Book of Abstracts

isem 2013

TOULOUSE - FRANCE

Ecological Modelling for Ecosystem Sustainability

October 28th - 31st

UNIVERSITÉ TOULOUSE III PAUL SABATIER

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Program at a glance

Sunday 27th October	Monday 28th October	Tuesday 29th October	Wednesday 30th October	Thursday 31st October
	Opening ceremony	**Plenary sessions** B. Fath - T. Legovic	**Plenary sessions** H. Sverdrup - S. Jorgensen	**Plenary sessions** M. Loreau - P. Legendre
	Plenary sessions P. Ciais - W. Mitsch	**Concurrent oral presentations** MGC, MIE, TATC, EF	**Concurrent oral presentations** MGC, MIE, TATC, EF	**Concurrent oral presentations** MGC, MIE, EF
	Concurrent oral presentations MGC, MIE, BAE, EF	**Poster presentations 1** MGC, EF, BAE	**Poster presentations 2** MIE, EF, TATC	**Poster presentations 2** MIE, EF, TATC
	Poster presentations 1 MGC, EF, BAE	**Information about publication in journals**	**Special session 1** Matrix Population Models	**Special session 2** Behavior monitoring
			Workshop Species Distribution Models	**Closing and award ceremony**
Welcome reception Toulouse (Hôtel d'Assézat)	**Ice breaker** Meteo France campus	**Cocktail reception** Toulouse (Galeries Lafayette)	**Conference dinner** Toulouse (Hôtel Dieu)	

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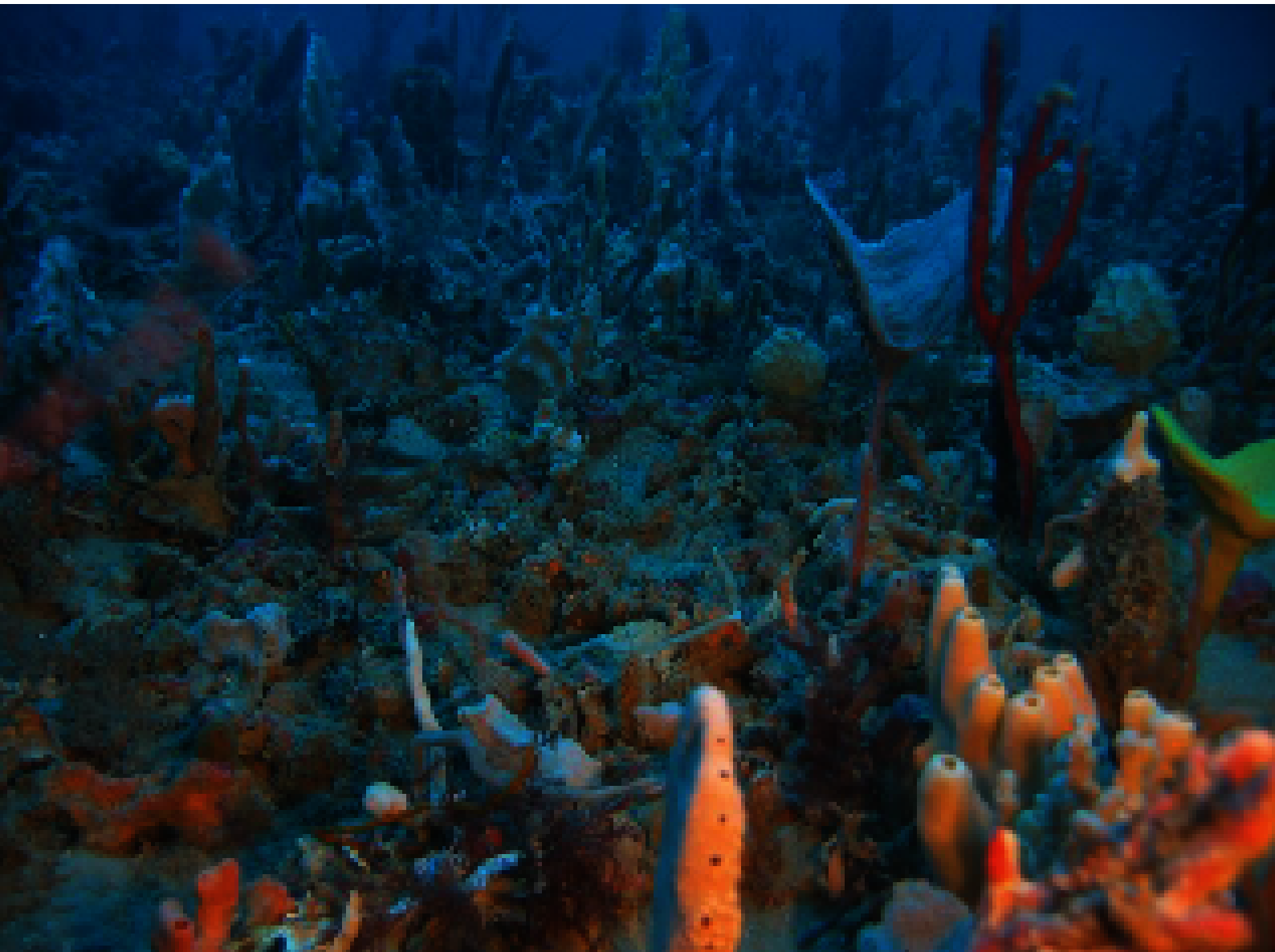
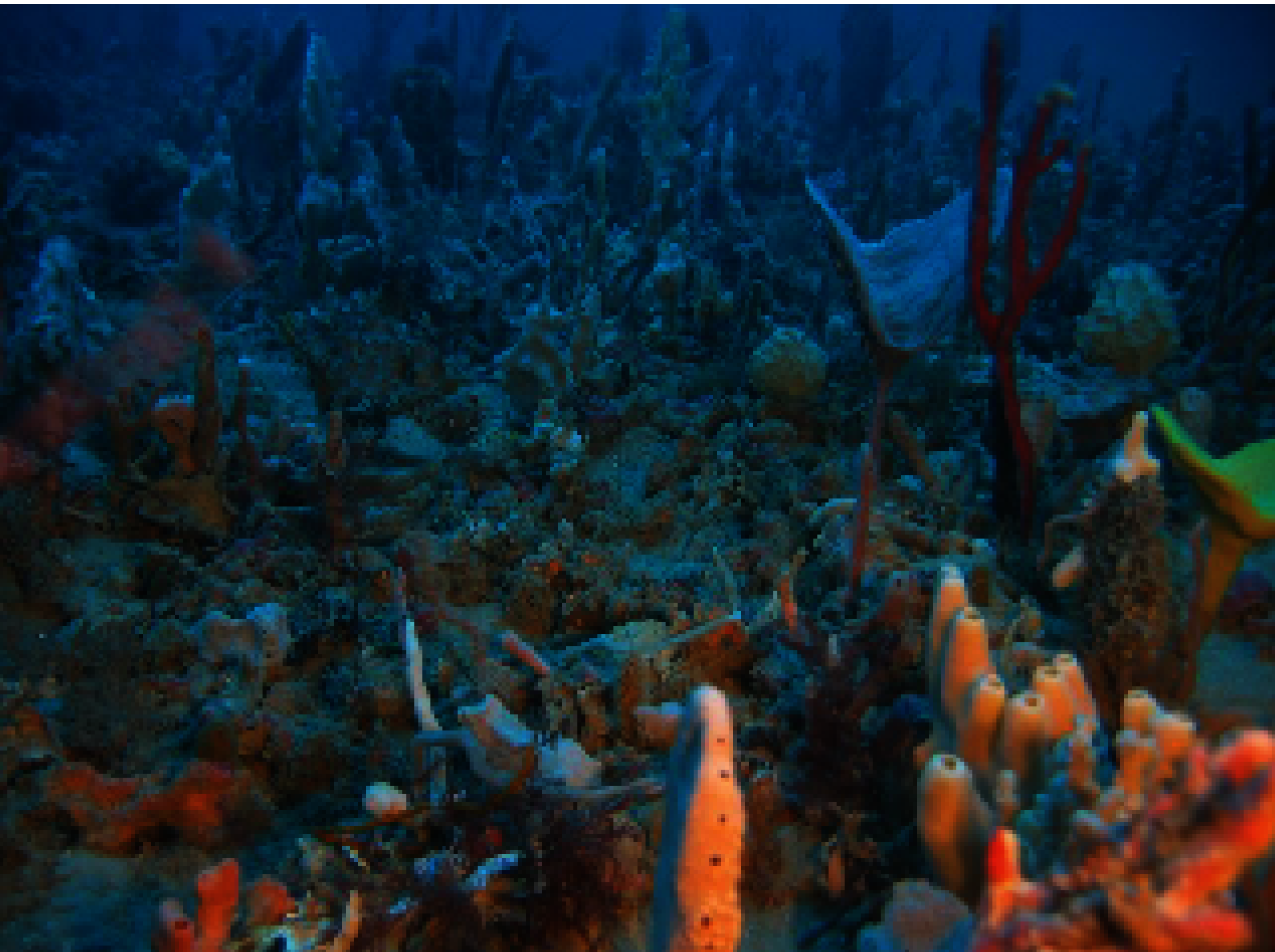
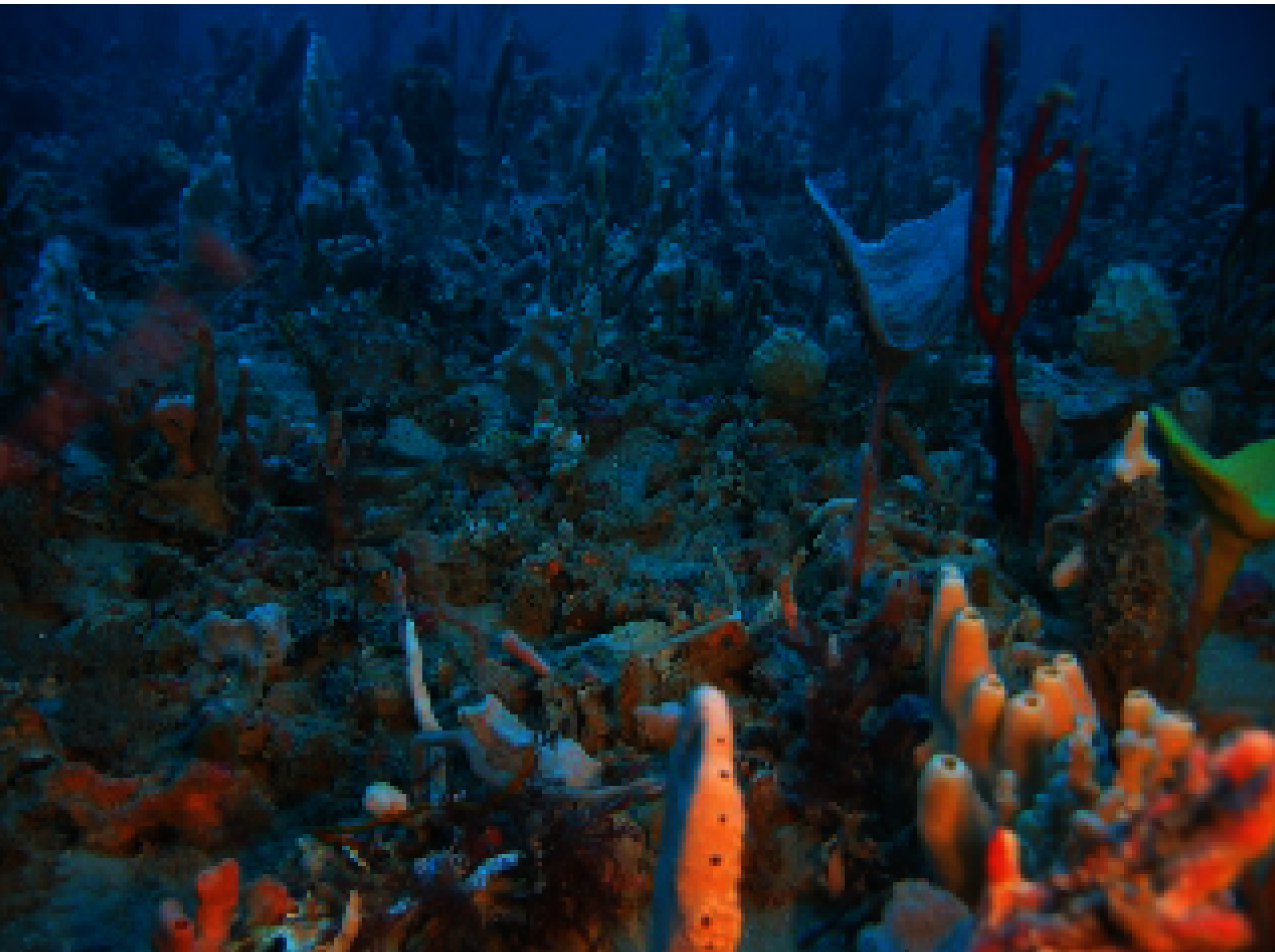


Part I

Oral presentations - Short Abstract



Modelling in the context of Global Change (MGC)



1.1 Modelling the impacts of climate change on hydrology and water quality in mediterranean limno-reservoir

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Silvia, Martínez-Pérez

Antonio, Sastre-Merlín

Erik, Jeppesen

Speaker : Eugenio, Molina-Navarro, University of Alcalá, Spain

Water scarcity and water pollution constitute a big challenge for water managers in the Mediterranean region today and will exacerbate in a projected future warmer world, making a holistic approach for water resources management at the catchment scale essential. We expanded the Soil and Water Assessment Tool (SWAT) model developed for a small Mediterranean catchment to quantify the potential effects of various climate change scenarios on catchment hydrology as well as the trophic state of a new kind of waterbody, a limno-reservoir (Pareja Limno-reservoir), created for environmental and recreational purposes. Simulations showed a noticeable impact of climate change in the river flow regime and consequently the water level of the limno-reservoir, especially during summer, complicating the fulfillment of its purposes. All the scenarios predicted a deterioration of trophic conditions in the Pareja Limno-reservoir and a switch from an oligo-mesotrophic to a mesotrophic state, which may threaten the maintenance of a favourable water quality. Our model framework may help water managers to assess and manage how climate change affects aquatic ecosystems.

1.2 Investigating the drivers of the recent warming of Lake Zurich

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The surface waters of Lake Zurich (Switzerland) have been warming by almost 0.5 °C per decade during the years 1981 to 2012, similar to other Central European lakes. Simulations of temperature and stratification with the one-dimensional lake model Simstrat show that this warming can be fully explained by the observed meteorological changes. The model is driven by homogenized time series of air temperature, solar radiation, vapor pressure, wind and cloudiness supplied by MeteoSwiss. Model runs where the trends for individual forcing variables were removed allow estimating the contributions of the different forcing variables to the overall and seasonal warming trends. The results imply that the contributions of the individual drivers in the recent past differ from those expected for future scenarios based on forcing derived from global climate models. Consequently, the effects of future climate warming on stratification and mixing processes in Central European lakes and on their ecosystems may be qualitatively different from those observed in the recent past.

1.3 Impact Analysis of Climate Changes on Stream Temperatures in Ibo River Basin by a Stream Order Network Model

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Changes in fluvial ecosystems due to global climate changes have been great concern for sustainable river basin management balancing ecological conservation and water resources utilization. However, their impact seems to be difficult to evaluate due to wide variety of basin characteristics along a river network both in nature and social environment. For better basin-wide assessment for fluvial ecosystems, this research have tried to develop a network model which uses geomorphologic laws of river basins with stream ordering systems to connect stream links from sources to the river mouth. The stream ordering systems are able to represent accumulate structure of a river basin. Modeling eco-hydrological quantities with the stream ordering systems could give us a scientific tool to manage fluvial ecosystems appropriately throughout a river network. In this presentation, the stream order network model is used to analyze climate change impacts on stream temperatures, one of the most fundamental indices for fluvial ecosystem assessment. The model uses the Horton's geomorphologic laws to connect thermal transport between stream links, while within each stream link it uses a theoretical solution derived from a thermal energy equation with Taylor-series approximation to predict the longitudinal variation of the river temperature. The stream ordering systems used here are the following two systems; Horton-Strahler's stream order and Shreve's link magnitude for accurately representing accumulate structure of a channel network. Furthermore, the model takes into account solar radiation reduction due to both riparian vegetation and basin topography, as well as thermal advection effect from lateral base flows on various land use types. Climate change predictions on air temperature and precipitation from IPCC AR4 and several Japanese academic bodies are used as the model inputs to predict future stream temperatures. Analyzed river basin is the Ibo River, located in the western part of Japan. The basin area is 810 km2 and the mainstream length is 70 km. In the Ibo River, stream temperatures in 31 points throughout the river network have been observed since May 2006 to understand their spatiotemporal distribution characteristics and to obtain calibration temperatures for the model development. Comparison of the model prediction with the observation showed very good agreement throughout the river network for all seasons, confirming the model predictability of the stream temperatures. The impact analysis of the climate changes shows the prediction that the amount of stream temperature rise may be greater in the upper streams than in the down streams in the river network and greater in summer than in winter. Therefore, the present model suggests that the upper streams in summer may have most significant impact on thermal environment in the fluvial aquatic ecosystem in the Ibo River network.

1.4 Simulation of the temperature regime of soils in southwestern Pribaikalie

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Intermountain depression occupy a quarter of the Baikal region. Due to the relative isolation and clear physical and geographical boundaries there are specific natural conditions: a variety of landforms and landscape conditions in a limited area, the geological outcrops and modern volcanic formations, areas of perennial frozen rocks and exits of hot mineral springs. Climate of southwestern Pribaikalie was characterized by long-term monthly data of weather station TUNKA (Buryatia) from 1961-to 2010. The changes in the depth of soil freezing (November-April) and the depth of thawing (April-August) were analysed. The depth of freezing / thawing of the soil was equal to penetration depth of the zero isotherm. Average monthly air temperature, snow depth, and monthly total precipitation were considered as predictors in the simulation. Software package developed at the V.B. Sochava Institute of Geography SB RAS (http://irigs.irk.ru/work.html) was used for development and study of multi-factor stochastic models. At the first stage simple model was analyzed. Simple model describes the dependence between one variable, considered as a function, and other variables considered as arguments. More complex models were generated as a set of basic models. Relationships between variables were treated as stochastic or described by their joint probability distribution. Model evaluation function was constructed as its conditional probability density function for given values of the arguments. Statistically significant reduction in the depth of freezing and increase in the depth of thawing of the soil was observed during the years 1961-2010. According to the simulation results, air temperature in October (at low temperatures the lack of snow cover is often observed), height of the snow cover, and air temperature in the previous month are the major contributors to the freezing of the soil in all months of the cold period. Beginning of the process of thawing of soil is associated with the transition temperature thru 0 ^{0} C. From April to June, the temperature of the air in April is one of the main arguments in the model. Contribution of air temperatures of current and previous months is also significant. In August, total precipitation of the current and previous months affect the thawing of the lower layers of the soil. Observations at the meteorological station TUNKA allow to characterize the temperature regime of the soil to a depth of 320 cm. Characteristic of temperature of the deeper layers at the moment is the result of simulation. Now in Tunkinskaya Basin scientists from the V.B. Sochava Institute of Geography SB RAS have installed automatic temperature sensors to a depth of 10 m. This will give a better assessment of the impact of climatic changes on the mode of soil freezing and thawing.

1.5 Life cycle assessment of a typical urban domestic sewage purification biogas digester in China

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In the current context of energy shortage and climate change, developing more energy-saving and cleaner urban domestic sewage purification system and making full use of biogas resources are playing important role in developing countries like China. Biogas is “cleaner energy” in that it replacesfossil fuels with clean methane, which reduces the release of greenhouse gases as well as other detrimental emissions.Sewage purification biogas digester is a popular kind of disperser sewage-treatment plant in China and is suitable for cities where sewage treatment plants are not applicable, Life cycle assessment (LCA) is often used to evaluate the environmental impact of a product or a production process from its very origin to the final destination. In this study, an impact assessment is conducted for a typical urban domestic sewage purification biogas digester in China based on the life-cycle inventory analysis of different stages (i.e., construction stage, maintenance stage, feedstock supply stage, biogas energy utilization stage, sewage sludge treatment stage and final demolition stage). The primary energy demand (PED) is calculated for the plant’s energy consumption, and the environmental impact categoriessuch as global warming potential (GWP), eutrophication (EP), acidification (AP) and photochemical ozone creation potential (POCP) are also assessed. Based on the results of energy and environmental assessments, ad-hoc suggestions on the system optimization and further application of sewage purification biogas digester are proposed. Key words: wastewater treatment; biogas digester; life cycle assessment

1.6 Grazing Effect Offset the Carbon Sequestration Induced by Climate Change and CO2 Fertilization Effects in a Central Asia Dryland

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Carbon dynamic of the dryland ecosystems in Central Asia is influenced by intensive grazing as well as rapid changes in climate and atmospheric CO2 concentration. To quantify the relative contribution of the three factors, a grazing module was added to the Arid Ecosystem Model (AEM), a process model that simulates the synergetic effect of multiple environmental stresses on the structure and functions of dryland ecosystems. The model was validated against field observations, and applied to the 60 M ha rangeland in Xinjiang, a Central Asia dryland locates at the Northwestern China. Scenario analyses were conducted to isolate the effects of climate change, CO2 fertilization, and the intensified grazing from 1979-2007. The simulation results indicate that changes in climate and atmospheric CO2 concentration during the 28 years enhanced ecosystem carbon sequestration, especially in the biomass. The grazing, however, resulted in carbon loss, which offset the carbon sink created by the other two factors. The study highlights the importance to consider both human disturbances and changes in climate and atmosphere when evaluating ecosystem sustainability in Central Asia dryland.

1.7 SOMDY: a new model of C sequestration based on chemical quality by 13C CPMAS NMR and physical aggregation of organic matter

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The contribution of agro-ecosystems to carbon sequestration in the form of soil organic matter (SOM) is increasingly considered as a mitigating factor for climate change. The stocks of organic matter in soils result form the balance between inputs and outputs of carbon within the belowground environment. Inputs mostly derive from plant leaves and roots litter, as well as from agricultural amendments, whereas outputs are primarily from SOM breakdown. SOM decomposition has been reported as mostly affected by temperature and water availability at regional and global scale, and by carbon chemical quality and soil microbial communities at local scale, where climate can be considered relatively uniform. However, the temperature sensitivity of decomposition of different organic-C pools, and mostly of the recalcitrant SOM components, is still debated, due to the fact that the recalcitrant pools are mixtures of complex molecules intrinsically low reactive, and simple compounds with low decay rates owing to environmental constraints. Among these, physical protection by low reactive compounds into SOM aggregates, as well as chemical protection after adsorption onto mineral surfaces, although not implemented in current models of SOM dynamics, can dramatically affect decomposition rates. In this work, a new model of Soil Organic Matter DYnamic (SOMDY) is presented. The SOMDY model is based on an advanced description of SOM chemical quality by 13C-CPMAS NMR instead of traditional C/N ratio. Different microbial communities can be simulated according to different C turnover rates. As a major novel point, the model includes also the effects of physical aggregation of organic matter, then describing physical and chemical protection for different C types. SOMDY was calibrated using different datasets, derived from manipulative experiment in both controlled conditions and agricultural fields, and then validated on CO2 emission data from extensive field experimental measurements. The simulation results showed the model capability to predict SOM quality changes during decomposition processes, including the effects of addition of organic amendments (e.g., compost applications, crop residual burial), as well as the impact of different tillage practices on the physical structure of soil aggregation.

1.8 A conceptual model for a carbon sinks and water purification combined system

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Greenhouse gas emissions and sewage discharge caused by human activates led to global climate change and deterioration of water environment. Cycles of elements carbon, nitrogen and phosphorus in the ecosystem are strongly interfered. A system named nature powered carbon sinks and water purification combined system is developing to absorb carbon dioxide from air and N and P from wastewater through ecological engineering both in terrestrial and marine ecosystems. This research proposes a conceptual model to deliver primary principle and construction of the system. Planted wetland forest and artificial wetland, which fillings with active carbon or biochar materials carbonized by wetland woods are state variables in terrestrial system. Artificial breeding shellfish or macro algae, and artificial wetland, which fillings with processed shells are state variables marine system. The model can be used to evaluate the potential results of ecological engineering applied as a tool in carbon sinks and water purification.

1.9 Will cover crops maintain their efficiency to reduce nitrate leaching under climate change scenarios in the French context?

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In arable cropping systems, it has been widely demonstrated that cover crops sown between two main crops could be an efficient solution to decrease nitrate leaching and then nitrate pollution towards aquifers. Their efficiency depends on pedoclimatic conditions and the dates of sowing and destruction (Justes et al., 2012). In France cover crop are generally sown in summer -from late July to early September- and destroyed in autumn and winter -between October and March. The objective of our work was to analyse by simulations using the STICS soil-crop model (Brisson et al., 2008) the effect of climate change on cover crop efficiency to mitigate nitrate pollution in the future. The applied goal is to evaluate the effect of climate change on optimal dates of sowing and emergence of Italian ryegrass used as cover crop.

Nine French sites with contrasted climate were selected in order to represent the main cropping system regions of the country. Simulations were made with STICS in order to take into account the effect of temperature, soil moisture and CO2 concentration on soil and plant processes. The fallow period considered was between wheat harvested in July and maize sown in April. Three emergence dates were tested: July 25, August 25 and September 25. The A1B scenario, with an increase of temperature by 2-3°C and CO2 concentration about 700ppm in 2100 (GIECC, 2007), was chosen to assess the effect of climate change. Three periods were considered: recent past (1988-2008), near future (2028-2048) and distant future (2068-2088). The 20-year length for each period allowed us to take into account weather inter-annual variability.

Results of simulations showed that despite an increase in temperature, increasing the mineralization of soil nitrogen, and situations with more summer water stress, cover crops maintained a good efficiency in French conditions provided to adapt the technical cropping sequence. Later emergence dates are needed to avoid water stress which will be more pronounced in late July and early August in the future, especially for sites with low rainfall. Simulations also indicated that later emergence dates, at the end of September, would be more effective due to an increase in temperature, this period generally being without water stress. However, this later date did not allow optimal reduction of nitrate leaching in some colder regions. Consequently emergence in late August will be preferable, despite an increase in the variability of the response across years. Finally, emergence occurring in early September could be the most efficient solution because it will be associated with more regular annual performance, particularly in the South of France. In conclusion, cover crops will remain effective to mitigate nitrate leaching under predicted climate change scenarios as compared to actual climate, provided that the dates of sowing will be adapted according to pedoclimatic conditions.

1.10 Mathematical modeling of net ecosystem exchange for grassland at urban area

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We measured the net ecosystem exchange (NEE) of small grassland located at Tomsk city (West Siberia, Russia) during spring and summer 2012 with an automated soil flux system LI-8100 with clear chamber. CO2 fluxes have clear diurnal variations with maximum at night time and minimum at day time. The net CO2 exchange of terrestrial ecosystems is determined by the difference between C uptake due to photosynthesis and C loss due to respiration. A process-based model was used to simulate the carbon dynamics. Processes represented include plant photosynthesis and respiration, litter and soil decomposition. Photosynthetic rate depends on solar radiation and temperature, soil respiration depends on soil temperature and wind speed. 30 minutes time step is used for model runs. Empirical coefficients of the model were estimated for each day of observation by inverse problem solving. The modeled NEE of 0.38 and 2.08 umol/m2/s (emission) for May and August 2012 compares well with the measured NEE of 3.9 and 2.14 umol/m2/s. There is good agreement between the model output and the observations in night time but not so good during day period. Using the component model, we were able to estimate relation of soil and plant respiration to daily photosynthesis.

1.11 Salinity effect on rice biomass production: seasonal and transient modeling of plant responses

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Salinity is one of the detrimental abiotic stresses which occurrence is expected to increase with climate change, particularly for rice systems in coastal areas.Development of crop modeling to account for salinity effects on rice production was done to assist in understanding the stress complexities and its unpredictable dynamics. The objective is to identify and characterize key parameters needed to deliver scientific solutions to alleviate the stress effects in order to improve and sustain rice productivity under salt affected conditions.

Greenhouse experiments were carried out with the genotype cv.IR64 to quantify rice plant responses to different gradients of salt stress during vegetative stage (0, 4, 8, 12 dS m-1). Data analyses were done to formalize the responses pattern for leaf stomatal conductance, leaf transpiration and photosynthesis rate. Equations describing the process under stress were implemented into the rice crop model ORYZA2000 which then used to simulate salinity effects on rice biomass production and leaf area. Sensitivity analyses were performed to assess model outputs variability with genotype salt tolerance and weather conditions. Comparison with a generic seasonal model was carried out to estimate the pertinence of detailed model in salinity modeling.

The studied genotype cv. IR64 was observed to be sensitive to salinity with first sign of stress effect after 14 days of exposure. Leaf gas exchange responses to salt stress were identified as a chronological adaptation. A sigmoid function with three parameters, the genotype potential, its tolerance and its resilience to the stress, was developed to quantify the salinity effect on biomass production rate. Simulations of the improved ORYZA2000 integrating the new function had higher accuracy to represent the observed data on biomass production and Leaf area index than simulations with the generic model. Contributions of key factors such rainfall distribution variability and genotype tolerance were significant for the variability of the model outputs for leaf area index and biomass production.

The version of ORYZA2000 used was found suitable to simulate rice growth under salt stressed conditions at early stage of plant growth. Further studies are undertaking to assess the model ability to capture the effect of salt stressed conditions during vegetative stage to rice yield which is likely to involve plant recovery with effect on biomass production rate and allocation strategy. With the suitable model, sensitivity analyses could be a useful approach in identifying adaptation and mitigation strategies to climate change, where breeding effort has to be enforced and where extension work in suitable management practices is needed.

1.12 Comparing the greenhouse gas performances of different crop residue utilization modes based on dynamic life cycle analysis

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Abstract:Bioenergy from crop residues is a one of the prevailing sustainable energy sources worldwide. As crop residues can be used in different ways to generate heat and electricity, before these alternative technologies enter the market, tradeoffs must be made based on a life cycle approach considering environmental superiorities. In this paper, we proposed a dynamic life cycle analysis (LCA) approach, which improved the status-quo life cycle analysis approach by considering time-varying factors, e.g., greenhouse gas characterization factors, improved efficiency, emissions characteristics, and increased lifetime, etc. Two indicators, GHG payback time and net GHG benefits are also proposed to make tradeoffs on different alternatives selection. The proposed dynamic LCA is then applied to estimate the life cycle greenhouse gas emissions of two crop residue based bioenergy production systems, i.e., corn stover gasification and heat generation from anaerobic fermentation. The results of this paper can identify the carbon hotspots of the crop residue utilization, and shed light on issues that “Are crop residue conversion technologies carbon-mitigation?” and “which is the most promising crop residue conversion approach?”. Keywords: Dynamic life cycle analysis, Crop residue utilization; GHG cost benefit analysis

1.13 Measurements of spatial population synchrony: influence of time series transformations

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Spatial population synchrony has been identified in most taxa. Two principal mechanisms have been proposed to account for this phenomenon (i) dispersal among populations and (ii) the spatial correlation of density-independent factors (the "Moran effect"). It is essential to identify which mechanism is causing spatial population synchrony, since this makes it possible to predict the fate of metapopulations (i.e. persistence vs extinction). To do this, several authors have used time series transformations (TSTs). However, TSTs often lead to contradictory outcomes, and there is currently no consensus about how population time series should be handled. Here, we used 3119 time series involving 34 fish species found in French rivers to test the effect of three commonly-used TSTs on synchrony measurements: detrending (eliminating the temporal trend), prewhitening (eliminating the temporal autocorrelation), and a combination of both: detrending and prewhitening. More specifically, we tested whether temperature influenced fish population dynamics, and compared the results obtained using the three TSTs to those obtained with raw data. For several species, and regardless of the TST used, we found evidence of a Moran effect on population dynamics as (i) most populations were synchronous over long distances, (ii) most populations were influenced by temperature and (iii) eliminating the long-term trend reduced overall species synchrony. Globally, detrending had the least influence relative to raw data, while removing both components had the greatest influence. Indeed, depending on the species considered, TSTs could lead to contrasting/contradictory results, regardless of the analysis used. We discuss the consequences of TSTs, and suggest some guidelines on how population time series should be processed before analysis. Nevertheless, as the results could be very different depending on the transformation applied and the species considered, we advocate using different transformations and interpreting the results with great caution, taking all transformations into account.

1.14 Climate change affects Scots pine stands in the western Pyrenees differently depending on site conditions

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Climate change can effect tree productivity and therefore forest management plans need to account for these effects. Traditional growth and yield tables do not have the potential to estimate growth in environmental conditions different from the past. Therefore, simulation of the main ecological processes responsible of stand productivity and that could be affected by climate change needs to be included in decision-support forest management tools. Growth in Scots pine forests was estimated using the ecosystem-level model FORECAST-Climate. FORECAST-Climate uses a hybrid modelling approach in which historical data on tree growth is modified by simulating key ecological processes. The model was calibrate for two sites in the western Spanish Pyrenees (Aspurz: 650 m.a.s.l., cool Mediterranean climate; Garde, 1350 ma.s.l., humid continental climate), under two different climate change scenarios for year 2100 (moderate change: 2ºC increase in average summer temperatures and rainfall reduction in 20 mm in summer; severe: 6ºC increase in average summer temperatures and rainfall decrease in 60 mm in spring-summer, from 1970-2000 average levels). Results indicate that in Aspurz stand productivity (measured as total biomass) could be reduced up to 13% in 100 years as a consequence of increase evapotranspiration demand, and increased nutrient leaching due to faster soil organic mineralization rates above tree uptake and soil retention capabilities. Reduction in stand productivity would a consequence of slower tree growth but also of increased tree mortality for water stress. On the other hand, stand productivity in Garde could increase by up to 14% in 100 years as a consequence of the reduction in growth limitation by cold winter temperatures, and the associate increase in growing period. In addition, nutrient availability could be increased by a moderate increase in soil organic matter decomposition and nutrient mineralization rates. These results show the utility of ecosystem-level forest models to estimate climate change effects on forest productivity. Our results also indicate the need for evaluation of climate change effects at the local level, in order to develop effective forest management plans for climate change mitigation and adaptation.

1.15 Modeling approach to evaluate the effect of long-term climate variability and change on water quality and aquatic ecosystems in Lake Biwa.

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1.Introduction Current studies understand that lakes can influence local and regional climate, as open water has significantly different radiative and thermal properties compared with other surfaces. While the effect of climate change on thermal structure, water quality, and subsequently aquatic ecosystems also is known and indicated to be important. Lake Biwa ecological model with watershed runoff model was used to evaluate thermal structure of Lake Biwa in the near future 2030s using the output of the recent Regional Climate Model (MRI-AGCM3.2 (Mizuta et al., 2012)) with 20-km grid. The future simulated result indicates that thermal structure will be greatly changed, and subsequently the seasonal turnover annually occurred in present will be potentially stopped. These phenomena may greatly change water quality and sediments, and influence aquatic ecosystems in Lake Biwa. On the other hand, declining DO and increasing the concentration of phosphate in sediment overlying (SO) layer have been already measured in this decade in Lake Biwa.

2.Method For evaluating long-term phenomena of water quality near SO layer, the water-sediment interaction model with the detailed biogeochemical process was developed incorporated into the ecological model (Komatsu et al., 2006) and then described the current behavior of DO and nutrients in the hypolimnion in Lake Biwa. The developed model was combined with the meteorological output generated by MRI-AGCM3.2. To evaluate the long-term effects of climate change, the outputs simulated in near future 2030s were compared with those simulated in 1980s.

3.Result and discussion The developed model with water-sediment interaction processes is validated for the years 2004 and 2010 using measured water quality and could describe the long-term changes water quality in hypolimnion and SO layer for the last decades. Therefore this model has high credibility and sensitivity to analyze the long-terms change of lake water quality and sediments, and can be applied to evaluate the effect of climate change on Lake Biwa's environment. The 10-year averaged annual mean temperature of the surface water in the 2030s was predicted to increase by about 1.2 ℃ compared with the 1980s. Increasing water temperature change hydrodynamics in lakes and thermal stratification strength in near future, and subsequently turnover in winter will be stopped during three years in 2030s. This ecological model with water-sediment interaction indicates that during the period decreasing DO in hypolimnion developed the anoxic layers in hypolimnion and sediments and subsequently will increase the concentration of phosphate in the developed anoxic layers. This model study indicates that the change of water quality in hypolimnion influence water quality and change dynamics of the aquatic ecosystems, especially algal growth in epilimnion.

1.16 Prediction of presence and absence of insect species from land cover and climatic data using Adaptive Neuro Fuzzy Inference System (ANFIS) and Artificial Neural Networks (ANN)

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The population dynamics of insects is highly affected by climate, therefore effective prediction of species distribution using climatic and environmental data is important in agricultural and environmental ecology. Two artificial intelligence approaches employed to predict distribution of 5 insect species from climatic and land cover data and compared with a conventional statistical approach (stepwise regression). Neuro-Fuzzy Interface System (ANFIS) was used to predict insect distribution from 5 climatic and landcover variables, while Artificial Neural Networks (ANN) model was able to handle much more variables as inputs. In this study ANFIS system was used to predict presence versus absence of insects from given environmental and ecological variables as input to the model. Base on training data, we were able to obtain the proper outputs for each selected inputs. We found the ANFIS model to be highly effective in predicting distribution with limited number of predictor, having a range of 86–99.5% correct predictions. In comparison with statistical models that depend completely on the availability and quality of insect distribution data and uses lots of input variables, our model was able to predict the present/absence with high performance using limited number of inputs. Predictions are in county level which gives the resolution needed for local ecological management and can be utilized for planning biological control practices and preventive invasion of non-native pest into a new area.

1.17 Modelling the Contribution of Wildfires in the Future Distribution of Dominant Endemic Tree Species in Western Himalaya

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Recent climate change is thought to be affecting significantly the composition of high altitude flora globally by causing shifts in species distribution. Modeling species' future distribution under projected climate change scenarios leads to the understanding of the behavior of endemic plants in altered climatic conditions. Wildfires cause regional climate change and pose threats to the Himalayan biodiversity. In the present study, we predicted future distribution of four endemic tree species Pinus roxburghii, Quercus semecarpifolia, Rhododendron arboretum and Cedrus deodara in western Himalaya as per SRES-A1B scenario for year 2030, 2050 and 2080, under i) without wildfire and ii) with wildfire conditions. We integrated wildfire events occurred in western Himalaya during year 2008 to 2012 as a predictor variable along with 35 climate variables in the Maxent model, to project the future distribution of four endemic species. We observed significant reduction in the distribution range of the endemic species under 'with wildfire' condition than under 'without wildfire' condition. Future prediction of endemic species revealed varying patterns of distribution pertaining to variability in species response and variability in climate change as per prediction year. Shifts in the distribution range of four endemic species was observed, with drastic range reduction along central and southern parts of study area under 'with wildfire' condition. Under 'without wildfire' condition, we observed prominent shift towards north and north-eastern regions in the distribution range of endemic species, owing to availability of higher atmospheric moisture in the northern and eastern parts of western Himalaya. We observed higher rates of range reduction in the distribution range of endemic species during 2050-2080 as compared to 2030-50. We also proposed modification of existing protected area network of western Himalaya to cope up with the alterations in composition of native due to climate changed induced species' shifts.

Keywords: Species distribution model, wildfires, climate change scenario, Maxent

1.18 Cascading impacts of climate change on coastal marine ecosystem and related goods and services

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While many studies explore the effects of climate change (CC) on a variety of abiotic components of marine habitats, suitability of selected target species, and specific ecosystem processes, less researches focuses on the functioning of an ecosystem as a whole, as emerging from the superposition of direct, indirect and cascading impacts on different ecosystems components. Here we presents a downscaling experiment linking a regional atmospheric model to local hydrodynamical, biogeochemical, ecosystem and target species population dynamic models, used to evaluate the effects of climate change on a temperate coastal lagoon ecosystem, along with goods and services provided by this ecosystem. In all the climatic scenario considered (IPCC A2 and B2) the changes in the the seasonal rain pattern affect the timing of nutrient inputs to the lagoon and causes a reduction in plankton productivity. These changes then propagate –with a delay in time- along the food web through a multi-path cascade. However, and notably, the biomass of higher trophic level organisms of commercial interest significantly differ among different scenarios. This differences arise from the dynamics of the extremes (yearly maximum) values of ecosystem components, rather than of their averages values. Changes in the nutrient load maximum discharge (scenario A2) favors primary producers that have higher maximum values (peaks) that propagate up in the food web to ecological function groups directly related to the grazing food chain. Conversely, small modifications of the timing of the nutrient peaks (as in B2 scenario) implies less exploitation of nutrients by primary producers due to temperature limitations and the enhancement of the groups in the food web that are more related to detritus-based food chain. Assuming a constant exploitation rates for target and non-target (discarded) species over the 30 years of simulations, we observe divergent changes on fisheries landings among the two different future scenarios. Ecological indicators highlighted also divergent changes in food web biodiversity and complexity. Simulations also show that clam aquaculture activity will suffer and point to the need for management policies to mitigate the adverse effects of climate change.

1.19 The role of environmental variability in the dynamics of the South Pacific albacore tuna and potential impact of climate change

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Albacore tuna (Thunnus alalunga) are widely distributed in tropical, sub-tropical and temperate zones worldwide with six separate stocks being reported in the literature. The status of these stocks varies with recent estimates from stock assessment models ranging from exploitation within sustainable limits in the Pacific Ocean to overexploited in the north Atlantic Ocean. Aiming at quantification of the stocks, however, these models cannot attribute observed trends and stock variability to the impact of environment or exploitation. The model SEAPODYM explicitly describes the spatial dynamics of a species with detailed population structure according to the definition of its spawning and feeding habitats; the habitat-driven movements and recruitment are modeled with help of advection-diffusion-reaction equations. The habitats are derived from environmental variables: temperature, dissolved oxygen, primary production, zooplankton and micronekton. The model includes a Maximum Likelihood Estimation approach, which results in optimal solution predicting the catch and length frequencies of catch provided the best fit to the observed data. We parameterized SEAPODYM for the South Pacific albacore stock using physical and biogeochemical forcing on 2x2 degree spatial and monthly temporal resolutions obtained from the NCEP-OPA-PISCES reanalysis. We performed the optimization and validation study in order to reconstruct the spatio-temporal dynamics of albacore population during the period 1960-2008. The model predicted spatial distributions of population densities at different life stages and seasonal migration cycle are consistent with observed longline catches per unit of effort. Then, the predictions were projected until the end of the century using IPSL-CM4 A2 simulation. Here we present the detailed analysis of population spatial dynamics and the first evaluation of potential impact of climate change under IPCC A2 emission scenario on the stock of south Pacific albacore tuna.

1.20 Dynamic modelling of the Canarian Houbara Bustard habitat in Fuerteventura (Canary Islands)

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Within changing landscapes and small-sized areas, biodiversity conservation and management requires a wide knowledge of the factors that are affecting species, helping decision-making process in order not to damage local biodiversity. The Canarian Houbara Bustard (Chlamydotis undulata fuerteventurae) is an endemic subspecies from Canary Islands (Spain). It´s currently distributed only on the islands of Fuerteventura, Lanzarote and La Graciosa (eastern islands), and it is considered "Endangered" on the Spanish Bird Red List. Nowadays, the population of the Canarian Houbara is relatively well monitored, and during the last years, a good sampling methodology has been implemented. This methodology, which has been developed within a LIFE Project from 2003 to 2007, has made possible to estimate a total population of approximately 1000 birds.

However, changes within the Houbara habitat in Fuerteventura have not been deeply studied, despite the fact that this island has undergone a big tourist and housing expansion along the last decades, and this island used to be the major focus of Canarian Houbaras. This paper is focused on modeling the habitat of Houbara Bustard in Fuerteventura, based on both environmental and socio-economic factors, which is included in a sustainability dynamic model of the Fuertenventura Biosphere Reserve. This model allows us to assess the potential impacts of different scenarios and land use changes. The houbara sector takes into account the rates of habitat loss for each impact factor within the island. Roads and urban growth are the main factors that are affecting the habitat of this evasive species. Intensification of agriculture (irrigation) and abandonment of traditional systems (gavias) are also important factors. In this work, it has been modelled habitat changes during the last 20 years. Model results are consistent with available observed data on Houbara habitat. Results show a reduction of the habitat around 10% along the last 10 years. The simulation of some future trends, such as different socio-economic circumstances and management measures, shows that this reduction might last during the next years.

1.21 Biotic turnover in tundra, forest and peatland ecosystems in permafrost regions of the Northern EuroAsia under climate change

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Transformations of terrestrial ecosystems due to global climate change and anthropogenic activities are reflected in the functioning of their biogeochemical cycles. Aggregated mass-balance schemes of carbon and nitrogen biological turnover in peatland and forest ecosystems boreal and forest-steppe zones are the source of numerical data on carbon and nitrogen fluxes and storages in principal ecosystem components and a foundation of knowledge on inter- and intra-system exchange processes sensitive to climate change and human perturbations. The aggregation procedure accounts for biological form and functional role of each ecosystem component. It is carried out for peatlands and spruce forests of middle and southern taiga at the European territory of Russia (Alexandrov et al., 1994; Kozlovskaya et al., 1978) and some types of oligotrophic bogs and pine forests of middle, southern taiga and forest-steppe in Western Siberia (Golovatskaya, Dyukarev, 2009; Vedrova, 1997; Kosykh et al., 2010; Bazilevich and Titlyanova, 2008). A sequence of dynamic compartment models for combined carbon-nitrogen cycling with elements of a hydrological cycle is obtained as a result. Carbon-nitrogen interaction is provided by two biochemical mechanisms which served a basis for one of the first models of their turnover in a mesotrophic peatland earlier (Logofet and Alexandrov, 1984): 1) intensity of litterfall is propotional to the C:N ratio in the living phytomass that reflects nitrogen starvation of plants; 2) decay rate for dead organic matter decreases with the increase of C3/N3 ratio. These two rules work both for peatland and forest ecosystems (Alexandrov et al., 1994). Flows can depend on climatic variables – annual temperature and precipitation over vegetation period. Stationary points of each model reflect climax states of biological succession while stability loss corresponds to transitions between these states. Methods of bifurcation theory allow determine stability boundaries for steady states of each model in the space of parameters depending on climatic variables and some hydrologic characteristics. The most important among them are carbon assimilation, peat formation and decay of dead organic matter rates. For modeling consequences of climate change a set of scenarios formed by two climate models моделей (MPIM-ECHAM5, UKMO-HADGEM1, HadCM3) included in the 4th IPCC Report (2007) is used. The typical feature of these scenarios is CO2 doubling in the atmosphere with 1% annual rate and a constant content after the doubling until 2100. In result, a part of oligotrophic bogs in western-siberian middle taiga can be transformed into fir forests while meso- and eutrophic peatlands are probable to shift into a fen state. However, raised bogs (ryams) in southern taiga can convert both into pine forests and into grass fen. Anthropogenic perturbations (fires and peat mining) can correct natural trajectories of peatland and forest ecosystems evolution. The work was supported by the project of the Earth Sciences Department of the Russian Academy of Sciences "Processes in atmosphere and cryosphere as a factor for environmental changes" and the Russian Foundation of Basic Research (projects 13-05-00781a, 12-05-01092a, 12-05-33050).

1.22 Towards the relative role of climatic and anthropogenic factors in the water quality and ecological dynamics of an estuarine environment – Mira channel (Aveiro lagoon, Portugal)

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Long-term trends in estuarine water quality and ecological dynamics, namely those related to climate change, are a matter of concern nowadays. Human disturbance, as climate change, may also represent a potential threat to the estuarine ecosystems health, and the interplay between these distinct drivers should be further investigated. Thus, this study evaluates the relative influence of climate change and anthropogenic pressures in an estuarine environment, the Mira channel (Aveiro lagoon, Portugal). The Aveiro lagoon harbours one of the largest salt-marshes in Europe, supporting at the same time several economic activities. The study was performed taking advantage of the three-dimensional hydrodynamic and ecological model ECO-SELFE, duly validated with dedicated field campaigns. A set of 1-year scenarios was established to study the individual and combined effects of: i) various components of climate change, including the air temperature increase, changes in the precipitation regimes and sea level rise, and ii) anthropogenic pressures, including a dredging plan under evaluation, a marina construction and an emergency by-pass wastewater discharge. The analysis suggests that, in general, climate change overwhelms the effects of the analysed anthropogenic interventions. Overall results suggest that the circulation (tide and river flow) is one of the main drivers controlling the water quality and ecological dynamics along the Mira channel. Changes due to sea level rise are the ones that influence these dynamics the most, leading to a significant increase of salinity along the channel and a decrease of nutrients, chlorophyll a and dissolved oxygen throughout the year. During the summer season these effects may be enhanced by the reduction of the freshwater discharge. The predicted changes suggest a decrease of the primary productivity, which may affect the entire food web. Shifts on species composition and further progression upstream of marine species are also expected to occur. Results also suggest that the identified effects may be more important in shallow estuaries. These findings constitute a first contribution towards the understanding of the relative role of climate change and anthropogenic pressures on the water and ecological quality of the Aveiro lagoon and should be further extended, to support the sustainable long-term management of this estuarine system.

1.23 Can we simulate the Amazonian forest response to persistent drought conditions with the ISBA-Ags land surface model?

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The two severe droughts that have impacted the Amazon rainforest in the last decade are of great concern. Indeed, droughts reduce the carbon uptake by photosynthesis and enhance tree mortality, therefore reducing the carbon sink capacity of the Amazonian ecosystem during these particular events. Besides, future climate simulations based on the phase 5 of Coupled Model Intercomparison Project (CMIP) show a strong consensus on a drying and lengthening of the dry season in this region.

However, the rainforest response to a drier climate is still an ongoing research topic. Two long term rainfall exclusion experiments (TFE) lead in the Amazon provide a large panel of observations to understand the ecosystem response under a soil moisture deficit. It is also a great opportunity to evaluate and improve models' behavior in case of drought, comparing simulations and observations. This is particularly relevant for land surface models (LSM) that can be included in global climate models (GCM) to unravel the fate of the Amazon forest under a drier climate and the related carbon cycle feedback in global climate projections.

As the LSM ISBA-A-gs accounts for a complete carbon cycle representation and calculates an interactive leaf area index (LAI), it is able to simulate vegetation response. The model was first tested over the Amazon watershed using data from several FLUXNET towers (http://fluxnet.ornl.gov/). This led to new parameterizations in order to improve the carbon and water fluxes simulations. This new version of ISBA-A-gs is here used to simulate both control and TFE plots, for each site (Caxiuana and Tapajos). If the model shows a good skill to simulate soil moisture for both control and TFE plots, it is under-sensitive to simulate the vegetation response in case of drought. Indeed, observations show a strong decrease in transpiration rate, LAI and biomass while ISBA-A-gs underestimates the effect of drought on transpiration and mostly biomass. ISBA-A-gs represents mortality as a simple average turnover and is therefore not adapted to represent drought-related mortality and the resulting loss of biomass. Therefore we first propose a sensitivity analysis to the soil moisture stress function on vegetation. We then implement a tree mortality function to better simulate the vegetation response to drought.

1.24 Numerical simulation on the effects of pollutants on marine ecosystem of Pacific coast in Japan by using MEC model

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Coastal, marine, and freshwater ecosystems are vulnerable due to global warming and climate change. The present study is tinted the Great East Japan Earthquake and Tsunami disaster caused serious impact on the Pacific coastal environment. The major concern of this research is the diffusion of heavy and radioactive materials caused by 2011 Earthquake and Tsunami disaster and Fukushima nuclear accident in Japan might negatively be affected the marine ecosystem. This study is undertaken to investigate the hydrodynamics and transport process within the Kamaishi Bay using an integrated 3-D MEC (Marine Environmental Committee) model and field measurements. Both numerical modeling and filed measurements investigations were carried out in this study to obtain a better understanding of the hydrodynamic process and the key water quality indicator distributions that have a significant impact on the overall water quality characteristics within the Bay after 2011 tsunami. In this study, we simulated the changes of water quality and sediment in coastal area of Kamaishi Bay on June (low flow season) and September (high flow season) in 2009, 2010 and 2012. The selective radioactive materials such as Cesium-134 and Cesium-137 were mentioned as several sites of the Bay and other water quality, such as nutrients salts, was also evaluated. Furthermore, we analyzed radioactive materials by measurement of gamma rays. The results were found that measured and simulated contaminations of radioactive materials were under the environmental standards in Japan. Measured T-N and T-P concentrations were not so large different from those before the disaster. Meanwhile, we found that the amount of radioactive substances in sediment comparatively low at the sample sites of the Kiamichi Bay. Due to the low potential exchange pollutants with the open sea, the chemical and biological processes are particularly important in simulating the governing of water quality characteristics of this coastal water bodies. The MEC model has been used to predict the distributions of various key water quality indicators and tide flow in the different layer of Kamaishi Bay. The results of this study show that water quality and the sediment structures in Kamaishi Bay have no serious radioactive problem after the disaster. So, the research findings from this study could therefore have implications for the coastal environmental management of Bay and Seas.

1.25 A mathematical model of spatiotemporal changes in seagrass ecosystems

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Seagrass meadows in shallow coastal areas play a critical role in ecosystem stabilisation, via their provision of a habitat for aquatic species, modification of current flow and water turbidity, globally-significant storage of carbon, and regulation of nutrient recycling. However, seagrasses are in decline worldwide, and their decreased resilience to large disturbances (e.g. cyclones and floods) due to changed environmental conditions (e.g. eutrophication, dredging) is notoriously difficult to identify and predict. Thus, there is a crucial need for improved tools to predict the nonlinear relationships that drive seagrass loss and recovery. In this paper, a mathematical model of the spatiotemporal evolution of subtropical seagrass meadows is presented. The model investigates spatial patterning of the seagrass ecosystem in response to disturbances such as eutrophication and sea level rise. Critical thresholds for environmental parameters that determine the risk of seagrass meadow decline are elucidated.

1.26 Remote Sensing Model SEBAL Applying in Alpine Cold Grassland-wetland Ecosystem, the Source Region of the Yellow River, China

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The source region of the Yellow River is located in the eastern of Tibetan Plateau at an altitude of 3900 to 5300 m with the diverse land covers and the special ecosystems. The study aimed at monitoring and analyzing the patterns of evapotranspiration (ET) in the source region at a large scale. Based on Surface Energy Balance Algorithm for Land (SEBAL) model, we retrieved the energy fluxes with Landsat 5 remote sensing images and the meteorological parameters of the area in the summer of 2006. In this study, the unsupervised classification was performed first to illustrate the land covers. Secondly, the key variables in SEBAL model, including the normalized difference vegetation index (NDVI), surface albedo (a), the surface radiation temperature (Ts), net radiation (Rn), and sensible heat fluxes (H), were calculated to show the spatial patterns of the energy budget distribution. From the results, the instantaneous evapotranspiration (ETinst) was higher in the cold and wet southern regions at the level of 0.25 0.40 mm/hr, while lower in the northern part, at the level of 0.10 0.30 mm/hr. The interaction between the land surface and the hydro-heat distributions in the source region were discussed with the correlation analysis among the key variables of the model. Our research assessed the surface evapotranspiration patterns and provided a fundamental realization about the possible impact of land cover changes and the potential moisture change in the alpine grassland-wetland ecosystem.

1.27 An integrated dynamic simulation model, CASiMIR Vegetation application at the Schwechat River

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In recent years the knowledge acquired in the field of hydrodynamics and vegetation modeling allowed the formulation and implementation of countless simulation models. However, most of these solutions consider only one aspect of the whole ecosystem, either vegetation or hydrodynamics. Little effort has been so far devoted in the modelization of the active feedbacks existing between these two ecosystem components. Hydrodynamics effects on vegetation are given by the morphodynamic disturbance exerted by floods and by their duration time. Conversely, vegetation affects flow properties by altering the roughness properties of the channel bottom. Vegetation roughness is a dynamic factor related to flow depth and plant properties such as stem flexibility, lateral spacing and canopy density. When modeling the evolution of a riparian landscape, these properties have to be taken into account in order to effectively mimic the effects of the flow stage-vegetation relationship. This objective was fulfilled by implementing CASiMIR vegetation (dynamic vegetation model) coupled with a hydrodynamic model (see: "CASiMIR Vegetation: linking riparian vegetation and hydrodynamics"). Hydrodynamic effects on vegetation were simulated using mean water elevation as key input for the recruitment simulation; bed shear stress and stream power were instead used and tested as indicators of morphodynamic disturbance. Additional input is the duration and extent of the flood waves over the vegetation period. The results presented here originate from a case study at the Schwechat River (Austria) and are focused on the comparison between the alternative usage of stream power or shear stress as morphodynamic disturbance indicators. The Schwechat is an extremely dynamic stream near Vienna; riparian landforms and vegetation stands within the active channel are subject to rapid turnover and the modeling of such environment represented a challenge. Simulation spanned a four-year time interval and included the replication of one major flood. The simulations show how the alternative use of stream power or shear stress as morphodynamic indicators yield results of comparable accuracy and emphasize the validity of the novel approach implemented within CASiMIR vegetation.

1.28 General ecology and human ecology: exergy and demography.

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The concept of exergy has appeared at the basis of thermodynamics and physics.(Wall, 1994). Until now this concept was used in technical and economical models, in description of usage of natural resources and other interactions between society and nature as well as between different human societies. The other energetic concept with similar essence is emergy (Odum, 1983). These concepts are useful enough in comparisons of technical, economical and social systems. As a rule, this utilitarian approach does not pay any attention to the general ecology viewpoint and biological rules which unavoidably govern human societies. First of all, important population ecology characteristics: dynamics of numbers, age structure, mortality and fecundity. These demographic parameters together with social and technical components make the content of modern human ecology. However, exergy and/or emergy still are still not well elaborated for human ecology as a synthesis of humanitarian and hard sciences. Such a broad perception put several paradox questions: (1) Is reproduction of population of humans a useful work from the thermodynamic viewpoint? (2) Is intellectual and physical labour a useful work from the thermodynamic perception? (4) Is it possible to assess culture as a group adaptation of humans in terms of thermodynamic effectiveness? (5) Is it possible to explain evolutionary fitness (fast growth rate of humankind) in terms of exergy? (6) How demography is related to energetic effectiveness? For example, according to canonical demographic Euler-Lotka equation for description of human populations' age structure under certain assumptions, burth rate is proportional to exergy. The demographic transition means increase in the mean life span of humans, and in this case several existing models would predict a decrease in the rate of hyperbolic population growth rate with lowering of numbers. Usage of exergy concept for qualitative and quantitative description of different processes in human ecology (both economical and purely ecological) would be very useful tool of understanding their nature and regularities.

1.29 A Participatory Method to Map Interlinked Climate Change Vulnerabilities and Assess Adaptation Strategies in Multiple-Resource Social-Ecological Systems

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Forests cover more than 760 000 sq. km of Quebec province territory, 90% of which are on public lands. The temperate deciduous forest represents around 110 000 sq. km of this area mainly in the southern part of the province. Located on the periphery of the densest urban centres, many regions in and around this vegetation zone host forest-dependent communities particularly vulnerable to climate change. Following several years of crisis in the forest sector, the Quebec department of natural resources issued the new Sustainable Forest Development Act in April 2013. Among several major changes in forest management, this law puts forward two strategic orientations: 1) ensure integrated resource and land management at local and regional scales, and 2) account for climate change impacts in current forest management decision making. Based on Elinor Ostrom's framework to study sustainability of social-ecological systems (SESs), we present a method to structure the development of modelling approaches to tackle climate change adaptation issues at local and regional scales. Originally proposed to diagnose the sustainability of single-resource SESs, we propose a participatory approach to extend Ostrom's framework for multiple-resources management in order to map the way climate change vulnerabilities are linked together through connected single-resource SESs. Our approach is intended to foster the achievement of integrated resource and land management in the context of climate change. The first step of our methodology consists of a participatory process carried out with forest and climate change experts. Following an approach inspired by the Actors-Resources-Dynamics-Interactions method (ARDI), this first step results in a conceptual model of interconnected SESs' vulnerabilities to climate change. Following this preliminary step, the output conceptual model is then used as a basis to identify knowledge gaps and as a starting point to co-develop models with local stakeholders. These models (e.g. role-playing game, agent-based model) are developed as tools to assess climate change adaptation options based on ecological, social, and economic criteria. Although our method is generalizable to other natural resource management situations, it is presented in the context of forest-dependent communities adaptation to climate change.

1.30 An integrated modelling of interactions between ecological processes and human decision-making: The MAELIA multi-agent platform

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The MAELIA project (Multi-Agent for EnvironmentaL norms Impact Assessment) develops a simulation platform for the assessment of the socio-environmental effects of management strategies of water resources given the social and climate changes. It focuses on the modelling of low-water management, which is the most strategic water issue in the Adour-Garonne basin (South-West France). To address the direct/indirect or expected/unexpected effects of the investigated endogen and hexogen factors, the platform represents and simulates hydrological, agricultural and normative processes and their interactions. To represent the hydrological processes (the soil phase and the routing phase of the water cycle) the SWAT formalisms have been analysed and re-implemented into the MAELIA software modelling and simulation platform. To represent crop growth we recode formalisms of an empirical and robust crop model developed at INRA Toulouse that represents effects of the hydric stress and irrigation strategy on yields of the main crops of South-West France. The originality of the platform comes from a multi-agent approach where a large number of software agents simulate the spatialized and dynamic behaviors of actors playing a role in water management and uses: agricultural, domestic and industrial withdrawals, management of water stored in dams, regulations of water uses. In this communication we focus on the original conceptual and software frameworks of MAELIA regarding the representation and simulation of interactions between the ecological processes and the human decision-making processes at a high spatial and temporal resolutions. We describe how human how we manage interactions of different processes with their own spatial and temporal resolutions (field, farm, HRU, water sub-basin, regulation zone, dam watershed zone...). We highlight our modeling approach that simulates reciprocal and continuous feedback between human activities and ecological processes to the difference of approaches based on the sequentially use of an agent-based model, to simulate human behaviors, and then of an hydrological one to simulate effect of these activities on the water cycles. Finally we discuss the challenge currently faced, related to calibration and evaluation issues and simulation of scenarios of the socio-hydrosystem evolutions over decades.

1.31 Ecosystem Services Supporting Decision Making in Environmental Impact Assessments

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(Preferably in the sessions concerning topic 1.7 linking ecology, economy and sociology or 1.4 sustainable management of natural resources.)

Environmental impact assessment (EIA) is a systematic method to analyse and anticipate direct and indirect effects of activities. EIA considerably distinguishes itself from other assessment tools in that it is regulated by law. When the EIA method was introduced, it changed the prerequisites for getting consent for environmental hazardous activities.

Within the EIA method, assessing alternatives is a powerful systems analysis to assess efficient resource use. However, in practice, few alternatives to a proposed project are assessed. Mitigation measures within the proponent's mindset often dominate. If the EIA instrument shall fulfil the need as a base for decisions to steer towards sustainable development, alternatives proposed by others, outside the proponent's sphere, must be allowed within be the scope of assessment. Ecosystem services is a concept increasingly discussed in international policy making, aiming to describe the values of ecosystems to human well being. Including ecosystem services as part of EIA alternative analysis could improve the EIA process, thus better supporting sustainable decision-making. At first glance, we see two immediate uses of ecosystem services within the EIA method. The first potential is when assessing the impact of a proposed project, by including decreased delivery of ecosystem services and not only environmental disturbances. The second potential for ecosystem services is as support to open up for innovative alternatives, i.e. other ways to fulfil the needs of the proposed activity.

An increased understanding of ecosystem services could, within the EIA method, support a more comprehensive understanding of impacts from human activities, and help identify possible sustainable and advanced solutions to a proposed project.

1.32 Complementarity between socio-economic and emergy evaluation of agricultural production systems: the dairy farming sector in Slovenia

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Agriculture is a production system that directly benefits from nature. Recently the sector has to comply with and efficiently address several challenges from both an environmental and an economic perspective. Agricultural producers and moreover, decision-makers in agricultural policy, have to find an optimal balance between free ecosystem services and economically evaluated agricultural practices, in order to optimize the use of natural resources, enable positive economic results and to achieve the highest possible sustainable production. Evaluating alternative management decision options solely from an economic perspective does not provide sufficient information for integrated and sustainable planning of agricultural production. This paper aims to provide multiple-criteria performance analysis which integrates both biophysical and economic assessment using emergy and standard economic performance methodologies. This new approach is demonstrated through an evaluation of the dairy production in Slovenia. For this purpose the milk production sector was categorized into nine farm types distinguished by size, technology and intensity of milk production. Data were collected from official administrative agricultural agencies in Slovenia. The assessment starts with socio-economic analysis. Performance of the farm types is assessed with respect to their profitability, productivity and income sufficiency. Emissions of GHGs are estimated as an indicator of the production's environmental impact. In addition, emergy analysis is applied and several emergy indicators are calculated to define biophysical efficiency and sustainability of the farm systems. Data mining cluster analysis identifies major criteria that discern farm type homogeneity or heterogeneity. The results of emergy analysis show that biophysical efficiency indicators favour larger and highly intensive farms, whereas ecological farms have a much greater ability to exploit free natural resources and place lower pressure on the local environment. Analysis of emergy flows reveals for all farm types a high dependency on the wider national and international economic system, suggesting that agriculture itself has little ability to affect its own sustainability. Finally, comparative analysis integrating biophysical and socio-economic indicators was carried out. The results show high complementarity of applied indicators, which confirms the advantage of this method compared to a standard economic performance methodology.

1.33 Robustness of social-ecological systems to external disturbances: a system dynamic model of the oasis of Comondu (Mexico)

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Traditional social-ecological systems (SES) are the result of the complex relationship between humans and the environment and the institutions to manage natural resources. The Oasis of Comondu (Mexico) is a traditional SES with a long history of sustainable use of natural resources like freshwater, pastures and soil. Users were adapted to inter and intra-annual variations of rainfall and to extreme weather events (droughts and hurricanes). Economic activities included agriculture in irrigated lands and livestock in rangelands. However, since the middle of the 20th century, the profitability of irrigated land has fell and the population has decreased from 1006 inhabitants in 1940 to 257 in 2010. We used in-depth interviews and surveys to stakeholders, participant observation and official data to conceptualize the internal structure and dynamic of this system since 1940. Results indicated that external development processes in other areas (e.g. agricultural expansion and modernization, tourism development and new highways) caused an important increase in human migration. We developed a dynamic simulation model to study the structural causes explaining the dynamic of the oasis. Considered factors included human population, livestock, land use, and capability to invest in local services and infrastructures, among others. Simulation results were consistent with the dynamics of the real system. The system, which was dominated by endogenous forces in the past, is now controlled by external forces. Users' adaptation by means of the replacement of agriculture to livestock has allowed the persistence of the system but, at the same time, users have become more vulnerable to external climatic disturbances. Large fluctuations in livestock due to droughts and hurricanes caused an increase in human migration to urban areas. Depopulation has weakened several regulatory mechanisms such as local institutions and the investment in local infrastructures. Future applications of our model will include an analysis of different scenarios (e.g. climate change and tourism development) and an integrated assessment of sustainability.

1.34 Emergy as an additional indicator in a model of integrated management of the human-environmental system of reindeer herding

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Suggested for 1.4 sustanable managemen of natural resources.

Several models have addressed the management of the Fenno-Scandinavian mountain region, for example Sverdrup et al (2010, Swedish EPA) presented many Causal Loop Diagram models of the Swedish mountain management. Burkhard and Müller (2008, Ecol.Indicators 8:828-840) presented a model for the Fenno-Scandinavian reindeer herding, including also an indicator system for the management. In this paper we add the relatively new measure emergy to these models, and discuss the benefits achieved. Emergy is a measure appearing when applying the energy hierarchy principle to natural (e.g. forests, lakes, or mountains) or human (e.g. mountain societies, cities or countries) systems, postulating that energies in any system will self-organize in hierarchical patterns given time to do so. Emergy is expressed in relation to one type of energy occuring in the hierarchy, most often solar emergy Joules, seJ. In the model by Burkhard and Müller (2008) the emergy values will add information both on the thermodynamic part of the model, but also on the economic side since emergy values in seJ can be alternatively expressed in a proportional, currency related unit, for example Em€ or Em.$The significance is that Em€ or Em$ measures the contribution different items give to the whole system, rather than how individuals give market values for different items; a donor value approach rather than a receiver or market value approach

1.35 Models and methods as support for sustainable decision-making

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Suggested for 1.4 sustanable managemen of natural resources. Since the 1960s the urgency to steer mankind towards a more sound environment has grown. Currently humanity is in a transition period between today's old paradigm - business as usual - and the new one, aiming at operationalize sustainable development goals. There is a growing understanding, that to move towards sustainable development ecological sustainability is necessary but not sufficient. Steering society in this direction necessitates making decisions that at least do not counteract sustainability. Such decisions have to rest firmly on a natural scientific basis. Natural laws, such as thermodynamics and conditions set by ecosystems, can therefore not been ignored, when a) searching for technical solutions to environmental problems and fully understand the consequences of such solution and b) improving steering instruments to guide human actions.

During the years a number of models/methods/systems have been developed to underpin sustainable decision-making. Related to ecosystems we have e.g. the carrying capacity and resilience models, to resource use there are Life Cycle Assessment (LCA) and Ecological Footprints, to economy there are eco-economy and green economy, to law there are Environmental Law Methodology (ELM) and Sustainable law. Emergy synthesis, an environmental accounting and assessment method takes a wider grip embracing everything from thermodynamics to economy.

There still is no "standard method" for this kind of decisions, which makes it important to contrast different methods. Some methods might enforce each other, whereas others might drive in different directions. It is therefore important to understand the methods in relation to each other.

1.36 Systems effecting systems when managing energy resources – a case study of modeling and understanding consequences of technical options in an energy system

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Intended session: 1.4 sustainable management of natural resources

Managing natural resources to minimize impacts driving global change requires system understanding. The ecological systems are affected by different human interventions e.g. through the use of natural resources and generation of emissions. The 'ecological footprint' of a provided service can differ significantly according to both the choice of technology as well as the interactions of a specific technology option within the overall technical systems. Such interactions within the technical system may have significant impact on the modeling results regarding ecological consequences for a specific technical option. These interactions are important to understand for good decision support and policy making in the context of global change. This will be illustrated by the case of using air-to-air heat pumps for space heating in Sweden. In recent years, air-to-air heat pumps have been the most sold technology for space heating in residential buildings in Sweden. Newly produced air-to-air heat pumps can provide heat energy from outdoor air at temperature as low as -20°C. A drawback of air-to-air heat pumps is their reduction in efficiency as the outdoor air become colder. In this study, the use of air-to air heat pumps is compared with other commercial technologies integrated in the Swedish and European energy system. Results show that although air-to-air heat pumps are presently very cost effective for the end user and give relatively low final energy demand for space heating, by comparison to other commercial technologies seen integrated in the Swedish and European energy system, air-to-air heat pump are inferior regarding the use of resources and in securing peak load power demand. Thus, by modeling the performance of air-to-air heat pumps first by including only its interaction with the building and then by including its interaction with the larger energy system suggest that there is presently a micro economic driver for the local investor pointing in the opposite direction regarding management of natural energy resources compared to what would be desirable in the context of global change.

1.37 Improvement in process-based eco-hydrology model toward evaluation of boundless biogeochemical cycles in global scale

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Recent research shows inland water may play some role in continental carbon cycling though its contribution has remained uncertain due to a paucity of data (Battin et al. 2009). While wetlands provide important role on hydrologic and biogeochemical cycle and preserving valuable species, boreal and subarctic ones might store relatively much soil carbon as peat and affect dynamics of greenhouse gases such as methane (Limpens et al. 2008). The author has developed process-based National Integrated Catchment-based Eco-hydrology (NICE) model (Nakayama 2008a, etc.), which includes surface-groundwater interactions and down-scaling process from regional to local simulation with finer resolution, and can simulate iteratively nonlinear feedback between hydrologic, geomorphic, and ecological processes. In this study, NICE was further extended to implement map factor and non-uniform grid through up-scaling process of coordinate transformation from rectangular to longitude-latitude system applicable to global scale. This improved model was applied to several basins in Siberia and Japanese wetland to evaluate the impact of coordinate transformation on eco-hydrological changes. Simulated eco-hydrological process after up-scaling corresponded reasonably to that in the original there after evaluating the effect of different latitude. This simulation system would play important role in improvement in biogeochemical activity in spatio-temporal hot spots (Frei et al. 2012) and boundless biogeochemical cycle along terrestrial-aquatic continuum for global environmental change (Cole et al. 2007; Battin et al. 2009).

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1.38 Modelling freshwater coastal natural resources under climate variability.

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Current management of Great Lakes fisheries and coastal resources does not consider environmental variability expected from climate change. Resource managers recognize the need to evaluate the impact of a shifting climate, but uncertainty about the impacts, on fisheries and fish habitats (e.g. coastal wetlands), and the long term nature of climate change, has prevented consideration of adaptation strategies. We integrate spatial and ecological databases, statistical and process-based models that link habitat supply with fish production in the nearshore zone of the Great Lakes using a variety of approaches. Spatial and temporal interactions among local elevation profiles, water level fluctuations, wetland distributions, and thermal regimes, coupled with habitat usage patterns, influence overall nearshore production and habitat supply. Both water temperatures and water levels in the Great Lakes are expected to change on average and in phenology. Water levels are projected to change because precipitation patterns and thus supplies are projected to change throughout the Great Lakes drainage basin. Changing winds, storm frequency and severity, and ice cover will also affect the sediment dynamics and thermal structure of coastal areas. Using the latest climate projections from a range of GCM x RCM combinations, as well as down-scaled physical model output, existing trends, variation and cyclicality, we project changes to nearshore habitat supply.

Supplies are calculated for different thermal guilds of fishes currently in Lake Ontario based on ecological niche associations for different life stages. Relative fisheries production is projected for select species using a modified matrix approach combined with bioenergetic relationships. The habitat supply for representative fishes was used to assess the long-term effects of habitat quality and quantity on population dynamics at whole-system and zone scales. Habitat and potential production changes were compared between historic base case and various climate model combinations; mainly B2 scenarios.

Outcomes of the modelling address specific questions including: Where would productive coastal habitats be located in the future, and what are the probable habitat availability and production trajectories for nearshore fisheries belonging to different thermal guilds? Results indicate that some coastal segments or habitat types, species and guilds are more sensitive to concomitant water level, temperature, and habitat changes than others. A nonlinear response between habitat supply and population responses suggested that lags and compensatory mechanisms may confound short-term responses, which has implications for monitoring impacts and strategic management. Key uncertainties and the prognosis for nearshore habitats given multiple stressors will be discussed.

1.39 Structural Recovery Brings about the Hope of Functional Stability: the Land cover and Evapotranspiration Changes during 1990-2009 in the Source Region of the Yellow River, China

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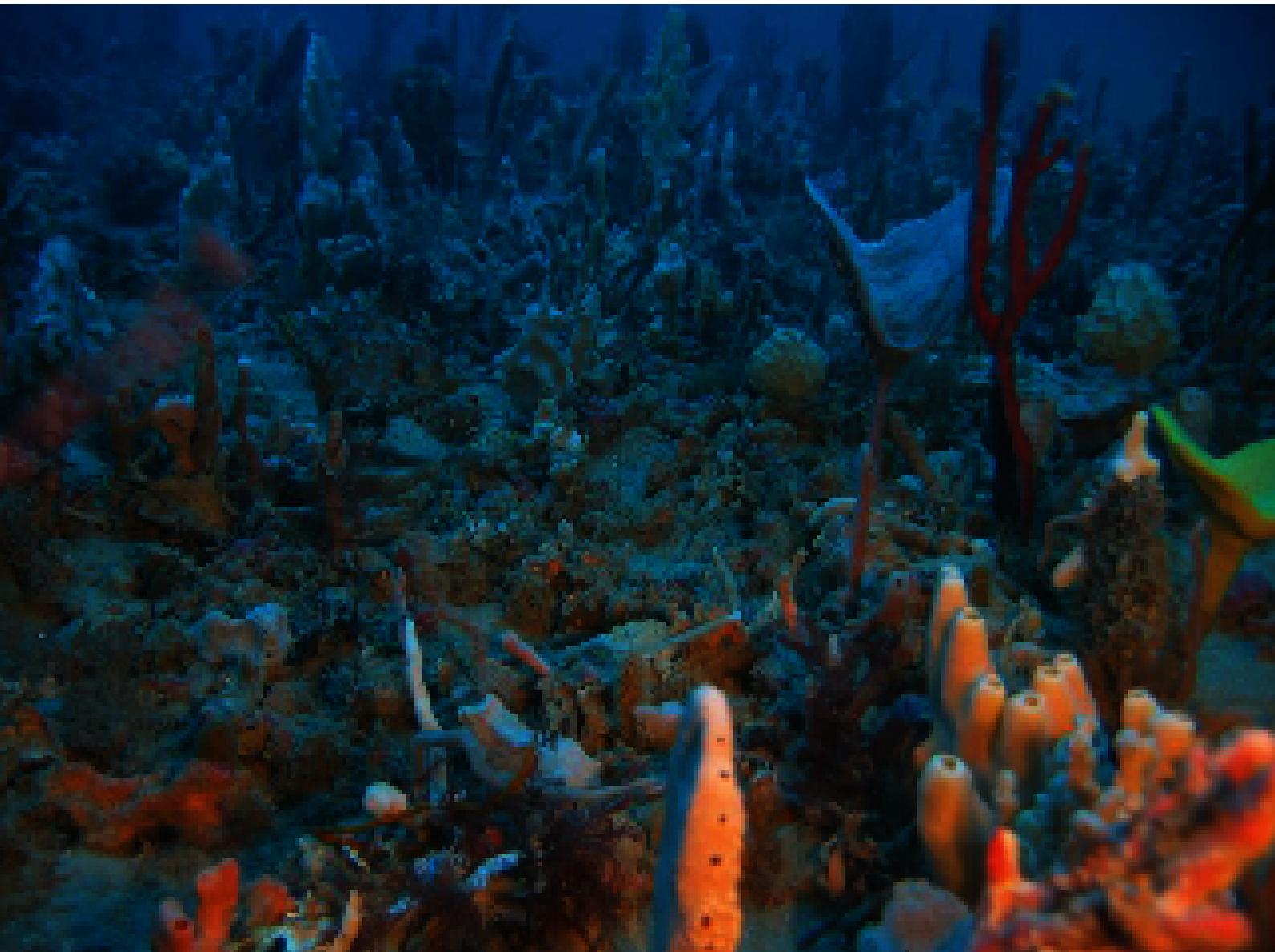
The surface water recycle becomes a key concern in the source region of the Yellow River. The region is located in the eastern of the Tibetan Plateau at an altitude from 3900 to 5300 m as a sensitive and fragile alpine grassland wetland ecosystem. To monitor and analyze the surface cover type and hydrological function at large scale in a dynamic way is important for the sustainability of water use in such ecosystem. We investigated the land cover change and the pattern of evapotranspiration (ET) of the area with an approach of remote sensing classification and modeling for the past 20 years (1990-2009). The results shows that the grasslands degraded severely in the period of 1990-2000 and the ecological restoration implemented in 1990s achieved the initial success. The low coverage grassland and high coverage grassland increased while the bare soils and middle coverage grassland decreased since 2000. We retrieved ET and surface radiation temperature (Ts) for summer seasons of 1990-2009 applying energy balance models and satellite images. The model was performed by ATCOR module in ERDAS IMAGINE 2011. Ts of the whole area is always increasing since 1990, while grasslands shows a slight declining tendency in 2006-2009. The trends of ET are the same for the different land covers. ET of the area got down to the lowest in the summer of 2000 at the level of 0.85 cm/day, and rose up continuously to the level of 1.65 cm/day in 2009 as close to the level in 1990. We combined the results of land surface cover changes and the trends in the regional hydro-heat conditions to conclude that due to the grassland restoration, the level of ET for recent years has been recovered to the level of 1990. Under the global warming, the function of the vegetation to adjust and stabilize the regional climate was realized. In this study, the improvement of integrity and quality for the grassland in the source region of the Yellow River was also proved to be one of the important parts for the normal hydrological recycle and water conservation.

From individuals to ecosystems (MIE)



2.1 Linking macro and micro scales in a predator-prey individual-based model

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Predation models based on differential equations, such as the classical Lotka-Volterra predator-prey model, allow understanding the interactions between populations of prey and predators at a population scale. But what about predation models at an individual scale? How to link both macro and micro scales in order to comprehend these interactions? Only a few existing papers tackle these questions. Some authors proposed elements of response on how it is possible to apply classic population predation models to individuals, but strong assumptions limit the scope of the results. We propose here an approach that facilitates linking both micro and macro scales in predator-prey models. While the macro model is aspatial and continuous in time, the micro (individual-based) model is discrete in both space and time. The choice of spatial and temporal granularities requires an important consideration. The model reproduces phenomena evolving at two temporal scales: a rapid one focused on the interaction between individuals of each population (predation process), and a slower one for the growth and natural death processes, whose parameters remain calibrated at a population scale. Predation rate of prey and birth rate of predators are observed during the individual-based simulation according to local interaction rules: individual movement rules and the prey perception range of the predators (predation distance). This perception can vary with the introduction of shelters for the prey which allows exploring the effect of spatial heterogeneity on the dynamics of both populations. Both micro and macro models have been implemented on the NetLogo platform. Experimental simulations explore the influence of the perception range (from 15m to 45m) and of the density of shelters (from 0 to 70%) on the evolution of population sizes through time. The cyclic behaviours of the system are still observed. This work illustrates how we can link both spatial scales through methodological choices and gives an interesting path which can be explored in order to develop predation models focusing on testing the effects of spatial heterogeneity.

2.2 Modelling consumer-resource interactions in a metacommunity framework

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Ecological communities are governed by processes at various spatial scales. Metacommunity theory aims to integrate different spatial scales into a single ecological modelling framework. A metacommunity is a set of communities in a patchy habitat; communities in the different patches are connected by dispersal. Metacommunity models allow us to study the effect of dispersal on the structure and functioning of communities at the local scale, that is, at the scale of each community, and at the regional scale, that is, at the scale of the metacommunity as a whole.

Here we argue that the relationship between dispersal and metacommunity diversity should not be studied in isolation of other abiotic and biotic flows in the metacommunity. We present a mechanistic metacommunity model in which consumer species compete for a single resource. We consider both consumer species specialized to a habitat patch, and generalist species capable of using the resource throughout the metacommunity. We derive analytical results for different limiting values of consumer dispersal and resource dispersal, and complement these results with simulations for intermediate dispersal values.

Our analysis reveals generic patterns for the combined effects of consumer and resource dispersal on metacommunity diversity of consumer species. We show that distinct dispersal conditions favor specialist and generalist consumers, and that hump-shaped diversity-dispersal relationships are not universal. Diversity-dispersal relationships can also be monotonic increasing or multimodal. Our work is a first step towards a general theory of metacommunity diversity integrating dispersal of organisms at different trophic levels.

2.3 Modelling Integrated Multitrophic Aquaculture systems

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The constantly increasing demand for seafood, during a period of saturation for the fisheries sector can only be met by sustainable growth of the aquaculture sector. Presently, growth of fed species' intensive monoculture is limited by the environmental impacts and economic requirements. A viable solution for mitigating the environmental impact of waste released from fish farms is integrated multitrophic aquaculture (IMTA). Integrating bioextractive organisms that take-up particulate organic matter or dissolved inorganic nutrients with monocultures of fed species has the potential of reducing the particulate and soluble waste loads within effluents, whilst producing a low input protein source that may also increase the farm income. A typical IMTA system accommodates two or more ecologically compatible species that can co-inhabit with no conflict for food or space and that have counterbalancing biological and chemical effects. The fish waste is exploited as a food source for extractive organisms of lower trophic levels giving an added value to the investment in feed.

The objective of this project was to construct a model that can act as a matrix for designing and evaluating commercial scale open-water IMTA systems. The models were implemented in the visual simulation package Powersim Studio 8, a graphical interface object-oriented modelling software.

The IMTA matrix developed is a systems model with sub-models for each IMTA component. These sub-models interact with each other and with the environment via nutrient and particulate organic matter. The sub-models are a seaweed growth model for Porphyra sp., a sea cucumber growth model for Holothuria forskali, a phytoplankton model, a salmon growth model and a nitrogenous waste release model. The nitrogenous waste release model illustrates the amount of dissolved and particulate nitrogen that is released from the salmon farm. When combined with the extractive organism growth models and with the phytoplankton model, it is possible to calculate the amount of nitrogenous waste that could potentially be absorbed by the extractive organisms. The complete model is a nitrogenous waste release-assimilation model that determines the overall closed-system IMTA efficiency of dissolved and particulate nitrogen recovery.

The present model and its sub-components already simulate growth of the components of IMTA with reasonable accuracy. Work is ongoing to validate the growth models and the model outputs are now being used to derive a spatial representation of the released IMTA salmon farm wastes. The waste release-assimilation model is being merged with a Geographical Information System (GIS) model illustrating the temporal and spatial patterns of nutrient and POM plumes at the salmon farm site.

2.4 How species diversity and distribution shape gap patterns: a modeling study

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Treefall gaps as one of the most significant disturbances in ecosystems play a crucial role in maintaining species diversity, confirmed by numerous forest observations. However, the systematic work on whether and how community structure and composition influence gap formation is still lacking. In this simulation, we apply a spatial model to predict how species diversity (including richness, difference and evenness) and distribution shape gap patterns, based on species-specific mortality responses to climate extremes. Generally, species richness and difference increased gap size and coherence, which may promote diversity maintenance, but also increase the community susceptibility to invasion by exotic species, because of increased gap size diversity creating more diverse niches. Interestingly, intermediate intraspecific aggregation yielded the maximal average gap size, which would maximize the opportunity for both local and exotic species filling these gaps. Furthermore, lowest intraspecific clumping (i.e., random communities) minimized gap size and coherence, indicating that studies on randomly structured communities might underestimate community invasibility relative to the realistic communities with some degree of intraspecific aggregation. Gap compactness which relates to gap perimeters was linearly increased with species difference and intraspecific clumping, while it was almost not influenced by richness. Increasing gap compactness may provide more gap recolonization opportunity for potential colonizers through reducing competition with gap-edge species, and also may reduce gap expansion rates by decreasing environmental disturbances. Species evenness, perhaps the least-investigated aspect of diversity, generally exerted a negative effect on gap formation, indirectly supporting the negative evenness-invasibility relationship. As realistic communities always have more or less inequality of population size among species, ignoring species unevenness would overestimate community resistance to invasion. However, the dominant species with different mortality traits generated different evenness effects (positive or negative) on gap forming, strongly suggesting that traits of dominants may be the key to the evenness-invasibility relationships in natural communities. Overall, understanding the factors that determine gap formation would be a step towards a better comprehension of diversity maintenance and invasion dynamics.

Keywords: Community invasibility; gap coherence; gap compactness; gap density; gap recolonization opportunity; gap size; intraspecific aggregation; species difference; species evenness; species richness

2.5 Modelling the distribution of the invasive fish Pseudorasbora parva in lowland river systems

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The highly invasive freshwater fish species topmouth gudgeon (Pseudorasbora parva) expanded from East Asia to Central Asia, Europe and Northern Africa. Insight into the relation between topmouth gudgeon distribution and environmental conditions is crucial to predict its expansion and to identify potential measures for reduction or control of the species. Therefore, the distribution of topmouth gudgeon was modelled in a lowland river system in Belgium, focusing on the impact of environmental conditions and anthropogenic pressures on the habitat suitability for topmouth gudgeon. Different modelling techniques such as Random Forests and data-driven fuzzy models were applied and compared. The results demonstrate the relation between anthropogenic influences and habitat suitability for topmouth gudgeon. Based on these findings, river managers may select appropriate measures to reduce or control the distribution of this invasive fish species and thus conserve valuable native species. Consequently, our study contributes to integrated water management and may provide a promising approach to gain insight into the expansion dynamics of invasive species.

2.6 Development and application of an integrated model to assess the potential distribution of an invasive amphipod species

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Ecological models have been recently used as a new and powerful tool to perform risk assessment of invasive species. Because of the complexity of biological invasions, an integrated and interdisciplinary approach is required to support the risk assessment and understanding of the processes involved. In this study, we used an integrated modelling approach in order to assess the future distribution of Dikerogammarus villosus, a highly invasive species, under changing environmental conditions. First, a habitat suitability model was constructed based on a regression tree model, to determine the preferred chemical water quality conditions. Secondly, this habitat suitability model was combined with a chemical water quality model, because it was expected that the suitable habitat would increase with improving water quality. Finally, migration speed, based on a network analysis, was taken into account, to model the spatio-temporal spread of D. villosus. According to our model simulations, the species is primarily present in large rivers and canals with a hard bank structure and a moderate to good chemical water quality. With improving water quality due to a decrease in nitrogen and orthophosphate concentration, the species will be able to colonise new habitats rapidly. Based on its calculated average migration speed of 5 km per year, it is expected that within 15 years the species will be able to colonise all main watercourses in Flanders, where the water quality is sufficient and the habitat is suitable. A validation based on the observed presence shows that the model accurately predicts areas with a high suitability for D. villosus. Our integrated modelling approach is useful as a practical method to perform risk assessment for areas vulnerable to invasion.

2.7 Evaluating reliability of habitat suitability models with indirect measures of bird survival and reproductive performance data

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Because individuals can regularly meet environmental conditions considered beyond their limits of tolerance, data on species abundance or occurrence can be misleading indicators of the real suitability of environmental conditions. In particular, the indiscriminate use of all species presence records to build habitat suitability models can result in an overestimation of the amount of suitable areas for the reproduction of the species, which may have significant conservation consequences. Alternatively, measures of survival (e.g. body condition) and reproductive performance of the organisms are considered reliable indicators of habitat suitability. However, such factors are only available in a restricted number of sites, which prevents them from being used to quantify habitat suitability at a landscape or regional extent. Nevertheless, they can be used to evaluate the relevance of habitat suitability models based on species presence records. For 19 passerine bird species and at multiple spatial resolutions, indirect measures of body condition for adults and juveniles (ratio of weight and wing length) and reproductive performance (ratio of juveniles-to-adults) were obtained from Constant Effort Sites (CES) mist-netting data in Catalonia. These measures were compared to habitat suitability values derived from models based on bird presence records collected during the Catalan Bird Breeding Atlas (CBBA). The results illustrate the extent to which habitat suitability values derived from models built with species presence records may reflect the suitability of environmental conditions for the survival and reproduction of the species.

2.8 How to deal with input data characteristics in data-driven aquatic species distribution modelling – in search of an optimal cross-validation categorisation scheme

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Recent research demonstrated the impact of data characteristics, such as prevalence, on the results of data-driven model optimisation. These insights are particularly important for ecological modelling since ecological data often show low prevalence and data characteristics affect model optimisation results stronger in these extremes of the prevalence range. Consequently, there is an urgent need for more insight into the impact of data characteristics on the model optimisation results, which should lead to appropriate approaches to generate reliable models over a wide prevalence range. This paper focuses on the relation between the output type (presence/absence or abundance) and prevalence, and aims to identify an optimal categorisation scheme applied to obtain cross-validation folds. Data-driven models were developed based on presence/absence and abundance data from rivers in Spain. To create cross-validation folds, three categorisation schemes were applied: random splitting, output variable-based splitting and input variable-based splitting. Comparison of these schemes illustrated the differences in optimisation results when applied for cross-validation. The results of our paper is a further step towards the generation of more reliable ecological models over a wide prevalence range, and may therefore enhance the applicability of species distribution models.

2.9 Exploiting taxonomic rank for habitat modelling with predictive-clustering trees

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The biological structure (species composition) of a community reflects both the direct response of the component species to the prevailing abiotic environmental conditions, as well as their interactions (direct and indirect). The task that we address is to relate the abiotic environmental conditions of a site (spatial unit of study) to the biological structure of the corresponding community (i.e., the presence or absence of species/taxa). For a single species/taxon, the task of modelling species distribution can be considered as a classification problem (which can be solved by machine learning approaches, such as decision trees): A set of sites described with environmental variables and the presence/absence of the given taxon at these sites are used to train a model for predicting the distribution of the taxon.

For multiple species/taxa, the task of predicting community structure corresponds to the machine learning task of structured (output) prediction: As compared to classification, where a single label has to be predicted, here complex objects (such as sets of labels, or hierarchies thereof) have to be predicted. The corresponding tasks are referred to as multi-label classification (MLC) and hierarchical multi-label classification (HMC). Predicting the structure of a community is intrinsically a HMC task, since the taxonomy of living organisms is organized as a hierarchy and multiple species typically coexist at each site.

The machine learning approach of Predictive Clustering Trees (PCTs) can handle various types of structured output (including HMC) and has been successfully used in the context of predicting community structure. In this work, we explore in detail how the exploitation of the information about taxonomic rank during the model induction affects classification performance. We use PCTs to build several types of models. We consider three datasets: data about the Collembola community in the soils of Denmark, data about organisms living in Slovenian rivers and data about vegetation in Victoria, Australia. For each dataset we construct four different habitat models. First, we construct two types of

local models: (1) models for each species separately (single target classification) and (2) models for each branch of taxonomic hierarchy (hierarchical single-label classification). Next, we build two types of global models: (3) a model which considers all species at once but is unaware of underlying taxonomic hierarchy (multi-target classification) and similarly (4) a global model for all species which exploits information about taxonomic hierarchy (hierarchical multi-label classification). Our results show that the inclusion of the taxonomic ranks of the species can improve the predictive performance of the habitat models.

2.10 Statistical hydraulic habitat models for guiding river flow management in a context of rapid change of available water resources and uses - An example of minimum flow estimation in a tropical insular stream.

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Satisfying increasing water uses (drinking water consumption, hydropower production…) while preserving aquatic ecosystems is becoming a burning issue which requires establishing methodologies adapted to meet targets of instream flow management. In particular, management tools are expected to be simple and rapid to implement because pressures on water resources evolve quickly and substantially (climate change and human activities).

In this scope, we developed further existing statistical habitat models allowing a wide range of application (mountain and plain rivers, in tropical and temperate regions) to quantify the potential ecological impacts of flow management. Statistical hydraulic habitat models combine with biologic preference models for hydraulic local habitat (e.g. velocity, water depth…) and statistical hydraulic models to provide habitat values at the reach-scale for a given range of discharges. These statistical hydraulic habitat models require less time and resources, and are simpler to use by ecologists. The outputs such as curves of habitat value vs discharge are a useful tool to define the minimum flow for bypass sections or below water intakes.

As study case, we propose an original application of a statistical hydraulic habitat model for guiding flow management below a water intake in a steep tropical stream in Guadeloupe (the French West Indies) characterized by an extreme flow regime (flash floods contrasted by very dry season). We estimate the impacts of various scenarios of minimum flow and abstraction discharge rate, following the requirements of the national legislation. For each scenario and for two years with contrasting hydrology, we estimate the number of days where the actual abstraction rate would be impossible and the number of days where the hydraulic habitat would be strongly reduced. Our scenarios include both fixed and varying values of minimum flow. Finally, we discuss the choice of one scenario considering socio-economical, hydrological and biological contexts (extreme flow regime, endemic and diadromous species, and stakes).

2.11 Modelling zebra mussel population persistence in reservoirs

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The zebra mussel (Dreissena polymorpha) is a widespread invasive species with large impacts on aquatic ecosystems. Their introduction into a new ecosystem is often associated with significant changes to the food web, economic impacts, and losses to biodiversity. Due to a pelagic life stage, zebra mussels have been very successful when invading lentic ecosystems, but have demonstrated limited success in lotic ecosystems. However, many lotic ecosystems have been modified by the creation of reservoirs. These reservoirs can act as stepping stones for invasive species allowing range expansion and invasion into new landscapes, and can serve as source populations for propagules into downstream lotic ecosystems. Here we present a simulation model to determine the physical characteristics of a reservoir necessary for the persistence of a zebra mussel population. Our simulation model consists of four sub-models: a zebra mussel life history model, a temperature model, a reservoir model, and a hydrodynamic model. Preliminary results indicate that zebra mussel population persistence is limited by reservoir size and reservoir perimeter is the best predictor of population density. In addition to size, depth and flow had significant effects on equilibrium zebra mussel densities. Results from this model will be used to predict reservoirs which, if invaded by zebra mussels, could serve as a threat to persisting native mussel populations in lotic ecosystems.

2.12 Ensemble forecasting of fish species distributions in China lakes

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Although SDMs (Species Distribution Models) have been wildly approached in both basic and applied ecology over the last decade, dozens of studies begin to demonstrate that projections by alternative models can be so variable as to compromise their usefulness for guiding policy decisions, since the techniques used have always varied in both performance and predictions. Thus in present study, we combine ten alternative techniques ensemble, for the sake of assessing the usefulness of an ensemble forecasting framework and comparing the performance of alternative approaches in forecasting species distribution. Total of ten SDMs are applied to model the current distribution of 105 indicator fish species in 135 lakes across China with 19 environmental factors extracted from Arcgis 10.1. Firstly, ten SDMs are constructed for each species respectively use the calibrated dataset (70% of the sites), every SDMs repeat 100 times and total of 1000 models are thus obtained for each species. Then the model validations are performed use the validated dataset (30% of the sites), AUC (area under the curve) and Accuracy are applied to evaluate the model. Lastly, validated models are used for predicting species distributions in all sites, Cohen's kappa test and predictive Accuracy are adopted to assess the predictive performance of each SDM for all species. Our results demonstrated that the predictive performances are species-specific in each model, few model could give equally reliable prediction for all species. Overall, one average model is obtained from all the ten SDMs seem to perform better than each of the single model. We highlight that more consensual and accurate prediction could be obtained for species with the ensemble modeling. Actually, this work is the expansion of one of my previews study which predict fish species distributions in China lakes use the multi-response regression tree, thus here we compare the performance of multi-response model with species-specific model either, the results indicated that multi-response model could be easily and better used for species distribution, especially for large community dataset.

2.13 An agent-based model of Atlantic salmon migration in Scottish coastal waters

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The Scottish Government aims to generate the equivalent of 100% of Scotland's electricity demand from renewable energy sources by 2020. Meeting this goal is likely to involve a contribution from 'marine renewables': offshore wind, wave and tidal stream power. To ensure that this development is environmentally sustainable, it is necessary to undertake robust assessment of the potential interactions between renewable energy arrays and marine organisms. The Atlantic salmon (Salmo salar) is an iconic and economically important species in Scotland. Salmon undertake extensive migrations, passing through coastal waters on their way to the North Atlantic as smolts, and on their way back to home rivers as adults; they may pass through areas designated for renewable energy development during these migrations. Consequently, the potential for interactions between fish and marine energy devices is of concern to numerous stakeholders. In order to assess the possible risks to migrating salmon, it is first important to understand how many fish (if any) pass through such areas. Unfortunately, there are very few data available to help resolve this question. One potential resource, unique to Scotland, is a historical archive of results from tagging studies carried out in the early 20th century. These studies would be impossible to replicate now because of the decline in coastal salmon fisheries, therefore a modelling approach is necessary to explore coastal movements of fish. We use the available data to inform an agent-based model of the movements of salmon through Scottish coastal waters, implemented using the software package NetLogo. This approach works by representing the coastal seas as a linear series of 'cells' corresponding to the salmon fishery districts from which salmon tag returns are reported, alongside a parallel series of cells representing the home rivers to which salmon are trying to return. At each time step, individual fish can migrate along the coast, or, if appropriate, move into their home rivers. This model can be parameterised using existing data on coastal fishing effort, productivity of home rivers, and other factors, in order to explore their potential influence on patterns of recaptures, and to test hypotheses about the coastal movements of salmon. Ultimately, our aim is to use this model as a means of estimating the proportions of fish from rivers across Scotland that may pass through proposed renewable energy sites such as the Pentland Firth.

2.14 A first spatially-explicit agent-based model of jaguar population dynamics.

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A single species spatially-explicit agent-based model has been developed that illustrates the role of simulation modelling, integrated with an adapted least-cost modelling approach and real-world geographical data, in exploring jaguar population dynamics. The range of the jaguar, Panthera onca, has been reduced by around 50% and now consists largely of a fragmented heterogeneous landscape. Jaguars are a flexible and adaptable cat and utilise a wide-range of habitats but remain an elusive and difficult species to study and a clear gap exists for studies utilising spatially-explicit agent-based models of large cats in large-scale landscapes. There has been a shift in ecological modelling from the traditional 'top-down' approaches to the 'bottom-up' individual-based approach that better reflect the complex nature of populations and ecosystems. These agent-based models capture the variability amongst individuals and the interactions between individuals and the environment, as well as multiple-scale interactions and feedback: features usually ignored in analytical models. Previous attempts at modelling jaguar population dynamics have mainly focused on field-based landscape connectivity analyses. Incorporating real-world geographical data into a computer simulated model of jaguar movements introduces a novel approach to understanding the movement of high-level animals and highlights the potential for using computer simulated data in real-world ecological problems. The goal here is to develop a model that can explore and predict the effect of landscape structure on population resilience of wild jaguars in central Belize. Presented, is a model that realistically captures the behaviour and dynamics of a population of jaguars in a real-world setting. The construction and application of the simulation model is described along with its calibration, validation and sensitivity analysis. Realistic population dynamics and territory sizes were obtained, with agents undergoing typical reproductive and mortality events. Validation of model output to field data produced similar trends, although the model appears less sensitive to more socially motivated and fine-scale movements, outside those directed towards feeding and reproduction. Mortality, fecundity and the level of interaction between agents are critical in driving the dynamics of simulated populations.

2.15 An integrated process of individual-based model calibration and quantitative evaluation: example of the forest dynamics model Samsara2.

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Individual based models have been developed in community ecology with great hope because they reveal the relations between community structure and dynamics and can be used to analyse the impacts of small differences of management practices. However these models are usually calibrated with individual-based data, and the aggregation of individual behaviours in a simulation may lead to community dynamic patterns quantitatively unreliable. Moreover the complexity and number of parameters is usually huge, which makes difficult to find data for calibration in a great number of conditions. One way to improve these models is to follow an integrated development process, by combining initial model calibration, evaluation at the community level, sensitivity analysis, parameter selection, and simplified community level calibration in multiple sites. We present such an integrated approach for Samsara2, a model of mixed-species mountain coniferous forests dynamics. We made an initial calibration of the different demographic processes (competition for light, growth, mortality, regeneration) based on individual tree measures and short term forest observation plots. We then used historical forest management data to evaluate the model capacity to predict community dynamic patterns over a 50 year long time period. We performed a sensitivity analysis to evaluate the uncertainties and most influent demographic parameters that could play a key role in the evolution of the community structure. Finally, we recalibrated the most influent parameters using an approximate Bayesian computation approach with community level historical data corresponding to different stand histories and conditions. We show how this integrated approach improved our knowledge of the demographic processes in these communities, the coherence of the different processes within the model, our understanding of their influence, their ranges and their interactions, and our capacity to make quantitative predictions in a range of forest stand conditions.

2.16 Conservation planning under multiple objectives: a comparison of quantitative approaches to identify priority areas for the conservation of stream fish assemblages

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Freshwater ecosystems and their biodiversity are increasingly threatened by human activities. However, resources to protect them are limited. Thus, quantitative and systematic approaches aiming at identifying the most valuable areas for conservation with respect to their biodiversity are urgently needed. Focusing on the spatial distribution of stream fish assemblages predicted from ecological niche models, we developed a framework for the selection of priority areas according to a multi-faceted approach of the diversity that includes the taxonomic, functional, natural heritage and socio-economic aspects of the diversity. These four aspects of the diversity correspond to four different objectives for conservation planners and environmental managers. They often tend to focus on one single aspect because it is easier to deal with a single value of conservation priority than with several different values, especially when the aspects of the diversity considered lead to different values of conservation priority which are not spatially congruent. Therefore, we chose to compare four different methods of multi-objective prioritization: (i) a scoring approach defined as a linear combination of the four objectives; (ii) a method using a conservation tool (Zonation software) that can spatially optimize the selection, including the particularities of the freshwater environment (e.g. longitudinal connectivity) in the prioritization; (iii) a method based on the Pareto frontiers that ranks the different areas according to a dominance relationship between them, and (iv) a method based on the complementarity between the areas that maximized the cumulated values of each objective in the top-ranking areas. We then assessed the spatial congruence between the four prioritization methods. We found that the choice of the prioritization method had more influence on the selection when the proportion of the total area to conserve was low because the methods were slightly less congruent in this case. Consequently, when the resources for biodiversity conservation are limited, environmental decision-makers must carefully consider the prioritization method to include in their assessment. By summarizing the advantages and drawbacks of each prioritization method, this study will help conservation managers to select the most suitable method according to their requirements.

2.17 Development of a comprehensive river habitat evaluation procedure using environmental diversity based on multi-species physical habitat suitability model

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River habitat evaluation procedures based on physical habitat suitability models, such as PHABSIM and its successors, are popular as a tool for river improvement work designing. Most of them evaluate habitat value by multiplying habitat quantity (= habitat area) and habitat quality (= preference of a specific species to several physical habitat parameters such as velocity, depth, substrate, and cover). Although these procedures have contributed improving many rivers, sometimes they have been misused to degrade river ecosystems by giving higher evaluation to a monotonous river for which a specific life stage of a specific species shows higher preference. Careful application of these procedures, such as using multi-species / multi-life stages, should be able to avoid these misuses. However, improvement works for small rivers, which have sometimes more bio-diversity than big ones, tend to lack such carefulness because of their limitation in budget and time. This research tries to develop a one-pass comprehensive small river habitat evaluation procedure which gives higher evaluation to a river that holds higher bio-diversity. Firstly, we collect existing river fish physical habitat suitability models for various species and determine common set of habitable parameter values for all species. Then we divide the range of each habitable parameter into three categories which represent behavioral modes like resting, feeding, etc. These categories allow us to evaluate environmental diversity of physical habitat. Secondly, we conduct fish distribution survey and physical environmental parameters survey in some small river sections which span from low to high physical environmental diversity. Evaluated environmental diversity show a good accordance with biomass abundance and bio-diversity. Thus we successfully prove that our environmental diversity can be an index for good river ecosystem. Thirdly, we develop software to evaluate the environmental diversity from physical geometry data of a river. Although we need further improvement of our index and software, our procedure could be used for better river design for multi-species without additional biological survey which consumes budget and time.

2.18 Planning connectivity enhancements in river networks through modelling of habitat accessibility

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The fragmentation of rivers by human infrastructure has had negative consequences for many aquatic species. Catchment managers have therefore sought to reverse this impact, modifying or removing structures to restore river connectivity. However, exploring barrier modification options to find those that are most effective is a major challenge for decision makers. In this presentation we introduce an exploratory model that accounts for the dendritic structure of river systems and the interaction between multiple barriers to investigate how weir modification affects the accessibility of habitat for two migratory fish in the Don Catchment, UK. The cumulative impact partial barriers have on model output is investigated, as is the implications of this for rivers with series of fish passes, and the use of expert judgement to estimate barrier passability. Alternative strategies for opening up the Don Catchment favoured different species, highlighting that the planning of connectivity enhancements is about making tradeoffs among multiple species. The results were highly sensitive to uncertainty in the passability of a barrier, so expert judgement of this parameter is unlikely to deliver the required accuracy. The cumulative effect of multiple partial barriers is potentially very severe, meaning that series of fish passes could be ineffective in restoring catchment connectivity for migratory fish.

2.19 Deciphering processes behind spatial patterns of genetic diversity: The case of dendritic river networks.

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Describing and understanding spatial patterns of biological diversity is a central topic in ecology. Ecologists have been pioneers in describing spatial patterns of biodiversity such as latitudinal gradients of taxonomic and functional diversity. Understanding processes behind those patterns (and the exceptions) has been essentially possible by comparing empirical patterns to theoretical models. However, intra-specific genetic diversity remains a biodiversity facet for which very few spatial patterns have been described so far. An exception concerns spatial patterns of genetic diversity in dendritic river networks (DRN), whereby an increase in neutral genetic diversity downstream (IGDD) as been repeatedly reported. IGDDs are generally interpreted as the product of the downstream-biased asymmetric gene flow inherent to that ecosystems. Nevertheless, IGDDs may also reflect historical processes such as colonisations or differentials of effective population sizes (Ne) along the upstream-downstream gradient. By pipelining multiple programs, we simulated and analysed genetic data under three DRNs to determine which of the asymmetric gene flow, differential of Ne and colonization hypotheses is/are more likely to generate IGDD, and under which conditions. We further used these simulations to identify summary statistics that may help to discriminate among these three hypotheses when IGDD are observed in the wild. We found that IGDDs are mainly generated by asymmetric gene flow and by differential of Ne. We also demonstrate that little asymmetry is sufficient to establish a significant IGDD pattern. Furthermore, we identified discriminant summary statistics that will be helpful for future genetic-based inference studies. This work is part of the IMPACT project.

2.20 Multi-objective parameter optimization of the simulation model SALMO as prerequisite for scenario analysis on Meiliang Bay of the shallow eutrophic Lake Taihu

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The lake model SALMO (Simulation by means of an Analytical Lake Model) was applied to simulate the water quality of the Meiliang Bay in Taihu Lake. The model SALMO is based on complex ordinary differential equations that represent the nutrient cycles of PO4-P, NO3-N and the food webs consisting of diatoms, green algae, blue-green algae and cladocerans. As SALMO includes 104 parameters, making it unsuitable for calibration with conventional methods, this study used the real coded genetic algorithm, which is more efficient for global optimum searches and has a faster convergence speed, to optimize the selected 30 key parameters of SALMO. Five years of water quality data were collected from the Meiliang bay, and the data in 2005 and 2007 was used for calibration while data in 2006, 2008 and 2009 was used for validation. The model efficiency and accuracy were largely improved after optimization. The optimized model was applied to simulate 5 scenarios, that are reducing 50% of the load and sediment release of PO4-P; reducing 50% of the load and sediment release of NO3-N and a biomanipulation by reducing 50% of the values of parameters related to the mortality of zooplankton, for algal bloom management. The results indicated that PO4-P is the limiting factors of algae growth in the bay, and the essential measure to control algae blooms is to reduce the nutrients releasing from sediment.

2.21 Interaction of life history, stratification and nutrient loading in tropical harmful algal blooms

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Information on the mechanisms driving tropical harmful algal blooms are limited relative to the more well-known temperate HABs such as those caused by Alexandrium fundyense. The interaction of cyst seeding and large-scale transport appear to be key in the latter's blooms. In the Philippines, HABs occur not along long open coastlines, but in embayments that are highly influenced by run-off and stratification. We investigated the interaction of cyst seeding, mixing, stratification and nutrient loading in the formation of blooms of the recurrent HAB species, Pyrodinium bahamense var. compressum (Pbc) using an integrated biophysical model. The model is composed of a 3D hydrodynamic model, a watershed nutrient input model, and an individual-based population model. Results from field studies in the past years indicate that Pbc blooms develop a few months after the onset of rains and consequent stratification of the water column. Pronounced blooms are observed at a particular time of the year and in certain areas of the Bay. In order to investigate the roles and linkages between re-suspension and seeding by cysts, stratification, and environmental conditions in the development and ensuing patterns of these blooms, scenarios testing these factors and processes were run in the model. Comparisons with field results highlight the role of cysts, the influx of low salinity and nutrient rich waters at particular times in the year in bloom formation within the bay.

2.22 Modelling of phytoplankton functioning and primary production estimation in Peter the Great Gulf based on satellite data

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The phytoplankton distribution in a vertical column of water under the influence of light, temperature and mineral content is simulated. Concentrations of mineral substances and phytoplankton are changing under influence of diffusion. Photosynthetically active radiation and temperature are modelled according to the climatic seasons of the annual cycle and conform to the climatic conditions typical of Peter the Great Gulf in Sea of Japan. The phytoplankton content in the ocean is reconstructed by means of mathematical model of "diffusion-reaction" type. The model estimates of the phytoplankton content are made on a basis of sea surface satellite data for Peter the Great Gulf. These model experiments use the data for years 2008 – 2011. By means of numerical experiment we show the seasonal effects of phytoplankton vital activity. The features of spring and autumn blooms of phytoplankton are shown. The phytoplankton biomass on the surface layer has local minimum in summer. Yet, as model calculation shows, it has high level of biomass in vertical column of water with maximum phytoplankton density at depths about 20 – 30 meters. The biological productivity of marine ecosystems in Peter the Great Gulf is calculated by means of this model. The estimate of primary production is made by modeling the distribution of chlorophyll in a vertical column of water. The work is supported by grant 11-01-98517-_eas_a of the Russian Foundation for Basic Research and by grant 12-II-CO-01M-010 of the Far Eastern Branch of the Russian Academy of Sciences. Authors express their gratitude to the Multiple Access Center for satellite monitoring of the environment of Far Eastern Branch of the Russian Academy of Sciences (Vladivostok, Russia).

2.23 Development of two-dimensional simulation model on primary production in streams

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1. Purposes Primary production is a key energy source sustaining stream ecosystem as well as allochthonous energy such as falling leaves. Especially, in midstream segment benthic attached algae has a main role as primary producer, and we need to know not only spatial distribution of production but also the temporal change because benthic attached algae would be influenced by current velocity and water depth, which are unstable physical elements to determine the productivity and the standing crop. Especially flood event is an indispensable element because it cause dislodgement of attached algae form bed material periodically which are brought by the change of bed form with transportation of bed material. Thus we need to combine a model of primary production and a model with the aspect of hydraulics of sediment transport in order to simulate primary production in a sequence of temporal scale in reach scale. 2. Materials and methods (1) Overview of the models We developed two parts of model and combined them. One is the model simulating primary production and the other is the removal riverbed simulation. Primary production model is composed of diffusion process for nutrients and growth model based on Michaelis-Menten kinetics. In the development of the part of nutrient diffusion, several layers were established in biofilm, and then SRP and inorganic nitrogen concentration from top to bottom were calculated based on their eddy diffusivity. The removal riverbed simulation model had been developed in other research project. (2) Verification of models We verified the primary production model in experimental streams , which are located in Aqua Restoration Research Center and in the downstream section of Agigawa-Dam. The results indicated that the model simulated temporal change of biomass (in chl-a) accurately. (3)application of model Based on the verification, the combined model were applied into Chikuma River, which flows through in the central part of Japan, which has relatively steep bed slope and wide channel width. Three objective sections were set up in order to evaluate how bed slope influenced primary production. Simulation period is one year, in which flood events were included. 3. Results and discussion The simulation model showed the distribution of temporal change of primary production and biomass in objective area. Though we were not able to verify whole results of them, observation at several riffles of primary production and biomass indicated that primary production model simulated their phenomenon well. In terms of the distinction between three sites, we confirmed clear distinction in both productivity and biomass, and the differences of current velocity and water depth, which were associated with bed slope, were strongly influenced on primary production.

2.24 Integrating telemetry data and expert knowledge in a spatial-temporal model for pike (Esox lucius) in a lowland river.

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Pike populations in Belgium have been suffering from eutrophication, water pollution and habitat loss since the fifties of the previous century. To set up more effective restoration programs in the future, more information is needed on the spatial and temporal dynamics of the species, specifically on their migration dynamics and habitat use. Therefore we performed a telemetry study on fifteen pike in the Belgian part of the river Yser between November 2010 and December 2011 and integrated the telemetry data in a spatially explicit, dynamic model for pike populations in rivers. The model is based on matrix calculations adapted from Charles et al. (2000), who simulated demography and spawning migration of brown trout. A Leslie-type model simulating pike reproduction is coupled with a migration matrix simulating the annual spawning migration, and a second matrix simulating short time movements. Movement rates are based on radio telemetry observations, while demographic parameters are based on expert knowledge. The effect on the population dynamics of river modifications, such as riparian habitat restoration and dams was quantified by demographic indices, such as population growth rate and age distribution. We checked that (1) the methodology suits well for the spatial explicit and dynamic modelling of a potamodromous fish and (2) the model provides valuable information for river managers in selecting the most cost effective management options for pike in a lowland river.

Reference Charles, S., La, R. B. De, Mallet, J., Persat, H., Auger, P.,& Lyon, C. B. (2000). Annual spawning migrations in modelling brown trout population dynamics inside an arborescent river network. Ecological Modelling, 133, 15–31.

2.25 Taking into account spatial heterogeneity and temporal dynamics of landscapes when modelling population dynamics in farmlands

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Landscape habitat composition, spatial organization and temporal dynamics (i.e. heterogeneity) are expected to influence biodiversity and population dynamics. But the complexity of models that integrate those three components often lead to use simpler models. We hypothesize that these three components are important in farmland habitats, since the landscape is spatially structured and changing at several scales (e.g. crop fields spatial organization, crop rotation, field work, semi-natural habitats configuration). Farmland habitat structure is influenced by management decisions and agricultural intensification. Thus there is a need to understand how biodiversity responds to landscape spatial and temporal characteristics in agro-systems, both theoretically and empirically. We study this question using empirical data analysis and spatially explicit population dynamics modelling in dynamic landscapes. We first showed that we can infer a species regional response to habitat composition and configuration by scaling up local species response to habitat composition, and that the response to habitat configuration depended on habitat composition. We then studied in details the pattern of crop selection by the Skylark alauda arvensis, searching for synergetic effects of crops on habitat selection. Our results suggested that smaller fields and crops well mixed in the landscape may benefit this farmland habitat specialist. We also studied habitat selection of other farmland birds, and found that crop diversity was positively selected by some bird species specialized in open areas, suggesting again a positive effect of small fields and mixed crops (although crop diversity affected negatively some other species). Finally we quantified the effect of the landscape temporal dynamics (crop rotation) on a rodent species (common vole), and compared it to the effect of the spatial properties of the landscape (composition and configuration). We used a spatially explicit population dynamics model in a dynamic landscape. We found that the temporal dynamics of the landscape, and not only its spatial characteristics, had an important effect to explain the dynamics of this population. Our results emphasize the importance of integrating all aspects of habitat heterogeneity (spatial and temporal), at all scales, when modelling biodiversity response to global change, especially in agro-systems. All model simplifications concerning the spatial arrangement and the temporal dynamics of landscape elements, often necessary and sometimes justified, should always be justified.

2.26 Evolutionary responses to environmental change in a simple model: how do trophic interactions affect adaptation, persistence, and ecosystem functioning?

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It is imperative that we understand joint ecological and evolutionary responses to climate change to predict future threats to biological diversity. According to recent studies and reviews, it is an open question of how different types of species interactions (e.g. predator–prey) will affect predictions and there exists little theoretical understanding of how trophic interactions may set limits on evolution. We aim to test how trophic interactions may modify the whole ecosystem response to temperature change and allow or prevent persistence of the ecosystem and services (biomass at different trophic levels). We do this in a semi-realistic setting with species growth and interactions determined by temperature and resources of the environment for both a producer species and the additional herbivore species. We vary different factors including: presence of a top trophic level herbivore species, speed of adaptation of different trophic levels, and speed and distance of environment change. We hypothesize that trophic interactions will change population densities, which, indirectly affect adaptation and persistence through altering rates of trait change acting in a similar manner to competition. To address the case in which the trait involved in the species interaction is distinct, but possibly genetically correlated, with the trait responding to environmental change, we conduct our modeling under two scenarios to bracket the range of possibilities: traits perfectly correlated and traits uncorrelated. We consider evolution to occur in a two phase process: first, evolution to steady state in a constant environment and then evolution from that steady state during the environmental change. We found that the addition of a herbivore trophic level affects population size of the producer, strength and direction of selection, and in particular the evolutionary equilibrium, that is it determines the starting location in trait space before the environment changes. For the correlated trait assumption, the addition of the trophic level decreased producer species biomass and made the producer species more likely to go extinct and at a faster rate, contrary to a previous study. Increased mutation rate for both species can increase or decrease producer species biomass. Increased thermal niche width can decrease persistence time by affecting the location of the starting location in trait space in the constant environment. For the uncorrelated trait assumption relative to the correlated trait assumption, traits evolved slower, and took much longer to reach their equilibrium, even though they moved less in total. In addition, there was more herbivore extinction than the correlated assumption, along with less producer biomass unless the herbivore went extinct.

2.27 Temporal fluctuations of environmental conditions and intra-specific polymorphism: a model simulating the flowering phenology of gorse (Ulex europaeus)

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Global change is expected to induce changes not only in the mean of environmental conditions but also in their year-to-year variations. It thus can impact species maintenance and distribution, as well as their polymorphism. Indeed, temporal variations of selective pressures are one of the mechanisms allowing the maintenance of intra-specific polymorphism. Such mechanism was first modeled by Haldane and Jayakar (1963), but has never been validated experimentally, maybe because their conditions are too restrictive (diploid locus, strict dominance, random mating and infinite population). We have tested the application of this model to the polymorphism of flowering phenologies observed in the common gorse (Ulex europaeus, Fabaceae). In this species, two flowering types coexist in most populations: long flowering plants, which produce pods subjected to freezing in winter and seed predation in spring, and short flowering plants which produce pods only subjected to seed predation in spring. These two selection pressures are unpredictable and exhibit strong year-to-year variations. We established a model of maintenance of polymorphism by temporal variations of the selection pressures of gorse, modeled on the hypotheses of Haldane and Jayakar. As a first step we established a simple model, diploid and panmictic, calibrating the selective values from biological data. Secondly, we relaxed these conditions to get closer to our biological model by adding hexaploidy and partial assortative mating. We demonstrated that temporal variations can maintain polymorphism in conditions much less restrictive than those modeled by Haldane and Jayakar, and that a change in the magnitude of these variations may have strong effects on the expected polymorphism. Our results allow exploring the conditions in which global change can potentially affect intra-specific polymorphism.

2.28 Dynamic modeling and mechanistic effect models to analyse ecological interactions and toxic effects within a microcosm

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In the last decade, Clément and coll. worked out an innovative protocol for a laboratory microcosm bioassay. Effects on classical life history traits (survival, growth, reproduction) are assessed on five species: microalgae, duckweeds, daphnids, amphipods, chironomids. This protocol allows considering interactions between species and between biota and water and sediment. In such a microcosm, organisms are exposed through multiple ways making difficult to relate observed effects to exposure concentration, which vary in time and space due to degradation or sorption for example. Moreover, conversely to single-species bioassays where individual responses are simply linked to toxicant concentration, the microcosm response may result from indirect and/ or direct effects. Facing such a complexity, modelling appears as a relevant way of improving result interpretation. Indeed, taking into account functional interactions within mechanistic effects models provides a more in-depth understanding of biological responses and a proper way of testing various assumptions on the underlying mechanisms. Experiments were conducted under controlled conditions without toxicant for each of the sub-systems involved in the microcosm (daphnids-algae, duckweeds-algae and hyallela-daphnids-algae). These experiments were designed to identify and empirically describe all the interactions between species. In a first approach, simple mathematical sub-models based on ordinary differential equations were built on each of the sub-systems. Concomitantly, sensitivity analyses based on Sobol' indices were performed on each sub-model to identify (i) parameters that do not influence model predictions and that can be fixed to a nominal value, and (ii) influent parameters that require to be estimated by fitting sub-models to experimental data with optimization procedures. Various techniques were used among which Bayesian inference involving Metropolis-Hastings algorithm and a more efficient algorithm based on a particle filtering approach. These methods gave a joint posterior distribution of parameter estimates, from which medians and credibility intervals for each parameter were extracted and correlations between parameters quantified. First results are greatly encouraging. The different sub-models appeared relevant to properly describe the functioning of the corresponding sub-systems. In particular the time course response of the different state variables was well reproduced whatever the species and the sub-system in which it was involved. These results incite us to further develop an overall model at the scale of the whole microcosm. A reference version without toxicant would be the first step, while the second step could focus on the effects of pollutants on the general functioning of the microcosm. At the end, such a predictive model could be used as a tool for risk assessment.

2.29 Natural resources of city facing a threat of urban growth

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The natural resources depleted and deprecated for the rapid growth of the cities are a major challenge for the sustainable development resonated in urban and regional policy. In this study, the no protection of water resources and agricultural lands over the sprawl area of Istanbul in Turkey is considered through imagining a rectangular grid of map. The array constructions in rectangular grid on the map of Istanbul would be a cellular automation. This model with complex behaviour of urban and rural society on the depleted water land and agricultural land will design using cellular automata according to population dynamics and other dynamics where local interactions affect. I argue that the model could be a helpful planning idea for the protection of water resources in the Istanbul region- city versus its growth.

2.30 Modelling forest management in Sweden: trade-offs between carbon benefit and biodiversity conservation

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Swedish forests play a vital role in mitigating climate change by reducing carbon dioxide emissions. Emissions reduction depend on forest management strategies because when the aim is to increase forest growth and product harvest, the carbon sequestration and substitution of carbon-intensive materials increases so as the total carbon benefit. It remains unclear, however, whether intensively managed Swedish forests secures required habitat for biodiversity in future. The urgency of the global need to mitigate climate change by reducing carbon emissions by means of forestry is very important but that might eventually jeopardise biodiversity habitat. There have been many discussions of needing a better scientific understanding about increasing set aside forest area, particularly the productive forest, to help conserving biodiversity and its trade-offs. We perform a comprehensive model based analysis including forest management, product use and carbon benefit of Swedish forest sector. We define different forest management scenarios i.e. reference, intensive forestry and increase set aside for modelling. A system analysis method uses five models to analyse net primary production (BIOMASS), forest biomass growth and harvest estimation (HUGIN), soil carbon stock calculation (Q Model), substitution of carbon benefit estimation (SUBSTITUTION) and international market assessment (GLOBIOM) for the next 100 years. We combine biodiversity habitat indicators such as forest age structure, tree composition, dead wood availability and preferred habitat types by red listed species in boreal forests and our forest's state during the whole study period for all scenarios. Finally, we evaluate the effect of forest management scenarios in total carbon benefit and indicators of biodiversity conservation. The result showed that a forest management policy where large areas are set aside will potentially increase carbon benefit and supports biodiversity conservation but reduces product supply and trade for short period. However, carbon benefit and product supply both decrease in the long-run but increase the biodiversity conservation potential. Substitution carbon benefit level also plays an important role in calculating carbon balance. It appears that trade-offs between carbon benefit and biodiversity conservation exists. The country policy should address the issue and prioritise forest area for management and set aside to fulfill the country objective.

2.31 An integrated hydrodynamic-ecological modeling approach to understand how to manage and sustain the oyster fishery in Chesapeake Bay.

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Oyster reefs are key components of many estuarine systems because they contribute to ecosytem function by providing habitat, improving water quality, stabilizing benthic and intertidal habitat, increasing landscape diversity and producing more oysters. However, oyster reefs are among the world's most endangered marine habitat. Given the breadth of environmental benefits oysters provide, as well as their commercial importance and cultural significance, sustainable oyster restoration has become a priority in several regions, including the Chesapeake Bay. Current restoration strategies include treating restored reefs as permanent sanctuaries, which removes them from the fishery, or harvesting reefs on a rotational basis. However, given the complexity of oyster population dynamics, which depends on interactions between a complex life history (i.e., sessile adult and motile larval stages) and a suite of environmental factors including but not limited to temperature, salinity and flow regime, it is currently unknown which restoration strategy provides sustainable reefs.

In order to determine how different oyster management strategies affect the oyster population in Chesapeake Bay, we developed an approach that integrates a 2-D hydrodynamic model, Adaptive Hydraulics (ADH), a larval transport model, and a spatially-explicit, agent-based population dynamics model to simulate long term dynamics of ten oyster reefs in the Great Wicomico River on the western shore of the Chesapeake Bay. Within the population dynamics model, individual agents represented aggregates of individual oysters. The integrated model was evaluated using pattern-oriented modeling. We simulated three different management strategies (no harvest, selective harvest and rotational harvest) across the reef metapopulation and evaluated the environmental and commercial benefits of each strategy. Our results indicated that the connectivity among reefs (i.e., the spatial structure) must be considered before implementing a harvest regime. Harvesting without understanding the source/sink dynamics of the reefs resulted in a complete fishery collapse, yet yielded higher commercial yield in the short-term, whereas selective, rotational harvest, resulted in lower annual monetary yield, but the fishery persisted throughout the simulation. These systems-level model results can help natural resource managers understand ecosystem-level processes leading to more informed decision making across spatial and temporal scales.

2.32 Ecological modeling of H5N1 avian influenza and its evolution in China

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Constant mutations and evolution of the HPAI H5N1 virus make how to predict and control the transmission of avian influenza a commonly concerned scientific question in the international society, and an important strategic issue on maintaining the socioeconomic stability, securing preventive and control system of the disease in China. More than 80% of the total H5N1 human cases have been reported in avian influenza endemic areas, indicating hotspots for bird-to-humans transmission. Thus it is important to study the spreading mechanism of the H5N1 virus between birds and humans to improve our understanding of the virus transmission and evolution. Here we applied a pixel based SEIR Cellular Automata model to predict human responses to the H5N1 virus infected from poultry. With limited data and computational ability at the country level, patch-based SEIR CA epidemic model is a feasible and effective method to simulate avian influenza transmission. Furthermore, this research analyzed the evolution of the H5N1 virus in poultry and wild birds that may infect humans. After geocoding and mapping genetic data of the H5N1 from the GenBank with the outbreak data of poultry and wild birds from the OIE, we modeled the cellular SEIR epidemic with outbreak data among birds as sources of human infection. The highly pathogenic H5N1 viruses in poultry and wild birds that could infect humans were identified. Through constructing phylogenetic trees and estimating genetic distances, we analyzed the evolution of the H5N1 virus in poultry and wild birds that could infect humans. Poultry was identified as a major source of human infections. Subclades and sublineages of the H5N1 virus continued to be endemic in various regions of China during 2004 to 2011. The virus in wild birds and poultry that could infect humans has been continually evolving in China.

2.33 Changes of Biome Transition Zones in China since 1960

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Abstract The climate change dominantly control on the spatial distribution of the major biomes types on a global scale, especially influences on the Biome Transition Zone (BTZ) expected to be among the most sensitive area to climate change. The BTZ is the key area to understand the relationship between climate and landscape diversity at broad scales for it has a higher level of landscape species richness than in neighboring biomes. So, the aim of this paper is focus on quantitatively identifying, classifying and conveying the highly explicit changes of different BTZ. Its major context includes these parts as follows: 1) Three bioclimatic datasets, with a spatial resolution of 1km×1km, will be selected to classify the BTZ type in China. These include the mean annual biotemperature (MAB), average total annual precipitation (TAP) and potential evapotranspiration ratio (PER) during the periods from 1961 to 1970 (T1), from 1971 to 1980 (T2), from 1981 to 1990 (T3), from 1991 to 2000 (T4) and from 2001 to 2010 (T5); 2) the Holdridge life zone (HLZ) model will be improved to help classify the biome transition zone (BTZ) in China since 1960; 3) The spatial distribution change, area change, mean-center shift and biome diversity of every BTZs types will be computed and analyzed in terms of above five period's climatic datasets; 4) Finally, we will discuss the validity and suitable range of the improved HLZ model, and discuss which BTZ type change of area, mean center and ecological diversity are more fast among all BTZ types under the current climate change. Keywords: Holdridge life zone model; Biome transition zone; Spatial distribution change; Mean center shift trend; Ecological diversity change; China

The framework of this paper: 1. Introduction 2.Materials and methods 2.1 Datasets Mean annual biotemperature (MAB), average total annual precipitation (TAP) and potential evapotranspiration ratio (PER) during the periods from 1961 to 1970 (T1), from 1971 to 1980 (T2), from 1981 to 1990 (T3), from 1991 to 2000 (T4) and from 2001 to 2010(T5) simulated by HASM in terms of 752 meteorological stations in China since 1961. 2.2 The improved HLZ model 2.3 The mean center shift model of BTZ 2.4 Ecologcial diversity index 3.Results 3.1. Spatial distribution of BTZ in China 3.2. Area change trend of each BTZ type in China 3.3. Mean center shift trend of each BTZ type in China 3.4. Eecological diversity change of BTZ 4. Discussion and conclusions

2.34 Diversification of sugarcane habitats for the control of Eldana saccharina Walker

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Eldana saccharina Walker (Lepidoptera: Pyralidae), an insect indigenous to Africa that feeds on wild grasses and sedges, and more recently cultivated graminaceous crops, is a serious problem in the sugarcane industry of South Africa. Conventional control methods have been proposed and researched for the control of E. saccharina in sugarcane. Although contributing towards suppression, none of these have proven very successful in preventing E. saccharina infestations. Harvesting of sugarcane at a younger age is still considered the largest controlling factor of E. saccharina in sugarcane.

The manipulation of planting and harvesting schedules has been recognised to have a negative impact on pest populations. This may be as a result of a more diverse habitat in terms of crop age. It has been shown that population densities of herbivore pest insects are often reduced in vegetationally more diverse habitats. It is therefore possible that suitably diversified sugarcane habitats (with respect to cane age) exist, in which the harvesting of the different fields at different points in time, may have a negative impact on pest populations. Combining such field layouts with pest control methods may reduce the cost and effectiveness of achieving suppression.

In order to investigate E. saccharina infestation levels in diversified sugarcane habitats, a mathematical model of E. saccharina population growth and dispersal has been formulated. The model describes the population growth and dispersal in a temporally variable and spatially heterogeneous environment. The model consists of a discretized reaction-diffusion system with variable diffusion coefficients, subject to strictly positive initial data and Neumann boundary conditions on a bounded spatial domain. The model has been used to identify field layout structures that perform best in terms of suppressing average infestation over time. The model, as well as numerical results obtained for different sugarcane field layouts, will be presented.

2.35 A hybrid model to explore the emergence of vegetation spatial patterns due to plant-soil negative feedback

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The effect of global change on vegetation pattern formation has been an active topic of research for the last decade. It has been shown that the spatial distribution of vegetation could be seen as early warning signal of critical environmental transitions. To gain insight on this phenomenon, several models have simulated the formation of diverse vegetation patterns - spots, labyrinths, gaps and stripes - using partial differential equations (PDE) of plant biomass and water dynamics in the soil. In a first class of models, the emergence of different patterns appeared to be driven by singular environmental regimes leading to local water depletion. Alternatively, in recent modelling efforts, the occurrence of regular vegetation patterns could be related to plant-soil negative feedback (NF), which consists in the accumulation in the soil of toxic compounds released by the decomposition of litter of the same plant species.

All the above-mentioned models have been implemented using reaction diffusion approaches translated in continuous mathematical form (i.e. ordinary or partial differential equations). In particular, the lateral water fluxes and the spatial dynamics of vegetation have both been expressed as continuous diffusive terms. While physical diffusion is surely natural to represent water flows, it is questionable whether plant dynamics (i.e. plant dispersal, through seed or vegetative propagation) can also be appropriately described therewith. Instead, an Individual based modelling (IBM) approach would seem preferable.

In this context, we present a new hybrid model (IBM with integrated System Dynamics (SD)) featuring individual plant growth and dispersal, water dynamics in the soil, and negative feedback through litter decomposition. Technically, SD serves to describe water dynamics and plant metabolism, while IBM is used to simulate stochastic plant growth and propagation. We then present some results on the formation of vegetation patterns with changing environmental parameters.

2.36 Numerical Simulation Model of River Ecosystem based on River Continuum Concept and Flood Pulse Concept

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The river continuum concept (RCC) states that the physical and biological variables in river ecosystem vary with a continuous gradient of physical conditions along a river (Vannote et al., 1980). This is largely argued from the standpoint that energy input, organic matter transport, storage and use by macro-invertebrates functional feeding groups are regulated largely by fluvial geomorphic processes. In contrast to the RCC, the flood-pulse concept (FPC) was derived for rivers with floodplain to explain the role of flood in the river ecosystem (Junk et al., 1989). The FPC states that an important hydrologic feature of large rivers is the flood pulse which derives lateral organic matter (OM) input from the floodplains as well as OM from upper reaches.

In this study, a numerical simulation model was developed to describe the river ecosystem based on the longitudinal and lateral transport of OM and nutrient based on RCC and FPC. The model is composed of the following four sub-models: 1) non-uniform flow model, 2) heat budget model, 3) biological model and 4) materials cycle model. Water flow and temperature are calculated in the 1st and 2nd sub-models by using the physical condition settings, the observed meteorological data and the discharge data in order to describe the continuity and the variability of river ecosystems along a river. The trophic dynamics in river ecosystem are calculated in the 3rd and 4th sub-models.

The series of numerical simulation was performed and the results of the simulation have been revealed the followings: Coarse particulate organic matter provided during autumn in the mountainous segment is decomposed by the biological action and is transported to downstream according to the discharge magnitude, which affects the longitudinal distribution of biomass of the functional feeding groups of benthic macro-invertebrates. The role of floodplain as a sink or a source of organic matter depends on the river segment features and the magnitude of flood discharge; The floodplain acts as a source of OM during relatively large flood, where as it becomes a sink of OM during relatively small flood. Comparing the various organic matter sources to river ecosystem in the target river, the largest source is the primary production by attached algae, followed by lateral input from the floodplain, and then litter input from mountainous segment.

2.37 Fuzziness and heterogeneity of metacommunities in a complex transitional system: the lagoon of Venice

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Spatial heterogeneity is a common feature of coastal and estuarine systems. It influences the composition and structure of biological metacommunities (MCs). The observed composition of a local community results from the interaction of local (i.e., species interaction, species-environment relationships) and regional (i.e., migration, dispersal) factors. Thus borders between communities are not sharp and they are difficult to be correctly identified using traditional clustering methods. On the other hand direct gradient analysis are useful to relate species' distribution to environmental parameters, but treat communities as assemblages of single species, each with its own distribution pattern. We tried to overcome the methodological and conceptual differences between the continuum and community-unit concepts by applying a combination of Fuzzy k-means (FKM) and Redundancy analysis (RDA). The case study was the hard substrate macrophytobenthos and macrozoobenthos in the lagoon of Venice. In 2004 macrobenthic assemblages were sampled in 80 sites evenly distributed in different lagoon's habitats, like shallows, tidal flats, sea inlets, and channel side-shallows. Applying FKM and RDA we were able to identify a hierarchical organization of the lagoon's MCs. While due to tidal driven mixing and effective dispersal of organisms all the lagoon can be considered a single MC, strong environmental gradients define different habitats inside the lagoon. To each habitat a different habitat-MC is associated, with a defined biological structure and composition. At the level of single sampling sites, the composition of the assemblage is a mixture of different habitat MCs. The borders between habitat-MCs are not sharp, but show a high degree of fuzziness, as could be expected in such a complex environment. Using fuzzy membership grades we related each habitat MC-to physical, morphological and biogeochemical properties, thereby enabling an analysis of the roles and relative importance of various environmental parameters in shaping the spatial structure of the macrobenthos. We applied different techniques to describe the typical biological structure and composition of each habitat-MC and briefly discussed the utility of each of them. Our approach facilitates the practical application of the MC concept results also emphasize the importance of considering heterogeneity and fuzziness when working in highly heterogeneous and complex natural systems.

2.38 Including Design in Ecological Energetics

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Contemporary ecological theory has a strong foundation in energetics. The careful consideration of mass and energy fluxes within and between organisms in concert with their surroundings has allowed for the development of a ecological theory and the gains made from applying these principles are substantial. Yet a critical feature of ecology, the physical design inherent to natural systems, is not easily defined in terms of classical thermodynamics, mechanics and electromagnetism. Extending ecological energetics via irreversible thermodynamics has provided additional insight into the potential drivers of evolution and allows for the addition of time as a variable, but can do little to elucidate nature's ubiquitous patterns. In this work it is proposed that the physical designs found in nature are inherently energetic, and that they can be explained and in many cases even predicted using constructal theory. The existence and persistence of any flow system is determined by the changing interactions within itself and its surroundings. In the constructal paradigm, parasitism and cooperation are allowed to be equally effective answers to the same basic ecological question: how does a species persist and procreate? Furthermore, we can escape teleological and reductionist views simultaneously when we realize that constructal theory offers an alternative to "optimal" solutions in nature, and replaces them instead with "better". In this paper, examples of how we may begin to apply constructal theory to ecological analysis are presented: The formation of river channel shape, tree shaped flows, and turbulent flow structures are examples of ecologically relevant inanimate systems. Animal locomotion, the morphology of fish, and the necessity of migration to survival are presented as examples of animate systems. The graphical and mathematical formulations accompanying these examples can be applied to a myriad of ecological system components. The general statement of the constructal law is powerful precisely because we are surrounded by, embedded in, and indeed ourselves are flow systems.

2.39 Improving individual mortality predictions using individual growth deviations from species growth in a tropical forest

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We report that an individual-based modelling approach of tree growth helps improving predictions of tree mortality in a highly mixed tropical forest stand. Tree mortality is an important process driving forest dynamics, which significantly impacts forest biomass turnover and thus carbon balance of tropical forests. However, because trees are long-lived organisms and mortality events are quite rare, we generally lack data to properly understand this process and its determinants at the individual level. By comparison, longitudinal tree growth data covering several decades for each tree are now available thanks to regularly monitored permanent sample plots throughout the tropics. Different authors have shown that mortality sometime depends on tree size (U-shape relation) and most often strongly depends on past growth (used as a synthetic proxy for the effect of many unmeasured variables related to tree vigour). Nevertheless, the link between growth and mortality is poorly understood and growth is usually taken into account rather crudely in mortality models. We tested the ability of several output variables resulting from growth models to predict mortality in an undisturbed wet evergreen monsoon forest in the Western Ghâts of India, regularly surveyed for more than 20 years. We used a mixed modelling framework to estimate an individual growth effect as an indicator of time-consistent individual growth deviation from the corresponding species-specific growth response to ontogeny (tree size) and environment (competition, aspect, slope and annual population effect). This individual growth effect proved to be a better predictor of individual mortality than classical indicators of past growth, that are usually based on a limited number of growth years and do not differentiate properly tree vigour from contingent effects. This individual residual effect can be interpreted as a frailty indicator that integrates the growth performance of a tree over 20-years, given its species and growing conditions. Our findings underline the importance of considering intra-specific variability and interactions between demographic processes to properly represent individual behaviours within ecological communities. We believe that such an approach based on an explicit link between individual growth and individual probability of mortality is of great interest to improve forest dynamics simulations and explore different scenarios of evolution of tropical forest ecosystems.

2.40 A mathematical model for growth of Japanese sea cucumber Apostichopus japonicus beyond one year

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A distinctive ecological phenomenon of Japanese sea cucumber, Apostichopus japonicus (Selenka, 1867), is aestivation. This state is entered in response to environmental factors (with temperature as the main indicator); however, the mechanism remains unclear. This study is an effort to adopt an effective quantitative approach for studying the mechanism in order to avoid a negative outcome of aquaculture. In the present study, a full lifecycle mathematical model is developed based on the Scope for Growth (SFG) concept, to assess the environmental impacts and predict growth of A. japonicus for a long-term period. In addition, bacteria effect on digestion ability is also considered to overcome the influence on growth of sea cucumber with different food sources. Further, a set of model parameters is originally established and estimated through quantitative analysis of independent laboratory experimental A. japonicus datasets by means of linear and nonlinear regression. For missing information, general parameter values are cited from the existing studies. Moreover, the parameter sensitivity analysis based on Monte Carlo method is conducted to determine the relative importance of physical process during the lifecycle of A. japonicas. The developed model is applied to laboratory and field condition. For laboratory condition, the observed data are collected from published laboratory experimental sources; while for field condition, the observed data are obtained from Gokasho Bay, Mie prefecture, Japan. The model is validated by comparing predicted results with observed growth data of A. japonicus. The comparison results demonstrate that the model is sufficiently accurate for describing the dynamic growth of A. japonicus in full lifecycle and quantitatively assessing the impacts of A. japonicus on material cycling.

2.41 Coupling growth and mortality models to detect climate drivers of tropical forest dynamics

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Climate models for the coming century predict rainfall reduction in the Amazonian region, including deep changes in water availability for tropical rainforests. To assess the sensitivity of tropical forests to climate change and to test the extent to which climate variables related to water regime, temperature and irradiance shape the long-term dynamics of neotropical forests , we develop a new integrated modeling framework. In a hierarchical Bayesian framework, we coupled tree growth and tree mortality processes into an individual-centered forest dynamic model at the community scale. The growth process interacts with the mortality process thanks to the past growth which is used to build a tree vigor index. The tree vigor index is related to the distance between the observed growth and the expected modeled growth and plays a key role in the mortality process. The model handles all the species from the forest community using functional trait values instead of the species taxonomy. These functional traits are integrated as proxies of the ecological strategies of the trees and permit generalization among all species in the forest community. Our model was explicitly designed to deal with diverse sources of uncertainty, including the complexity of the mortality process itself and the field data, especially historical data for which taxonomic determinations were uncertain. We developed a MCMC algorithm to infer and validate the model with together longitudinal growth data and punctual mortality data collected at Paracou study site, a tropical rain forest in French Guiana where 20,340 trees have been yearly censused over 20 years. Climate covariates were finally added as external drivers of the forest dynamics. These drivers are selected in a list of climate variables for which future predictions are available thanks to the IPCC scenario. We stressed the need to include these relationships into forest simulators to test, in silico, the impact of different climate scenarios on the future dynamics of the rainforest.

2.42 Statistical modelling of brown trout (Salmo trutta) growth: new descriptors of trout populations and implications for management in Navarra, Northern Spain

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We revisit the von Bertalanffy growth function (VBGF) model of brown trout under the form of a statistical model depicting the distribution of fish length over time, space, and fish individuals. This model provides new descriptors of trout populations namely second order moments which complete standard first order moments of VBGF parameters (time of emergence, growth rate, and asymptotic length). This model also predicts a complex shift of the dispersion of individual trout lengths over time. We confront this model to data collected over 20 years on 61 points distributed over a 120x80 km area in the Navarra province, Northern Spain. Complex dispersion of trout length over time is indeed observed, such a dispersion is in accordance with the model predictions, and subsequent interval estimates of model parameters are successfully computed. Results show that the growth rate is fairly constant among fish individuals in the study area and that dispersion of trout length over time is due to variations among fish individuals of the time of emergence (standard deviation: 7 days) and of the asymptotic length (coefficient of variation: 0.10). The latter parameters are stable for the last 20 years indicating no significant change of brown trout growth for the last two decades in spite of variations in climatic conditions and in trout management regulations.

2.43 Growth dynamics of Potamogeton pectinatus L. in Lake Burullus, Egypt: A modeling approach

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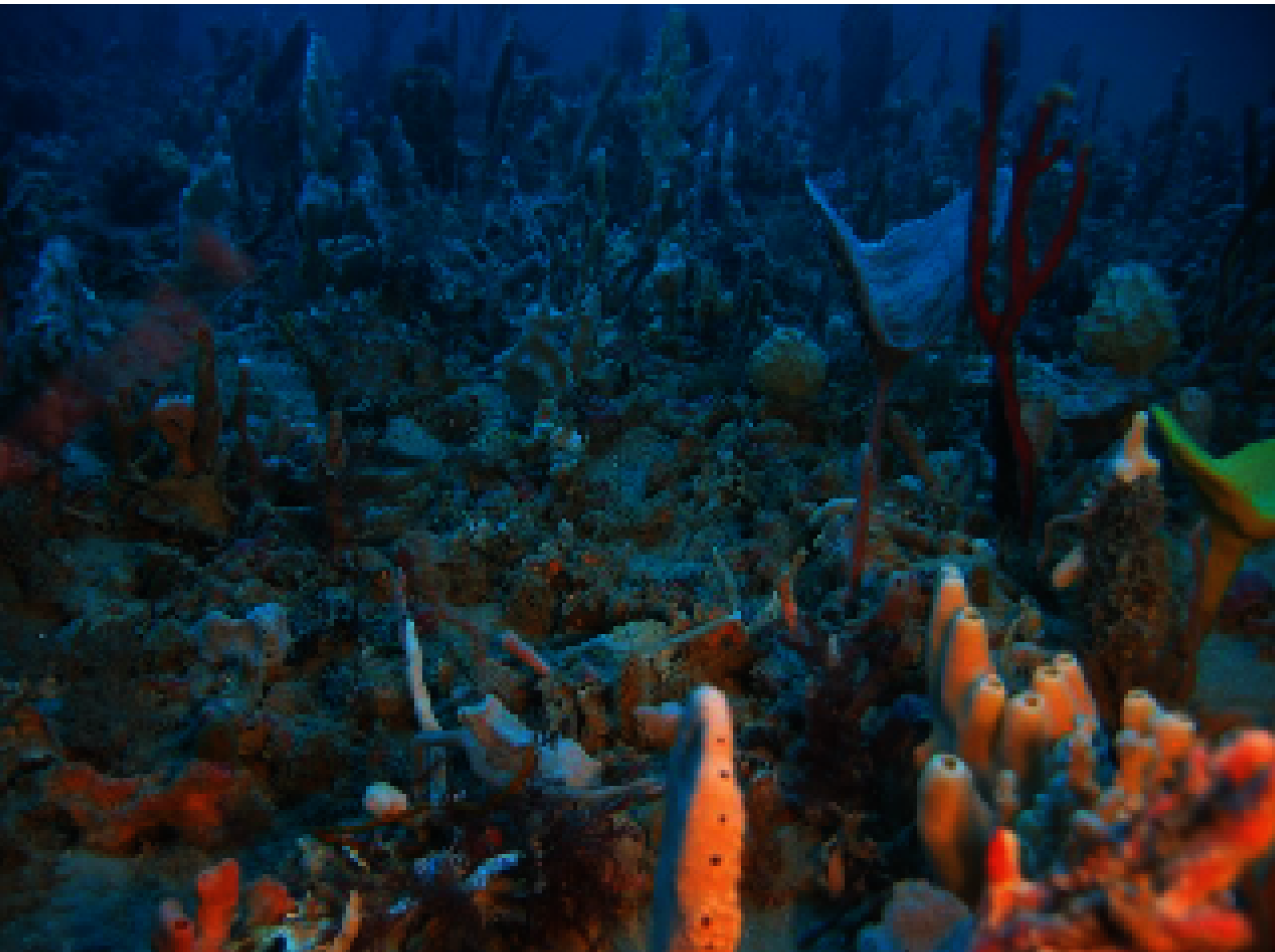
In present study, we used a macrophyte model to describe the growth production and the interaction between above- and below-ground organs of Potamogeton pectinatus in Lake Burullus, Egypt, one of the Mediterranean eutrophic lakes. The aim of this study was to answer the following questions: 1) Is the macrophyte model, originally developed for and applied to P. pectinatus growth in a temperate region (Lake Veluwe, The Netherlands) suited to simulate P. pectinatus growth in the south Mediterranean region? and 2) How is biomass production of P. pectinatus distributed among the various plant organs?. Above- and below-ground biomass of P. pectinatus was sampled monthly from April 2011 to December 2011 at three sites of Lake Burullus using three randomly distributed cylindrical core sampler of 16 cm diameter at each sampling site. Shoots started to grow in April, reached the maximum biomass of 2040 g DM m−2 in September, and then rapidly decreased in the fall when they moved into the senescence stage. Tubers biomass reduced from 100 g DM m−2 in April to 24 g DM m−2 in August due to the upward translocation for the initial growth of shoots, gradually increased to a maximum biomass of 200 g DM m−2 in October by downward translocation from shoots and roots. The maximum above-ground biomass of P. pectinatus (20.4 t DM ha−1) in Lake Burullus is almost similar with the range of 15.7 − 19.9 t DM ha−1 recorded in previous estimates of some Egyptian wetlands, while it is higher than the range of 0.2 − 19.0 t DM ha−1 recorded in some countries. P. pectinatus allocated approximately 82.3% of its total biomass to shoots, 15.5% to tubers and 2.2% to roots. In the present study, significantly negative correlation was detected between the maximum above- and below-ground biomasses of P. pectinatus and latitudes. This finding agrees with the latitude-correlated switch in life cycle strategy for this species as suggested by some authors. General trends for above-ground biomass, such as the slow initial growth rate followed by a high growth rate, the timing of peak biomass, and the decline of biomass due to senescence, were successfully reproduced by the model. Many characteristics typical for the tubers biomass, such as the reduction of tubers biomass during the early growing season, and the increase in the tubers biomass during the later period of the season, because of the translocation of materials from current photosynthesis and shoots and roots dry matters, were also reproduced. In general, there was good agreement between the calculated results and field data although simulated results were slightly different from observations for below-ground biomass. In conclusion, macrophyte model is well-suited to simulate the growth of P. pectinatus in the south Mediterranean region and could be used in wetland management activities to predict the potential growth of P. pectinatus in Egyptian wetlands.

Ecosystem functioning (EF)



3.1 Improved ecological network analysis for environmental sustainability assessment; a case study on a forest ecosystem

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Human activities have an impact on environmental systems. In light of environmental sustainability assessment, methods are needed which quantify this impact. Ecological Network Analysis (ENA), a method to study and analyse ecosystem networks and their changes, could be an adequate tool to do so. However improvements to ENA are needed, described further on. We look specifically to the applicability in the field of life cycle assessment (LCA), a tool in which the total environmental impact of resource extraction and emissions during a product's life cycle is quantified. To better quantify this impact in LCA, as a first objective, the alteration of ecosystems induced by those processes needs to be accounted for. As a second objective, the flow networks of ecosystems, responsible for the formation of the extracted resources, should be included in the product's life cycle. In ENA, total system indicators are calculated which assess an ecosystem's functioning (e.g. cycling). Alterations of ecosystems can be represented by changes in the values of those indicators (achievement of second objective). ENA is based on the computational framework of Input-Output Analysis (IOA). This framework is also used in LCA allowing for a possible extension of a product's life cycle in an LCA with the ecosystem flow networks of ENA (achievement of first objective). The ENA/IOA framework itself was revised and improved in this study to better fit in an LCA framework, prior to integration and application in LCA. One adaptation was to enable physical compartmentalisation of the surrounding environment of the studied (eco)system. This allows for a specification of destinations and sources of export and import flows, respectively, which is desired in LCA to assess the impact of these flows. Next to that, the adapted framework was made applicable to non-steady state systems by applying Finn's concept (1976, 1977), in which increase, increment, and decrease, depletion, in stock are considered abstract export and import flows, respectively. As an example, the adapted ENA framework was applied to a forest ecosystem. However, there are no standards yet for the different choices in the ENA methodology, which can have an influence on the indicator values. Hence, defining such standards is a next important research step.

3.2 Comparing indirect and direct effects within ecological networks: a stochastic approach

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In this paper, we take advantage of a different representation of ecosystem models to provide a better understanding of indirect effects. We focus on pathways of individual particles that flow through systems. Particles represent small units of flow material, such as 1g of biomass. The view of an entire system from the perspective of particles provides a more practical and intuitive basis to study indirect relations than earlier input–output based algebraic methods. Our findings show that the conventional I/D (ratio of indirect to direct effects) formula differs from its intended meaning, which is supposed to compare indirect and direct flows. We come up with a new pathway-based I/D, which revises the current formula and accurately compares indirect and direct flows. One of the main uses of I/D is to compare ecosystems; however, how the indirect effect is defined and measured might affect the results of analysis. This work has significant impact on past and future studies using I/D as a measure for system analysis and comparison. I/D, proposed for evaluating ecological networks, is potentially applicable to analyze systems in other areas.

3.3 Robustness indicators for aquatic ecological networks - a static model approach

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Robustness is a universal feature of ecological systems which promotes their sustainability over time. We studied robustness of an aquatic ecosystem, specifically an estuarine system, using ecological network analysis. Estuaries provide us with many ecosystem services and they are consequently prone to face anthropogenic stress. In South Africa, temporarily open/closed estuaries (TOCEs) occupy a significant percentage of coastal boundaries. Ecological network analysis is one approach to deduce ecosystem structure and function. One of the South African estuaries, namely Mdloti, is analysed using Ecopath software. The food web energy flow networks are perturbed following different scenarios which are assumed to be a result of selected anthropogenic stresses (eutrophication, overfishing) to the system. Several network indices are analysed for the various perturbation scenarios such as total system throughput (TST), average mutual information (AMI), Shannon's diversity index (H), redundancy (R), Finn's cycling index (FCI) and ascendency over capacity ratio (A/C) showed more or less consistent patterns in revealing the change inflow pattern and magnitude in the networks in different scenarios. Along with the introduction of perturbations into the system, the flow pattern among the system compartments changes, and consequently the values of the network indices. Measurements of robustness of two different seasons of this estuary by using different networks and change of robustness for different scenarios show that A/C and AMI could be potential indices to express changes in robustness within the system. H was not as a good indicator for change in robustness. R and FCI did not change consistently in all the scenarios.

3.4 Resolving the complexity of ecological networks

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Ecosystems are often described as flows among compartments, which form ecological networks. These networks can be fairly large and complex, making it extremely difficult to understand and control. We propose Network Flux Analysis (NFA) as a powerful tool to tackle the complexity of ecosystem models.

It is possible to represent an ecological network in terms of fluxes, where a flux represents the smallest process within an ecosystem that can theoretically sustain itself. This can be a material cycle within an ecosystem, or a simple foodchain in a complex foodweb. Even a small network can have a high number of fluxes. However, we observe that a low number of fluxes actually dominate. Therefore a few fluxes can often accurately represent a complex ecosystem. Actually, various complex physical systems are analyzed using similar approaches, based on different methodology, such as Fourier Analysis or Principal Component Analysis.

In this talk, we will introduce fluxes as a new building block for ecosystems, and present how ecological networks are represented in the flux space using the intertidal oyster reef and the Georgia salt marsh ecosystem models. We'll then show how the simplified and original networks compare using various measures.

3.5 Designing a multi-species spatially-explicit nature reserve network construction framework based on extinction probability: A case study of Wuyishan nature reserve, China

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with the purpose of species' long-term persistence, nature reserve network construction has been acknowledged as a simple yet effective way to protect species to avoid anthropogenic activities. this study focused on the identification and construction of multi-species spatially-explicit reserve networks in nature reserves. a three-step framework was proposed considering both species representation and elimination of the negative impact the anthropogenic barriers impose on species turnover. we detected the subset of anthropogenic barriers responsible for the failure of species' direct dispersals between fixed representative reserves and then added constructed reserves to remove these influences. the proposed framework was applied to m. thibetana and l. nycthemera, two sensitive species in wuyishan. the results showed that when designing a reserve network only for m. thibetana, four representative reserves, one constructed reserve and two migration routes were identified. taking both m. thibetana and l. nycthemera as targeted species, a reserve network including ten representative reserves, three constructed reserves and fifteen dispersal routes was selected, covering 43.17% of the total area of wuyishan nature reserve. the selection of constructed reserves significantly lowers the extinction probabilities of both m. thibetana and l. nycthemera in either reserve or the whole network. in addition, by comparing the fixed reserve network with current functional zoning of wuyishan, 83% of the reserve network lay in the core zone, while 11.28% and 5.72% located in the buffer zone and transition zone, respectively. the results suggested that the current core zone in wuyishan nature reserve general planning should be extended by replanning and restricting the tourism and roads to be out of the constructed reserves and the direct dispersal pathways between constructed reserves and the corresponding reconnected representative reserves. such a framework is a necessary post-evaluation that can provide an effective way facing multi-species protection and provide guidance to policy decisions..

3.6 Dynamic simulation of sustainability in Biosphere Reserves

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The application of a systemic perspective on Biosphere Reserves is important to address the close relationships between the environmental and socio-economic processes and to take into account potential limiting factors, particularly evident in the case of insular systems as the Fuerteventura Biosphere Reserve (FBR). This socio-ecological system contains some potential challenges related with, on one hand, its arid environment (annual rainfall under 120 mm) which determines a very low productivity at once a particular biodiversity with numerous endemic species. On the other hand, the tourist development is relatively recent, which has allowed that part of the island has been maintained apart from the tourist transformation. In order to improve the overall understanding and the key issues for environmental, social and economic sustainability of the island, a dynamic model for Fuerteventura Biosphere Reserve has been developed. The model, structured in 5 model sectors (Land Use, Biodiversity Conservation, Water Use, Environmental Quality and Socio-touristic Sector), has been calibrated using 1996–2011 data for 24 available variables. Moreover, a set of 35 sustainability indicators has been integrated into the model. Several model testing procedures has been successfully applied. Results regarding comparison between observed values and model simulations show that the model successfully tracks the behaviour of this socio-ecological system. The rising trend in tourist population generates an increasing natural resources consumption and causes important changes on land uses, which represent one of the main threats in biodiversity conservation. The increasing land uptake by artificial uses is emphasizing the natural system vulnerability to other processes, such as overgrazing and the degradation of natural habitats, which host numerous endangered species. The equilibrium between the maintenance of vulnerable arid environment and the economic development based on tourist activities, highlights the need for integrated approaches. Fuerteventura Biosphere Reserve dynamic model represents a useful tool in the sustainable management of this insular Biosphere Reserve and to facilitate the decision-making processes.

3.7 The role of "total landscape area" and "link importance" parameters in assessing forest habitat connectivity for biodiversity conservation using Conefor Sensinode 2.6

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Conefor Sensinode 2.6 is a software package that helps in quantifying the importance of habitat areas and links for the improvement of landscape connectivity for biodiversity conservation strategies. In the forest habitat connectivity studies, surrounding non-habitat patches also play an important role as it makes the path for connectivity. Response of the software package on the total landscape area (AL) and link importance is studied to assess forest habitat connectivity. AL is the total landscape area which is the combination of both habitat and non-habitat patches. If no AL is entered (as it is optional) in Conefor Sensinode 2.6, we get numerators of the LCP, IIC, and PC indices ie., LCPnum, IICnum and PCnum. In the software package "Link importance" comprises of three parameters, namely "link removal", "link improvement" and "link change". Effect of losing an existing link is examined in link removal. The potential benefits of strengthening connections between habitat patches are analyzed in link improvement. Link change defines how user-defined changes in the links translate in connectivity gains or losses. Correlation between threshold distance and IICnum showed R2 value 0.96. With the increase in threshold distance, IICnum increased logarithmically. After giving the AL value of the study area again the Conefor Sensinode 2.6 is run for threshold distances 100m, 200m, 250m, 500m, 750m, 1000m, 2000m, 3000m, 4000m and 5000m. Then dIICintra, dIICflux and dIICconnector are analyzed. In the study area, for the chosen potential patches having high importance values, individually these indices are assessed and graphs are plotted. Link importance result showed that the chosen potential patches are appropriate for connectivity analysis. This analysis facilitated to understand the importance of individual patches based on the link importance. Thus the link importance helped to assess forest habitat connectivity for biodiversity conservation.

3.8 Predicting ecosystem stability from community composition and biodiversity

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As biodiversity is declining at an unprecedented rate, an important current scientific challenge is to understand and predict the consequences of biodiversity loss. Here we develop a theory that predicts the temporal variability of community biomass from the properties of individual component species in monoculture. Our theory shows that biodiversity stabilises ecosystems through three main mechanisms: (1) asynchrony in species' responses to environmental fluctuations, (2) reduced demographic stochasticity due to overyielding in species mixtures, and (3) reduced observation error (including spatial and sampling variability). Parameterized with empirical data from four long-term grassland biodiversity experiments, our prediction explained 22–75% of the observed variability, and captured much of the effect of species richness. Richness stabilized communities mainly by increasing community biomass and reducing the strength of demographic stochasticity. Our approach calls for a re-evaluation of the mechanisms explaining the effects of biodiversity on ecosystem stability.

3.9 Environmental synchrony and dispersal interactively affect the stability of metacommunities

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The metacommunity model provides an ideal platform to investigate the combined effects of local biotic and abiotic interactions and spatial processes on the dynamics and functioning of ecosystem. In an ongoing work, we study the stability of metacommunities under the effects of various ecological processes: species synchrony in response to environmental change, spatial synchrony in environmental fluctuations, and spatial dispersal. We start with the simple neutral case in which species are ecologically equivalent (in both resource consumption and environmental response). Analytic solutions show that environmental synchrony can increase the temporal variability of productivity in both meta- and local communities; in contrast, dispersal reduces the temporal variance. At metacommunity level, however, the stabilizing effect of dispersal is weak and only detectable when environmental fluctuations are strongly asynchronous. In consistence with previous findings, environmental synchrony and dispersal in our model can both contribute to spatial synchrony between local communities. We then perform simulations to explore the more realistic non-neutral case. Preliminary results from a two-patch model indicate that both environmental synchrony and dispersal can have stabilizing or destabilizing effects on ecosystem variability, depending on their influences on community composition. Generalist and specialist species exhibit different responses: for instance, environmental synchrony always increases the temporal variability of specialist species, but can have a nonmonotonic effect on generalist species. Based on the non-neutral model, we will further explore the effects of spatial insurance and spatial averaging in order to better understand the interactive effects of environmental synchrony and dispersal on ecosystem stability.

3.10 Forest management scenarios and their effects on ecosystem services: modelling results from Sweden

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Swedish forests have been actively managed for last 100 years. The active management has led to increase forest biomass production, harvest, wood product use and thereby has increased Swedish forest sectors role in country economy. It is unclear, however, whether actively managed forest are supporting or jeopardising the forest's ecosystem services. Lately, the Swedish society have been critical about intensive forest management claiming that it has been deteriorating forest ecosystem and limiting ecosystem services. There have been suggestions for a better scientific understanding for the effect of different forest management strategies on different ecosystem services. We use a system analysis approach to perform a model based analysis that includes forest management and their effects on different indicators of ecosystem services in Swedish forest landscape for the next 100 years. Forest management scenarios with different management intensity are assumed based on set aside area. Forest management scenarios such as, Reference, Intensive Management, Environmental and Conservation are chosen to analyse. We use empirical forest growth model HUGIN to calculate forest biomass production, harvest amount including all types of biomass i.e. stem-wood, bark, needles/leaves, branches and tops, dead wood availability in the forest floor, forest age structure and tree species composition. With these values, we set indicators for different types of ecosystem services under supporting, provisioning, regulating and cultural services for example, biodiversity conservation and recreation. Moreover, we perform a comprehensive literature review to establish the ecosystem service indicators in Swedish forest landscape and combine them with our modelling results for the assessment. Finally, we evaluate the effect of forest management scenarios in ecosystem services in Swedish forest landscape. Our preliminary result showed that intensive forest management would increase forest biomass production thus creates opportunity for economic benefit as well as carbon emissions reduction benefit. However, a forest management policy where large areas are set aside will potentially support biodiversity conservation and natural succession of forest. We found a mixed result for the cultural services that any of the forest management strategy would increase importance for future generation.

3.11 Applying Bayesian belief networks and GIS to model the ecosystem service recreational use

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The ecosystem services concept, a method to value seminatural landscapes based on their provided services, is increasingly gaining attention in science and policy. In densely populated regions, recreational use is recognized as an important ecosystem service that significantly benefits human well-being. Lacking data on recreational use and complex interactions between ecological and sociological processes, which determine the delivery of the service, currently impede the integration of recreational use in integrated ecosystem service assessments. Our research proposes a method to model yearly recreational visitor numbers for a case study in Flanders, Belgium, taking into account both supply and demand for recreation. Survey data, expert knowledge and existing models were combined in a Bayesian belief network (BBN) approach. Three BBNs with limited complexity were developed to model site quality (supply), recreational frequency (demand) and distance decay of recreational frequency. Model results include a raster map of site quality, an average individual's recreational frequency and a distance decay function of recreational frequency. Combining these model results with spatially explicit information on population density, accounting for both substitute effects between multiple recreational sites and for remoteness of sites, a raster map of yearly predicted visitor numbers could be obtained. Significant differences were observed between the obtained recreational use map and the site quality map. Although previous attempts to model recreational use have focussed merely on site quality based on personal landscape preferences, the observed differences clearly indicate the value of taking into account societal demand for recreation, remoteness of recreational sites and substitute effects between multiple sites. The proposed methodology indicates the added value of Bayesian belief networks in ecosystem service modelling, especially regarding combining multiple data sources and delivering spatially explicit results. Additional research is needed to assess the applicability of BBNs to model a wider set of ecosystem services. The use of BBNs to explicitly account for spatial interactions associated with ecosystem service delivery is an important challenge for future research.

3.12 Ecological engineering as a tool to improve the sustainability of soil remediation in remote locations and developing countries

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Toxic compounds from industrial activities accumulate in the ecosystems at an unsustainable rate. Ecological engineering has been proposed as a tool to design ecosystems that integrate human society with its natural environment for the benefit of the both. Bioremediation is generally considered an ecological engineering practice but even if it addresses one of the core goals of ecological engineering, i.e. restoration of damaged ecosystems, bioremediation can be energy-intensive and have low reliance on self-design, particularly if excavation and ex situ methods are employed. From a thermodynamic point of view, most organic pollutants are composed of molecules with high embodied energies and free energy potential that are appealing features for the use of ecological engineering, especially in locations where economic incentives are small for any kind of remediation to be performed, Based on positive experiences from an ongoing research project in Nicaragua, in which by-products and waste material are used as primary feedstock, it is concluded that the principles of ecological engineering can be useful to make in situ bioremediation a more sustainable practice in remote locations and developing countries.

3.13 Environmental sustainability of integrated human/industrial-natural systems

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Human/industrial systems and ecosystems are intertwined. Products are brought forth not only by human/industrial systems but in reality by a combination of integrated human/industrial systems and ecosystems. As such, the environmental sustainability of integrated human/industrial and ecosystems should be assessed. More specifically for Life Cycle Assessment (LCA), a tool to assess the environmental sustainability of a product, ecosystems should be included in the product's life cycle. A framework is introduced to do so. First, Linear Inverse Models (LIM) are proposed to model these integrated systems. Secondly, the systems can be studied and modelled if they are in non-steady state by assuming increase, increment, and decrease, depletion, in stock as output and input, respectively. Thirdly, the uptake of emissions, an ecosystem service, a remediating impact, is taken into account. As a case study, a LCA was performed on an integrated system of an intensive forest and a processing chain to process produced wood to sawn timber. Resource consumption was assessed and the impact on human health and biodiversity was also assessed using specific impact methods. The production of wood in the forest has the highest impact on biodiversity loss and resource consumption through land occupation. On the other hand, the forest also exerts a remediating effect on human health, mostly via capture of airborne fine particles. These findings illustrate the potential relevance of accounting for the environmental impact (in LCA) of integrated human/industrial systems and ecosystems. However, further research is needed to better quantify the environmental impact of such integrated systems.

3.14 Donor values in emergy assessment of ecosystem services

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Suggested for 2.5 ecosystem services. There are currently many definitions of ecosystem services in use. Common is an aim to visualize contributions, assets and costs not traditionally covered by market valuations, thus often giving ecosystems much lower value than their importance to economy. Emergy accounting, with its approach of donor values in contrast to receiver or market values, is one approach to assess contributions from the ecosystems and increase our understanding of the values of ecosystem services. Pulselli et al. (Ecol. Mod. 222:2924-2928) have connected the donor-side approach with a user side approach for ecological services. In this paper we investigate the donor-side more in depth, and put up an emergy model with two possible main paths to assess values for the ecosystem services: 1) the emergy values of the natural driving forces (ES-DF), as sun, rain, wind and land cycle, and 2), the emergy values delivered directly to the human society and economy (ES-PS, environmental production systems). The first approach can be assessed with the common calculation procedure of emergy accounting; the second includes more challenging feedback flows of different types. The implications of these different feedback flows are discussed in the paper. The Millennium Ecosystem Assessment terminology of supporting, providing, regulating and cultural ecosystem services relate primarily to the emergy ES-PS flows.

3.15 Potential effects of climate and fisheries changes on the structure and functioning of the Adriatic Sea ecosystem

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Synergies and antagonisms between climate and fisheries effects have been seldom quantified jointly. The integration of biogeochemical processes and food web dynamics in an End-to-End modelling approach gives a possible way to tackle this issue by implementing scenarios analysis. In this work, we analyse the potential cascading effects of simultaneous climate-driven and fisheries changes on an End-to-End model, which represents the Adriatic Sea ecosystem with 47 functional groups and five fishing gears. A set of 81 scenarios was implemented by simulating 3 different climates, i.e. modification in the seasonality of river runoff, and 27 fishing management options, i.e. increase/decrease of fishing effort by gears and of fishing mortality of target species. The simulated long-term evolution of biomasses and flows in the food web allowed determining several ecological indicators of ecosystem structure, organization and diversity. Comparison between results from scenarios implementing only climatic changes, scenarios implementing only fisheries changes and scenarios implementing both climatic and fisheries changes allowed for detect positive and negative interactions between the two drivers. Nevertheless, results at functional group level highlight complex patterns, including the fact that climatic changes cause a decrease in trophic suitability of some species, (such as hake), which cannot be compensated by a decrease in the fishing mortality (down to -25%). This suggests that fisheries management can hardly mitigate the climatic impacts for certain critical species. Conversely, indicators of ecosystem structure and functioning highlight the presence of counteracting feedbacks between climate and fisheries. Overall the scenarios analysis allowed to infer on possible synergies and antagonisms between climatic and fisheries effects propagating in food webs that might be appropriate to consider in future management.

3.16 Comparison of the response of structural and food web entropy-based indicators in real cases studies representing natural as well as extreme spatio-temporal variability

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Entropy-based indicators focusing on ecosystem composition and on trophic flow structure have in the past been investigated for their theoretical complementarity in terms of characterising ecosystems. The indicators focusing on the former are measures of the departure of an ecosystem away from the thermodynamic equilibrium with the surrounding environment, and, as such, they reflect the organisation acquired by an ecosystem along the pathway of development. The indicators calculated from the trophic flow structure give information on the diversity of pathways and efficiency with which energy moves through an ecosystem. Under the hypothesis that the more complex and efficient ecosystems are also more developed, both types of indicators are used as orientors as well as indicators of ecological quality. Although most of the proposed functions have a good theoretical basis and have shown to represent useful indicators, their validation on empirical data describing the variability of real ecosystems over time is still pending. The aim of the present contribution is to show how several structural (Exergy, Structural Information and the Eco-exergy index) and food web (Total System Throughput, Average mutual Information, Ascendency) entropy-based indicators perform in describing the ecological changes that have occurred in selected estuarine systems. The empirical systems in question are both small and large estuaries in South Africa. The small estuaries feature a natural cycle, following the prevailing seasonal rainfall pattern that spans from experiencing an open connection to the sea to being closed off from the sea for weeks or months at a time. Distinct differences in biomass, diversity, productivity and network responses have been documented for these systems for their open and closed phases. The larger estuary comprises St. Lucia situated in the iSimangaliso Wetland Park, South Africa's first World Heritage Site. This St. Lucia estuary has, in the preceding 10 years, undergone unprecedented extreme conditions due to both anthropogenic interventions and natural climatic variability, resulting in extreme spatial and temporal gradients of biomass and diversity. Extreme conditions have been interrupted by a natural event opening the estuarine inlet to the sea, and these are reflected in the food web whole ecosystem indices.

In addition to whole ecosystem indices, the contribution of individual components (e.g. functional groups) to the comprehensive whole ecosystem indices is described for all indices calculated in order to compare the contribution of these groups to the whole. As an example, this analysis conducted for average mutual information indices showed that basal groups (detritus, primary producers, bacteria) overall contribute more to the systems AMI value as groups on higher trophic levels (e.g. zooplankton or fish).

The aim of this study was then to (1) investigate in-depth the ecosystem state of several estuarine systems, and (2) to investigate the complementarity of some structural (Exergy,

3.17 Analysis and modeling of temporal and spatial coherency of NPP dynamics in Sayan Mountains (South Siberia) forest stands

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One of important characteristics that reflect qualitative and quantitative processes in the biosphere is assimilation of carbon by plants. The amount of carbon fixed by plants is characterized by NPP. Net primary production of forest cenoses is very variable and depends, in part, on a variety of external modifying factors such as intensity and spectrum of solar radiation, climatic conditions in the area. Less studied are features of long-term NPP dynamics associated with self-regulation processes of tree growth in a forest. Mountain forests are a convenient object for analysis and modeling of long-term NPP changes that do not depend on climatic factors, since in mountain forests climatic conditions are uniquely determined by altitude. Temporal and spatial coherence of mean annual NPP time series (Yrs. 2000 - 2012) was studied according to data from satellite observations of MODIS / TERRA. Mean annual NPP estimates' series were examined for different altitudinal zones in the Sayan Mountains (South of Central Siberia). Altitudes ranged from 600 to 1,800 meters above sea level. This area is lengthful vertically and has well-marked mountain-belt vegetation complexes, where mixed forests, fir and pine coniferous forests, alpine meadows and alpine tundra successively come one after another. Spatial and temporal coherence of NPP time series for different habitats is analyzed. Methods of nonparametric statistics and spectral analysis were used to evaluate characteristics of NPP periodicity and coherence of various NPP time series. The analysis showed that during investigation NPP time series have been changing synchronously within the same macro-hillside regardless of current weather conditions and plants' species composition at different altitudes. A second-order AR model was used to describe temporal dynamics of NPP. Such behavior of studied time series suggests a lag in growth of woody plants. To explain the lag effect an ecological analogue of the economic "multiplier-accelerator" model by Paul Samuelson was considered. This work was supported by RFBR (grant number 12-05-00494)

3.18 Study of the phosphorus dynamics of a shallow eutrophic impoundment - East Calcutta Wetlands, a Ramsar site in India through simulation model

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The East Calcutta Wetlands is one of the largest waste water fed aquaculture in the world. It is the aggregation of salt marshes, salt meadows and waste water fed ponds that receive waste water from various small and large scale industries, and urban settlements. The available nutrient supports the grazing food chain of the wetland ecosystem and agriculture around it. A little imbalance between the nutrient load and utilization by the autotrophs results in eutrophication. In this wetland, there has been a gradual decrease in the fish production for the last few decades. The physical and chemical conditions of the system are deteriorating continuously. So, Modelling of the system is needed to mitigate the problem of eutrophication and identify the important parameters that govern the system dynamics. Here, a dynamic model is constructed to study the phosphorus dynamics of the system. The four state variable includes; inorganic phosphorus, phytoplankton, zooplankton and detritus. Important processes, like mineralization, uptake, grazing, predation, sedimentation are considered in the model. Field data are collected over two years and incorporated in the model as graph time function. Sensitivity analysis is performed and the model is calibrated and validated with different sets of data. Model results show that the rate of settling of phytoplankton is the system sensitive parameter. Average depth of the wetland and extinction coefficient have important role in governing nutrient (phosphorus) and phytoplankton dynamics. Moreover, the model result also shows top-down effect on zooplankton predated by the fish population. The paper outlines some important management strategies that can be applied to this system to alleviate the eutrophication problem of the wetland ecosystem.

Key words: Dynamic model; Eutrophication; Fish; Phosphorus; Plankton; Waste water

3.19 A long-term assessment of the emergy use in an Argentinean agroecosystem

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The emergy synthesis could be a useful environmental indicator as it quantified both the energy required directly and indirectly to create a product or service. Although, it could be used as a basic measure of real wealth on a long term, there are a few studies showing the time trend of emergy flows in managed systems. Here, we used emergy synthesis for identifying historical trends in both ecological and economical productivity and efficiency in an Argentinean agroecosystem. The study site was located in the northwestern of Córdoba province (32°45´S, 62°10´W), within the subhumid area of the Pampean region (Argentina). We used agronomic and environmental data, covering the time period form 1984 to 2010, from a long-term experimental site. We analyzed the historical emergy performance of corn, spring soybean and the wheat/summer soybean double crop (i.e. summer soybean crop sowed immediately after wheat harvest). The emergy synthesis classified the system inputs as local renewables, local non-renewables and purchased and the sum is total system emergy use. The different flows are primarily expresses in their own units (joules, grams, dollars) and then multiplied by their solar transformities to transform them into emergy units (seJ). Finally, a set of emergy-based indices and ratios were calculated to evaluate system sustainability. The three crops studied shared a common temporal pattern characterized by three identifiable phases. The first (1984-1994) was characterized by a significant improvement of emergy metabolism due to 1) the decreasing of purchased emergy inflow, 2) the increasing efficiency of the purchased inflow (i.e. EYR), 3) the increasing of the overall system efficiency (i.e. transformity), 4) a greater system renewability, and 5) the increasing in the emergy received for emergy delivered in the economic system. The second phase (1995-2001) showed a break in this positive trend due to a plateau in 1) the system transformity, 2) the economic trade balance, along with an increase in the emergy purchased (used at lower efficiency). Finally, during the third stage (2002-2010) the cropping systems reduced the deterioration rate exhibited in the former period by reducing the EYR negative annual rate. Emergy accounting revealed the environmental costs associated with two technological changes that occurred simultaneously. Firstly, the increasing of purchased emergy was linked to higher emergy costs due to transgenic crops introduction by 1995. Oppositely, the adoption of zero tillage would mitigate the GMO environmental costs due to lower environmental pressure on soil condition and thereby increasing the return of emergy invested. The changes detected in the historical analysis would largely replicate the regional pattern in terms of technology adoption, and the results would allow extending the findings to other ecosystems in the Pampas region with similar characteristics.

3.20 Industrial metabolism process analysis of sulfur in Lubei (Shandong) eco-industrial park

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Lubei eco-industrial park in Shandong Province was established early, well-developing, at a high profit, and has become one recognized throughout the world. In regard to the studies of the metabolism processes of element in eco-industrial parks, current studies mainly accounted the flow, stock, and utilization efficiency of some elements, and few analyzed complex internal characteristics of the metabolism processes combining structural and functional attributes. In this study, we discussed the delivering, transforming processes and the internal characteristics of the industrial metabolism processes of the element sulfur in Lubei eco-industrial park. Introducing Network Analysis Method, we analyzed the structural and functional characteristics of this network from the angle of nodes, which are the members of the network, and the paths, which link the nodes, and further combined these two characteristics to identify key node (it is Cement clinker sintering), periphery nodes (they are Ammonia plant and Power plant), and key paths (they are Sulfuric acid plant to Ammonium phosphate plant, Cement clinker sintering to Sulfuric acid plant, and Ammonium phosphate plant to Cement clinker sintering) in the network. And these results helped to reflect the advantages and the disadvantages of Lubei eco-industrial park in structure and function, and to make suggestions about future sustainable development of Lubei eco-industrial park.

3.21 Permanent outbreaks of forest insects: Population dynamics analysis and modelling

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The work is devoted to analysis and modeling of population dynamics of species that exhibit a permanent outbreak. It is known that the phase of stably-sparse population is virtually absent on population dynamics curves of forest insects in permanent outbreak. Population proceeds from the depression phase with a minimum population density to the expansion phase with maximal population density (Isaev et al 2001). The populations of Zeiraphera griceana Hbn. in the Swiss Alps and Lymantria dispar L. in the Southern Urals were objects of our analysis. The objectives of our work were: - analysis of population dynamics peculiarities and nature of cyclical fluctuations in population densities for those insect populations that exhibit a permanent outbreak; - study of correlations between weather parameters and characteristics of population density; - assessment of variability in these types of outbreaks for these eruptive species; - development of a mathematical model of permanent outbreaks. An idea that density-dependent factors play a key role in regulating population dynamics allows to nicely explain the development of permanent outbreaks. Weather factors also have an influence on changes in population density of these species, however this impact is much less significant than that of density-dependent factors and growing conditions. A mathematical model of population dynamics for species that exhibit a permanent outbreak is proposed. The model is based on the study of population dynamics patterns. It allows to assess impact of regulatory and modifying factors on population dynamics of these species. Thus, it is shown that contribution of weather factors is 10-15 % of the total population density variance for gypsy moth population in the Southern Urals. This work was supported by RFBR (grant number 11-04-00173-a).

3.22 Analysis of plant's biomass and elements for simulation of ground vegetation dynamics in boreal forest

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We have proposed an approach to simulate ground vegetation dynamics in the frame of the EFIMOD-ROMUL soil-vegetation dynamic model of biogeochemical cycles developed for the boreal forest. The approach is based on the idea to simulate patch mosaics in the forest floor which is specified for the forest type and which is defined by the ecological-phytocoenotic species group dominating in the patch. The forest type is currently defined by dominant tree species in overstorey and dominant ecological-phytocoenotic group in ground vegetation. We have described the main variants of patch mosaics in the forest floor for different forest types distinguished in boreal and hemiboreal forests. We have also developed a database on plant species biomass and chemical elements in the plants. Vascular species, mosses and lichens were included. Published data for different patches in different forest types on above ground biomass and under ground biomass for species and groups of species of various life forms and for various fractions of plants were composed into the database of over 7000 entries. Original data from the Centre for forest ecology and productivity of Russian Academy of Science on the main chemical elements in different fractions of plants located in different patches of various forest types were composed into the database of over 2500 entries. Numerical summaries for the groups of species and for the forest floor patches have been calculated and analyzed. The analysis showed that forest floor patches had more uniform biomass values in comparison with the biomass values calculated for the ecological-phytoconetotic groups of species and for the groups formed by the species life forms. The proposed forest floor patches were well differed by the biomass values. At the same time species belonging to the analyzed species groups had similar values for the content of the main chemical elements. The patterns allow us to develop the proposed approach and to simulate ground vegetation dynamics by the changing the proportion of different patches contributed to the biogeochemical cycle in forest ecosystem.

3.23 Improving the saprobic system by data analysis: Abundance-related saprobic values for bioindicators in Slovenian rivers

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The saprobic index of river water quality is derived by using the saprobic system, where biological experts assign saprobic values and indicator weights to indicator species/ taxa. The saprobic value specifies the saprobic condition preferred by the taxon, while the indicator weight defines how specific the taxon is to its preferred saprobic condition. The overall saprobic index of a sample is a weighted average of the saprobic values of the taxa present in the sample, where abundance levels and indicator weights are taken into account. However, indicator weights and saprobic values are independent of the abundance levels.

We analyze data from biological river quality surveys of Slovenia, which indicate that, depending on the abundance level at which the species is recorded, the saprobic value and indicator weight can vary significantly. We propose an improvement of the saprobic system that is based on abundance-related saprobic values and indicator weights. To derive abundance-related saprobic values and indicator weights for 116 taxa, to be used in an improved version of the Slovenian saprobic system, we analyze some 1100 biological samples.

We first describe the proposed improvement conceptually and then formulate it mathematically. The results are expressed in terms of abundance-related saprobic values and indicator weights. For many taxa, there are marked differences among the saprobic values and indicator weights for different abundance levels. The most significant differences are highlighted and are discussed in relation to field experience wherever possible. The abundance related saprobic values and indicator weights are even more representative of the taxa' sensitivities to pollution than the overall values produced by a data-based revision of saprobic values and indicator weights proposed earlier.

The proposed method provides a sound data-based approach to the derivation of abundance-related saprobic values and indicator weights. If applied more widely across Europe, it could help to harmonise and improve the performance of the various saprobic systems currently in use. It could possibly even go a step further and help harmonise different biotic indices, such as the saprobic index and the BMWP (biological monitoring working party) score.

3.24 Time trends in atmospheric deposition and forest canopy interaction under changing climate

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Trends in atmospheric deposition and forest canopy interaction were investigated in Lithuanian ICP Forest level II monitoring stations Dubrava from 2000 until 2012 and in Kazlų Rūda from 2005 until 2012. The aim of the study was to evaluate temporal changes of bulk and throughfall deposition fluxes and the contribution of the canopy exchange processes to total deposition in relation to the main climatic factors. Dry deposition and canopy exchange were estimated with canopy budget model which distinguishes between internal and external input sources to ecosystems using the 'filtering approach'. Temporal trends in ion deposition fluxes were evaluated using the non-parametric Mann-Kendall test and Sen's slope estimator. For SO4-S both sites showed significant decreasing trends in throughfall deposition. SO4-S throughfall deposition in Dubrava during the period of 2000-2012 decreased by 43.1 % (0.25 kg ha-1 per year), mainly reflecting the decreasing input of dry sulphur deposition. SO4-S throughfall deposition in Kazlu Rūda during the period of 2005-2012 decreased by 52.7%, with a slope of 0.29 kg ha-1 a-1. Decreasing trend in nitrogen (nitrates and ammonium) deposition were characteristics for both sites, though statistically significant decline was detected only for ammonium at Kazlų Rūda, where the annual change consisted approximately 0.56 kg ha-1 a-1. Despite the significant decrease in suphur and nitrogen deposition, the load of sulphur and nitrogen remains relatively high (>5 kgS ha-1 a-1, 11 kgN ha-1 a-1). According to canopy budget model estimation, the bulk ammonium deposition amounts to about 48.4% of total NH4-N deposition, dry deposition contributes 30.9% and 20.7% of total ammonium input to forest is retained by the canopy. Potassium in throughfall was predominantly caused by canopy leaching, which contributed between 54% and 90 % to the total flux of potassium reaching the forest floor. The rate of K+ leaching from forest canopy was temperature and precipitation amount dependent, indicating that higher temperature and higher precipitation enhance nutrient loss from the foliage. Key words: atmospheric deposition, canopy budget modelling, canopy exchange, throughfall, temperature

3.25 RReShar: a functional –structural forest model to simulate tree regeneration according to resources

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In many parts of the world, forests are facing rapid climate and practice changes, so that their evolution and composition will be difficult to predict. Yet forest managers and owners obviously need this knowledge to adapt their silviculture and if necessary replace some species by better adapted ones. Their current choice will indeed influence economic and ecological results for the next century, at least. Forests are complex ecosystems made up of several strata that interact with each other mainly according to resource availability, namely light (that also controls microclimate), water and nutrients. Modelling forest dynamic is indeed a key tool to assist the management of complex uneven-aged forest stands. RReShar (Regeneration and Resource Sharing) is a functional - structural model aiming at modelling forest dynamics, and particularly the regeneration stage, according to resource availability. It is implemented under the simulation platform named Capsis (www.inra.fr/capsis) helping to run and compare different scenarii of forest stand dynamics.

In RReShar stand structure is explicitly described, including all the strata of the forest ecosystem, i.e. adult trees, suppressed trees, saplings and seedlings growing in the understorey (regeneration) and herbaceous/shrubby vegetation. This detailed description of stand structure allows to take into account biotic and abiotic processes of interaction (competition / facilitation) between the different components. Growth and mortality functions are based on the interactions with light and water in this model version. The simulated scene is a 1 ha plot divided into square cells of a chosen size (a few meters). Adult trees are explicitly spatialised on the plot, whereas understorey vegetation and small trees are considered as a multi-species layer whose characteristics vary at the cell level. Vegetation is described by its height and cover. Tree regeneration, i.e. seedlings and saplings, are initialised as cohorts characterized by a diameter and height distribution. The overstorey and understorey growth time step is annual, whereas within this annual loop, the light interception by the different strata and water cycle (interception, evapotranspiration and soil water content) processes are daily simulated.

Currently, RReShar is calibrated with data coming from uneven-aged mixed Quercus petraea – Pinus sylvestris stands with an understorey colonised by Calluna vulgaris, Pteridium aquilinum and Molinia caerulea in temperate conditions. Forest dynamics (regeneration, growth and mortality) are compared according to different scenarii of stand structure and climates on the short and mid terms.

3.26 Using models and spatial analysis to discussion the irrationality of the spatial pattern of China's food production

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In the past decades, China has been witnessing the change of food (mainly grain) transportation from "South Grain to North" to "North Grain to South" (NGS). The NGS pattern used to be considered a combination of advantages in regional resources and market demands. China's grain production growth more and more count on the northern regions. This may aggravate some problems like water shortage and ecosystem deterioration in North China. We attempted to better regionalize and discuss the irrationality of the NGS pattern of China. Food production and population data of 1985-2010 was collected and GIS spatial analysis and modeling methods were used. Multi-level spatial analysis and contrast between North and South China was carried out from three aspects: (1) Ecosystem food provision potential (EFPP). Step-by-step-modifying models were constructed to assess EFPP, parameters including solar radiation, temperature, humidity, topography, soil, and landuse. (2) Conversion ratio of the EFPP (CR-EFPP), representing the ratio of actual food production to the EFPP. High EFPP and low CR-EFPP means high remaining food potential for future exploration (or protecting, increasing). (3) Population pressure of food provision (PPFP). PPFP was calculated based on food production, population, nutrition ingredient, and consumption standards. High PPFP means food deficiency. Results:

(1) The EFPP in South and Southeast China is much higher than in the North regions, while the CR-EFPP is the opposite; this means the South and Southeast China has more remaining food potential to explore (or to protect). CR-EFPP in Northeast China is the highest (81%), indicating the food provision in Northeast China is approaching its maximum potential. In the future it is not wise to rely solely on food provision increases in North China, which may aggravate some problems like water shortage and ecosystem deterioration.

(2) PPFP in the South and Southeast of China is much greater than in the North and has been rising, indicating that South and Southeast China have deficiency in food supply and is more and more dependent on food transportation from North China. It is necessary to preserve the fertile and high-yielding croplands as well as reclaim new food resources in the southern and eastern to improve its food self-sufficiency. From the above results, we can derive that the NGS pattern of China is irrational. This is in opposition to the present pattern of NGS but consistent with some other studies of domain experts, who also claim the NGS pattern may need adjustment.

3.27 Effect of salinity and temperature on plankton dynamics of Hooghly-Matla estuarine system, India

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The Hooghly-Matla estuarine complex is one of the important estuarine systems of the world. Litter biomass contributes nutrient to the adjacent estuary through tidal influence. Salinity and temperature play an important role in regulation of phytoplankton and zooplankton dynamics of the estuary. In this article, an NPZ model is considered with Holling type-II response function. The present work focuses on salinity and temperature based equations of plankton dynamics. The essential mathematical features are analyzed in terms of local and global stability around the interior equilibrium, which is the most important equilibrium state of the model. The equations of three components model (nutrient, phytoplankton and zooplankton) are solved both analytically and numerically. For numerical solution, numerics are used from real data base of Hooghly-Matla estuarine system. This model identifies a combination of set of points of the salinity and temperature of estuary which helps to determine the dynamics of the system. In addition, this model also predicts the effect of global warming (rise or fall in temperature and salinity) on plankton dynamics of the system.

Keywords: NPZ; Equilibrium point; Local Stability; Global stability

3.28 CASiMIR Vegetation: linking riparian vegetation and hydrodynamics

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Flow regime, riparian vegetation and geomorphic context are inherently bound by a relationship of mutual dependency. Such dependence is expressed by various combinations that originate typical riparian vegetation spatio-temporal patterns and fluvial forms in response to climatic and hydrodynamic drivers. Over the last years, the scientific and technical knowledge developed in river sciences allowed the implementation of many hydrodynamic, sediment transport and vegetation simulation models. However, these models are often focusing on one single ecosystem component hence neglecting the above mentioned relationships. To fill this gap, we implemented a dynamic floodplain vegetation-hydrodynamic model that simulates the spatio-temporal evolution of riparian vegetation in response to hydrodynamic variables. Main model components are an adapted version of CASiMIR vegetation and the commercial hydrodynamic model Hydr_AS-2D. To couple these two models a custom interface has been developed that handles the data transfer between the two applications. Main feature of the interface is the capability of performing the conversion to and from two different spatial data models (raster vs. mesh). The conversion is required because CASiMIR consumes and produces spatial data in raster format while Hydr_AS-2D spatial model is based on an unstructured mesh. During the course of the simulation, data exchange between the two models proceeds in automated fashion; CASiMIR provides a roughness grid as input to Hydro_AS-2D while this model supplies to CASiMIR the necessary data (mean water elevation, bed shear stress, stream power and inundation duration) to simulate progression or retrogression of vegetation stages. The simulation time step is one year and the outputs are in both spatial and tabular form. The developed prototype represents an advance towards a more comprehensive representation of riparian ecosystems and is hence a first step towards integrated ”hydro-biodynamic” modeling of fluvial processes. The applicability fields of the prototype encompass all those situations where a long-term simulation of the riparian landscape is required (e.g. river restoration, dam operation scenarios etc.). So far, the prototype was tested in several case studies (see ”An integrated dynamic simulation model, CASiMIR Vegetation application at the Schwechat River”), for different river types found in different climatic zones.

3.29 Spatio-temporal dynamic modeling of plant communities responses to hydrological pressures in a semiarid Mediterranean wetland

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Semiarid Mediterranean saline wetlands are semi-terrestrial ecosystems, which yearly undergo dry periods of several months, and shelter a rich, endemic and sensitive biota. In the last decades, the expansion of agricultural irrigated areas in semiarid Mediterranean catchments has led to altered inputs of water and nutrients to lowland wetlands. Hydrological alterations have affected characteristic plant communities, resulting in the replacement of valuable halophilic salt marsh and salt steppe plant communities by more generalist and opportunistic taxa like reed beds. Thus, assessment of plant communities is considered an important aspect for evaluating wetland condition. This study aims to develop a spatio-temporal dynamic model of three characteristic wetland plant communities in response to hydrological pressures from the catchment in a semiarid Mediterranean wetland site. Wetland plant communities and watershed irrigated agricultural areas were mapped by means of remote sensing at several dates between 1984 and 2008 and then used as calibration data. A dynamic 0D model was initially developed using Stella software and then converted into a R script by means of the StellaR software. Spatial dimension of the model was included using the 'raster' R package and differential equations were solved using the 'deSolve' R package. Neighbourhood relationships and spatial flows that represent plant communities expansion have been developed and tested. Results show that in 2008 salt steppe had lost more than a half of its original area. On the contrary, reed beds, practically absent in 1984, occupied an important area in 2008, after an important expansion process since 1995. The relative changes between salt steppe, salt marsh and reed beds can be explained by the interaction between soil moisture and conductivity gradients, mediated by the distance to ephemeral channels and the flow accumulation maps. The initial increase of water inflows from the basin resulted in increased soil moisture and higher salinity, which favored the expansion of salt marsh at the expense of salt steppe. At a later stage, around 1995, the increased water inputs reduced water salinity and allowed the expansion of reed beds. The model reproduces this pattern of change along time.

3.30 Lagrangian Coherent Structures: A Tool for the Simultaneous Evaluation of Individual and Integrated Properties of Ecological Flows

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The numerical modeling of complex ecological interactions is a rapidly growing field in scope and availability. A key issue when determining what type of model to apply is the choice of studying either individual interactions or the behavior of the system at large via the integration of parameters. The viewing of individuals and their interactions is carried out from the Lagrangian perspective, whereas the viewing of integrated ecological properties is done using an Eulerian perspective. Recent advances in mathematical physics have introduced a methodology which allows for the simultaneous viewing of Lagrangian and Eulerian perspectives by mapping the time evolution of the Finite-Time Lyapunov Exponent (FTLE) field. By viewing the FTLE fields, it becomes possible to identify discrete regions of cumulative individual behavior, or Lagrangian Coherent Structures (LCS). Thus far, LCS have proven to provide valuable linkages in the fields of transport, animal locomotion, and turbulence. In this work, we introduce the concept FTLE fields and their corresponding LCS through an example in ecohydraulic modeling.

3.31 Modeling the water outflow in an arable ecosystem

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The quantity and quality of surface and ground water are of primary importance for species distribution, community composition, and ecosystem processes. Thus, the protection of the surface and the ground water from pollution is important for protecting arable ecosystems. Such protection can be achieved by successful implementation of environmental mitigation strategies, which are mainly based on predictions of soil water outflows from the agricultural fields to the surface water of arable ecosystems. There is a clear need to develop models capable of predicting the water quantity and quality across an arable ecosystem at the field scale. Such models are important if we want to understand the possibilities for protecting the species in arable ecosystems and reduce the negative consequences of water pollution on their habitats. Modelling water flows at the field level is mainly based on mechanistic approaches combining a theoretical description of different water flows in the soil and data from field experiments (used for calibration and validation of the models). On one hand, such a modelling approach is expensive to parameterize. On the other hand, the models are in general too broad in their predictions, which can lead to incorrect interpretation of their results. In this study, we propose a new approach to model soil drainage water flow and surface runoff in an arable ecosystem at field level. We use a methodology based on machine learning and data mining techniques, i.e. supervised learning. Our focus is mainly on describing the process of water flow through soil and accurately predicting the amount of drained water. The methodology is applied on data collected from the experimental station La Jaillière, France. Data form 11 fields are collected daily since 1987. The data describe the meteorological conditions, applied agricultural practices, crop development, the amount of drainage and runoff outflows, and the concentration of the active substances in the drainage and runoff water. The high accuracy of the learned models confirms their reliability in predicting the amount of water outflows, either as drained or surface runoff water from the fields. The results contribute new knowledge to the general understandings of processes involved in the water cycle in arable ecosystem and its outflows. They are of practical importance, as these processes present one of the largest pollution sources of surface and ground water in arable ecosystems.

3.32 River ecosystem assessment based on exergy efficiency

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Physical habitat simulation model and ecological model which have been widely used is effective to evaluating the habitat of fish and the water quality. However, these models are not enough to evaluate the health of the river ecosystem. At the present time, the integrated assessment of the river ecosystem, which is based on detailed investigations of fish, aquatic animal, attached algae and water qualities, has been conducted. The results of these investigations are difficult to understand and judge the health of the river ecosystem, and therefore the universal and easy-to-understand assessment of the river ecosystem is needed. River environment has been assessed by water quality index such as BOD and COD. But the increase of interest on the river environment induces the request for the assessment of river ecosystem.

In this steady, the assessment method of river ecosystem based on exergy efficiency is developed. In this assessment, exergy (effective energy) budget in a certain section of river is considered. The supply sources of exergy in a river ecosystem are light exergy for photosynthetic activity Exs and exergy of organic materials (detritus) on riverbed Exid which are supplied from water shed area during flood. When the river ecosystem recovers after flood, the exergies of organic materials and organisms consist of attached algae Exa, aquatic animal Exi and detritus Exd. Consequently, exergy efficiency ? between the initialization by flood and the recovery is calculated by the ratio of organism exergy produced in system (=Exd+ Exa+ Exi+ Exf) to exergy supplied from outside of system (=Exid+ Exs). In this definition, the initialization by flood means the renewal of attached algae on the riverbed.

The assessment method of river ecosystem based on exergy efficiency was applied to several points in Saba River. Field observations of water quality, river sediment and amount of detritus, attached algae and benthic animal were conducted at 8 points in Saba River. The temporal variations of exergy efficiency at 4 points of Saba River were estimated by these observation results and the prediction model of attached algae and benthic animal. The result shows that the exergy efficiency can clarify the difference of the soundness of river ecosystem between the 4 points of Saba River, where no significant difference was observed in terms of water quality and river sediment.

3.33 Ecological Modeling of Regional Sustainability: A Case Study from Xinhai, Chongming Island, China

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Modelling sustainability at a regional scale is an essential focus for understanding and achieving sustainable development goals. Ecosystem services contribute to human welfare directly and indirectly, therefor sustainability of development is necessary to be assessed from ecological view. Xinhai, the study site, with an area of about 105 square kilometers and a population of about 21,300, is located in the western Chongming Island in China. Two models were made for indicating the sustainability of this area. The carbon model obtained all the processes that involve carbon, including natural functions and human activities. The eco-exergy model calculated the work energy of ecosystem, which can represent the capacity of ecosystem services. The result from models showed a complete carbon balance (net carbon emission is zero) and eco-exergy with flat or growth depended on upgrading of the economic structure, optimization of energy consumption and extension of ecological capacities.

3.34 Modelling of Basic Tendencies in Ecosystem Development by cyclical-organized System of Linear Ordinary Differential Equations

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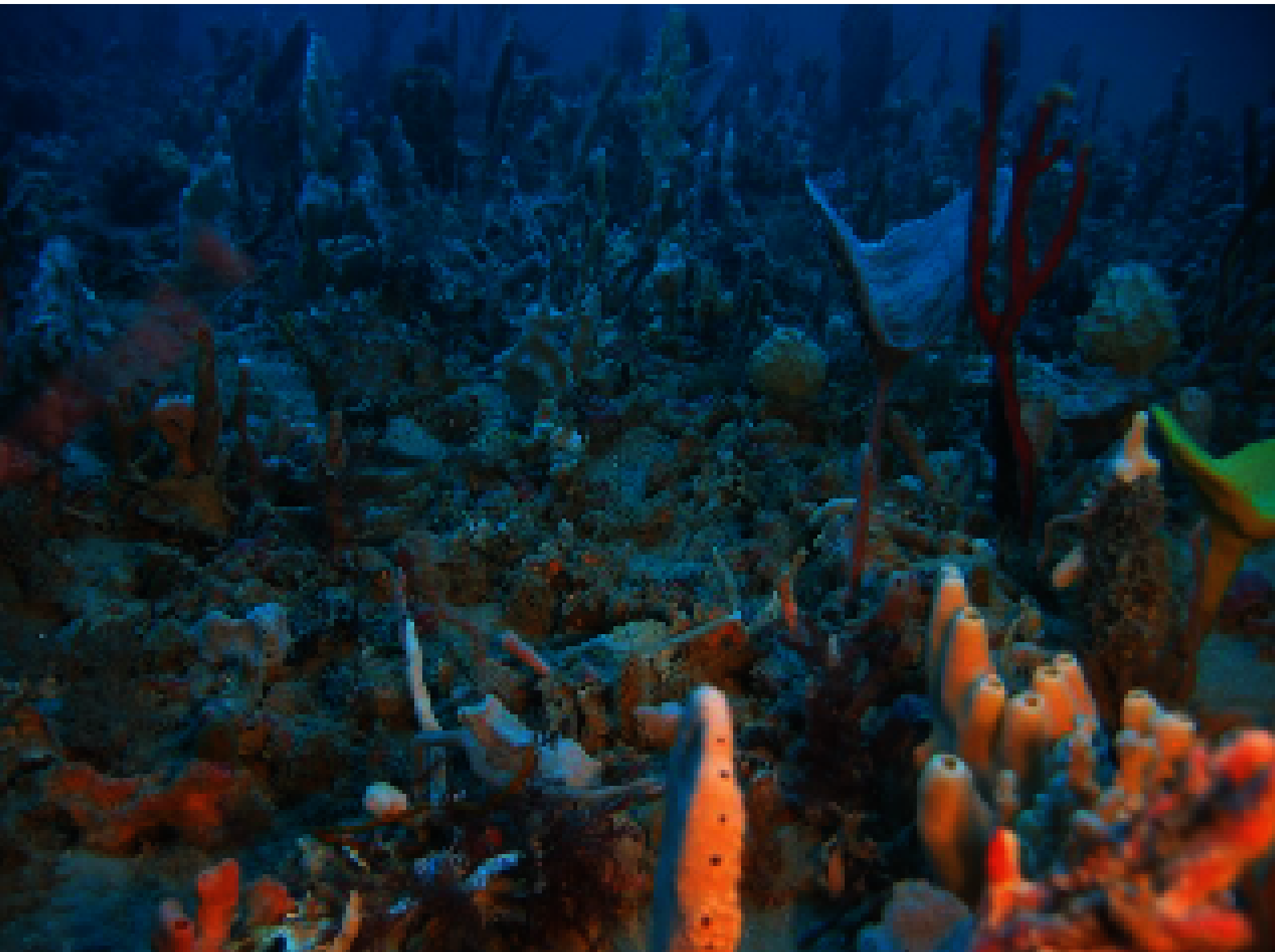
The mathematical model of two joined matter flows forming ecosystem dynamics has been elaborated. These flows are considered as result of linkage of vegetation productivity (or microbial productivity - in microecosystems) and organic matter destruction in ecosystem. The model can be also interpreted as a model of ecological succession or as a model of turnover of organic matter during ecosystem development. It is represented by a system of linear ordinary differential equations with constant coefficients. There are two special groups of variables in the model. They simulate dynamics of "substrate" X=(x0, x1, . . ., xn) and "biomass" Y=(y0, y1, . . ., xn). The n number is equal to the number of successive communities watched in the ecosystem. There are two constants in the model: constant biomass growth rate (or uptake rate from substratum) "a" and biomass death rate (or rate of matter return in substratum) "b". The numerical values "a" and "b" are equal to 0.0382/CUT and to 0.00618/CUT, correspondingly (CUT - conditional unit of time). This assessment of the rates were done according to data of soil microecosystem described below. They are not changing for all pools of "substrate" X and "biomass" Y. The model is developed as follows. The amount of matter from a substrate pool xi is transforming into biomass pool yi+1. The corresponding part of pool yi+1 is returning to a substrate (to a pool xi+1). This process is repeating for all i = 0, 1, . . ., n. As a result the cyclicsystem of linear ordinary differential equations could be written as: dX/dt=bY-aX, dY/dt=aX-bY. The model is a central point for modelling method of ecosystem development introduced here. Using this model, it is possible to analyze concrete ecosystem processes. It is necessary to add corresponding equations in this case to the depicted above cycle-system. The model is applied to the forest and laboratory microecosystems data taken from literature. First, some age trends of biomass and its annual increments in forest ecosystems, which take place in different geographic provinces of Northern Eurasia, are represented. Two successive communities developing within 300 (or 120) years in each of these forest ecosystems were detected and are counted by the model. Second, wheat straw decomposition in a laboratory soil ecosystem and selenium compounds transformation in lake sediments are also represented. Successions of microorganisms were detected as a result of numerical analysis of dynamics of the corresponding chemical elements (nitrogen or selenium) in these microecosystems and are counted by the model. It has allowed also to explain some features of dynamics of the CO2 production during the wheat straw decomposition. The validation of models using literature data is good. Thus, the model has following features. It allows for description of the ecosystem development at different level, from microecosystem up to forest ecosystem. Modelling of ecosystems differs by adding of several equations, which are specific for the ecosystem under consideration. However its structure is not changing as well as numerical values of constants "a" and "b". Conditional unit of time only changes its

Biogeochemistry and ecotoxicology (BAE)



4.1 Long-term increase in diatom abundances in Lake Kasumigaura, Japan: An effect of silicon release from resuspended sediments ?

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Factors for the increase in diatom abundances in Japanese eutrophic Lake Kasumigaura during 1981–2010 were assessed by database analysis and model simulation. The relationships with dissolved silicon (DSi) were especially focused since those concentrations increased simultaneously, which probably caused by release from resuspended sediments (Arai et al., 2012). The observation of such long-term trends in lakes is rare; therefore, analyzing their relationships is useful to assess the influences of DSi concentration changes on diatom blooms. Based on the monthly dataset, N:P:Si ratios suggested that Si was the element most limiting diatom growth after DSi depletion. The seasonal relationships between DSi and diatoms showed a hysteresis loop, representing as follows: (i) diatom growth by uptake of DSi in a better state (e.g., at optimal temperature), (ii) rapid sinking of diatoms after DSi depletion, and (iii) no diatoms with DSi supply from river inputs and release. The relationships were mostly characterized as a two-round loop during the 1980s (spring and autumn diatom blooms), while a one-round big loop during the 2000s (extensive winter–spring blooms). Modeling and simulation of major processes involved in DSi (inflows, outflow, uptake by diatoms, and release from bottom and resuspended sediments determined by our laboratory experiments) and diatoms (outflow, sinking, and growth limited by light condition, water temperature, and DSi concentration) showed a one-round big loop during the 2000s. Diatom abundances declined with the release from resuspended sediments removed, indicating the impacts of the recent release on diatom blooms in the lake. Simulation also suggested that DSi release and degradation of light condition by resuspension might cause the change of the loop from two-round to one-round. These findings implicate the significance of the interactions between sediments and water to phytoplankton blooms.

4.2 Eutrophication of turbid tropical reservoirs: Biogeochemical modeling for the case of Cointzio, Mexico

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The overall water quality of lakes and reservoirs in many regions of Mexico continues to deteriorate. The Cointzio reservoir (capacity 70 Mm3), located in the southern part of the Mexican Central Plateau on the Trans-Mexican Volcanic Belt, is no exception. The region has a temperate sub-humid climate with the wet season occurring from June to October. The reservoir drains a volcanic watershed of 627 km2, where domestic waters are rejected without treatment. It is an essential component of the drinking water supply (20 %) of Morelia city (1 000 000 inhabitants) and for downstream irrigation during the dry season (January to June). The high content of very fine clay particles and the lack of water treatment plants lead to serious episodes of eutrophication, high level of turbidity and benthic anoxia as evidenced from an intensive field survey in 2009. Low secchi depth (< 30 cm) and high phosphate concentrations (0.5 mgP L-1) have led to high Chlorophyll a concentrations (up to 70 µg L-1) concentrated in the near surface of the reservoir. Anoxic conditions persisted in the hypolimnion during six months (May to October). The present paper aims at examining the ability of vertical one dimensional (1DV) numerical models to reproduce the main biogeochemical cycles in such a water body and to test several possible scenarios corresponding to different options to reduce nutrient loads (P and N) to the reservoir. A physical mixing model using a k-epsilon scheme and a biogeochemical advection-diffusion-reaction model (Aquasim) were implemented. The k-epsilon model accurately reproduced water temperature profiles with a low to moderate density stratification, as compared to less turbid environments. The Aquasim biogeochemical model was able to reproduce the main patterns of Dissolved Oxygen (DO), Phosphate and Chlorophyll a concentrations within the Cointzio reservoir during the target year 2009. The results of simulations of different scenarios will be discussed in term of water quality improvement regarding efforts in nutrients inputs reduction. To our knowledge, this study provides the first numerical application of Aquasim to simulate high eutrophication levels in a very turbid tropical reservoir. It points out the advantages and limitations of such operational 1DV models and thus will help stakeholders to adopt appropriate strategies for the management of such turbid tropical reservoirs.

4.3 Applying AQUATOX foodweb model in determining the ecological risk of PAHs in Baiyangdian Lake, North China

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There is a growing interest in the application of ecological models to improve the ecological risk assessment (ERA) of chemicals. For this study, the AQUATOX model was adapted using 18 pelagic and benthic populations derived from field data obtained at Baiyangdian Lake between April 2009 and March 2010. The model was evaluated to examine its utility in assessing the ecological risk of nutrients in aquatic ecosystems. Model parameters were calibrated to simulate the complex seasonal patterns of Baiyangdian Lake biomass populations. Sensitivity analysis revealed the potential importance of indirect effects and demonstrated the vital role of parameter values in determining the biomass of each trophic level. The model was highly sensitive to parameters related to temperature limitations and respiration rates. Moreover, it was effective in estimating risks associated with the direct toxic effects of PAHs for each population and the indirect ecological effects distributed through the coupled pelagic-benthic food web. Comparison analysis determined the model could provide a good basis in ascertaining ecological protection levels of "chemicals of concern" for aquatic ecosystems. Furthermore, AQUATOX can potentially be used to provide necessary information corresponding to early warning and rapid forecasting of pollutant transport and fate in the management of chemicals that put aquatic ecosystems at risk.

4.4 Can organisms regulate global biogeochemical cycles?

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Human activities are profoundly modifying the global biogeochemical cycles of key elements such as carbon, nitrogen and phosphorus, mostly through increased nutrient supply. Given these massive alterations, it is critical to understand to what extent and how global biogeochemical cycles are regulated. Resource consumption is the most common regulatory process at local scales, but most of resources are inaccessible for organisms at global scales. We built a generic model of resource access limitation to elucidate the ability of organisms to regulate nutrient pools in both accessible and inaccessible form and thereby the biogeochemical cycles of these nutrients at global scales. Our model predicts that either autotrophic organisms have a strong impact on accessible pools and exert weak regulation on the rest of the system, or they have a weak impact on accessible pools and exert stronger regulation on the rest of the system. We applied this generic model to nitrogen and phosphorus cycles in the ocean by describing the dynamics of both nutrients and two autotrophic populations, nitrogen-fixers and non-fixers. Changes in nitrogen supply appear totally absorbed by organisms contrary to phosphorus supply, probably as a result of nitrogen fixation, which allows nitrogen cycle to be more adaptable than phosphorus cycle. Although nutrient concentrations in the inaccessible layer are incompletely regulated with respect to changes in the phosphorus supply, nutrient ratio is almost perfectly regulated. Our results suggest that organisms may be able to regulate nutrient ratios in their environment, but it seems unlikely that they can efficiently regulate both the accessible and inaccessible pools.

4.5 Combined effect of atmospheric nitrogen deposition and climate change on temperate forest soil biogeochemistry: a modelling approach

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Anthropogenic activities highly contributed to increase nitrogen (N) and sulfur (S) atmospheric emissions since 1880. Since the 1980s, within Geneva Convention on Long-Range Transboundary Air Pollution, European countries have joined their efforts to abate atmospheric pollution. In France, atmospheric S emissions decreased by 80% whereas the decrease was less obvious for N. Thus, atmospheric deposition and effects of N on ecosystems remain a major research challenge during last decades. Atmospheric N deposition is known to severely impacts forest ecosystem functioning by influencing soil biogeochemistry and nutrients balance, and consequently, tree growth and global forest health and biodiversity. To assess the impact of N deposition on ecosystems, the concept of "N critical loads", defined as the maximum N deposition that an ecosystem can tolerate without any harmful effects and changes, was developed. Moreover, because climate influences greatly soil processes, climate change and atmospheric deposition must be conjointly taken into account to assess the evolution of forest ecosystem status over time.

To test different scenarios and their potential interactions on the long term, dynamic biogeochemical models such as ForSAFE have been developed. Here, we run this model to predict the combined effect of atmospheric deposition and climate change on two temperate French forest ecosystems dominated by oak and spruce, and more precisely on forest soil biogeochemistry, from nowadays to 2100. Two atmospheric N deposition scenarios were tested (CLE – Current Legislation in Europe – and MFR – Maximum Feasible Reduction) combined to three climate SRES scenarios from IPCC (current, A2 – the worst climate scenario – and B1 – the best climate scenario). After a step of calibration and validation, the changes in base saturation and N content in soil were compared between all these scenarios combinations and N critical loads were estimated and discussed. Thus, acidification and eutrophication recovery of the two forest ecosystems could be predicted up to 2100.

4.6 Modelling of E.coli transport in river waters as a means to investigate relationships between settlements within the riparian zone and faecal pollution of water bodies.

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The naturally oligotrophic rivers of northern Sweden are generally characterized by a low pollution level and high hygienic quality. E.coli, an indicator of fresh faecal contamination, shows however increasing trends and two recent outbreaks of the Cryptosporidium parasite in city drinking water supplies has caused great concern about drinking water security and ecological status of water bodies. There is also an increasing demand for scenic plots of land close to rivers and lakes for both permanent dwellings and holiday cottages and there is a need for better understanding of relationships between settlements within the riparian zone and river water quality.

Measurements of E.coli are made at fixed sampling points along the river. A transport model for E.coli in river water was developed based on literature data for E.coli inactivation rates, water temperature and hydrological conditions. The model was used to estimate the source distance upstream each sampling point in the investigated section of the river. This procedure enabled the establishment of sections of the river that could influence each sampling point by point or diffuse emissions of E.coli. Studies on human development within the riparian zone of each section could then be related to E.coli data at the sampling points.

Data on the latest 20 years of development within the riparian zone was gathered from the local municipality archive which contains information on all new and changed properties. The development data was compared to 18 years long time series of seasonal water quality measurement in the studied river. The analysis also considers the effects of known point sources of faecal pollution within the investigated sections such as discharge from municipal sewage treatment plants.

This study shows that E.coli is transported considerably longer during winter compared to summer in a regulated section of the river. Lower water temperatures in the winter increases the survival time of E.coli but there is also a strong effect of water regulation for hydro-electric power generation that completely changes the water flow pattern to relatively higher flow during the wintertime compared to non regulated parts of the river. Both these effects increases the transport distance of E.coli. The study also shows the importance of considering the features of the nearby water body when planning for new settlements.

4.7 Modelling trace metals in a large river (The Garonne, SW France) by coupling the MOHID hydrodynamic model to the WHAM7 chemical speciation model

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Surface water contamination by trace metals (TM) is becoming a major environmental problem. Concentrations of TM in aquatic ecosystems can sometimes reach critical values for biota and ecosystem functioning. The importance and bioavailability of TM in rivers varies according to their sources, to the chemical and mineralogical state of the suspended particulate matter (SPM) and to in situ conditions such as hydrology, morphology and the physico-chemistry of the river. Existing river models frequently use a constant partition coefficient (Kd) to quantify metal distribution between SPM-adsorbed and dissolved forms. However, since Kd depends on the physico-chemistry of the water and the SPM, this formulation offers poor predictive power. A model describing the fate of TM along a river must then identify the main spatial and temporal processes affecting their Kds in addition to hydrodynamic and hydromorphological processes. In this work, the MOHID (www.mohid.com) model is used to solve the hydrodynamic St-Venant equations and the transport of dissolved elements by advection and dispersion. The model also simulates the erosion and deposition of SPM. However, MOHID is not adapted to model the complex sorption-desorption processes of TMs, expressed through variable Kds. This problem has been tackled by coupling MOHID to the speciation model WHAM7 (Windermere Humic Aqueous Model). WHAM7 is designed to consider the competitive binding of protons and metals to organic matter, mineral oxides and clays and so can calculate Kds for TM based on water and SPM physico-chemistry. The coupling of MOHID and WHAM7 has been tested across contrasting hydrological conditions on a section of the Garonne River (Southwestern France). A range of field sampling conditions across a network of 17 sampling sites (Garonne River and its principal tributaries) were considered according to hydrological conditions. Two TM were simulated to assess the performance of the model: uranium for its relatively high solubility, and lead for its high affinity with SPM and low solubility in the pH range of the system. Sensitivity analysis was performed to assess the relative importance of the different model parameters. In the longer term, this work seeks to advance knowledge of the important processes affecting riverine TM transfer and fate and to improve the hydro-biogeochemical modelling of TMs at the river continuum scale.

4.8 Modelling flow and contaminant transport in a floodplain area with MOHID model and role of the hyporheic zone: the case of the Garonne River (SW France).

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River and groundwater contamination by pollutants coming from agricultural areas has become a major concern for European environmental policies as well as for local stakeholders. Alluvial floodplains present an interesting case study for water quality and contaminants dynamics as they are characterized by a good connection with the river, a shallow groundwater level and support large agricultural activities. At the interface between surface water and groundwater, hyporheic zones of these fluvial hydrosystems present important river-aquifer exchanges and previous works have shown the key role of these areas in biogeochemical processes. In order to provide knowledge on contaminants transport and to quantify the role of the hyporheic zones in alluvial plains in biogeochemical processes, a modelling approach has been used based on hydrological and biogeochemical data. The fully-distributed and eco-hydrological model MOHID (www.mohid.com) has been applied to a study site located in the Garonne River floodplain, (South-West France). The hydrodynamic model is solving 3D Richards equation in the porous media, 1D St-Venant equation in the drainage network and 2D St-Venant equation for overland flow. Properties (as nitrate) can be transported in between compartments and transformed by biological processes in soil and river (e.g. mineralization, nitrification, denitrification). A large network of about 30 piezometers installed within the study-site (surface area 13 km2) provides a long-term and high-resolution calibration dataset of groundwater level and contaminants concentrations within the aquifer. Results show the ability of the model to represent hydrodynamic in permanent and transient flow conditions and contaminant transport within the fluvial hydrosystem. Especially, overland flow during flood events is well simulated. Simulations of river-aquifer exchanges underline the importance of the river as a main source of organic carbon – that plays a major role in denitrification process - for the hyporheic zone. Keywords: MOHID, hyporheic zone, flooplain, modelling, groundwater, biogeochemistry

4.9 Utilization of carbon in NPZ model of Hooghly estuarine system, India

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Hooghly estuary along with the luxurious mangroves of the Sundarbans, is one of the important estuaries of India. A quite rich mangrove forest patch in association with the creeks is visible at Sagar island, the largest island in the row. Degradation and leaching of litter provides nutrient for the growth and development of phytoplankton which in turn strengthens the grazing food chain from zooplankton to fish. Phytoplankton growth is influenced by solar radiation, nutrient and temperature. The model incorporates light acclimation by algae, self-shading, photosynthetic production and nutrient uptake. Water quality changes with seasons. The model uses the functional relations among the three state variables as observed in response to the changeable environment throughout the year there. The model is calibrated and validated taking carbon as the currency of the model. Dissolved inorganic carbon as nutrient, water temperature, surface solar irradiance, and salinity of upstream and downstream of the estuary are collected from the field. Model results indicate that the growth of zooplankton and phytoplankton are enhanced by increasing nutrient input in the system. The predicted temporal distribution and trends of plankton biomass, inorganic carbon is in general agreement with field observations. Sensitivity analysis at ±10% level has been done. The model captures the dynamics of plankton population, which serve as major food source for fish species of the estuary. This model could be predictive in search for the role of mangrove in estuary and its control on nutrient and plankton dynamics of this region which will be helpful in management aspect.

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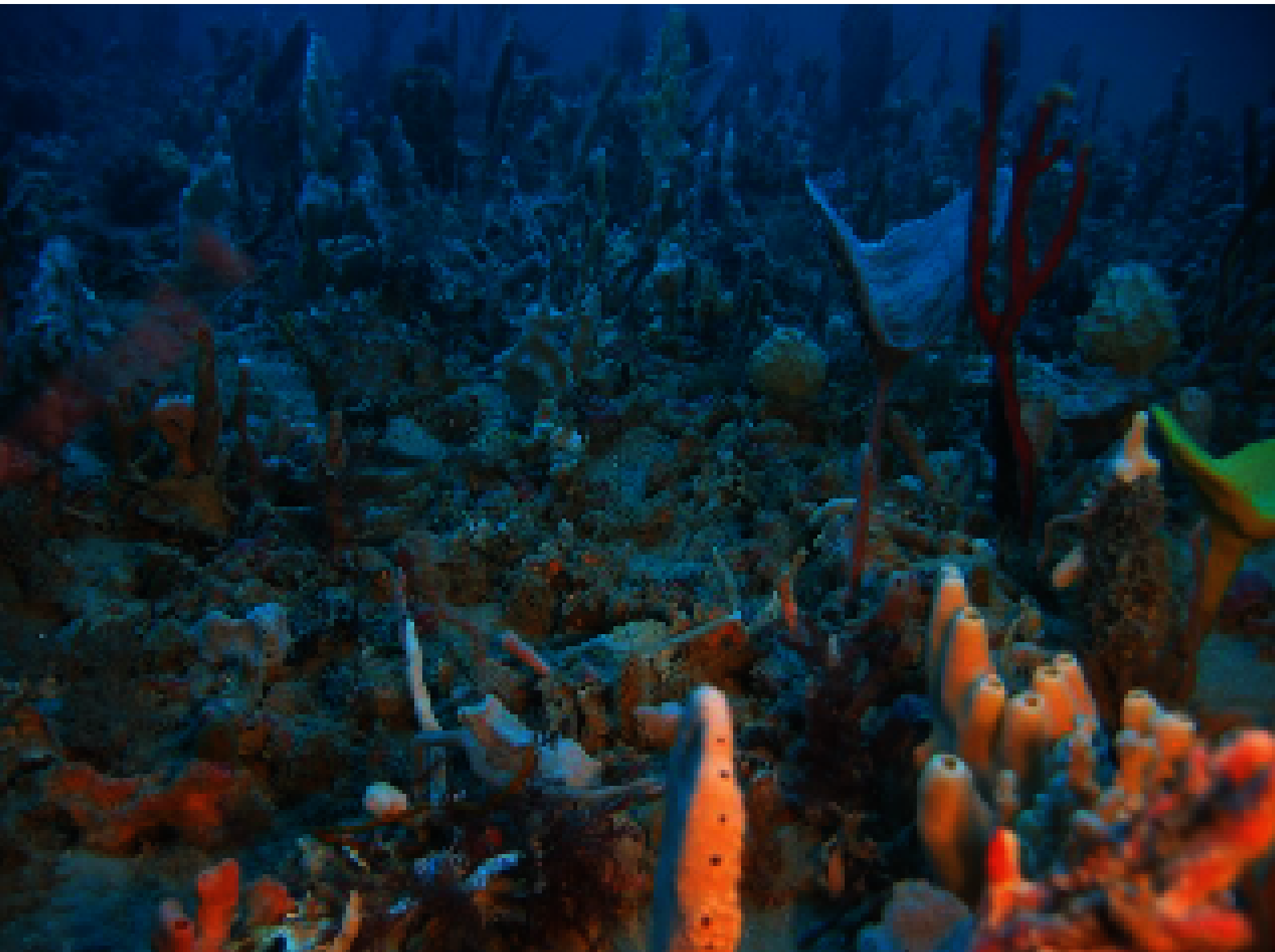

5.1 Likelihood-free inference for complex mechanistic models: calibrating the forest dynamics model Samsara2 with historical management data and prior knowledge.

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Ecological research increasingly relies on model-based inference. Often, models are too complex, or available data too coarse, so that standard likelihood-based methods cannot be used to estimate the model parameters. In those cases, a number of likelihood-free methods have been proposed. However, these methods rely on intensive model simulations, so that most applications have been restricted to relatively simple models with few parameters. We are here interested in the use of such methods with more complex models involving a large number of parameters. Calibrating these model parameters generally require a large amount of detailed data, which are yet only available in a small number of sites. In this study, we used aggregated data coming from historical management and we tested the limitations of current approximate Bayesian computation (ABC) approaches on the forest dynamics model Samsara2. Specifically, we used a 60 years-long temporal series to estimate the most influent parameters of tree growth and recruitment, by integrating prior knowledge on model parameters. We addressed four questions: (1) Is it possible to reach a reasonable posterior approximation of model parameters with a drastically limited number of simulations and relatively coarse data? (2) How many model parameters can be estimated with this approach and is this number limited by the number of simulations? (3) How much estimated parameters uncertainty is increased when propagating other model parameters and forest initial state uncertainties? (4) Is the method powerful enough to detect interspecific, spatial and temporal variations in population dynamics? With a relative small number of simulations and an appropriate choice of the model parameters, we demonstrated the relevance of the ABC technique to calibrate a complex model such as Samsara2. Our approach illustrates how detailed knowledge on ecological processes drawn from the literature or from detailed field studies can be combined with more widely available coarse data to calibrate complex mechanistic models. This approach potentially enables to perform the calibration of complex models to a large number of field sites, for which coarse data are available, instead of being restricted to the few sites were detailed studies have been conducted.

5.2 A food web simulation study on the effect of FADs on skipjack tuna on the Atlantic Ocean

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Skipjack tuna (Katsuwonus pelamis) is a widely distributed and highly exploited pelagic fish commonly found in tropical waters. This species is known to associate with natural and artificial floating objects. Since the early 1990s an increasing number of artificial Fish Aggregating Devices (FADs) have been deployed by fishermen to attract and aggregate tuna. Nowadays the majority of skipjack tuna catches operated by purse seiners occur in association with FADs. However, the consequences of this fishing strategy on the skipjack population and on the ecosystem are difficult to assess. Our aim is to investigate the impact of FADs on skipjack tuna communities using a network model to simulate the marine food web. We present a stochastic food web model that combines interactions of tuna with FADs and predator-prey behavior with different species. Tunas associated with FADs change their interaction rates w.r.t. their behavior as free individuals. For simplicity, we built a small food web, composed by 8 nodes. We performed stochastic simulations and sensitivity analysis on this dynamical system and determined the dependencies between various trophic components. This kind of study allow to understand if the massive deployment of FADs is detrimental for tuna's population and it will help to give useful guidelines for future sustainable management strategies of tuna fisheries.

5.3 Sensitivity analysis techniques for computationally expensive models: interest and applicability of two techniques illustrated with the case of mixed and uneven-aged mountain forests

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Recent studies have shown a growing interest in studying the response of ecosystem services (ES) to management scenarios. Due to the high complexity of ecosystem functioning, simulation models show a tendency towards increasing sophistication, coupling accurate modelling of management practices, species specific demographic processes, and explicit consideration of the environment. The resulting modelling systems generally involve numerous input parameters, requiring weighty experiment designs to refine the response of ES indicators to management, especially when aiming at studying the interactions between parameters. Sensitivity analysis (SA) techniques appear very useful in this context, as they enable the detection of influent factors and interactions. In this study, we especially addressed the issues encountered by complex and computationally expensive models, for which the applicability of many SA techniques is made impossible by the limited number of simulations conceivable. Our aim was thus to illustrate the interest and applicability of two SA techniques to study ES responses to management, based on the example of mixed and uneven-aged mountain forests. We used the spatially explicit and individual-based model Samsara2 to simulate forest natural dynamics, and a recently developed silviculture algorithm (UMA) to simulate uneven-aged management. We focused the study on two major forest ES: timber production and biodiversity conservation, which were assessed by several indicators (harvested timber volume, dead wood volume, floristic diversity...). First, we used a screening method (Morris) to detect the most influent factors (management and demographic parameters). Second, we used a metamodelling approach, i.e. the building of simplified models for each ES indicator, based on multiple regressions on influent factors. We then analysed the metamodels to identify the ranges of forest management and demographic parameters compatible with ES provision. Our results demonstrated the good applicability of these SA techniques in the case of time-consuming models, as well as their interest to accurately analyse the response of ES to management. A good understanding of the interactions between management and demographic parameters is also essential, especially in the context of climate change, which is expected to influence demographic process and thus modify the response of ecosystems to management.

5.4 Surface modelling of climatic change and its impacts on Ecosystems

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Surfaces of mean annual temperature (MAT) and mean annual precipitation (MAP) in Poyang Lake Basin of China since 1951 are simulated by means of a high accuracy and speed method (HASM) for surface modelling, using data from 100 weather observation stations scattered over and around Poyang Lake Basin. Methodologically, we analyzed HASM simulation accuracy of the climatic surfaces by comparing with results from classical methods such as IDW, Kriging and Spline. The analysis indicated that HASM accuracies of MAT surfaces are 88%, 109% and 129% higher than IDW, Kriging and Spline respectively. HASM accuracies of MAP surfaces are respectively 171%, 294% and 116% higher comparing with ones of IDW, Kriging and Spline. The bigger errors of the classical methods have led to a great distortion of spatial ecosystem pattern so that the results from HASM is employed to analyzing climate and ecosystem change in Poyang Lake Basin. The simulation results from HASM show that MAT was respectively 16.64℃ and 17.25℃ in the periods from 1951 to 1980 (P1) and from 1981 to 2010 (P2). MAP was 1595 mm and 1707 mm respectively in the P1 and P2. In other words, climate has become warmer and wetter in recent 60 years. The climate change has led to a considerable change of spatial pattern of ecosystems. Cool temperate moist forest decreased by 98% and warm temperate wet forest decreased by 36%, while warm temperate wet forest increased by 116% and subtropical moist forest increased 18% in the P2 comparing the ones in the P1.

5.5 Modeling the risk of highly pathogenic avian influenza H5N1 in wild birds and poultry in China

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Devastating epidemics of highly pathogenic avian influenza (HPAI) H5N1 in wild birds and poultry in China has underlined the need for improved understanding of the risk factors promoting the outbreaks and for identifying the high risk areas of outbreaks. There has been limited research on risk modelling of the HPAI H5N1 cases in wild birds and poultry in China. Here we applied a spatial regression model which consisted of a generalized linear mixed model (GLMM) and a variogram model to predict the HPAI H5N1 cases in China. GLMM was used to extract the association between each of the ten environmental variables and the HPAI H5N1 cases in wild birds and poultry. By adding a random term, GLMM incorporated a variogram model that reflects the spatial autocorrelation of the outbreaks among wild birds and poultry. The results showed that four environmental variables had significant effects on the number of cases of wild birds and poultry in China. These variables were annual mean temperature, poultry density, distance to lakes and wetlands, and minimum distance to the nearest bird migration route. Accuracy assessment demonstrated that the spatial regression model had desirable predictive ability. Furthermore, predicted relative risk map was produced based on the predicted number of H5N1 cases for each 10 km × 10 km pixel. This study identified that the high risk areas were in the northwest, middle, southwest and southeast part of China. These areas fall within two bird migration routes, Middle-Asia India Route and East Asia-Australia Western Pacific Route. This implies that wild birds and their migration may play an important role in spreading the HPAI H5N1 virus among wild birds and poultry in China. These findings will provide insights for our current understanding of the control and prevention strategies of the HPAI H5N1 outbreaks in China.

5.6 A new modelling framework to model species communities with habitat characteristics and species traits using hierarchical modelling

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Modelling ecological communities is often complicated because of the multivariate nature of the data. In addition, because most species in a community are rare the data gathered is often sparse making it difficult to obtain reliable inferences when constructing species specific models. To better understand how species distribute, ecologists have traditionally studied the relationship between species and their habitat. More recently, there has been a growing interest in including information on species traits in models to better distinguish the relationships species have among each other and with the environment. We propose a new modelling framework where habitat characteristics and species traits are used to model an ecological community through hierarchical modelling. Our approach can be used on data with various format (e.g. presence-absence and abundance) and makes it possible for linear as well as non-linear analyses to be carried out. In addition of the theoretical development proposed, we also designed an R package to perform different analyses within this modelling framework. We will illustrate the application of the method with simulated and real data.

5.7 Effects of grain size and data period on models of avian diversity using satellite imagery

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In this study we assess the capacity of satellite imagery to explain and predict bird community patterns during the breeding season in an agricultural landscape in south-west France. Precisely, our goal is to test the effect of the images' acquisition date and spatial resolution on the models' performance. We adopt an indirect approach using continuous data obtained from different sensors and assess whether these non-classified images provide results comparable with classified data (i.e. land-cover maps). To do that we constructed species richness models (generalized additive models) based on a sample of 573 counting points and on non-classified images made up of NDVI data and height data (DHM), making it possible to quantify the spatial and vertical heterogeneity of habitats. We compared the performance of NDVI data acquired on four different dates by the same sensor (SPOT-5). We also compared five NDVI images acquired over an identical period but by different sensors (WorldView-2, SPOT-5, SPOT-4, Landsat-5, MODIS) as well as two DHMs obtained from LiDAR (1m) and Radar (5m) data. The best models explain and predict the specific bird richness well (maximum $\%D^2$ comprised between 0.35 and 0.54 depending on the richness variable considered, maximum mean ρ comprised between 0.47 and 0.75).

Our results show that for a constant spatial resolution (10m) it is the NDVI data acquired at the beginning of the autumn that provide the best performance. Since, NDVI discriminates differently woody and open components of the landscape between the different periods of the year, the explanatory and predictive performances of the models vary. NDVI in October allow a better discrimination between crop areas and woody structures associated with high NDVI values, and thus better explain community patterns.

For a given period (September 2010), the higher resolution spatial data (2m) are the highest performing. However, in view of the cost of WorldView images, we suggest that 10m data (SPOT-5) provide a good trade-off for studying the distribution of bird communities.

For the height data (DHM), the effect of the spatial resolution is negligible. The differences of performance between the spatial resolutions of NDVI and height data are not as great as those between the data acquisition periods.

Finally, our results also reveal that for predictive purposes, the non-classified data (NDVI or DHM) constitute a good alternative to land-cover maps (discrete data) because they provide comparable levels of performance by choosing the optimum date and spatial resolution.

This suggests on the one hand that the choice of the NDVI image date is more important than that of the spatial resolution and on the other hand that the NDVI or DHM data can be used instead of classified data when constructing a bird-habitat predictive model.

5.8 Learning ensembles models of population dynamics and its application to modeling aquatic ecosystems

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Ensemble methods are machine learning methods that construct a set of models and combine their outputs into a single prediction. The models within an ensemble can have different structure and parameters and make diverse predictions. Ensembles achieve high predictive performance, benefiting from the diversity of the individual models and outperforming them.

Ensembles of models have been considered for different machine learning tasks, such as classification, regression and clustering, but not for the task of learning models of dynamic in the form of systems of ordinary differential equations (ODEs). Ensemble predictions have been recently considered for dynamic models of the climate system: However, these typically take a single climate model and generate diverse predictions by making small perturbations to the initial state from which the model is run or to the constant parameters of the model.

In our work, we develop approaches for learning ensemble (ODE) models of dynamic systems. We build upon existing equation discovery systems for learning ODE models of dynamic systems from observational data. After initial research on this topic, which used a completely empirical (data-driven) approach, recent have tried to integrate the theoretical and empirical paradigms for modeling dynamic systems: Besides observed data, they take into account domain knowledge. The latest developments in this area, i.e., the ProBMoT tool, use process-based formalism (focusing on entities and processes) to describe domain knowledge and ODE models.

We develop methods for learning diverse sets of ODE models by creating sub-samples of the observed data. Different bootstrap samples are created and ODE models learned from each of them, each of them being a constituent of the new ensemble. To make a prediction of the dynamics, each of the ODE models in the ensemble is simulated and their predictions combined.

We apply the proposed approach and evaluate its usefulness on a set of problems of automated modeling of population dynamics in aquatic ecosystems. Data on four lake ecosystems are used, together with a library of process-based domain knowledge. We evaluate the performance of ensemble models learned from the data and compare it to the performance of individual ODE models learned from the same data.

5.9 Relationship between the occurrence of SilverCarp larvae (Hypophthalmichthys molitrix) and hydrologic conditions in Pearl River

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The silver carp Hypophthalmichthys molitrix Cuvier et Valencinnes (Cyprinidae, Hypophthalmichthyinae), native to eastern Asian, is a large, commercially important fish in China. Asian silver carp has been introduced to many other countries for variable reasons and has become recently a nuisance. To understand the breeding characteristics of the Silvercarp bring a special importance both for the invasive population control and for the resource protection. Based on records from 2006 to 2011, we can find that from April to October the Silvercarp breedings vary from a minimum of 5 breeds to a maximum of 12 times a year. The breeding season occurs mainly from May to July. The Maximum yields occur in August by 80.4% of per year. The wavelet power spectrum (WPS) of daily discharge and the amount of larvae monitored from 2006-2011 provide a highly compressed and integrative picture of the relationships between them. According to the relationship between discharge patterns and the wavelet power spectrum of larvae Silver carp, on scale 8-10 (21-27days), we show that a significant positive correlation exists between the discharge and the amount of silver carp larvae. Moreover the fishes seem to be greatly affected by the flood peak. Sudden and repeated floods or hydrological fluctuations are required for Silver carp spawning, and hydrological fluctuation is the key factor stimulating fish outbreak spawning. Through statistical analysis of the flow data and larvae data, we found the amount of fish larvae caused by repeatedly hydrological fluctuations accounted for 72.5% of the total reproductive output from 2006-2011. The minimum daily water head and suitable daily discharge increase during the spawning season needed for the Silver carp breeding in the Pearl River is 3.49m and 13.59×103m3/s respectively. The period of repeated hydrological fluctuation stimulating fish outbreak spawning is 20-55 days. Restraining the repeated flow fluctuations and flood rise suddenly by hydrological regulation will be a preferable method to control propagation of silver carp.

5.10 Unraveling the relationships between freshwater invertebrate communities and interacting environmental factors

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Disentangling the influences of multiple environmental factors on ecosystem integrity is not straightforward, as environmental factors may interact and biotic responses may be non-linear. We aimed to unravel the relationships between freshwater invertebrate communities and multiple, interacting environmental factors. To that end, we analysed stream monitoring data of 689 sampling sites in the state of Ohio (USA) using Boosted Regression Trees (BRT). We used 16 environmental predictors covering geography, water chemistry, physical habitat quality and toxic pressure. Freshwater invertebrate communities were represented by the Invertebrate Community Index (ICI) and its 10 component metrics. The ICI was mainly related to physical habitat quality, nutrient concentrations (nitrogen and phosphorus), pH, latitude and watershed area. Comparison of the responses of the ICI and its component metrics revealed amplifying or cancelling effects of metric aggregation. Models including predictor interactions explained between 44 and 75% of the deviation in the biotic endpoints, while the baseline no-interactions models explained 38 to 67%. Different pairs of interacting predictors were identified across the biotic endpoints. Partial dependency plots illustrating the interactive effects showed that the biotic responses vary between models with and without interactions. Our study shows that taking into account predictor interactions may lead to higher model predictive accuracy, and emphasizes the usefulness of techniques like BRT which automatically explore possible interactions without a priori specifications.

5.11 The Pattern Trees, a new method to define local ecological preferenda: the case of French river diatoms.

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Diatoms are microscopic unicellular algae found in numerous environments like rivers, air or lakes. European Water Framework Directive requires the assessment of ecological quality of European surface water using biological indicators (bio-indication). Diatom assemblages are considered as good biological indicators due to species-specific sensitivity to local environmental conditions (ionic balance, nutrients...). The knowledge of species ecological preferenda is necessary to make correct interpretations in hydro-ecology. Ecological preferenda are usually defined with several methods such as experiment, expertise or classical statistics (univariate/multivariate analysis). Communities and environment often show non-linear relationships which call for handling by novel methods. Pattern Tree (PT) is a non linear method of classification using fuzzy logic where the result (a tree) expresses a set of decision rules leading to datasets classification. Fuzzy logic can model the uncertainty of natural language (e.g. when nitrate is "quite" low, this species is "not so" abundant). PT provides a set of functions (gaussian, trapezoidal etc.) to create classes of fuzzified values (fuzzification). The choice of these functions depends on the purpose and variables of the study. We created an R package named PatternTrees (available end 2013), including features that can be adapted to diatom communities as any other specific cases, by special fuzzification functions. For the study, we used a database of 1267 taxa and 5057 samples taken between 1994 and 2010 and characterized by chemical parameters (NO2 ect.). Depending on the species, we found ecological preferenda in accordance to expert knowledge and others unexpected but consistent. These results seem to indicate that Pattern Trees are a powerful method for hydro-ecology (e.g. assessment of water quality or definition of species ecological profiles). Further developments would consist in an automatic procedure to choose the best parameters of the model for each species.

5.12 Integrated tool development for effective use of the forest gap model ZELIG-CFS

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The management of natural resources is becoming increasingly complex. For this reason, integrated ecological models have been developed to facilitate the examination of the impacts of different management scenarios on various components of terrestrial ecosystems, such as water, nutrient and carbon stocks and flows, vegetation and animal populations. Many high system thinking solutions have been developed, but few of them integrate efficient software applications to facilitate the interpretation of simulation results by policy makers. For forest ecosystems, public pressures and national and regional regulations lead to enormous challenges to balance the needs between ecosystem sustainability and economic pressures to harvest wood for industrial transformation. Also, forest management is moving towards the development of multi-cohort mixed forest stands, which increase the complexity of forest intervention scenarios that can be conducted. For these reasons, it is essential that forest managers have access to integrated tools that facilitate the decision making process and allow them to extract added-value information from simulations. The gap model ZELIG-CFS is a process model that simulates the succession of North American forest types with complex structures. Recent advances in computing technology and the increasing availability of free or open-source software have allowed the efficient integration of different software applications to support ZELIG-CFS. These include a user-friendly interface component to manage simulation runs, display simulation results on line graphs and bar charts, and create linkages with the geographic information system Quantum GIS (QGIS) and the Stand Visualization System (SVS). The plugins developed in QGIS display on digital maps predicted changes in forest indicators, such as species proportions, at the landscape or regional levels following simulations of the succession of several forest ecosystems. The utilities that create input files for SVS facilitate the visualization of forest succession in virtual mode.

5.13 Sensitivity analysis for discovering key players in contaminated food webs

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We propose an indicator for the identification of keystones in a food web, Sensitivity Centrality (SC), based on the Sensitivity Analysis (SA) technique. Keystones are species with a structuring role in maintaining the functioning of their ecosystem, depending on their position and interactions, rather than their biomass. In a dynamic system, SA quantifies the effects of variations in the model inputs (the parameters) on model outputs (the state variables). In this study, the SC index was used to identify the most important species in a contaminated food web.

Procedurally, we start with a quantitative food web model, used to parameterize a dynamic Lotka-Volterra ODE system. Then, the results of the SA are used to obtain the SC index. Although keystoneness indices are typically employed in trophic analysis, here we apply SC to a newly defined bioaccumulation model of Polychronated Biphenyls in the Adriatic Sea. This application would identify which species has the largest effect on the diffusion of a pollutant through the whole food web. Thus, we consider SC as a descriptor of ecosystem health. We then compare SC with indicators based on the well-established Mixed Trophic Impact analysis and with indices of topological centrality, by simulating the extinction of keystones and evaluating the effects on community-level properties (e.g. total system throughflow).

We report that our index is able to express indirect trophic interactions as well as long-term dynamical effects. Results show that keystones, as identified by SC, have a prominent impact on global indices of the contaminated network, demonstrating that sensitivity analysis provides an effective way to detect sentinel species in a polluted environment.

5.14 Development and verification of river ecosystem variability prediction models

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1. Purposes Ecosystems are complex systems composed of the physical environment, biota and interaction among biota. As a result, it is difficult to model ecosystems, and much research has been done on the modeling. When trying to model a river ecosystem, its variability causes difficulties. To predict the variability of a river ecosystem, we need to develop models that reconstruct the physical environment and dynamic relationships between biota the physical environment. For dynamic representations, collaboration between river engineering and ecological modeling is needed. Therefore, this study aims to develop river ecosystem variability prediction models (REVPM) by integrating ecological modeling with river engineering, and to verify the accuracy of the models. 2. Materials and methods (1) Overview of the models REVPM are composed of a physical base model (PBM), a vegetation succession model (VSM) and a biota response model (BRM). This study focused on medium-sized land mammals (raccoon dogs and weasels) in the BRM. The PBM is composed of a 2D water current distribution simulation model and a removable riverbed simulation model, and can represent the distribution of water current and change of river morphology only by using discharge time series data, initial riverbed shape and its material. The VSM is composed of a cellular automaton model representing succession among gravel land and pioneer vegetation, and the response of the herbal and woody vegetation community to flooding disturbance. The BRM is developed by improving individual based models (IBMs), and simulates the behavior of virtual wild animals (VWA) on the physical numerical river morphology and numerical vegetation community. The VWA acts on the numerical river morphology and numerical vegetation community, considering the balance between intake energy gained by feeding and energy consumed by basic metabolism and activity metabolism. The VWA contains data on nest positions, resting areas and feeding areas, and selects goals, destinations and routes considering the purpose of behavior. The VWM selects the optimized route that minimizes the distance to destinations, considering spatial preference (e.g. vegetation community). The spatial preference is evaluated using behavioral data observed by a telemetry system for automatically tracking wild animals developed by the Public Works Research Institute (PWRI). (2) Verification of models The accuracy of PBM simulation results was verified by comparison with the results of river morphology surveys. The accuracy of VSM was verified by comparison with the results of image analysis using aerial photographs. The accuracy of BRM was verified by comparison with the results of tracking wild animals by the telemetry system. 3. Results and discussion PBM accurately represented river morphology in sections where the channel alignment was straight or gently curved, with small longitudinal channel transition. Although VSM could

5.15 A joint model-data fusion approach for monitoring the water and carbon fluxes

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Monitoring the seasonal and interannual variability of the water and carbon cycles over land is needed for many applications, including climate studies. The possibility of improving the performance of land surface models (LSM) using remotely sensed observations is an active field of model-data fusion research. The data assimilation technique permits integrating observations, in a statistically optimal way, into a numerical model. It allows the assimilation of biophysical products in order to reduce the bias between the model simulations and the observations and have a positive impact on carbon and water fluxes.

This work shows the benefits of assimilating remotely sensed surface soil moisture derived from ASCAT backscatter data and the GEOV1 satellite-based leaf area index (LAI) into the SURFEX modeling platform developed at Meteo-France. It consists of the land surface model ISBA-A-gs that simulates photosynthesis and plant growth and is used for predicting the continental vegetation state, surface fluxes and soil moisture. The vegetation biomass and LAI evolve dynamically in response to weather and climate conditions.The assimilation experiment was conducted across France at a spatial resolution of 8 km over a four-year period (2008-2011).

In the model simulation, the start of the growing season tends to occur later than in the observations. Similarly, the senescence phase is delayed. The assimilation is able to reduce this bias. The lack of detailed knowledge of the farming practices are compensated by the assimilation of the remotely sensed LAI. The analyzed seasonal LAI cycle across large cropland regions (north-eastern France) is closer to the observations.

A coherent impact of LAI and soil moisture updates on the carbon fluxes is noticed. Increased LAI values in the growing season due to data assimilation corrections trigger an increased photosynthetic activity. Similarly, lower LAI values corresponding to the senescence phase cause a decrease in the carbon dioxide uptake when compared to the original model simulations.

The spring drought of 2011 is an interesting case study showing the potential of the assimilation to improve drought monitoring and to help the model to react more efficiently to rainfall events after the drought period. This may be particularly useful to analyse the impact of extreme climate conditions.

5.16 Designing explanations of systems models for diverse audiences

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Sustainable policies are rooted in assumptions decision authorities hold about specific social-ecological settings. These baseline conceptualizations are increasingly informed by systems models as a means of integrating disciplinary knowledges. For a policy to be implementable, it should be validated by and incorporate expert, practitioner, and citizen perspectives. More persons interacting with models magnify the importance of clear model communication. Modeling texts lead students into the experience of modeling but often omit practical aspects of communicating models. How a model's rationale, results, and implications are communicated influences how it is used, or not used, in planning. As ambassadors for the model and the underlying science, modelers should consider these communications before and during model construction. Accessible and acceptable explanations benefit from listening to target audiences and anticipating how and why audiences may fail to understand aspects of the model. Synthesizing social research from technical communication, educational psychology, and science communication, we discuss common areas of confusion audiences have comprehending complex information and present strategies model developers can use to ensure model presentations are understandable and meaningful.

5.17 Using structurally flexible models to understand estuarine macroalgae blooms

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Nuisance blooms of ephemeral marine macroalgae have been documented in estuaries worldwide, and their increasing occurrence in some regions is still a cause for public concern. In Tauranga Harbour (New Zealand), a shallow, barrier-enclosed, meso-tidal lagoon, blooms of sea lettuce (Ulva spp.) of varying intensity and seasonality have been occurring since at least the early 1990s. Based on the available highly heterogeneous and sparse set of monitoring data, we aim to analyse the relative importance of environmental and population factors in triggering and sustaining the observed blooms. To this end, we use deterministic, process-based, mass-balance simulation models of low to intermediate complexity (order of 1-6 state variables, up to order of 20 parameters). Parameters, forcing and state variables are all implemented in the same functional form, so that the model is "structurally flexible". For example, a species-specific physiological factor may be changed from constant (parameter) to time-dependent (forcing in the broad sense) to state-dependent (state variable) with minimal changes to the code. This allows the easy adaptation of model structure to available data. In addition, submodels are implemented in a way to allow the evaluation of scalars, vectors or a combination of both. This simplifies multilevel structural verification (for example post-simulation diagnostic evaluation of intermediate terms) as well as statistical in contrast to simulation applications. One of the key components of many macroalgae models is the connection of external nutrients, cell-internal nutrient quota and growth. Using a computer algebra system, a short-term equilibrium solution to one of the commonly used sets of equations describing this process has been found. This factor can therefore be computed directly in addition to the more common evaluation as part of a coupled system of equations. Data for model development and validation stems from over 20 years of monitoring as well as a recent field campaign providing previously unavailable information, especially on the spatial and temporal variability of water column nutrients as well as drifting macroalgae biomass standing stock and fluxes. In conclusion, aiming at highest possible structural flexibility during model development can be very beneficial for subsequent applications, especially when the available data is heterogeneous and sparse as is common in field-based ecological applications.

5.18 Ontological Aspects of Process-Based Models and Domain Knowledge

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In the context of ecological modeling, the topic of automated modeling of the temporal behavior of dynamic systems has received considerable attention. Starting from observed data and domain knowledge, automated modeling methods discover ordinary differential equations (complete with structure and constant parameters) that fit the data. In recent research, the domain knowledge and the learned models of a dynamic system are expressed in a process-based modeling formalism and specify entities and processes in the observed system. The notions of entities and processes are of fundamental importance and can be found at the top levels of formal representations of general knowledge, such as the Basic Formal Ontology. Ontologies are knowledge representation formalism that use mathematical logic to clarify and define concepts and relationships within a domain of interest (e.g., population ecology). They can be used to improve the location, interpretation and integration of data based on its inherent meaning. Ontologies have assisted other disciplines (e.g., molecular biology) in unifying and enriching descriptions of data and, more recently, models stored in public databases (cf., the Systems Biology Ontology and biomodels.net). We believe that ecology can benefit from similar approaches and take the first steps in that direction. In this paper, we take these first steps with an attempt to formulate an ontology for ecological modeling. Note that, process-based models and domain knowledge for process-based modeling revolve around entities and processes, which are central concepts in top-level ontologies, they still do not constitute ontologies. We first discuss ontological aspects of a recent process-based modeling formalism and then indicate how models/domain knowledge expressed in that formalism can be transformed into ontologies and connected with domain ontologies for different areas of ecology. We expect these developments to be useful in the context of discovery/reusability of existing ecological data, ecological models and finding connections between the two.

5.19 E2E-Models: Using economics methods in ecological modelling

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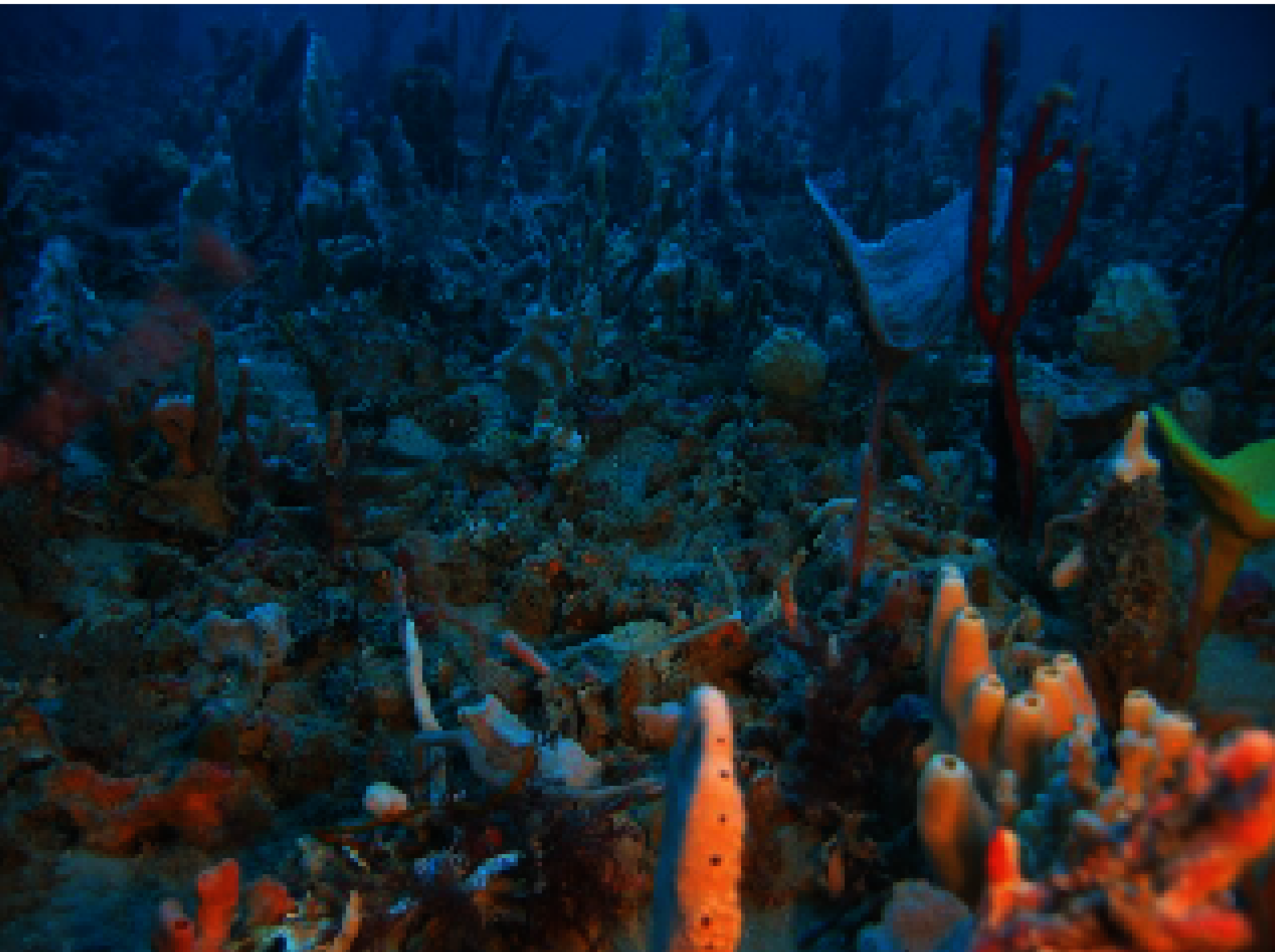
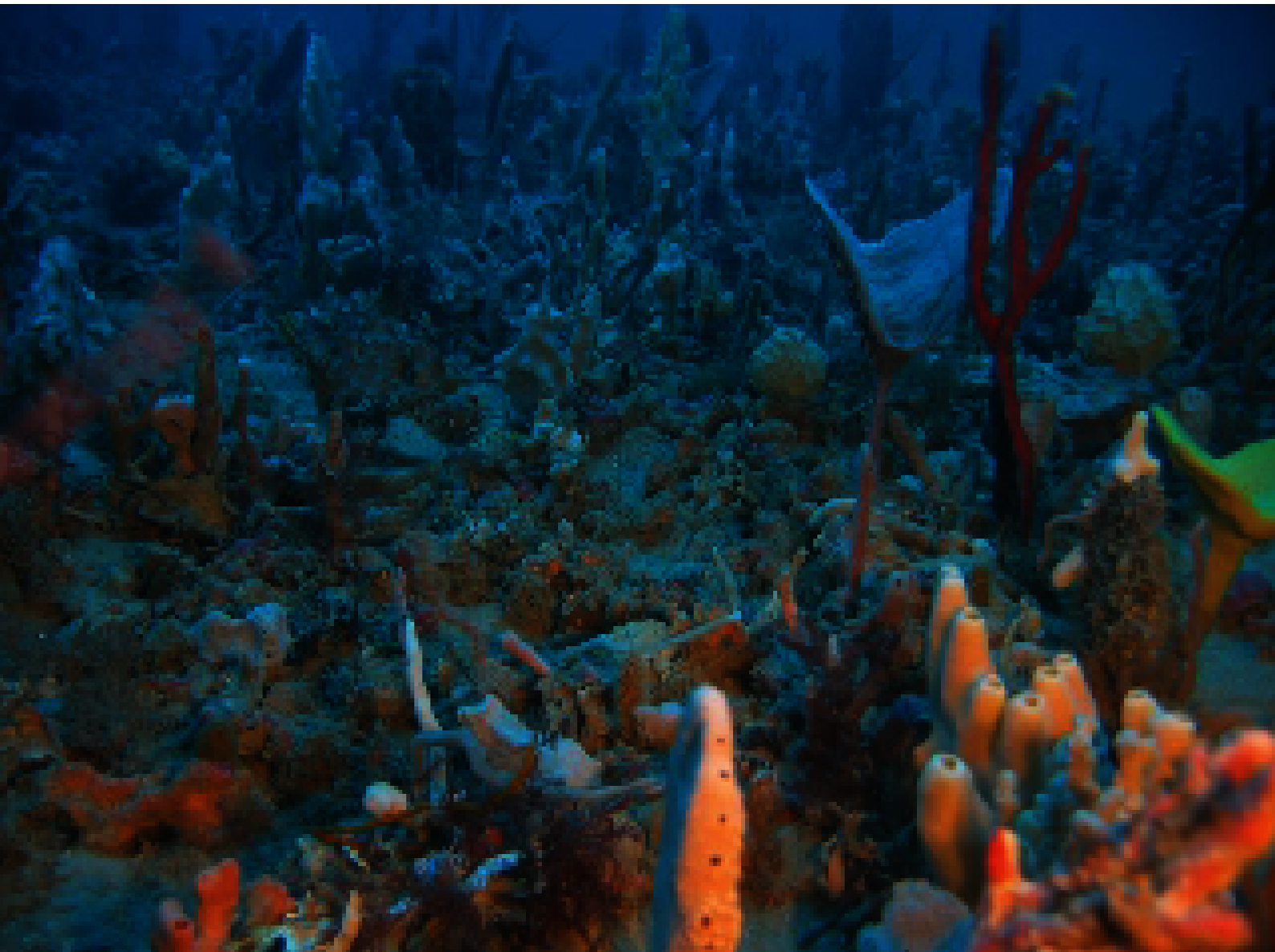
Economy and ecology both , in fact, study one and the same thing: distribution patterns of scarce resources in a system (Samuelson, 1993). However, there are differences in approaches and methods used in these sciences. Subjects described in economy are characterized by freedom to choose their behavior and also a desire to maximize the utility of the results. Availability of resources in economy is characterized by such a universal measure as price. When describing environmental objects it is supposed that they behave in either deterministic or chaotic manner. Such behavior is regulated by positive and negative feedback. This feedback systems reduce to a minimum the possibility to describe behavior of unrestricted individuals and populations in ecosystems and also to describe their choice of strategies which minimize the risks of individual and population destruction. In this paper I consider the possibility of describing ecological processes with economy approaches. Such ecological processes as plant growth, consumption of food by animals, food resource distribution among populations in a community with due consideration of availability and quality of this food resource, variation in species composition and abundance of species in an ecosystem are considered. In order to describe these processes ecological analogues of such models as the model of optimal economic growth (Solow, 2007), the model of optimal choice of goods by consumers, the model the distribution of wealth in society (Mandelbrot, 2004), portfolio optimization model of brokers on the Stock Exchange (Markowitz, 1959) are introduced. Conditions under which E2E-models can be successfully used and applicability limitations of this economic approach to describing ecological processes are discussed. This work was supported by RFBR (grant № 11-04-00173).

Part II

Special Sessions - Short Abstract



Special Session 1: Matrix population models : current challenges in theory and applications



6.1 Conditions for growth and extinction in Leslie matrix models with environmental stochasticity

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In this work we study some features of the behavior of Leslie type matrix models for age structured populations subjected to environmental stochasticity. In these models, the population lives in an environment that changes randomly with time in each projection interval. In this way, there is a collection of Leslie matrices, each one of them corresponding to an environmental condition, and in each time step of the model the environment to which the population is subjected is defined by a certain random variable that is usually chosen to be a Markov chain.

The main parameter that controls the dynamics of these kind of models is the so called stochastic growth rate (s.g.r.). When the s.g.r is positive the population grows exponentially with probability one and when the s.g.r is negative the population goes extinct with probability one. However, even in very simple situations, it is not possible to calculate the s.g.r. analytically. Although there are some bounds for the s.g.r., these are not very tight in most situations.

In order to find a useful way to study these models, the so called "lognormal approximation" has been proposed. The validity of this approximation has only been tested numerically and in very specific situations and moreover the approximation does not allow one to calculate this approximate s.g.r. analytically in parctice.

In the first place, this work examines both numerically and theoretically, the validity of the lognormal approximation, finding the range of situations in which it can be considered that it works well. In particular we find that the most important factor involved is the environmental correlation. When the sequence of environments is i.i.d. or negatively correlated the approximation works well, whilst the contrary happens when there is a strong positive sequential correlation.

Secondly, we build different bounds for the exact and for the approximate s.g.r. that work better that the bounds in the literature and analyze the conditions under which each bound works best. This is used to give necessary-sufficient conditions for the explosion and the extinction of the population. The general results are applied to the case of a population structured in juveniles and adults living in an ambient with two environments, one of them conductive to exponential growth and the other to extinction. In this way we provide simple expressions easy to check in practice that the ecologists can use to ascertain the extinction-explosion of populations.

6.2 Modeling dynamics of a short-lived population in changing environmental conditions, for example, the bank vole population

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Simulating the fluctuating dynamics of a short-lived population with high reproductive potential in changing environmental conditions is a primary consideration in population ecology. This study aims to model the dynamics of populations with a high specific growth rate (e.g., the bank vole, Myodes glareolus), accounting for density-dependent regulation in the context of global change, particularly global climate change. To describe and analyze population dynamics during the reproduction season, we suggest a discrete multicomponent model that includes the gradual complication of the age structure of the population. The model describes the dynamics of population age groups within a breeding season and between adjacent breeding seasons. This system includes two time scales, namely, six months (between breeding seasons) and one month (within a breeding season). Population dynamics is assumed to be formed by the processes of birth and death, depending on endogenous (e.g., density regulation) and exogenous factors (e.g., regional climate pattern). Functional relationships corresponding to the demographic parameters of the model were identified based on the results of correlation analysis. The proposed model of high dimensionality has complex dynamic modes. The nontrivial equilibrium of the system lost its stability with the Neimark–Sacker and Feigenbaum scenarios. The dynamic modes of the model were identified and analyzed by constructing parametric and phase portraits. The proposed model was verified using multi-year data based on a survey conducted in Udmurtia, Russia (57°20′ N, 52° E). The data included the age groups sizes of the bank vole. The age groups were one to two months, three to six months, and seven months and older. We estimated model parameters using the Levenberg–Marquardt method. Phase portraits corresponding to coefficient estimates were complex structures. Parameter estimates were located in the instability area of the nontrivial equilibrium of the model, suggesting the significant effects of endogenous and exogenous factors on population size. The proposed model describes basic trends in the population size of the bank vole, and enables the detailed scenario forecasts of changing environmental conditions.

This work was supported by the Russian Foundation for Basic Researches (Project No. 11-01-98512-_vosto_a) and the Far Eastern Branch of the Russian Academy of Sciences (Competitive Projects Nos. 12-I-OBN-05 and 12-II-SU-06-007).

6.3 Modeling of Evolution in Structured Population

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Specific features of population age structure determine many population characteristics. An understanding of the results of intra-population mechanisms in structured population is necessary for further study of the changes in population with changes in environmental factors, especially as many commercial species have complex age structures. With that, the conception of maximal equilibrated catch asserts that harvested populations are not in the same ecological conditions as non-harvested ones. So the conditions of selection and hence fitnesses of genotypic groups can changes in harvested populations. The matrix-based models of populations have been actively elaborated and used since the mid-twentieth century. These models provide for a detailed description of the age structure and study of its role and significance, and of the developmental stage-based pattern in the maintenance and evolution of population cycles. The question about the study of evolutionary factors (in the first place, natural selection) to change the genetic structure and the behavior of structured population dynamics is still poorly investigated. The aim of this study is continuing with investigation of structured population evolution. We consider simple model situation, when population has two age groups and one of its characteristic is inherited genetically by Mendelian rules. Such more detailed modeling approach allows us to see insight an evolution of structured population and reveal some non-obvious intra-population processes. A mathematical model of the dynamics of genetic structure together with age groups sizes is developed for population with genetically defined survival rate of its reproductive part. This model with analogous one for population with genetically defined reproductive potential allows us to construct a fuller appreciation of natural evolution in structured population. Conducted investigation shows that an increase in the reproductive potential and survival rate is accompanied by complication of the population number dynamics. But evolution increase of these parameters may be very non-monotonic with serious fluctuation. There is large variety of dynamic regimes of population genetic structure in considered models. And increase in the average survival rate of the reproductive part may both destabilize and stabilize the genetic compositions of the age groups in the populations.

6.4 Approximate aggregation methods and spatially distributed structured population discrete models.

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We consider a structured population inhabiting a patchy environment. The model couples two processes: individual displacements between patches and local population dynamics within each patch. We assume that individual displacements are faster than the local processes taken place at the population level. The time step of the model is that of the slow process, i.e., one time step corresponds to a single event at the population level. We assume that between time n and n+1 individuals can perform (lets say) k>1 elementary dispersal events, and so on within each (slow) time step. These assumptions yield, in a natural way, a two time scale system. Individuals dispersal is described by means of a matrix, whose entries can be density dependent. In addition, the dynamics of the structured population is described also by a matrix. Its entries can be as well density dependent although, in general, the slow process can be described by means of a smooth function.

The aforementioned model belongs to the general class of the two time scale systems. Many natural phenomenon can be described as the combination of different processes, each of them related to different organization levels and evolving accordingly to its own time scale (e.g., individual level versus population level). Modelling these phenomena gives rise to time scale systems, which couple fast and slow processes into a single equation system. These systems are difficult to handle since consist of a large number of coupled variables and equations. Under appropriate conditions, approximate aggregation techniques take advantage of the existence of different time scales and allow to build up a less dimensional, aggregated, system. The aggregated system describes some long term behaviour features of the two time scales system. It is done by translating the effect of the faster dynamics into the slower one. Approximate aggregation methods have been used along the last two decades to deal with ecological models.

6.5 COMPADRE III: A global database for plant population dynamics

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Ecologists and evolutionary demographers rely on comparative demographic data (across taxa, locations, and conditions) to explore general patterns of life and death. This is particularly true in the light of global change, to provide a mechanistic understanding of the processes needed to sustain and recover biodiversity.

Here we present PMD (Plant Matrix Database), a new database of matrix population models for plant demography (known in its earlier versions, dating back to the 1990s, as COMPADRE), developed at the Max Planck Society. The database currently contains ca. 900 plant and algae species for which population projection matrices have been published and digitised (> 15000 matrices), replicated in natural populations across time, space and under various experimental treatments (e.g. fire, herbivory, harvest). In addition, this unique resource contains covariates on the ecology, biogeography and phylogeny of these species, making comparative analyses amenable to many ecological and evolutionary questions.

This database is enabling: development of new mathematical models of demography, exploration of senescence in non-model organisms, linkage of functional traits to population dynamics and quantification of trade-offs in the plant kingdom We will briefly detail some of the lines of research), while pointing out challenges and suggesting future directions in the field of plant demography.

6.6 BioVeL approach to matrix population models and Integral projection models.

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BioVeL is a virtual e-laboratory that supports research on biodiversity issues using large amounts of data from cross-disciplinary sources. BioVeL offers to use ”workflows” (series of data analysis steps) to process data from one’s own research and/or from existing databases (e.g. ComPADRe / ComADRe, Max Planck Institute for Demographic Research). A researcher can build his own workflow by selecting and applying successive ”services” (data processing techniques), or re-use existing workflows available from BioVeL’s library. The workflows are based on published R-scripts and executed on the Taverna platform using an Rserve service deployed by BioVeL. They have been designed to accept input data in a text format but, in the near future, they will also accept various other formats (e.g. csv, R, data retrieved from databases). The output is easily and rapidly exportable to other software programs). This virtual laboratory cuts down research time and overhead expenses. We have created several workflows to analyse matrix population and integral projection models. The Matrix Population (MPM) and Integral Projection Model (IPM) workflows provide environments for creating a stage-matrix and integral projection model with no density dependence and perform several analyses on it. In collaboration with other researchers (e.g. Pacific Biological Station, Nanaimo, Canada) we are constructing more workflows for the analysis of other population models. This will facilitate the peer-review process of papers on this type of models, as well as support collaborative projects on comparative demography.

6.7 Adaptation on the ground and beneath: does the local population maximize its lambda1?

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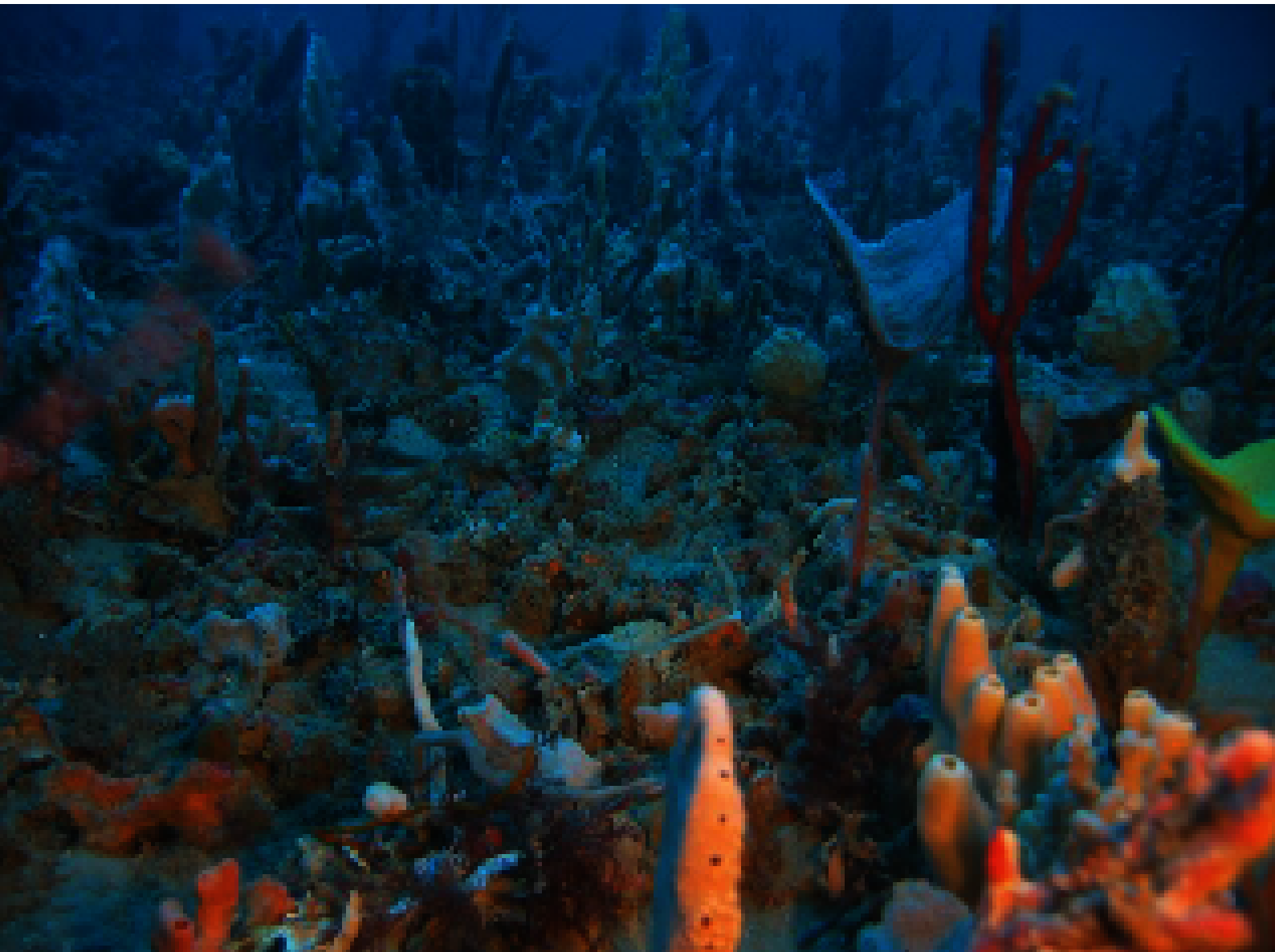
Local populations of plant species, such as perennial grasses, are considered to adapt to their environments by means of polyvariant ontogeny, i.e., diverse pathways that an individual plant may follow through a variety of the states in its life cycle expressed as the ontogenetic stages and chronological ages (in years). The corresponding projection matrix appears to be of more complex pattern that the classical Leslie or Lefkovitch ones, and its dominant eigenvalue (lambda1), in spite of the asymptotic role it plays in model dynamics, does measure the adaptation that the local population possessed in the place where, and at the time when, the population data were collected to calibrate the matrix. Lambda1 thus serves as the basis for site- and time-specific comparative studies. When a population of the wood reed (Calamagrostis epigeios) grows fast due to vegetative propagation, the age-stage status of each individual plant (in a sample plot) can be determined reliably from the morphology of its above-ground part, but the pointer to its parent plant (the rhizome that the individual plant has developed from) is reliably hidden beneath. Therefore, ontogenetic transition rates can well be calculated from monitoring data, but the age-stage-specific reproduction rates cannot (reproductive uncertainty). To overcome this kind of uncertainty in matrix calibration, we suggest a maximization principle: the uncertain rates should be such that they maximize lambda1 under current conditions. The calibration problem hereafter reduces to maximizing lambda1 under the constraints ensuing from data and the recruitment equation. This nonlinear problem with linear constraints has been mathematically proved to have a unique solution. However, to prove or disprove the maximization hypothesis, we had to dig up the whole rhizome system from a sample plot in order to calculate the status-specific reproduction rates directly and reliably. Even when the digging experiment does not confirm the maximization hypothesis, the unique solutions to the proper constraint maximization/minimization problems do provide for the quantitative bounds of adaptation under reproductive uncertainty.

Special Session 2: Behavior monitoring in ecological modeling



7.1 Behavioral uncertainty of Pomacea canaliculata according to the difference of acclimated temperature based on a hidden Markov model

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Golden apple snail (Pomacea canaliculata) is a freshwater snail native to tropical and temperate South America and has become a detrimental agricultural pest since the snail was introduced into Asian countries. So the studies on the ecology as well as behavior of golden apple snail helps to minimize the dispersal of the snail and is essential to the appropriate management for the snails. We compared the behavioral differences according to the different acclimated temperature based on a hidden Markov model (HMM). The golden apple snails were acclimated at four different water temperatures (15, 20, 25 and 30℃), and then their behaviors were observed every one minute interval for two days. Observed transition probability matrix in HMM was calculated based on Shannon entropy and observed emission transition probability was obtained from pre-determined nine behavior categories for training HMM. The transition probability from the snails' behavior in uncertain at time t to uncertain at time t+1 was lowest in lowest acclimated temperature (15℃). Contrary to other acclimated water temperatures, the behavior of clinging in the side of the aquarium with tentacle threaded caused the lowest behavior uncertainty in the highest acclimated water temperature (30℃). HMM successfully estimated transition probability and emission probability matrices with accuracy rates ranging from 55.9% (20℃) to 78.2% (25℃).

7.2 Persistence parameter: A reliable measurement for behavioral responses of medaka (Oryzias latipes) to environmental stress

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Abstract According to previous research, online monitoring systems provided a significant evidence for feasibility of the Stepwise Behavioral Response Model (SBRM) in detecting the effects of carbamate pesticides on movements of medaka (Oryzias latipes), being able to determine the state of indicator organisms, "No effect", "Stimulation", "Acclimation", "Adjustment (Readjustment)" and "Toxic effect". Though SBRM postulated that an organism displays a time-dependent sequence of compensatory Stepwise Behavioral Response (SBR) during exposure to pollutants above their respective thresholds of resistance, it was still a conceptual model based on tendency only in analysis. In this study, the phenomenon of bacterial persistence observed as early as in 1942 (Hobby et al., 1942) was used to interpret the relationship between SBRM and the two impact factors, exposure time and environmental stress. Quantitative measurements of SBRM led to a simple mathematical description of the threshold switch, which evaluated the effects of environmental stress on behavioral responses (BR) to decide the tendency of BR (Selye, 1973). The computational modeling results suggested that the persister (p), as described in the general equations of bacterial persistence model (Balaban et al., 2004) in changing environments, illustrated the behavior adjustment (or readjustment) clearly. The threshold switch between normal behavior movement and the behavior adjustment was found to depend strongly on the environmental stress but weakly on the exposure time of any given treatments. Consequently the persistence parameter, p, was critical in addressing for medaka to be adapted to fluctuating environments under different environmental stress. Keywords: Stepwise behavioral responses; Oryzias latipes; Persistence; Environmental stress References: Hobby G.L., Meyer K., Chaffee E. Observations on the mechanism of action of penicillin. P Soc Exp Biol Med, 1942, 50:281–285. Selye, H. The evolution of the stress concept. Am. Sci., 1973, 61: 692-699. Balaban N. Q., Merrin J., Chait R., Kowalik L., Leibler S. Bacterial Persistence as a Phenotypic Switch. Science, 2004, 305: 1622-1625

7.3 Stochastic Modeling in Stepwise Response Behaviors of Indicator Species under Stressful Conditions

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Stochastic Modeling in Stepwise Response Behaviors of Indicator Species under Stressful Conditions

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Behavior monitoring of an indicator species is an efficient measure of toxic effects in environment in situ. The stepwise response has been reported in the behavior response according to exposure time and chemicals. A stochastic model is proposed to describe the stepwise response behavior. We assumed that the behavior strength of indicator animal is a map from a stochastic space, and the stochastic property could be dealt with simply on the space after chemical exposure. The master equation was utilized to model the stochastic space and the transition rate is also assumed by well-known distribution functions for simplicity. From the stochastic equation, we could calculate the deterministic equation for macroscopic variable and integrate the equation exactly because of the simplicity residing in the stochastic system. We additionally introduced a mechanical model to match the stochastic calculations with the experimental results. By the proposed model, the stepwise response behavior could be addressed to present behavioral states of indicator species objectively under stressful conditions.

7.4 An individual based method for behavioral observation of multiple fishes

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We propose an individual based method for visual monitoring of fish behaviors. The individual fish was considered as an agent that constructed the movement trajectories of all individuals through video sequence. Hypothesized movement behavior of individual fish was presented for finding the optimized potential moments for each agent. The optimized movements were estimated by examining the minimal distance among individuals from time t to time t+1 and movement direction of each individual. The proposed method could also recognize head and tail of a fish, subsequently, the posture (i.e., angle) of the fish could be calculated. Therefore, tracking error will be minimized when fishes aggregated or move across each other. The proposed method was tested with 2-5 individual Zebra (Cyprinidae Danio) fishes in aquarium. Each of the tests was carried out for 10 minutes. The results demonstrated that the proposed method were stable to behavior observation of multiple fishes. The trajectories of the fishes were accurately obtained and the behavior parameters (e.g., velocity and acceleration) were accordingly measured.

7.5 Modelling of fish movement patterns - Linking individual behaviour and spatial population dynamics

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Analysing animal movement is essential for understanding processes such as the dynamics and spatial distribution of populations and has strong implications for the design and management of natural reserves. In tropical coastal ecosystems the movement patterns of juvenile and adult fishes are particularly important as many fish species undertake diel migrations to utilize resources from different habitats. These small-scale movement patterns play an important role in the energy transfer between habitats and link coastal systems like seagrass beds and coral reefs (inter-habitat connectivity). Consequently, spatial patterns of species abundance as well as individual movement behaviour are influenced by seascape composition and configuration. To identify essential habitat properties for key species and anticipate their behavioural responses to changing environmental conditions is therefore critical to successful conservation. In my presentation I would like to introduce an integrated approach combining hydro-acoustic movement studies with a spatially explicit, multi-species individual-based model (IBM) to better assess the role of inter-habitat connectivity on fish distribution and individual movement behaviour. The IBM integrates (i) fish species of different functional groups with their key life history features, (ii) a spatial representation of the environment (habitat structure), and (iii) the interactions of both depending on the tidal and diel cycle. Thus, the model will capture the link between individual movement and population dynamics and may contribute to the development of effective and sustainable management strategies of MPAs.

7.6 Modeling preference of fish for water sound to determine a migration path in a river

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Speaker : Rina, Febrina, Graduate school of Science and Engineering, Yamaguchi University , Japan

Water sounds are believed to have a considerable roll for fish to trigger their ascending behavior. Model an effect of underwater sound on fish preference is a promising technique to determine the migration path for comprehensive river habitat evaluation. In this research, we attempt to determine preference and its weight for underwater sounds through laboratory experiments using adult and juvenile Ayu (Plecoglossus Altivelis Altivelis). The experiment is conducted by using a watercourse which made of transparent acrylic and is installed underwater speaker in the one end. After that, we emit sound from speaker and conduct experiment with different sound pressure level. Sound source are pure tone (100Hz, 200Hz, 400Hz and 800Hz), white noise, sound recordings of a weir in Fushino River and a fish ladder in Misumi River. The result showed juvenile and adult Ayu avoid pure sound of 100 Hz and sound recordings of Fushino River weir, but prefer pure sound of 200 Hz and sound recordings of a fish ladder. Moreover, comparing the obtained weight, adult Ayu has higher preference in sound than juvenile. We define a procedure to calculate preference of sound and build it into our fish behavior simulation model on ArcGIS. The model could successfully reproduce observed fish migration behavior in a river.

7.7 Modeling the Dispersing-migrating Paths for Giant Pandas in the center of the Southern Slope of the Qinling Montains, China

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Abstract

The national investigations on giant panda population and habitat quality have shown that the Qinling Mountains has a high-density population of giant pandas. Our previous research also found two areas with very high density of giant pandas with one in the center of Foping and the other in the center of the northern Changqing. We hypothesized that the giant pandas in these two regions will disperse to the neighboring areas according to the density-limiting principles. The aim of this study is to model and identify the potential dispersing paths for giant pandas.

Our research area includes 5 nature reserves on the southern slope of the Qinling Mountains, which are Changqing, Foping, Guanyinshan, Laoxiancheng and Zhouzhi NRs. We used our existing GIS data and some data from the Third National Giant Panda Survey and established the Minimum Cumulative Resistance Model based on the relationships between the habitat suitability and the migrating cost. In this model, we adopt the areas with dense panda activity signs as the source locations of the giant pandas' dispersing to the neighboring regions through various habitats. The habitat factors which influence the movement of giant pandas were grouped and weighted through using AHP method, and the resistance cost was finally calculated. Based on the obtained spatial pattern of the resistance cost, we designed four scenarios of dispersing range with 2, 5, 10 and 20km.

The results showed that the giant pandas in the high-density areas may disperse divergently to the neighboring areas. Through looking at the spatial pattern of the resistance cost and human disturbance, 5km and 10km are the better dispersing ranges for giant pandas. For 2km range, there is few space resource of habitat for giant pandas to disperse with considering the general home range of the animal, while for 20km range, high resistance regions with human disturbance will block up the giant pandas' dispersing further in a wide range. Given 10 km range for panda dispersing, five representative least resistance paths were identified: 1) one extends southward from the southern Changqing to the border; 2) one extends southwest from middle Changqing; 3) one extends westward from the northern Changqing along the border; 4) one extends southward from the southeast Foping and extends eastward to Guanyinshan; 5) one extends northeast from middle Foping to Zhouzhi and extends northwest to Laoxiancheng.

This research can provide policy recommendation for an improved conservation plan of the giant pandas in the Qinling Mountains, which are: 1) habitats around the predicted dispersing paths should be protected and maintained; 2) establishment of new reserves can be planned in the southern areas of Foping and Changqing NRs where the habitat quality is suitable for giant pandas; 3) human interference on panda dispersing paths should be avoided.

7.8 Impact of heterogeneous landscape on invasion speed and stable density of invasive species

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A two species cellular automata (CA) system with one native species and a preponderant invasive species is established to investigate the effect of heterogeneous landscape on invasion speed and its equilibrium density. Heterogeneous landscape in the researched competition system results from habitat loss and fragmentation. Thought the massive simulation of the system, we show that: (1) Landscape heterogeneity has a positive effect on prevent biological invasion as the habitat fragmentation level increase, but when the aggregation level of habitat destruction is strong, this effect will diminish or fade out. (2)Habitat loss will slow down invasion speed, but if invasive species gets successful invasion and reaches stable state, habitat loss will increase the final equilibrium density of the invader. We can say that habitat destruction only has short-term positive effect on preventing biological invasions. (3)If a competitive advantage species (compared to the invader) is introduced, it will have a positive effect on control biological invasion. (4)As we take the mortality rate as an additional means of biological invasion control method (we assume that the method can cause the same damage on two species), such as herbicide, the dominant species is beneficial under the control method. This kind of additional control method plus a dominant competitive species will have good effect in biological control.

7.9 Application of Random Forests for assessing the invasion risk by the non-native rosy bittering subspecies Rhodeus ocellatus ocellatus in northern Kyushu, Japan

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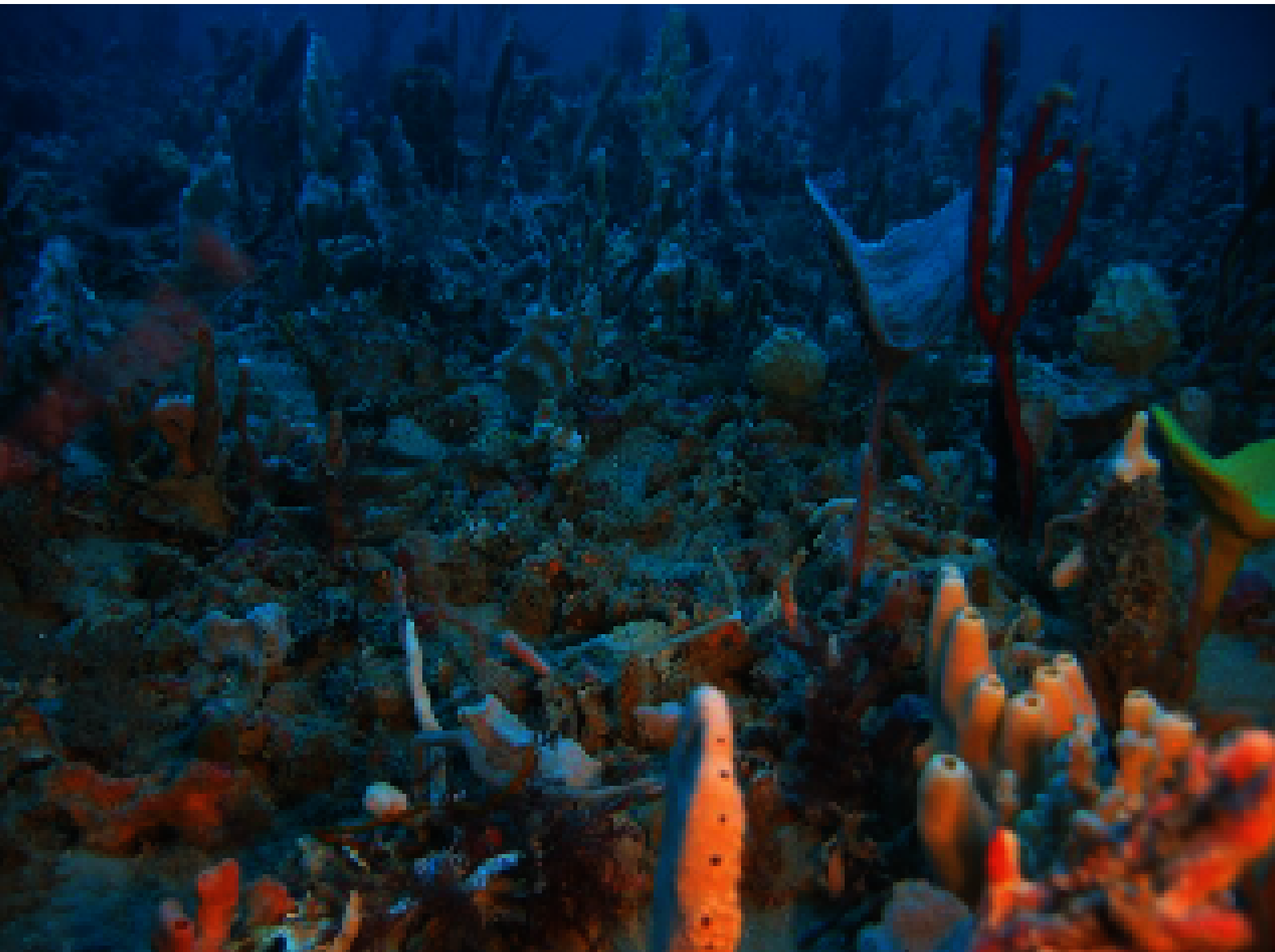
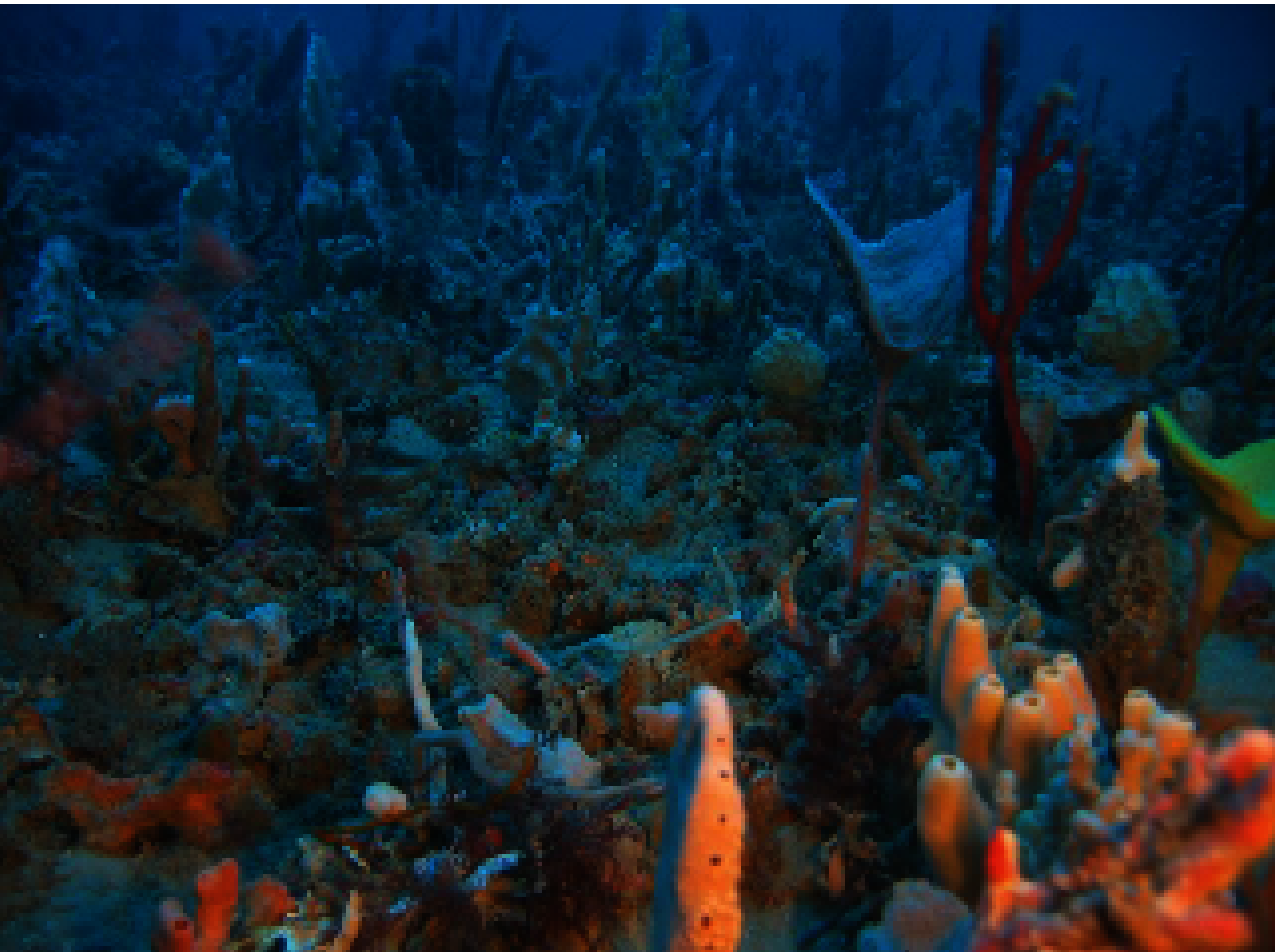
The non-native rosy bittering subspecies Rhodeus ocellatus ocellatus (Roo) has been recognized as an invasive species in Japan because of hybridization with native rosy bittering species R. ocellatus kurumeus (Rok). Indeed, the native Rok has already been replaced by the non-native Roo in several parts of Japan. It is therefore needed to develop a methodology for better understanding invasion ecology of the Roo and further minimizing the invasion risk by the fish. In this study, we applied Random Forests (RF) to model species distributions and habitat suitability of the non-native Roo as well as six native bittering species including Rok in northern Kyushu, Japan. Multi-scale environmental variables were used to characterize the species distributions. Specifically, invasion risk by the Roo was assessed based on the similarity of habitat suitability curves (HSCs), derived from the RF models, between native and non-native species. The present models showed very high performance in modelling species distributions and the HSCs obtained could represent ecological traits of the target species. The results suggest that the invasive Roo uses empty niches, expand their distributions and may thus impact on native bittering communities in the study region.

Part III

Poster presentations - Short Abstract



Poster session 1 (October 28th-29th)



8.1 Assessing the sustainability of fuelwood use in Africa in the context of global change

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A significant proportion of the population relies in Africa on fuelwood as a primary energy source for heating and cooking. The rapid population growth and the impact of climate change on ecosystems increase dramatically pressure on woody biomass resources, even if technological advances in using other energy sources can reduce the per capita demands for fuelwood. This study presents the outcomes of relatively simple models that are predicting the future fuelwood consumption on the basis of

• population growth estimates from the United Nations, • established fuelwood consumption patterns reported by the FAO, • and forecasted spatio-temporal changes in accessible biomass for Africa for the next 70 years, in response to climate change scenarios

We combine estimates of the currently available woody biomass, and demand in an indicator which we refer to as depletion time. This is a measure of the time needed before all biomass is consumed, assuming no regrowth – a depletion time of 10 years will call for very fast growing sources of woody biomass to meet need, whereas areas with a depletion time of more than 200 years may be satisfied with much slower growing sources.

With our first results showing an alarming depletion time for many African countries, we will discuss the boundary conditions of use of our models and datasets and address the question of the use of fuelwood as a sustainable future energy source in Africa.

8.2 Projecting species distribution under climate change: an objective approach to select climate scenarios

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1. Species distribution models are widely used to assess shifts in species range induced by climate change. Despite the large number of available climate change scenarios, many studies only use a few ones to project models, and the choice of these scenarios is often arbitrary. 2. We propose a clear guidance to select objectively a subset of climate change scenarios. Our proposed method, based on clustering approaches, reduces the number of climate change scenarios needed to project species distributions, while maximizing the coverage of uncertainty in future climate conditions. 3. To demonstrate the added value of the proposed method, we investigated the impact of an arbitrary selection of atmosphere-ocean general circulation models (AOGCMs) on the projected change in range size of three northeastern American tree species, using an ensemble forecasting framework. 4. Uncertainty introduced by an arbitrary selection of AOGCMs could be very important, especially when few AOGCMs were used to project future species distribution. Uncertainty decreased as the number of AOGCMs increased. 5. Our proposed method selected five climate change scenarios.

8.3 Impact assessment of land cover changes on surface water quality for the protected area Krivoklatsko

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The assessment of land cover effects on hydrology is essential for the development of sustainable watershed strategies. Specifically, relations of land cover changes to hydrological components will greatly improve predictability of hydrological consequences to land cover changes and thus can help local authorities make better decisions. However, given the limited availability of digital maps and terrain observations, it is difficult to quantify impacts of changes in land cover classes on hydrology. In this study, an integrated approach of hydrological modeling using geographic information systems (GISs), remote sensing, and surface water quality monitoring was applied to quantify contributions of changes for individual classes on changes in hydrological components. As a case study, hydrological modeling was conducted for each subarea of the watershed in the protected area Krivoklatsko (in the Czech Republic) using the Soil and Water Assessment Tool (SWAT). A few scenarios have been developed to test the SWAT response. The first scenario is focused on sustainable development, which represents the time period 1990-2009. The second scenario is focused on increased agricultural activities comparable to the situation before a year 1990. The third scenario deals with expansion of urban areas, which can be expected in the feature. While intensive agriculture is the strongest contributor to the increase of surface runoff and nutrients, appropriate extensions of urban areas can preserve sustainable development of the protected area. Our approach in quantifying the contributions of various land cover scenarios to hydrological components can provide quantitative information for local authorities in planning and making decisions for land cover and watershed management.

8.4 A bioclimatic model of forest-forming trees height in the Southern Siberia mountains

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Our goal was to evaluate consequences of climate warming for forests and forest-forming tree species in the Altai-Sayan Mts, Central Asia. Our bioclimatic model of the mountain forests and major tree conifer species were developed to predict their potential distribution in a GCM-predicted changing climate by 2080. Each forest type and conifer distributions were mapped by coupling our bioclimatic models with bioclimatic indices for the basic period and 2080. Climatic departures for the future climate were derived from two climate change scenarios the HadCM3 A2 and B1 reflecting the largest temperature increase and the smallest temperature increase correspondingly.

Our montane bioclimatic model (SibTreeClim) predicts a dominant tree species (Pinus sylvestris, Pinus sibirica, Abies sibirica, and Larix sibirica) and height at a given habitat. The model input parameters are climatic indices: growing degree days above 5℃ (GDD5), degree days below 0℃ (DD0), annual moisture index (AMI), equal GDD5/annual precipitation. Our modeled map of the tree species distribution showed fair-to-good match with the inventory forest map (Isaev 1990) with kappa statistics varying between 0.4-0.7. The comparison of our height map with laser-measured heights on the NASA world forests map showed a fair match with kappa 0.43. The relationship was used to predict stand heights under climate change at 2080.

Our simulations indicated that in the 2080 dryer climate the montane forests would decrease 30-50% by 2080. Water stress tolerant and fire-resistant Pinus sylvestris and Larix sibirica would outcompete water-loving Pinus and Abies sibirica from their current habitats. Both future climate scenarios predict stand height increase by 10-15 m in moist habitats and decrease and even forest replacement by steppe in dry habitats. The model also predicts new habitats suited to temperate broadleaf forests, non-existant presently, by 2080.

8.5 Impact of ocean acidification on carbon sequestration in the Mediterranean Sea

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The oceans absorb a relevant part of the CO2 atmospheric emissions. However, this causes an alteration of carbonate system, and an increase in acidity in marine systems. The Mediterranean Sea shows alkalinity and dissolved inorganic carbon concentrations much higher than those observed in the Atlantic Ocean at the same latitude, a fact tht might affect the dynamic of the local carbonate system and emphasize the need for a target study. In this work we estimate the scale of spatial-temporal variability of the carbonate system properties and the impact of physical and biological processes involved by using a validated 3D physical-biogeochemical model, OPATM-BFM, coupled to a OCMIP2 carbonate system model. Initial condition and boundaries conditions have been estimated from existing dataset. The reference simulation covers the contemporary conditions (1998-2005) forced by ECMWF fields and an atmospheric pCO2 ranging from 360 to 380 ppm. Results of the simulation show that a spatial gradient from the Gibaltrar strait to the marginal seas (Aegean and Adriatic seas) of DIC and Alkalinity is a permanent structure along the water column, although less marked in the intermediate and deep layers. Vertical profiles are generally characterized by lower values at surface, a sharp increase between surface and 200 meters and almost stationary values below 500 meters. At surface, alkalinity dynamics are driven by the terrestrial input, mainly located in the eastern marginal seas and the basin wide surface circulation, dominated by the intrusion toward east of the surface atlantic water and the two thermoaline cells of the western and eastern sub-basin. The results show that primary producers move CO2 into particulate organic carbon that sinks under the mixed layer and is then respired within the deep layers. Such carbon pump, combined with the inverse estuarine Mediterranean circulation, results in a net carbon export toward the Atlantic sea. Valuation of the environmental service, in this specific case under sea acidification scenarios, can be performed by considering the market-based, unitary values for carbon sequestration social cost, which are multiplied by the carbon flux estimates provided by the biogeochemical model. Additional simulations permit to understand the relative effect of different biogeochemical processes on carbon sequestration, as well as to project the impacts of alternative scenarios of future climate

8.6 Linking ecological and economical progress and planning by the Nature-Economy (SDR) model

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Suggested for 1.7 linking, ecology, economy and sociology.

Simultaneous efforts on different scales are necessary to move toward more sustainable societies, and it is also necessary to link ecological considerations with economic issues. Ideas for handling such considerations have started to appear, the EU call for Green Growth being one example. To a large extent models so far are working on a national scale or large region scale. There is a need for actionable methods to be used e.g. for authorities, for towns and municipalities, and in medium or small sized companies. At these scales there is a lack of combination methods, where economic issues and environmental issues occur in the same context. There is a need for parameters, and also a need for frameworks to establish relevant parameters. One proposed framework is the Nature-Economy model (also named the SDR model by Nilsson and Bergström, 1995, Ecol.Econ 14:175-184) aiming at establishing key parameters relevant for a specific company, municipality etc, that give information on if the system is effective, thrifty and sustainable. Business management can thus be applied to combine short term economic efficiency and long term sustainability impacts. The Nature-Economy (SDR) model is comprised of three parts; resource base, system and service. The key indicators represent three types of performance criteria: effectiveness (how effective are the services provided by the system?), thrift (does the system require a modest input of material resources and energy?) and margin (can the in- and outflows be sustainably maintained without impairing the resource base and essential ecological functions?) Indicators of all three types has to be developed to be relevant to each organization; and has been found to be best utilized when following development over time for the same organization. As a general rule, several indicators are needed for each performance criteria. The Nature-Economy (SDR) model has been applied in some authorities and companies. The indicators of the model can be designed to support environmental management systems, CR-reporting, etc. To date the margin indicators have been the most troublesome to establish, but at the same time they represent the most interesting possibility to connect economic performance to such as ecosystem services and long term sustainability impacts. Life cycle assessment and emergy modeling might be important tools to develop such key performance parameters for the Nature-Economy model.

8.7 Landsat data using in assessment of the southern forests of Tuva

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The paper presents regional forests change in interlinkage to climate change and the duration of flammable period. The objective of this study was to investigate the application of remote sensing of establishing area estimation and area change measurements of boreal forests in the Massif West Tannu-Ola, southern Tyva. For study of forests change of the Massif West Tannu-Ola and fire danger was using Chadan meteorological station data sets. The average temperature at Chadan meteorological station for the two-year period 2011-2012 was -1.4℃ above 1960's years 2.5℃. The result of processing of the data of the profile territory of the Massif West Tannu-Ola is presented. The analysis of spatial data helped to detect the growth of Siberian stone pine forests at the boundaries of forest. And the temperature increasing is the reason for more frequent fires. The natural and anthropogenic trends detected of boreal forest using Landsat series data. A set of spectral vegetation indices were applied to a set of images consisting of six Landsat data spanning the period from 1976 to 2011. The TM5/4 and TM7/4 band ratios were found to correlate well with ground-based measurements of forest damage fire at boreal forest. Some changes were found based upon spectral values the NDVI, NBR, NDWI, NMI and SWIR/NIR.

8.8 PLANT INVASION HOTSPOTS ALONG RIVER SYSTEMS AS A RESPONSE TO CLIMATE CHANGE IN SW FRANCE

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Speaker : Eric Tabacchi , Laboratoire Ecologie Fonctionnelle et Environnement (ECOLAB), Toulouse, France

Over 1100 introduced riparian and aquatic plant species observed along the river systems of the Adour-Garonne watershed (SW France, 116,000 km^2), only 60 species can be identified as true invaders. These species exhibit a wide range of biological traits that can explain their high abundance among introduced species along the upstream-to-downstream gradient. Overall, introduced species accounted in average for 25 at the river stretch (500 m long) scale within the riparian corridor. Using presence-absence data on 902 study sites scattered along the main river systems, we performed stepwise logistic regression models in order to predict the upstream-to-downstream distribution of the occurrence probability of 58 invasive species. Then the models were applied to IPCC scenarios in order to assess future distributions of invaders. Mean air temperature explained up to 70% of the models variation, followed by land-use and rainfall. The typology of models outputs highlighted three species groups. The first group (8 species) included ruderal, non specialized species that occupy a wide range which will not significantly change in the future according our prediction. The second group (36 species, mainly Americans) included thermophilous plants that will increase their occurrence, especially in lowland regions. The third group (10 species, mainly Asians) included very aggressive plants that will increase their occurrence in mountain regions. Upstream-to-downstream distribution outputs confirmed direct field observations. Models predicted an average increase in occurrence of up to 200% at the piedmont zone that appears as a very sensitive regional ecotone. A critical perspective of developments in riparian invasion ecology is proposed to conclude the presentation.

8.9 Modeling the fifteen years dynamics of phytoplankton genera using artificial neural network in Lake Taihu, China

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Artificial neural network (ANN) with and without principal component analysis (PCA) on the input data has been applied to develop a model quantifying the interactions between abiotic factors and phytoplankton genera based on a fifteen years data set of monthly observations in Lake Taihu, China. Results showed that the timing and magnitude of various phytoplankton blooms could be successfully predicted in eight sampling sites, and PCA can significantly enhance the prediction performance of the model. Important factors that lead to the dynamics of phytoplankton were evaluated by a sensitivity analysis and the results are compared with the outcomes from a Self-organization Map (SOM) model based on the Maximum Flux Principle (MFP). In addition, an ANN short-term forecasting model concerning the relationship between the Exergy (calculated from both the phytoplankton and zooplankton community) and the abiotic factors in the lake has also been developed based on a time-delayed training.

8.10 Transformation of aluminum, manganese and iron in the of Natural Environment of the Eastern Siberia

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In the framework of strong anthropogenic activity the pollution of natural water with heavy metals became an especially acute problem. There are no reliable mechanisms of self-purification. The analysis of the data measured at the departments of "Krasnoyarsk Center for Hydrometeorology and Environmental Monitoring with regional functions" in a small rivers of East Sayn mountains (Mana, Bazaikha and Big Sliznevo) was performed. The pollutants whose concentrations exceed the MPC (maximum permisisble concentration) and have natural and anthropogenic sources were selected. Those include Al, Mn, Fe. In general, heavy metals showed a significant excess of the MPC standards in rivers, little exposed to human activity. The main idea of this work is development of standards of acceptable content of pollutants is based on the parameters of the natural regional background. The calculation of the background were performed with using the data for 9 years for each substance For this purpose was applied non-parametric Wilcoxon-Mann-Whitney criteria. Calculated background concentrations for aluminum is 2.1 times the MPC and 8.4 times – klark for sea water. Background values of iron and manganese are close to the MPC. The next stage in the development of regional water quality standards is consideration of local peculiarities of metals migration. The general scheme was proposed by example of Al, Mn, Fe. The chemical composition of surface water depends on rainfall, temperature, soil type, rock bottom of the ponds, the morphology of the flora and fauna as well as the duration of the impact of these factors. We used a standard evaluation of the degree of water contamination with sediment accumulation factors. In the given work were received following results: - detection of natural background pollution of river water with Al, Mn and Fe; - development of a regional scheme of peculiarities of Mn, Fe and Al migration with regard to surface water; - detection of the fact that the compounds Mn predominantly comes from groundwater and Fe and Al with the runoff from the basin. To clarify the regional migration patterns of metals it is a necessity to study of connection of metal content in the snow cover and surface water. Development of regional MPC should focus on the self-cleaning capacities of aquatic ecosystem and response to pollution of aquatic organisms.

8.11 Impact of extreme turbidity on the hydrodynamics of tropical reservoirs: the case study of Cointzio, Mexico

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In the context of climate and human-induced changes, soil erosion and sediment load toward reservoirs and lakes is increasing worldwide, with considerable implications for the management of water resources and the ecological health of aquatic ecosystems. Among the most severe social, economic and human-health related issues figure tourism and fisheries activities, the hydropower infrastructures efficiency and viability, the increased cost of dam maintenance and water treatment, the water pollution. As highlighted by recent reviews, the impact of increased sediment load on the ecology of lakes is principally driven by fine particles. Their presence in suspension reduces drastically the penetration of light within the water column, which in turn diminishes the volume of water contributing to the primary productivity. This optical effect at small scale has severe large scale implications, in such a way that mineral turbidity is generally recognized as the main physical effect of increased sediment load on aquatic ecosystems. The present study has been conducted in the Trans Mexican volcanic belt, a region which suffers high erosion, with severe repercussions on waterbodies. The reservoir of Cointzio (capacity 70 Mm3), has been monitored from 2007 to 2009 to understand its hydrodynamic regime. During the of study, secchi depth never exceeded 0.3m (mean of 0.2m and minimum of 0.02m). The processes controlling the dynamics at month scales were quantified by running 1D numerical models with increasing degree of complexity. To explore the lake dynamics at smaller timescales, a 3D numerical model was used. The idea of the numerical modelling approach was first : (i) to identify the primary effects of sediment load and turbidity on the hydrodynamics of hollow reservoirs, as compared with clear waterbodies ; (ii) to assess the appropriate balance between model complexity and data availability to propose operational management tools. Results of field and numerical modeling pointed out an unexpected behavior. Instead of reinforcing seasonal stratification, extreme turbidity actually reduced sun heating layer to such a degree that wind-driven waves mixed it easily. At large scale, the vertical diffusion was almost constant so that the three layer system (epilimnion, meta-limnion and hypolimnion) that typically developed in reservoirs was not observed in Cointzio.

8.12 Analysis of ecosystem functioning and structure of the Tyrennian Sea with a food web model

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The ecosystem of the central part of the Tyrrenian Sea is described with a food web model that incorporates a large set of local information by species regarding long term trawl surveys, gut content analyses, stock assessments results and fisheries statistics. The model integrates also other sources of ancillary information and describes the ecosystem in the years 2007-2010, by means of 62 functional groups (from phycoplankton to marine mammals) and 4 main fishing fleets operating in the area (trawlers, longline, purse-seine and passive nets). A novelty of the model consists in the integrated but distinguished representation of shelf and slope functional groups. A large set of indicators was calculated on the food web flows and biomasses in order to analyze its structure and functioning. The results highlight that the system is structured in 5 trophic levels, with equal importance of detrital and grazing food chains. The model also allowed quantifying the main relations between pelagic, demersal and benthic domains: a key functional role was identified in the Euphasiacea group that represent a main source of food for demersal and benthic groups (0,7 e 0,1 t km-2 year-1, respectively) and in the small pelagics largely consumed by demersal groups (0,13 t km-2 year-1). Biomass structure resulted to be different between slope and shelf especially for small pelagics, mesopelagics, sharks and crustaceans. Differences in fishing pressure between slope and shelf, support the possible important role of fisheries in shaping the structural differences identified. Ecosystem services were evaluated also calculating the Primary production Required (22.2% of Primary Production) and the proportion of export with respect to the production of the commercial species (18% in the slope and 40% in the shelf). Overall these figures highlight an important potential impact of fisheries with the trawl fishery having the highest impact (represent 60% of the PPR and 56% of total landings). The model allowed to quantify direct and indirect impacts among fishing gears and functional groups: results highlighted the large impacts of trawlers on the Tyrrenian Sea ecosystem.

8.13 Ecosystem services in evaluating value chains when moving toward a bio based society

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Suggested for 2.5 ecosystem services.

A worldwide shift from a fossil based to biobased economy is slowly underway. Even if fossil resources will be still be used in foreseeable future, an increased use of biomass as resources, not least for fuels, can be expected. A systematic, worldwide increase in demand of bioresources will inevitably put larger potential pressures on ecosystems and the environment. To be able to minimize or fully avoid damage, or at least unnecessary damage to human welfare, we among other things need the increased understanding of including ecosystem services into life cycle assessment of products and services. Such a combination of understanding basic responses from impacts on ecosystems by technical systems, and environmental interactions of technical systems over the whole value chain of a product or service will give possibilities to identify important hot spots as well as optimizing technology use to minimize damage to important ecosystem services. Yet we have not achieved this. We argue that important reasons are that we still need to understand how to include ecosystem services in LCA, and that this is complicated by the fact that there are two main paradigms regarding ecosystem services – the donor value approach and the receiver value approach. Approaching the problem through the case of an expected increased forest bio fuel production from the boreal forests of the Mid Sweden region, we demonstrate the different approaches. We argue that for now we will probably need to use the two approaches in parallel.

8.14 A model for seasonal phytoplankton variations in the Oualdia lagoon (Moroccan Atlantic)

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The relative dynamics of phytoplankton complexes in the Oualidia lagoon (Moroccan Atlantic coast) ecosystem evolution was simulated by an ecological model. The system state in the model is described by: phytoplankton, zooplankton, dissolved organic matter, and dissolved mineral nitrogen. Two types of models were successfully elaborated, i.e. (1) the descriptive model to explain the dynamics of phytoplankton concentration in the Oualidia lagoon as a result of independent environmental variables, and (2) the phytoplankton concentration model prediction. The descriptive model for phytoplankton dynamics integrates and presents in a user-friendly way the knowledge collected through measurements over a period of two years (2011-2012) at six stations in the lagoon. Such presentation contributes to a better understanding of the ecosystem functioning. It is shown that the modeling results are adequately corresponding to the observation data.

8.15 How to characterize three different types of Swedish ecosystems depending on natural or anthropogenic regimes?

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Natural ecosystems may differ significantly regarding inflows and outflows of energy and matter, both in types of flows and over time. Human use of ecosystems often changes composition of species but often also the frequency, strength and form of pulses through the systems. Let's consider a northern boreal conifer forest, an alpine heath system above the tree line and an oligotrophic river ecosystem, respectively. All three can be situated in northern Sweden.

The systems are built up by their organisms which are a result of succession of the system and the time span between different changes such as fire in the forest peaks in reindeer population in the alpine heath and the flow of water during the year in the river. These changes can be seen as pulses which will have an impact into the future. A peak in reindeer would for instance affect the amount of lichens for about 80 years in an alpine heath.

These three different ecosystems also represent three different types of use by human. In the forest, trees are harvested over a time span of approx 100 years. In the alpine heath system the main harvest is reindeer meat, taken out on an annual basis. In the river system the harvest of highest economic value today is hydropower using the speed of water; this power is harvested continuously but the amount is depending on energy prices and amount of water in magazines. All three systems have changed because of the use by the human society.

As the natural pulses are changed by human activities there are different effects. For instance in the forest there is a loss of different types of forest since forestry speeds up the natural succession in some forest types and slow it down in others compared to the likely time spans between natural fires. The reindeer herders strive to minimize the natural dynamic process and to stabilize the output between years. By this peaks followed by dramatically declines are avoided. In the river the power harvesting process leads to a different pattern in the flow of water over a year compared to an unregulated river.

Our idea are to test if the observed changes can be better understood by analysing the changes in time span and quantity between natural flows and flows under anthropogenic regimes. The first step in creating such understanding is by analysing the changes in time span and quantity between natural flows and flows driven by human use.

8.16 Ecosystem-Based Fisheries Management in the Lake Goesan in Korea

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A mass balanced trophic model was developed for ecosystem-based fisheries management strategy in the Lake Goesan, Korea, using Ecopath with Ecosim software. The samplings were conducted in the Lake Goesan from 2010 to 2012 monthly. From the field study, we defined three different trophic levels such as producers (macrophyte, phytoplankton, detritus), primary consumers (zooplankton, zoobenthos, Carassius auratus, Hemibarbus labeo, other fishes) and secondary consumers (Siniperca scherzeri, Micropterus salmodies, Pseudobagrus fulvidraco, Leiocassis ussuriensis). Trophic levels in the Lake Goesan ranged from 1.0 to 3.5. A total of 441 tones of fisheries resources were estimated to current stock in the Lake Goesan. The sustainable fisheries stock use could be possible by maintaining optimum fishing intensity F40 according to ecosystem-based fisheries model in Goesan Lake.

8.17 Spatially explicit assessment of ecosystem service supply in Europe

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Considering the increasing popularity of the concept of "ecosystem services" (ES) in landscape management and environmental policies, it is urgent to assess the complex relationships among ES supply, and between the variety of demands for ES and the actual supply. Besides, identifying the relationships between ES, and particularly negative associations or "trade-offs", is essential to foresee the impact of changes in one ES provision on other services or to set up an efficient management of multi-functionality. In the context of the FP7 VOLANTE project on socio-economic and environmental consequences of transitions in land use, we analysed the provision of several ES across Europe. We investigated the associations among ES following three steps: (i) detecting ecosystem services associations, (ii) identifying bundles of ecosystem services and their geographic distribution, and (iii) the drivers of these bundles and trade-offs. Overall, our results demonstrate that European ecosystems provide a variety of services, with often high multi-functionality (i.e. supply of multiple ES at a given location). Indeed, the studied services can be clustered into three broad groups. Among these groups, several services are closely and positively associated: biocontrol services, forest-related services and, to a lesser extent, carbon sequestration, whereas food-feed-fibre production is negatively associated to pollination, carbon sequestration and forested-related services. The clear distinction between forest-related ES and other ES, together with the strong correlation levels among forest-related ES, and a strong contribution of mid European forested regions to the total ES provision are robust for several reasons. First and foremost, forested regions also tend to be those with more remaining natural habitats in general, thus contributing not only to forest-related ES but also to a variety of other ES (e.g. pollination). Potential drivers of ES bundles were also explored (e.g. land cover, climate factors, population and economic densities). Using Redundancy Analysis, we were able to isolate variables significantly affecting the multiple dispersion of ES. Here, we present one of the first spatially explicit assessments of current ecosystem services supply across Europe. Regional and especially climate-related patterns of European ES supply, reflecting the nature of European landscapes, and the underpinning drivers will be discussed.

8.18 Uncertainty in water and carbon fluxes simulated by the SURFEX model : Contribution of the meteorological forcings

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Land Surface Model (LSM) have been initially designed to represent the exchange of energy and water between the surface and the atmosphere. In the last two decades, the representation of vegetation and of the vegetation functioning in these models have been greatly improved with the inclusion of the main processes governing the carbon cycle (photosynthesis, respiration). In this study we present results from the SURFEX modelling plateform that includes the ISBA-A-gs vegetation model. the ISBA-A-gs model computes for any point of the globe the energy, water and carbon balance, based on the ECOCLIMAP parameter Database and soil texture maps.

The uncertainty in the simulated water and carbon fluxes arises from various sources including the imperfect representation of processes and the uncertainty in the input dataset.

This study focuses on the impact of error/uncertainty in the meteorological forcing on the simulated water and carbon fluxes. We use 2 types of forcings 1) meteorological measurements from towers of the FLUXNET network and 2) local extraction of global reanalysis (ERA-Interim) on these sites. In addition to the meteorological forcing, the FLUXNET database provides flux and water fluxes measured by eddy covariance that will be used to compare with the model simulations.

We compare model simulations driven by local fluxes (30-minute temporal resolution) with simulations on the same site driven with global reanalysis (global resolution, 3-hourly resolution). We analyse how the error in the meteorological forcing propagates in the model and in the simulated fluxes. We analyse the sensibility of different versions of the model to these forcing errors.

8.19 Puumala virus activity in the cis-urals natural focus: autonomous or externally forced oscillations ?

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Understanding mechanisms of Hantavirus activity fluctuations in natural foci and predictions of epidemic outbreaks in humans are the actual problems of epidemiology and medical theriology. Puumala virus (PUUV) is the agent that causes hemorrhagic fever with renal syndrome (HFRS) in humans. HFRS is widespread within temperate/boreal zone of Europe and ranked first on incidence among all zoonotic disease in Russia. It is highly endemic at cis-Urals with an annual incidence up to 56 per $100,000$ inhabitants. Epizootic monitoring of the bank vole (Myodes glareolus - the main host of PUUV) carried out at vicinity of Izhevsk ($56^{\circ}50'N53^{\circ}11'E$) and PUUV antigen in lungs of voles was detected by ELISA. The first part of time series of log-density of infected voles ($1981 - 1995$) is similar like self oscillation with about 3 years period and the simplest harmonic model has a good fit ($R^2 = 0.79$). The one time per year data can be model successfully via nonlinear difference equation for density-dependent growth of population with discrete generations: $N_{t+1} = 1 + 2.8N_t/[1 + (N_t/4.3)^{24.9}]$ with $R^2_{1981-1998} = 0.85$. However, the forecast of PUUV activity is losing the phase of observed fluctuation (and thus its worth) without taking into account the quasi-periodic external force interventions - the linden (Tilia cordata) mast events in previous years which supply the voles with extra winter food for early start of breeding and thereby synchronized PUUV outbreaks via infection risk burst in susceptible voles. Accounting of winter breeding $WB(0,1)$ is the most accurate (with advance about 0.5 years) predictor both for PUUV activity and HFRS outbreaks $(HFRSO : 0,1)$ in humans ($1973 - 2012$: $T_{Kendall}(HFRSO/WB) = 1.0, Z = 9.1$). Linden fruits harvest (L, points $0..5$) as only predictor, provides earlier but less accurate forecast ($1973 - 2012$: $T_{Kendall}(HFRSO/L) = 0.7, Z = 6.3$). Thus, the dynamics of PUUV activity in cis-Urals natural focus can be compared with possibly autonomous oscillation, but synchronized by pulses of quasi-periodic external force, and PUUV epizootic outbreak in the optimum range of the reservoir host (in contrast to other parts of the bank vole range) can be compared to resonance phenomenon.

8.20 Key issues on the development of species sensitivity distribution models and their applications to ecological risk assessment

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The species sensitivity distribution (SSD) model is one of the most commonly used methods for ecological risk assessment. There are usually four steps for the development of SSD models and their applications: 1) to obtain the toxicity data of the pollutants; 2) to fit the SSD curves; 3) to calculate the potentially affected fractions (PAFs) of the individual pollutants for the ecological risk assessment of an individual pollutant; and 4) to calculate the accumulated multi-substance potentially affected fractions (msPAFs) for the joint ecological risk assessment of multiple pollutants. Among the above four steps, the first two steps are paramount. In the present study, the following five key issues are discussed: 1) how to select the appropriate species; 2) how to preprocess the toxicity data collected from ecotoxicity database; 3) how to transform the acute toxicity data into chronic ones; 4) how to make the best fitting of toxicity data; 5) how to determine the uncertainty of the SSD mode. In responses to these questions, some principles were proposed to select appropriate species; three methods including the geometric mean, weight assigning and all raw data without processed, were compared to determine the appropriate method for the DDT toxicity data preprocessing; the method of Acute to Chronic Ratio (ACR) and the binary correlation analysis were contrasted by using the Zinc toxicity data for the transformation of the acute toxicity data into chronic ones; the BurrIII, Loglogistic and lognormal models were compared to determine the best fit model by using the Dichlorodiphenyltrichloroethane (DDT) toxicity data to invertebrates; and, the comparisons of the coefficients of variation (CVs) for the toxicity data and exposure levels in Lake Chaohu of eight polycyclic aromatic hydrocarbons (PAHs) were presented to demonstrate the uncertainties of the ecological risks assessed by the SSD model, based on 5000 Monte Carlo simulations.

Keywords: ecological risk assessment, species sensitivity distribution model, species selection, data preprocessing, best fit model, uncertainty analysis.

8.21 Quality of drinking water in networks distribution, by the organic and mineral matter deposit effects from the plant treatment until the consumer case study treatment drink water plant –Boudouaou

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The maintenance of drinking water quality from the treatment plant to the consumer tap is a major concern to water distributors in algeria . From a biological point of view, this maintenance must be characterized by a stability of bacterial growth. However, drinking water distribution systems are continuously exposed to a flow of biodegradable organic water and a flow of microorganisms, coming from the water treatment plant, but also from incidents (breaks, repairs) on the distribution network itself. A part of these microorganisms (heterotrophic bacteria, particularly) can grow in this oligotrophic environment, and can thus colonize the entire drinking water distribution system, Bacterial dynamic in distribution water drink system (boudouaou- corso – east of Algiers) systems is complex, because it depends on different parameters, like the biodegradable fraction of organic carbon, the presence of a residual disinfectant, the nature and, the biomass of bacteria, and the fixation of bacterial biomass resulting in the formation of a food chain, with a so some results gives a free chlorine residual between 0.05 and 0.2 mgl, showed that the number of cells and biofilm bacteria was about the same as in the non-disinfected control water. No biofilm, however, was formed in their system with a free chlorine residual of 0.5 mg1. The decrease of microbiologic contamination and the limitation of the microbiologic degradation require the use of chemical disinfectants, like chlorine, which act on the microorganisms themselves, or the use of new technologies, which act on the causes of the presence of bacteria by decreasing the concentration of organic matter in the distribution network . Regression analysis of producing algal (chlorophyll) Measures taken in the distribution system is 50% with a significant increase in biodegradable organic carbon 30% at the point ”D” of the hydraulic system

8.22 Numerical diagenitic modeling of two estuaries Aulne and Elorn, Brest, France

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We used a numerical model of sedimentary early diagenetic processes that includes oxic and anoxic mineralization in two estuaries Aulne and Elorn, Brest, France. The model belongs to the new wave of early diagenesis models that account for depth-dependent bioturbation and porosity profiles; it can be used both for calculating steady-state conditions and transient simulation. It was developed to reproduce the cycling of carbon, oxygen, and nitrogen; it resolves the sediment-depth profiles of carbon, oxygen, nitrate, ammonium, and other reduced substances. Organic carbon is modeled as two degradable fractions with different first-order degradation rates and nitrogen: carbon ratios, to account for the decreasing reactivity and N/C ratio of the organic matter with depth into the sediment. The values of several parameters (bioturbation coefficients, porosities, sedimentation, temperature, the bottom water concentrations of O2, NO3, NH3,...) were constrained using literature, experimental data.

The distributions of different profiles predicted by steady-state calculations are compared to observed data sets from our two estuaries. After adjustment of the critical parameters (the degradability rate constants for two fractions of carbon, the organic matter flux and the fraction of fast organic carbon deposited at the sediment–water interface), the model provide good agreements between predicted and measured profiles for each data set.

8.23 The first biogeochemical model of the Sidi Abderhman Lake (Safi, Morocco)

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In this study, we use a complex aquatic biogeochemical model to examine competition patterns and structural shifts in the phytoplankton community in the Sidi Abderhman Lake (Safi, Morocco) under nutrient enrichment conditions. Our model simulates multiple elemental cycles (N, P, Si), multiple functional phytoplankton (diatoms, green algae and cyanobacteria) and zooplankton groups. It also takes into account recent advances in stoichiometric nutrient recycling theory, and the zooplankton grazing term is reformulated to include algal food quality effects on zooplankton assimilation efficiency. The model provided a realistic platform to examine the functional properties (e.g., kinetics, growth strategies, intracellular storage capacity) and the abiotic conditions (temperature, nutrient loading) under which the different phytoplankton groups can dominate or can be competitively excluded. Our study highlights the importance of improving the mathematical representation of phytoplankton adaptive strategies for resources procurement (e.g., regulation of transport kinetics, effects of transport kinetics on the kinetics of assimilation, relationship between assimilation and growth) to effectively link variability at the organismal level with ecosystem-scale patterns.

8.24 A dynamic model to simulate the metal toxicity on Daphnia magna with realistic exposure scenarios

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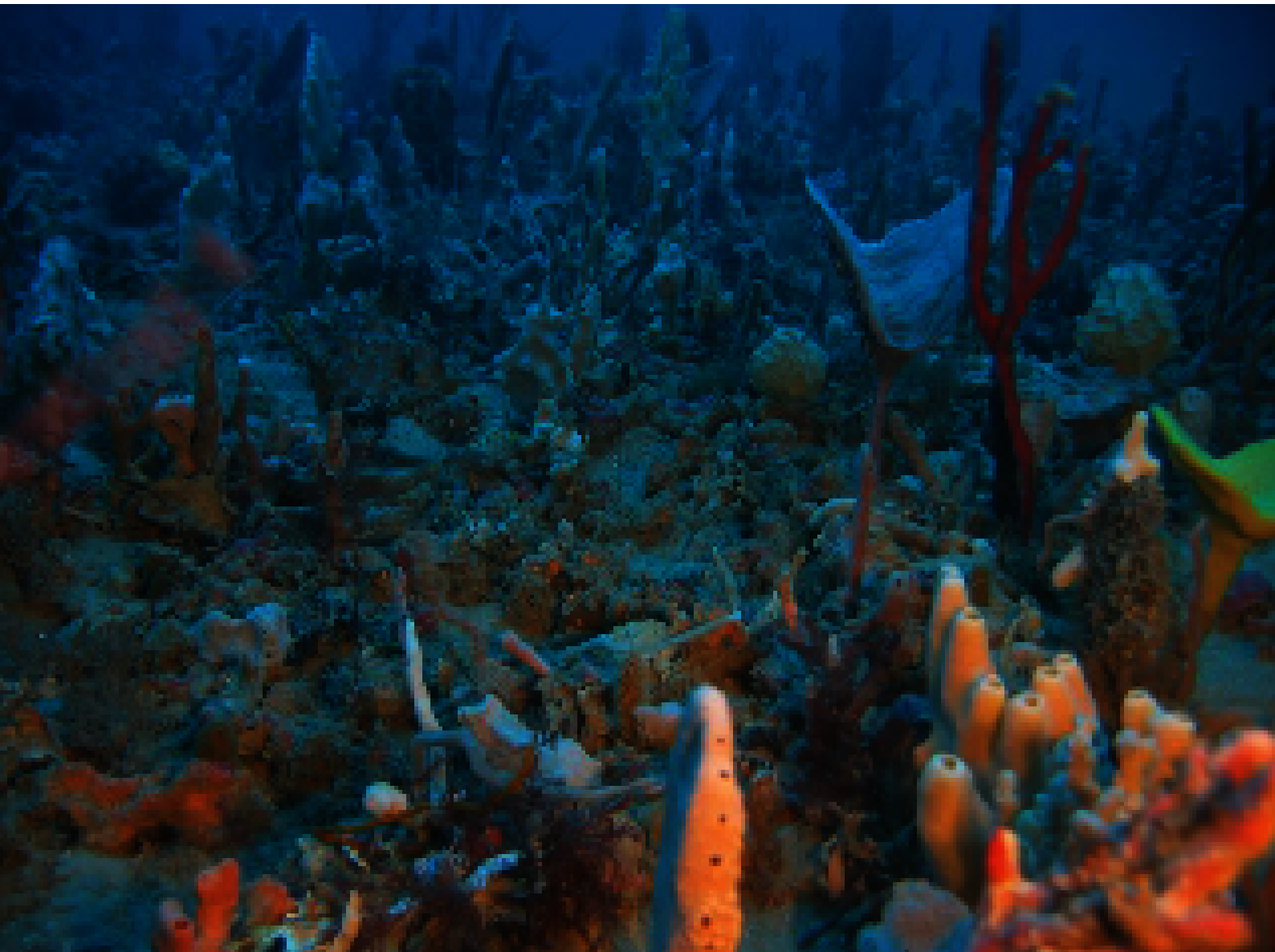
Recently, model approach in freshwater ecotoxicology that including integrated mechanistic understanding has become important. The overall objective of this study was to simulate the whole freshwater system that including population dynamics of Daphnia magna and behavior of toxic metal ion and organic materials in underwater and sediment. The model construction was conducted using the Powersim® software. The model was designed to simulate the dynamics of D. magna population and mass flow of the nutrients and the metal ions between each component, water, sediment, and the organisms. Model calibration and verification were performed using data sets obtained from a microcosm experiment. The simulation results show that the fluctuation of D. magna population and mass flow of materials were well estimated by dynamics model. Overall, the results show the dynamics model can be used as a useful tool for evaluating long-term metal toxicity on D. magna population with more realistic exposure scenarios.

Poster session 2 (October 30th-31st)



9.1 Carbon Dioxide Sequestration in Vertical Garden Systems

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A dynamic model was developed to evaluate the carbon dioxide (CO2) sequestration in a vertical garden system, from the introduction of plants in the garden structure until their end of life. We assumed to use plants adapted to survive in a Mediterranean climate. The different steps considered in the model are: 1) the carbon uptake by plants in the vertical garden, 2) the loss of carbon by natural mortality and harvesting of vegetation, bringing residues in a composting plant, 3) the carbon accumulation in the produced compost, 4) the carbon distributed to 1 ha of orchard soil, 5) the carbon emissions by the bio-oxidation reactions from composting and the soil respiration due to microbial biomass metabolism. The model, involving different compartments, evaluates the services provided by the perennial herbaceous plants in removing CO2 from the atmosphere without generating a woody stock in time, like the forest trees. The model demonstrates that the herbaceous plants increases their biomass in time within the limits of the garden surface; moreover the compost produced from the residues allows the carbon accumulation in soil and in microbial biomass substrate. Despite the vertical garden vegetation and urban residential green-space do not absorb a large amount of CO2 from the atmosphere, they involve in the process of carbon sequestration other environmental compartments (such as compost, soil and microbial biomass), inspiring a sustainable management of vegetable wastes.

9.2 System Dynamic Modeling Approach: the Coupling System of Spruce Forest-Dwarf Mistletoe

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The parasitic plant, dwarf mistletoe (Arceuthobium) was one of the hazard that threatens the health of the coniferous forest, wide spreading both in Eurasian continent and the North American continent. Based on the phenomenon that dwarf mistletoe (DM)parasitic on the spruce forest (Picea), with the application of population dynamic and differential equation we build a life history model of dwarf mistletoe and spruce forest. Our model divided the state of symbiotic relationships into two relatively independent subsystem, the host system and the parasite system. In the subsystem, the host grows from seedlings and the parasite grows from seeds, which both followed by the input and output progress of growth to death and the complication of each life history. At the same time, we use suspect-infection model to couple the two subsystem and we gave the key assumption that the amount of dwarf mistletoe seeds determines the infection rate of the host trees, while that the rate of dwarf mistletoe shoots which can germinate successfully on the branches of the trees is depended by the amount of the infected trees. With the application of system dynamic tools to build our model, initial values and some of parameters were set as having referred from the common cases in the previous study, we compute and analyze the change of forest structure in the infection of dwarf mistletoe of 7 years whole life period with a spruce forest having 100hm2, 170000 initial amount of healthy trees, 5000 seedlings. At the assumption of each infected tree can germinate 1000 dwarf mistletoe shoots within the simulation period of 200 month, the forest experienced the process of increasing to slowly decreasing. But when we raise the ratio of DM shoots to per infected host to 2000 DM shoots/tree, the healthy trees in the spruce forest came up obvious decreasing directly and slipped down to the level of zero in the 10th year and the seedlings were not able to continue the upgrading. In condition of the change of dwarf mistletoe germination rate, DM shoots transformed from the exponential type (J-shaped) to the logistic type (S-shaped) and reached the limitation of the parasite population. Researching to build model and the results of computation is useful to reconstruct the invasion history and give a reference to diagnosing the current stages, or to prognosis the trends of the population.

9.3 Effect of harvesting on the fluctuation of populations with density-dependent birth rate regulation

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The paper investigates the mathematical model describing the dynamics of populations with a simple age structure (Frisman et al., 2011). The influence of density-dependent factors leads to the limitation of birth rate. The birth of many animals in nature declines significantly with the increase in population size. In this study, population is assumed to consist of two age groups by the end of each reproductive season: juveniles (immature individuals) and adults (participants in the reproduction process). Population dynamics comprises the processes of birth, death, and harvesting. Birth rate, which is a function of the age groups' sizes, is selected according to Ricker's model (Ricker, 1954). This formalization facilitates the description of density regulation, which leads to a differential decrease in reproduction intensity of individuals as the number of different age groups increases. Harvesting period is assumed to occur after the reproductive season. Yield is proportional to total population size; large, mature individuals from the old age class are harvested. A detailed analytical and numerical investigation of the proposed model is also conducted in this study. The model demonstrates various dynamic modes observed in similar model that does not include harvesting. Conclusions on stability loss for the model's nontrivial solution are drawn based on the intensity of intraspecific competition and harvesting. The birth rate limitation varies depending on the old age class size; increase in harvest leads to the expansion of the stability domain of the nontrivial solution. However, populations may exhibit irregular fluctuations. Stability loss is accompanied by the emergence of an invariant curve (it is Neimark-Sacker's scenario). When the birth rate decreases because of the increasing number of juveniles, the impact of harvest leads to a two-year fluctuation in population size; stability loss can be characterized by the Feigenbaum scenario. As a rule, increasing the intensity of harvest extends the stability domain and subsequently stabilizes population size. Nevertheless, certain simulation results demonstrate the non-monotonic variation in the stability domain of the nontrivial solution. This observation is due to the age structure of the population. This work is supported by the Russian Foundation for Basic Researches (Project No. 11-01-98512-_vosto_a) and the Far Eastern Branch of the Russian Academy of Sciences (No. 12-I-OBN-05, No. 12-II-SU-06-007).

9.4 Quantum-chemical study of the stability of pheromone molecules to environmental factors

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A pheromone is a secreted or excreted biochemical substance that triggers a social response in members of the same species. Pheromones are chemicals capable of acting outside the body of the secreting individual to affect the behavior of the receiving individual. There are alarm pheromones, food trail pheromones, sex pheromones, and many others that affect behavior or physiology. Their use among insects has been particularly well documented. In addition, some vertebrates and plants communicate by using pheromones. Quantum chemical modeling of the electronic structure and the total energy of several biological molecules important for the ecology have been carried out. Pheromone molecules of several forest moths presented in this work. The atomic and electronic structure of molecules pheromones are investigated by quant-chemical methods of the density functional theory B3LYP and semiempirical methods PM3/PM6. The conclusions about the reactivity of molecules the effect of the double bond and the conformation of the molecules on the different characteristics of pheromones. We have proposed a relationship between the behavior of these species and the absorption wavelength of the pheromone molecules.We have found that under ultraviolet irradiation the excited pheromone molecule is more eager to bonding with water. After absorption of radiation the deactivated molecules terminates participate in the ecological process. This work was supported by grants of RFBR 13-04-00375-A, Program of the President of Russian Federation "Leading science school" (grant № 1044.2012.2). We are grateful for the use of computation facilities of Joint Supercomputer Center of the RAS MVS-100K, Moscow and Center of high-efficiency calculations of IKIT SFU, Krasnoyarsk and Siberian Supercomputing Center of RAS, IC&MG SB RAS, Novosibirsk

9.5 The study of atomic and electronic structure of the bark beetles pheromones by quantum-chemical methods

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A pheromone is a secreted or excreted biochemical substance that triggers a social response in members of the same species. Pheromones are chemicals capable of acting outside the body of the secreting individual to affect the behavior of the receiving individual. The study of pheromone communication is one of the main directions of chemical ecology, is of particular importance for development of environmentally friendly ways to pest control species, and opens the way to control the behavior of insects. The development of new methods of pest control is necessary to consider the possibility of unforeseen negative consequences that may arise in the practical implementation. It is therefore necessary to carry out a theoretical integrate available materials, the further expansion of biological and chemical research and development of environmentally friendly ways to pest control species. In this work were theoretically investigated bark beetles because they are serious pest of forestry Quantum chemical modeling of the electronic structure and the total energy of several biological molecules important for the ecology have been carried out. The atomic and electronic structure of molecules pheromones are investigated by quant-chemical methods of the density functional theory B3LYP and semiempirical methods PM3. The comparative analysis of the semi-empirical quantum-chemical PM3 method and the method of density functional theory (DFT) B3LYP/6-311** basis, showed that atomic and electronic structures of the molecules similar. For the calculations, we can recommend both. DFT B3LYP/6-311** provides a more accurate description of the electronic structure, but requires more time and resources to the calculations than the PM3 method. We have proposed a relationship between the behavior of these species and the absorption wavelength of the pheromone molecules. After absorption of radiation the deactivated molecules terminates participate in the ecological process. This work was supported by grants of RFBR 13-04-00375-A, Program of the President of Russian Federation "Leading science school" (grant № 1044.2012.2). We are grateful for the use of computation facilities of Joint Supercomputer Center of the RAS MVS-100K, Moscow and Center of high-efficiency calculations of IKIT SFU, Krasnoyarsk and Siberian Supercomputing Center of RAS, IC&MG SB RAS, Novosibirsk

9.6 The Species Extinction on Model Ecosystems Caused by Habitat Destruction and Fragmentation

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Species extinction and loss of species biodiversity is a worldwide concern. One primary cause of species extinction is habitat destruction and fragmentation. It is evident that reduction of habitat area has damages on sustainability of the species. Habitat fragmentation should also affect the persistence of species. However, a cause-and-effect relation between the destruction of the habitat and extinction is very complicate. So far, the effect of local destruction has been studied in lattice models by two different approaches: bond destruction model and site destruction model. In the former, the lattice is partly destroyed. The interactions between adjacent lattice sites are not connected by barriers (walls). The barriers are randomly located between adjacent lattice sites. In the latter, the lattice sites are destroyed. The species cannot live on the destructed site. Here, we employ spatially explicit simulations with stochastic lattice models to compare different types of habitat destructions on extinction: (1) habitat fragmentation only (bond destruction), (2) both habitat loss and fragmentation (random site destruction) and (3) habitat loss only (continuous site destruction: destructed sites are connected). These systems correspond to lattice versions of the Lotka-Volterra model, where interaction is allowed between neighboring lattice points. Simulations are reveals that “habitat loss only” has a least effects on population extinction. The effect of habitat fragmentation alone is nearly equivalent to that of both habitat loss and fragmentations. Therefore, habitat fragmentation seems more important for species conservation strategy than habitat loss. Thus one large conserved area is much more valuable than many small distant patches, if the total areas are the same. The artificial corridors seem highly effective strategies for species conservation. However, we should be reminded that the target animals should have to use the corridors very frequently to be functioned. Some of the results cannot be explained by a mean-field theory such as the Lotka-Volterra equation. We discuss that endangered species may become extinct by a slight perturbation to their habitat.

9.7 Risk estimation of forest insect outbreaks when weather conditions are uncertain

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Risk estimation of forest insect outbreaks when weather conditions are uncertain

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In this work a program for modeling and analysis of forest insect population dynamics (for such species as Zeiraphera griceana Hbn. and Lymantria dispar L. which exhibit outbreaks in Central Europe and western Russia forests) is presented. For these species forest stand recovery after an outbreak and periodicity in population density changes are typical (permanent outbreak type).

In the program a model of population density changes on basis of historical data on population size and weather (Soukhovolskiy et. al.) is implemented. The program automatically calculates model parameters and present time series for the population dynamics. Data produced by the model is in good agreement with field data. Influence of weather factors amounts to 10-15 % of total regulating and modifying factors' influence. Analysis of the model revealed that for short-term prediction (2-4 years) of future population changes it is enough to have data on population density and weather conditions over the past two years. More accurately probability of an outbreak can be determined based on hypothesis of weather factors change. Analysis of a set of weather scenarios allows estimation of possible risks and damage for a forest stand, coming from insects, and thus allows to make forest protection arrangements in time. This work was supported by RFBR (grant number № 11-04-00173-a).

9.8 Dynamic modeling of an introduced ungulate: the Barbary sheep (Ammotragus lervia) in southeastern Spain

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The Barbary sheep is an ungulate native to northern Africa. Although it is listed as vulnerable by the IUCN in its native range it is considered as an invasive species in Spain where it was introduced in the 1970s in Sierra Espuña Regional Park. The species has different conflicting roles within the ecosystems of SE Spain. On the one hand as an invasive species it might pose a threat to native populations and communities and on the other hand it is considered as an economic hunting resource. We used data from literature review and censuses during the years 1998-2010 to build a dynamic simulation model of the population dynamics of Barbary sheep in the hunting reserve of "Sierra Espuña". The main variables of the model were Barbary sheep population size, the reproductive rate, the percentage of female breeders, hunting and outbreaks of mange (Sarcoptes scabei). The model has been verified by dimensional consistency tests, sensitivity analysis, tests of extreme conditions and statistics. We have analyzed different management scenarios including: i) the variation of the optimum density reference that determines hunting quotas, and ii) the effects of selective culling. The results seem to indicate that there is a density-dependent effect on the population of Barbary sheep. Maximum recruitment rates were not related to the larger size of the population but to density-dependent effects on reproduction. Our results might be used to help managers to take scientific sound decisions on population regulation of the species.

9.9 Some signs of sudden arrhythmia in the urals heart of small mammals population cycles.

Ivan Kshnyasev

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We investigated the dynamics of small mammals (SM: rodent, shrews and mustelides) in dark coniferous southern taiga in the Visimskiy Biosphere State Reserve (Middle Urals N$57°22'402$", $E59°46'409$") during more then quarter of century (since 1982). The long term SM population dynamics has apparently regular pattern (peak, trough, increase) - strong three-year periodicity (and weaker seasonality) in spite of environmental disturbances after catastrophic trees falls (caused snow storm 06.06.1995) and wild fire (1998). But later (after drought in 2005) some surprising signs of "fibrillation" are appeared yet, that can been observed by wavelet or short-time Fourier spectra. The summer of 2005 is characterized such deeper trough in SM abundance that we registered the unique (genetically proven via mitochondrial and nuclear DNA analysis) case of contemporary interspecies hybridization (female C. rutilus male C. glareolus). We got an estimate for parameters of population growth model with discrete breeding seasons: $X_{t+1} = R_0 X_t/[1 + (X_t/k)^\beta]$, using the density in beginning of reproductive season. High value of parameter $\beta \sim 61-386$, suggest that overcompensation is not exclusively result of intraspecific competition, but strong effects of specialized predators - small mustelides. The data slightly better can be fitted by newly introduced nonlinear (first order phase transition) model of exponential growth with a threshold (K): if $X_t < K$, then $X_{t+1} = a+exp(b+cX_t)$; if $x > K$, then $X_{t+1} = d$, ($R^2 = 0.92$). A threshold may be biologically interpreted simply as such prey density that "triggered on" negative density dependence not only via inhibition of the yearlings' maturation, but mainly via numerical response of specialist predators. We used GLM and IC model selection technique to determine the relative importance of different lags in delayed response of the least weasel on prey density, and got a maximum support ($w = 0.96$) for the lag about 9 month. At the next step we developed a system of two differential equations with delay and investigate the sensitivity of model trajectories to some parameters variations. We can only speculate do the observed shifts in SM dynamics is just a period of intermittency and the old regime should be back in future.

9.10 Modelling high-altitude belt vegetation zoning in mountain areas

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Altitudinal vegetation zoning is reflected in the fact that occurrence of certain tree species, shrubs and herbs change with altitude. Ecological model of second-order phase transition is proposed to highlight factors affecting species composition of plants, depending on the altitude. Also the model allows to determine boundaries of altitudinal zones for individual species. Phase transitions describe a situation when a certain tree species appear (transition from an ordered to a disordered phase) or, alternatively, disappear (transition from a disordered to an ordered phase) on a particular altitude. Function G (x1, x2, ...) is introduced to describe phase transitions for each tree specie and this function characterizes a risk of the tree specie being forced out . The function G (x1, x2, ...) depends on many different factors x1, x2, ..., affecting coenosis. It is assumed that function G (x1, x2, ...) reaches the lowest value possible when coenosis is in stable state. For simplicity we shall also assume that the function G (x1, x2, ...) can be approximated as function G (q) of a scalar quantity q (0 ⊠ q ⊠ 1). Value q is an order parameter and characterizes the stand. Expanding function G (q) in a Taylor series in even powers of the order parameter q enables us to write the analogue of L. Landau equation (Landau and Lifshitz, 1964) for describing environmental phase transitions. Height h of trees was selected as a control variable in the high-altitude zoning model. Relative frequency of occurence of i-th specie trees within a j-th altitude zone was selected as the order parameter q. Data on high-altitude forest zoning in Western Sayan mountains was used for verification of the model. Species composition of the forest stands included birch Betula pendula, aspen Populis tremula, Siberian fir Abies sibirica, Siberian stone pine Pinus sibirica, Scots pine Pinus sylvestris. It is shown that the proposed model of phase transitions successfully describes high-altitude tree zoning in Sayan Mountains and allows to quantify influence of climatic factors on trees occurrence, as well as interaction between different species of trees. Using universal phase transitions model to describe high-altitude vegetation zoning allows to evaluate reaction of plant cenoses to possible climate change.

This work was supported by RFBR (grants# 10-04-00256-a and 12-05-00494-a).

9.11 Dynamic simulation of trade-offs between ecosystem services on Biosphere Reserves.

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The management of Biosphere Reserves should pay attention to complex interrelationships established between ecological and socio-economic factors. The systemic perspective using tools such as dynamic models is essential to asses the ecosystem services delivered in the Biosphere Reserves, as Fuerteventura (FBR), in Canary Islands. By means of a sustainability dynamic model of the FBR, we analyse some ecosystem services, their changes a long time and identify potential trade-offs, in order to optimize the integrated management of the FBR and the decision-making process. Between the ecosystem services studied, are found: (i) natural vegetation conservation, (ii) food supply (both for cattle and cereals), (iii) aquifer recharge, (iv) population of threatened species conservation (such as Neophron percnopterus majorensis), (v) carcass disposal (vi) habitat conservation of endangered species (as Chlamydotis undulata fuerteventurae). Management measures aimed at enhancing some of these ecosystem services might be detrimental for others. There is considerable evidence about important trade-offs between provisioning and conservation services. However, there may exist less obvious trade-offs between biodiversity conservation services, as those regarding vegetation protection and scavengers species conservation, which are analysed in this work. Assesing how land use changes, socio-tourist dynamics and management decisions impact on multiple ecosystem services represents an important challenge which remarks the need for integrated approaches in which synergistic relationships and potential trade-offs between ecosystem services must be properly considered for better informed decisions.

9.12 Analysis of non-linear trends in the values of the net primary production of mountain forests of the Western Sayan Mountains (South Siberia)

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The boreal forest is one of the main elements of sustainability climate system of the planet at high latitudes, so knowledge of the net primary production (NPP) of forests is essential for an understanding of the current state and functioning of forest ecosystems. NPP is used to evaluate the flow of utilized carbon from the atmosphere by forest ecosystems. This value determines the degree of influence of vegetation on the global carbon budget. In addition, NPP depends on the climate, as an objective quantitative measure of ecosystem response to climate change. In this regard, there is an acute problem in assessing NPP of inaccessible forest ecosystems, which would allow timely and accurately identify areas of degradation and other negative changes in forest plant communities. One of the important approaches to solving these problems - is to use the space monitoring system. The main goal is to construct the spatial distribution of non-linear trends of net primary production (NPP) to identify the characteristics of the spatial and temporal dynamics of this quantity in the Western Sayan. Several methods of decomposition of the time series were chosen such as singular spectrum analysis (SSA, "Caterpillar»), SLT (seasonal-trend decomposition procedure based on loess) and the method of obtaining the trend composes based on the speed of approximation. Assessment data were obtained with the use of NPP MOD17 (MODIS/Terra). The time series of observations: 2000 - 2012. Analysis of the dynamic distribution NPP estimates showed the presence of degraded areas, growth and stable values of NPP. These results allow us to determine not only the territory and the date of change of vegetation, but also localize of nonnormal or stable behavior, which can use as a basis for monitoring and field research expeditions. The characteristics of methods were investigated, their advantages and disadvantages when used to assess NPP trends in terrestrial ecosystems. This work was supported by RFBR (grant number 12-05-00494)

9.13 Computer based modelling of clonal plant propagation across space linked to GIS

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Understanding the ability of plants to reproduce vegetatively is important to explain species persistence. The relationship between plant individual performance and clonal growth patterns are determinant in understanding the spatio-temporal development of plant. Different processes related to plant network architecture and resource translocation determine how plant communities are structured in space and time, which is difficult to evaluate due to hierarchical organization. Exploring and analyzing the effects of plant network architecture and resource translocation on plant performance is complicated to address through terrain experiments. Thus, computer modeling can be used to provide case oriented spatio-temporal simulation under various conditions. A new spatio-temporal model has been developed to provide simulation of clonal plant propagation across space in the environment of the abandoned sedimentation basin of a former mining area. Clonal plant propagation across space was simulated as a network of ramet units connected by branches. Initial units represent a set of plants that are identified in the area of interest at the start of simulation. Other units are created in the framework of a simulation period. The biomass of each ramet represents the accumulation of short-term resources, and is assumed to be dependent on its existing biomass. Initially, there is not included density-dependent competition among ramets or resource depletion. The growth ratio and the maximum of the biomass are expected to be dependent on the abiotic environment such as soil and its humidity. The accumulation for each ramet can be therefor described by a logistic law and complemented by other phenomena in order to simulate its growth and reproduction. Setting of the spatially dependent growth conditions in the model is based on samples captured in two areas of interest: population of Calamagrostis epigejos in the abandoned sedimentation basin of a former pyrite ore mining area, and population of Calamagrostis epigejos in the ash deposits of the power station. A few case studies partially based on terrain observations have been attached to the computer model in order to demonstrate the simulation outputs in the environment of parallel computing systems and geographic information systems (GISs). It is anticipated that the use of modern computer tools and advanced methods for spatio-temporal analysis will bring new insight into the studied clonal plant propagation.

9.14 Flexible metabolism approach in ecological modeling

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Traditional ecological models show bad predictability force when they used to describing complex, and especially closed ecosystems. This is manifested in well-known "Hutchitson Paradox" and contradiction between "complexity-stability" relations in models and real ecosystems (or "May Paradox"). Moreover, in framework of conventional ecological models closed ecosystems may exist only in case of one-element closuring. Due to experimental and observation data which show that in nature ecosystems may be closed by more than one element, that "prediction" of convention models may be named "Closuring Paradox". This work was devoted to create new model approach which can solve these problems of tradition ecology models. Different types of metabolism flexibility was exanimate by stochastic analysis to prove that this approach may solve above three paradoxes of modern ecology.

9.15 An input-state-output scheme for the representation of national economic systems through a combination of indicators

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Ecosystems and human (economic) systems can be viewed as thermodynamic non isolated systems, open to energy and matter, that self-organize towards higher complexity and organization, create order, and self-maintain. Investigation can be performed through the implementation of an input-state-output scheme in which different indicators can be combined to depict the metabolism of these system. A categorization of ecosystems has recently been presented (Coscieme et al., 2013, EcolMod, 258, 1-8) through the combination of emergy (input indicator), eco-exergy (state indicator) and ecosystem service value (output indicator). Similarly, national economic systems can be represented through the joint use of indicators in accordance with the input-state-output scheme. An classification and cluster analysis of economic systems under a sustainability viewpoint is provided by considering the emergy per capita (input indicator for the environmental performance), the level of employment (state indicator for the social organization), GDP per capita (output indicator for the economic product). Results show that the economic performance strongly depend on the availability of natural resources; a high employment (organizational) level is possible if resources are used in a sustainable way and a fairy low level of GDP is accepted. It is also apparent that an economic system that is oriented towards high GDP and high employment level without resources (hard dematerialization) does not exist. It can be shown that this scheme is also feasible with a different set of indicators, such as Ecological Footprint (input), the nighttime lights analysis (state/organization), ecosystem service value (output). The 3D representation and result interpretation may inspire overall nation specific environmental management schemes and sustainability solutions.

9.16 Key scenarios for simulation of spontaneous restoration on the abandoned lands

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Dynamics of vegetation on abandoned farmlands is still poorly studied although the area of these lands is huge: only in Russia in 20th century it consists of 70 000 000 ha and 2/3 from them was abandoned in the early 1990s. Modelling is an important means to forecast the vegetation dynamics on the abandoned lands and to estimate speed and direction of the restoration. We consider four control parameters which define the spontaneous restoration: (i) the presence or absence of outside impacts in the abandoned area: grass fire, first of all; (ii) fire frequency; (iii) phytocoenotic neighborhood of the area: species composition in surroundings that define possible seed flow; and (iv) a type of farmlands: pasture meadow, arable lands, or others. Abandoned farmlands repeatedly experienced fire and located within the poor phytocoenotic surroundings are widespread over the entire Russia. It is a typical situation everywhere and all known scientific articles exploring in varying degrees this option. Abandoned farmlands without fires situated close to rich in species forest are not well investigated yet, because they are extremely rare though this option may be to us a reference point giving the thresholds important for the modelling. We have found such a starting point of the reference: several former agricultural fields abandoned in 1992 and located in the core of Nature Reserve “Kaluzskie zaseki”. These fields have never burnt and they are situated inside the multispecies old-growth broad-leaved forests. Field data on vegetation, soil, soil mesofauna, and microbial activity have been collected. A conceptual model and key scenarios of spontaneous forest restoration have been developed. These data allow us to estimate quantity of different species at different points of succession.

9.17 A Conceptual Framework for Evaluating the Domains of Applicability of Ecological Models and its Implementation in the Ecological Production Function Library

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The use of computational ecological models to inform environmental management and policy has proliferated in the past 25 years. These models have become essential tools as linkages and feedbacks between human actions and ecological responses can be complex, and as funds for sampling have become increasingly limited. A key attraction of ecological models is the ability to apply them in new 'contexts' (i.e., locations, ecosystems, spatial and temporal extents) without having to collect extensive new datasets. There are, however, recognized risks when an ecological model developed in one context is applied in another. In order to better assess this risk we have developed a general conceptual framework that aids in evaluating the potential contextual range of a given model's application, and we have implemented this framework within a database that allows end users to browse, compare and select among ecological models. The framework draws on the "transferability" literature and the importance of a model's "life cycle", as described in the 2007 National Research Council Report, "Models in Environmental Regulatory Decision Making". The framework, in the form of a decision tree, assesses a model's conceptual validity (i.e., model type, complexity and structure) during development as well as its evolution and its use in the literature by evaluating its performance (i.e., validation, model comparison and uncertainty) and its similarity in four domains of context: scale, geography, ecology (e.g., geophysical, biotic, etc.), and parameter range or hyperspace. We will showcase the implementation of this framework in the Ecological Production Function Library (EPF-L), a database currently being developed by the U.S. Environmental Protection Agency. Its goal is to provide end users with an array of ecological models and a guided assessment of their applicability to the user's context.

9.18 Computing soil thermal conductivity from temperature time series

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A knowledge of the thermophysical properties of the soil is very important in numerous applications involving heat exchanges in the soil. We use inverse problem solving to estimate thermal conductivity at soil profile from soil temperature time series recorded at Bakchar weather station in West Siberia during 1966-2010. To evaluate the thermal properties, we use daily temperature measurements. The 1-D heat diffusion equation with phase changes was solved using an implicit finite difference scheme. Sequential optimization of the model parameters have resulted in estimation of thermal conductivity coefficients. The results indicate that this method is most effective in the upper part of the soil column in summer where daily temperature variations are large. Thermal conductivity has strong depth dependence. Variations of conductivity in time are small. The difference between the modeled and measured temperature is typically less than 0.2 ℃ and maximal errors occurs near zero temperature due to oversimplified physics of soil freezing and thawing. The estimation of thermal conductivity can be used for simulation changes in freezing depth due to air temperature and snow depth variations.

9.19 Application of a LUE model to estimate daily GPP and model uncertainties in different Italian forest ecosystems using a Bayesian approach.

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Forest models have been increasingly used in the last decades to study carbon fluxes and productivity of very different forest ecosystems all over the world. Over the last two decades, the need of simple and easy to use models for practical applications has become clear, and some have been developed for this purpose, keeping in mind the importance of understanding and considering the main drivers of forest productivity, trying at the same time to make them applicable to the widest possible range of ecosystems.

In the same period of time, it has become also clear that model performances should not be assessed only in terms of accuracy in estimates and predictions, but estimates on model uncertainties should also be considered an important criterion. Here we apply a simple semi-empirical Light Use Efficiency (LUE) model to several eddy-covariance Italian sites, considering coniferous forests, broadleaf forests and mediterranean shrubs, with different environmental conditions, to test its generality over different forest ecosystems. We estimate daily Gross Primary Production (GPP) over one year in each site and model uncertainties on both GPP and model parameters, applying a bayesian calibration based on a multiple chains Markov Chain Monte Carlo sampling.

The accuracy of model estimates of daily GPP over the entire period of simulation is very different depending on the site considered, with the best model performance when applied to coniferous sites. Model ucertainties are always smaller than data uncertainties from 20% to 65% on average depending on the site considered. Both GPP and uncertainties estimates are largely dependent also on uncertainties on the data, which makes their calculation a key process in this modeling exercise.

In conclusion, this semi-empirical model appears to be suitable for estimating daily and annual forest GPP in coniferous forests but is less accurate in other forest types, which limits its application to a narrow range of ecosystems. Moreover, the key process of calculating appropriate uncertainties on GPP data is not well established, suggesting the use of a more structured model with different outputs (i.e. GPP, NEP, forest growth) would be preferable in order to obtain trustable information on the ecosystem functioning.

9.20 Ecopath model at the turn of the millennium: challenges for the new century

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A review of the literature on Ecopath with Ecosim produced over the past decade (2001–2011) showed a sustained increase in the scientific production in international journals, with a 3 articles in 2001 to 25 articles in 2011. This production is highly concentrated in Ecological modelling and three other journals (>50% of papers), involving contributors from more than 20 countries. Research efforts are growing rapidly in Atlantic and Pacific Ocean. Studies on Ecopath also increase in Mediterranean Sea. Development of research is particularly strong in themes such as food web and ecologic studies, fisheries and carrying capacity. Yet, the application Ecopath is a rather imbalanced science, with 151 application on marine and 23 on river and lake during this period. Ecopath must progress from the present descriptive stage to synthesis, either through large-scale comparative analyses or the formulation of general models (e;g. end to end modelling), yielding the power to predict the time course of Ecopath increase. The development of a cooperative framework should contribute to expanding the scale of the research, develop the capacity to conduct new relevant research, establish a global network monitoring of this kind of models applications, and incorporate this kind of model into international programs examining the health and functioning of the marine and fresh water.

9.21 Development of a Remote Sensing and Automatic Data Acquisition and Management System for Modelling Mosquito Activity in Relation to Weather Conditions

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It is expected that global warming would increase the rate of development and emergence of mosquitoes through increasing temperature which is a crucial factor for the growth of the insects. With the increment in urban waterfront development and the changes in life style, the more time people spend enjoying outdoor activities, the more chance they are exposed to mosquito attack. The activity of adult mosquitoes are highly correlated with local weather conditions, including air temperature, precipitation, humidity, wind and time of the day and year, etc. Modelling variation in mosquito activity based on changing weather condition could make a significant contribution to enhancing public health by providing a mosquito activity forecast. For that purpose, it is highly required to monitor the activity of mosquitoes and local weather condition in real time and to manage the acquired data. The main objectives of this study includes the development of the model for mosquito activity prediction based on variable weather conditions in the urban environments. The second objectives is to offer a mosquito activity forecast service through the Urban Ecology Analysis& Prediction System including a data acquisition and management system. The activity of adult Culex pipens is monitored using the digital mosquito monitoring system in the observation sites along the polluted urban streams in Korea. The species is the dominant mosquito species in the urban environments and the potential vector of West Nile virus. The monitoring system attracts the female mosquitoes by spraying carbon dioxide and additional attractants. The number of the insects captured is counted automatically by the infrared sensor. The local weather condition in each observation site is monitored at the same time using an automatic weather station. The observed biological and meteorological data are transmitted to the TCP/IP data server via a CDMA wireless network with the preset time interval and stored in the Urban Ecology Analysis& Prediction System. The System integrates data collection, eco-informatics system for ecological modelling, and end-user applications for data management and analysis.

9.22 Linking morphological traits and functional strategies: a typological approach of tropical forests species.

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One of the major challenges in forest ecology is to understand the ecology, physiology and potential responses of the > 250000 species of vascular plants of the planet through the categorization of this diversity into functional groups. This approach is essentially based on functional traits analysis, but few investigations were made in tropical areas. The aim of this study was to determine functional groups in two contrasted tropical ecosystems, dry (DF) and mountain rain (MRF) forest (respectively rainfall of 1 200 mm/year and 10 000 mm/year). Guadeloupe Island in FWI presents both these ecosystems spread over less 100 km. In a first time, we developed an original species typology based on 7 «soft» traits, easy to measure (stomatal density, leaf trichom density, chlorophyll content, leaf nitrogen content, specific leaf area, wood density, leaf area, plant height). The method was based on principal component analysis (PCA) and agglomerative hierarchical clustering (AHC) applied to these traits measured at the individual level (Blazy et al., 2009). In a second time, we evaluated the relevance of these soft trait-based groups compared to a typology based on 5 «hard» ecophysiological traits, more costly to quantify but with higher functional significance (difference between predawn and minimum leaf water potential, stomatal conductance, maximal carbon assimilation rate, leaf water potential at 90% of loss of stem hydraulic conductivity). When performed on the dominant canopy species in DF and MRF (a total of 13 species and 60 mature individuals), the typological approach based on soft traits seems relevant to discriminate groups with a distinct functional reality. Through both ecosystems, we obtained 4 homogenous groups. Two were exclusively composed by DF«s or MRF«s species, indicating that a functional strategy can be linked to specific environmental conditions. The two other groups showed a mix of DF and MRF species indicating that different functional strategies can coexist in the same environment. These mixed groups seem distinct by their ecophysiological features, particularly in term of hydraulic characteristics. One group was composed by drought tolerant species, water spender species, with a high xylem embolism resistance, whereas the second one was composed by water saver species, less resistant to embolism. Therefore, a determination of functional groups based on soft traits could be useful to model ecosystem«s responses to environmental changes on a global scale.

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