or absence of sustainability in forest use, using case studies from the tropical forests of India. I will begin with examining the socially constructed nature of the concept, and various ways in which non-attention to this aspect has and continues to obfuscate the debates on tropical forest policy. I will then discuss in detail the various criteria, indicators and methods used in forest ecology to determine the sustainability of forest use and their strengths and weaknesses. Their application is illustrated through analyses of firewood extraction, grazing, and honey collection. Finally, I will discuss the various approaches to explaining why unsustainable forest use might be occurring and where. The economist's benefit-cost calculus, institutional analysis, and political economy explanations compete but can also complement each other if we are willing to embrace true interdisciplinarity.

Compulsory reading previous to the course: Lélé S. 1994, 'Sustainable use of biomass resources: A note on definitions, criteria, and practical applications', *Energy for Sustainable Development*, Vol.1, No.4, pp.42-46, available at <http://www.ieiglobal.org/ESDVol1No4/sustainableuse.pdf>.

Further recommended readings: Lélé S., Norgaard R.B. 1996, 'Sustainability and the scientist's burden', *Conservation Biology*, Vol.10, No.2, pp.354-365.
Lélé S., Norgaard R.B. 2005, 'Practicing interdisciplinarity', *BioScience*, Vol.55, No.11, pp.967-975.

Session: Climate Variability and Predictability: The Complex Nature of Global Change

Lecturer: Rainer Zahn

Short description

One of the most controversial issues in environmental research today relates to the operational stability of the present climatic regime. In particular, whether instabilities originating from natural forcing and/or human induced changes are sufficient to result in a significant restructuring of climate. The continuing build-up of industrial greenhouse gases in the atmosphere and concomitant increase in global temperatures has raised awareness that potentially decade to centuries of environmental change lie ahead and that these will have profound economic, political and societal impacts. Fundamental to this debate is the effect that future global warming will have on the ocean circulation because a reorganization of the

globally connected system of ocean currents - collectively referred to as the Ocean Conveyor Circulation - is the only known viable mechanism to induce substantial global-scale and notably, abrupt (<30 years) climate changes. Such changes necessarily involve the Ocean Conveyor Circulation as it is the oceans that distribute vast quantities of heat around our planet, and thus influence atmospheric heat budgets and climatic patterns on a regional to hemisphere-wide scale. Records of past marine climates, derived from deep-sea sediment cores, show that abrupt climate changes are not a new phenomenon but have occurred several times in the past. During such events the Ocean Conveyor has undergone considerable slow-down, perhaps even a complete collapse. The consequences of such events were a reduction of marine heat transfer to the North Atlantic that caused sub-polar climates to spread throughout central Europe within a few decades while Mediterranean Europe experienced phases of accelerated desertification. Scenarios of Ocean Conveyor slow-down form an integral part of climate prediction exercises that are carried out currently under the auspices of the *Intergovernmental Panel on Climate Change* so as to gain a fuller understanding of climate sensitivity to increasing atmospheric CO_2. Reducing the uncertainty in such predictions poses one of the major challenges in current climate research which reflects on the complexity of climate as a physical entity of immediate societal relevance.

Recommended readings: Clark P.U., et al. 2002, 'The role of the thermohaline circulation in abrupt climate change', *Nature,* Vol.415, pp.863-869.
Martrat B. et al. 2004, 'Abrupt Temperature Changes in the Western Mediterranean over the past 250,000 Years', *Science*, Vol.306, pp.1762-1765.
Pahnke K., Zahn R. 2005, 'Southern hemisphere water mass conversion linked with North Atlantic climate variability', *Science*, Vol.307, pp.1741-1746.
Rignot E., Kanagaratnam P. 2006, 'Changes in the velocity structure of the Greenland ice sheet', *Science*, Vol.311, pp.986-990.
Stocker T.F. 1998, 'Climate change - The seesaw effect', *Science*, Vol.282, pp.61-62.

Session: Earth System Science or the science of Gaia

Lecturer: Antoni Rosell-Melé

Short description

In the last few years an integrated vision of the earth as a complex system has been penetrating the scientific community. This is often associated to the theory of Gaia as a self-organized being, which is popular among environmentally concerned groups. Both views of the Earth attempt to provide solutions to major world problems because they move away from reductionist approaches and do not recognise disciplinary boundaries. In this presentation both views will be presented to show how they provide a realistic model of the Earth as a complex system.

Recommended readings: Steffen W., Tyson P. 2001, 'Global Change and the Earth System: A planet under pressure', The Global Environmental Programmes, Stockholm: IGBP, available at: <http://www.igbp.kva.se//uploads/ESO_IGBP4.pdf>.
Clifford N, Richard K. 2005, 'Earth System Science: an oxymoron?', *Earth Surface Processes and Landforms*, 30, pp.379-383, available at: <http://www.uky.edu/~ulack/Geo300/fulltext_ID=110429904&PLACEBO=IE.pdf>.
Kirchner J.W. 2002, 'The Gaia Hypothesis: Fact, Theory, and Wishful Thinking', *Climatic Change*, **52**, pp.391–408, available at: <http://seismo.berkeley.edu/~kirchner/reprints/2002_55_Kirchner_gaia.pdf>.

Lawton J. 2001, 'Earth system science', *Science*, Vol.292, pp.1965, available at: <http://www.sciencemag.org/cgi/content/summary/292/5524/1965>.
Lenton T.M. 1998, 'Gaia and natural selection', *Nature*, Vol.394, pp.439-447, available at: <http://tracer.env.uea.ac.uk/esmg/papers/reviewarticle.pdf>.
Lovelock J.E. 1989, 'Geophysiology, the science of gaia', Reviews of Geophysics, 27, p.215.
Lovelock, J.E. 2003,'Gaia and Emergence: A Response to Kirchner and Volk', *Climatic Change*, Vol.57, pp.1–3.
Steffen W, Tyson P, Jager J, et al. 2001, 'Earth system science – An integrated approach', *Environment*, Vol.43 (8), pp.21-27.
Volk T 2002, 'The Future of Gaia Theory', *Climatic Change*, Vol.52, pp.423–430.

Session: The Animal Forest: An Endangered Ecosystem

Lecturer: Sergio Rossi

Short description

There are increasing evidences that benthic communities play an essential role in the energy fluxes of the world's oceans. From the 50 up to the 800 meters depth, a forest dominated by animals interacts directly with the water column, capturing particles and returning part of the energy input in form of respiration, excretion and reproduction. The biodiversity is very high in these communities, in accordance with its complexity based on its different ecosystem temporal succession patterns. They extend from Antarctic waters to tropical seas, being present in almost all areas. These live three-dimensional structures that grow fixed on the substrate, concentrate biomass of different organisms (e.g. crustaceans, molluscs, dishes, etc.), that increase its biomass depending on the complexity (=longevity) of the main animal "trees" (e.g. corals, gorgonians, sponges, bryozoans, etc.), like the true land forest. The strategy of these called suspension feeders (i.e. animals that depend on the suspended material of the water column) is very successful, in part because 1) they are omnivorous and can feed on a wide size spectrum of particles and 2) its "tree like" structures has a low cost of energy (respiration and growth). Furthermore, the complexity of these so called "animal bioengineers" has a paramount role in the nursering effect, the concentration of larval and juvenile stages of many animals (including most species of commercial interest). Recently, new technologies like side SCAN sonar and Remotely Operated Vehicles demonstrate that anthropogenic perturbations (especially bottom trawling fishing) are the main cause of an accelerate destruction of these complex communities. The search and exploitation of new fishing banks is faster than our knowledge of these animal forests, which may become locally extinct in many areas of the world's ocean.

Recommended readings: Gili J.M., Coma R. 1998 'Benthic suspension feeders: their paramount role in littoral marine food webs', *Trends Ecology and Evolution,* 13, pp.316-321.
Coma R., Ribes M., Gili J.M., Zabala M. 2000, 'Seasonality in coastal benthic ecosystems', *Trends Ecology and Evolution,* 15, pp.448-453.
Tsounis G., Rossi S., Gili J.M., Arntz W. 2006, 'Population structure of an exploited benthic cnidarian: the red coral case study', *Marine Biology,* On-line DOI:10.1007/s00227-006-0302-8.
Rinkevich B. 2005, 'Conservation of coral reefs through active restoration methods: recent approaches and last decade approaches', *Environmental Science Technology,* 39, pp.4333-4342.
Roberts J.M., Wheeler A.J., Freiwald A. 2006 'Reefs of the deep: The biology and geology of cold-water coral ecosystems', *Science*, 312, pp.543-547.

Session: Social Multicriteria Analysis

Lecturer: Giuseppe Munda

Short description

In order to address contemporary issues economics and decision sciences need to expand their empirical relevance by introducing more and more realistic (thus more complex) assumptions in their models. One of the most interesting research directions in the field of public economics is the attempt to introduce political constraints, interest groups and collusion effects explicitly (Laffont, 2000). The main argument developed here is the proposal of the concept of "Social Multi-Criteria Evaluation" (SMCE) as a possible useful framework for the application of social choice to the difficult policy problems of our Millennium, where, as stated by Funtowicz and Ravetz, "facts are uncertain, values in dispute, stakes high and decisions urgent". This paper starts from the following main questions:

1. Why "Social" Multi-criteria Evaluation?
2. How should such an approach be developed?

The foundations of SMCE are set up by referring to concepts from complex system theory and philosophy, such as reflexive complexity, post-normal science and incommensurability.
To give some operational guidelines on the application of SMCE basic questions to be answered are:

1. How is it possible to deal with technical incommensurability?
2. How can we deal with the issue of social incommensurability?

To answer these questions, using theoretical considerations and lessons learned from real-world case studies, is the main objective of the present article.

Compulsory reading previous to the course: Munda G. 2004, 'Social multi-criteria evaluation: methodological foundations and operational consequences', *European Journal of Operational Research*, 158, pp. 662-677.

Further recommended reading: European Commission, 'Development and Application of a Multi-Criteria Decision Analysis Software Tool for Renewable Energy Sources', fifth framework programme, available at <http://www.exergia.net/mcda/reports/Del11+13+14_%5bSpain%5d.pdf>.

Session: MCE of renewable energy systems

Lecturers: Daniela Russi, Gonzalo Gamboa, Giuseppe Munda

Short description

Biodiesel is often presented as a solution for the greenhouse effect, as well as for the European energy dependency. However, on the one side biodiesel allows saving only a small amount of fossil fuels, and on the other side it can compete with food for land. The presentation will use the SMCE approach to explore the issue under different points of view, in order to discuss the social desirability of a large scale biodiesel production.

Session: Multi-criteria analysis of invasions processes: Testing multi-criteria methods for the analysis of *Hydrilla verticillata* in Lake Itzabal, Guatemala

Lecturer: Iliana Monterroso

Short description
Alien invasive species have become a key topic in conservation policies, they are considered to be among the main drivers of biodiversity loss. Management of invasion processes requires identifying causes, impacts and defining responses. So as to facilitate decision making, assessment tools should provide information on these aspects to social actors so as analyze consequences of different decision options. At the same time such techniques should be able to allow integration of different views, and be flexible and dynamic since invasion processes develop in the context of highly influential human agency. Therefore, it can be said that alien invasive species are complex phenomena because they develop under conditions of different perceptions regarding their definition, the impacts as well as the responses to the issue since all these aspects are subject to value-laden considerations.

This presentation addresses management issues associated with the invasion process of the alien invasive plant *Hydrilla verticillata* in Lake Izabal, Guatemala. It includes a description of the invaded ecosystem so as to understand socio-economic and environmental factors that favored the establishment of this alien invasive plant. This involves the identification of interest groups as well as possible sources of conflict regarding the implementation of management options to control *H. verticillata.*

Control options are identified and local management scenarios are evaluated with multi-criteria analysis. One of the objectives of this presentation is to evidence the scope of this assessment method to analyze a case of invasion in situations where only cost-benefit and cost-effectiveness analysis have been employed. The multi-criteria evaluation allows ranking feasible management scenarios according to a set of criteria selected during fieldworks and from literature review. A final discussion takes results obtained during these evaluation exercises and highlights important aspects to take into account to implement management responses in this ecosystem.

Session: Modelling multi-scale complexity for the Integrated Sustainability Assessment of water systems. Some insights from the Matisse Project

Lecturer: David Tàbara

Short description
All notions of sustainability are associated to particular assumptions about complexity. The study of complexity is important to trace the changing nature of the objects and subjects to be sustained, to know the way they interact with other similar objects and subjects, and to analyse how these relate to the wider environment upon they depend. However, complexity can be used almost for everything: as the ultimate explanatory cause of any kind of socio-environmental process or as its final consequence. To a large extent, the different conceptions and the strategic uses of complexity in science and policy discourses reproduce the similar dilemmas, contradictions, and tensions embedded in the discussions of the social and environmental sciences at large. For instance, a social constructionist approach to complexity would argue that small things are equally complex as big ones and it is only the *perception of complexity,* which mostly depends on the point of reference of the observer and not of the actual object observed, what is of relevance for the analysis. On the contrary, realists would reject this view and would search for the measure and quantification of complexity, often, from a fixed point of reference which could be given by 'science', by a given idea of the 'human scale', or from a of taken-for-granted social or biophysical boundary. In this presentation I will argue that taking either an extreme social-constructivist position or an

extreme realist one is of little help for the advance of sustainability science. Both positions need to be integrated and made operational in the design of *new tools and methods for Integrated Sustainability Assessment*.

Participatory approaches aimed integrating knowledge about the functioning of biophysical systems (e.g. evolution of CO2 concentrations) and knowledge about the functioning of social systems (e.g. evolution of global values and preferences) coming both from expert and non-expert sources can contribute to overcome some of the difficulties to define and deal with sustainability-related complexity in a robust and relevant way for science and policy purposes. Within the EU Matisse project, a work package is devoted to the development of new tools and methods able to assess sustainability in the domain of water. This is done through several procedures such as Integrated Assessment focus groups (Kasemir, et. al. 2003), by the co-development of a multi-scalar water stock-and-flows model (the World Cellular Model; Tàbara 2006) with stakeholders, and by supporting the creation of new, information-rich, relational, and systemic narratives on the persistent unsustainability problems of water use within the Ebro river basin. First results of this approach will be produced during the conference.

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Session: Payments for Environmental Services

Lecturer: Roldan Muradian, Nicolas Kosoy, Joan Martinez-Alier

Short description

Nature's ecosystems regulate and support natural and human systems through processes such as the cleansing, recycling, and renewal of biological resources. These processes, known as ecosystem services, contribute to purify air and water, assimilate waste, stabilise the climate, mobilise nutrients in soils and across natural ecosystems, and maintain biodiversity, among others. Ecosystem services are crucial for the sustainability of human development in economic, social, cultural and ecological terms (Daily*, et al.*, 1997). As the world's population and the global economy grow in the future, the demand for these services are likely to increase (Millennium Ecosystem Assessment, 2005).

Advocacy of markets for ecosystem services and Payments for Environmental Services schemes (PES) stems from a dominant logic of market environmentalism which has become prominent since the late 1980s (Smith, 1995). As the benefits provided by ecosystem services are neither priced nor marketed, resource users do not take into account the degradation of these services in their resource management decisions. Market environmentalism, therefore,

promotes the allocation of property rights and pricing of nature's services, and the creation of new commodity markets for nature's services. It is argued that efficient resource management requires the allocation of individual titles in land and resources and the trading of these resources and rights within a market that will assign high prices to scarce resources and encourage the sustainable management of renewable resources (Liverman, 2004). For this reason, markets for ecosystem services and PES schemes are increasingly seen as effective institutions to make the linkages between nature's services and human development explicit to decision-makers (Costanza*, et al.*, 1997, Farber*, et al.*, 2002).

The aim of this lecture is to show the inherent complexity of markets for ecosystem services, in particular PES, with the aid of case studies. Moreover, we will try to show that by commoditizing nature's services that once were provided gratis we are incurring into distributional and equity issues arising by the very creation of these new markets.
The lecture will be divided into 3 main sections. First, an introduction to environmental services and a brief overview of the global environmental service markets. Then we will go on describing PES markets by means of presenting several case studies of hydrological PES markets in Central America, their functioning and institutional frameworks. Finally, we will conclude with a series of advantages and constraints these markets pose at different geographical scales, local, regional and global.

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Millennium Ecosystem Assessment 2005, 'Ecosystems and Human Well-Being', Synthesis.
Smith, F. L. 1995 'Markets and the environment - a critical reappraisal', *Contemporary Economic Policy,* 13(1), pp.62-73.

Recommended readings: Kosoy N, Martinez-Tuna M., Muradian R., Martinez-Alier J. (article in press), 'Payments for environmental services in watersheds: Insights from a comparative study of three cases in Central America', Ecological Economics, uncorrected proof.
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Muradian R., Martinez-Alier J., Correa H. 2003, 'International Capital Versus Local Population: The Environmental Conflict of the Tambogrande Mining project, Peru', *Society and Natural Resources*, 16, pp.775-792.

Session: Reflexive Neo-Malthusianism in Europe around 1900

Lecturer: Joan Martinez-Alier

Short description
One main concern of Ecological Economics is the balance between human population and natural resources. This is rightly named "the Malthusian question" because Malthus predicted that human populations, if unchecked, would grow exponentially while agricultural production (and other land-based productions) would be subject to decreasing returns to the labour input. This article shows that over one hundred years ago, there was in Europe and America a successful social movement that called itself "Neo-Malthusianism". In contrast to Malthus' pessimism, it believed that population growth could be stopped among the poor classes by voluntary decisions. Women were entitled to choose the number of children they wanted to have. The movement did not appeal to the State to impose restrictions on population growth. On the contrary, in Southern Europe it was based on "bottom up" activism against governments and the Catholic Church.

Recommended reading: Masjuan E., Martinez-Alier J. 2004, 'Conscious Procreation: Neo-Malthusianism in Southern Europe and Latin America', International Society for Ecological Economics, Montréal 11-15 July, available at http://www.h-economica.uab.es/papers/23-2004.pdf.

Session: Complexity and Institutions

Lecturer: Arild Vatn

Short description
This session will focus on the relationship between complexity and social institutions. It will be divided into three interlinked parts. First, the concept of an institution will be defined and explored. There are two main traditions concerning understanding institutions; one that look at institutions only as external constraints to human behavior, and one that look at institutions as also facilitating choice, shaping the individual and offering meaning to human activities. The presentation will be based on the latter understanding. The concept of plural rationalities is linked to the latter understanding, and will also be explored.
Second, the concept of complexity will be elaborated. I will distinguish between natural and social/cultural complexity. Here I will draw heavily on what has already been learned through previous sessions. What I add is mainly some further discussions on the concept of social complexity, mainly looking at such complexity as a result of two factors: a) as a response to natural complexity and the interrelationships between humans as a consequence of such complexities; b) as a way to define and defend interests.
Finally, I will bring the two concepts together along three lines of reasoning. First, I will look at institutions as ways to simplify complexities influencing problem perception and communicative capacity. Second, I will look at institutions as framing valuation processes. Finally, I will look at institutions as structuring complex decision processes – both at the level of the individual and the society – as ways to handle complex relationships between man and nature and between humans.

Compulsory reading previous to the course: Vatn A. 2004, 'An Institutional Perspective on the Valuation of Biodiversity', Discussion Paper #D-37/2004, Paper presented at the 8th biennial conference of the International Society for Ecological Economics, Montreal, Canada, 11-14 July 2004, available at <http://www.nlh.no/ior/publikasjoner/Disc_pap_37_2004.pdf>.

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Richerson P.J., Boyd R., Paciotti B. 2002, 'An Evolutionary Theory of Commons Management' in National Research Council: *The Drama of the Commons*, Committee on the Human Dimension of Global Change. Washington DC: National Academy Press, pp 403-442.
Vatn A. 2005, 'Institutions – The web of human life', chapter 1 in *Institutions and the Environment*, Edward Elgar.
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