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Ecem 2014

Conference proceedings

8th European Conference on Ecological Modelling

Marrakech, MOROCCO - October 27-30, 2014

ROYAUME DU MAROC

ICTP Turning 50

MED Solutions

The International Society for Ecological Modelling (ISEM) promotes the international exchange of ideas, scientific results, and general knowledge in the areas of systems' analysis and simulations in ecology and application of ecological modelling for natural resource management. The Society was formed in Denmark in 1975, and today has chapters in Europe, Japan, and North America.

In 1997, the European chapter of ISEM organized its first conference in Pula, Croatia, starting the series of European Conference on Ecological Modelling (ECEM) that in the following years attracted an increasing number of scientists. ECEM conferences (last one in Riva del Garda, Italy in 2011) contributed in consolidating and promoting ISEM society.

ECEM 2014 conference is organized by École Supérieure de Technologie Essaouira (Univérsité Cadi Ayyad - Morocco) and the Istituto Nazionale di Oceanografia e di Geofisica Sperimentale – OGS (Italy) on behalf of the International Society for Ecological Modelling (ISEM).

This is the 8th European Conference on Ecological Modelling, and in agreement with ISEM we decided to have it in a North African country, Morocco, in order to promote the participation of scientists and students from Africa, to involve more African Scientists in the Ecological Modelling community and to launch the birth of an African chapter of the Society.

It was a challenge, but we are happy to see that here in Marrakech we will have almost 200 contributors from 35 different countries with all continents represented. Particularly we are happy that many of the contributions are from scientists coming from African countries.

The theme of this conference is "Beyond boundaries: next generation modelling". We do believe that this multidisciplinary cross-sectorial approach to science is more and more requested to meet the many challenges society posed to scientists, and that ecological models can contribute a lot in supporting such an approach. Because of this we will have keynote talks targeting different aspects, methodology, applications of the ecological modelling field: keynotes are well known worldwide experts of different fields from climate, to macroecology, from fishery to machine learning, from spatial model to model uncertainty and links to policy and society. But the contributions will span over all fields of ecological modelling.

We hope we succeeded in creating a welcoming environment, in which many discussions – and possibly collaborations - can develop.

Thank you for coming,

Cosimo Solidoro
President of the European chapter of ISEM

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Keynote Speakers

Icarus Allen - PML, UK

His scientific background is multidisciplinary, specialising in the numerical modelling of marine systems from individual cells to shelf wide ecosystems. Until recently, the overriding theme of his work has been the interfacing of biogeochemical process models with hydrodynamic models in 1, 2 and 3 dimensions and the analysis of the subsequent simulations. In general terms the focus of this work has been the coupled physical biogeochemical modelling of shelf seas, with a focus on the NW European Shelf.

Michael Doebeli - UBC, Canada

His work is in the context of evolution of diversity, theory of adaptive speciation, including evolution of cooperation and game theory.He has done important studies on the evolution of diversification and cooperation in E. coli. Evolutionary dynamics in ecology and dynamics of spatially structured populations are some important themes of his research.

Antoine Guisan - Switzerland

His main focus is on spatial predictive modelling of plant and animal distributions. His group develop models for various purposes, such as rare species management, assessing the potential impact of climate change on plant and vegetation distribution, and invading species forecasting. The main local study area for model development is the Swiss Prealps of Canton de Vaud, a mountainous landscape (ranging from about 400 to 3200 m). He also works on the entire scale of Switzerland (rare and invading species) and Europe (climate change models).

Sven E. Jørgensen - Denmark

He has received several awards, The Prigogine Prize, The Pascal Medal, The Einstein professorship at the Chinese Academy of Sciences, The Santa Chiara Prize for multidisciplinary teaching and the prestigious Stockholm Water Prize. His works represent seminal contributions to the ecological modelling and the use of numerical methods in several fields of ecology. He has published more than 364 papers of which 274 were published in peer-reviewed international journals and he has edited or authored 75 books, of which several have been translated to other languages.

Sovan Lek - EDB, Toulouse - France

His research concerns the biodiversity and the spatial distribution of fish according to the environmental characteristics and the response of fish community to the human disturbances, especially land-use, hydromorphology, climate warming. The distribution of fish is considered according to the scale of variation, varying from local to regional and global scales, in relationship with the environmental variables. He mainly interested in the use of Machine learning techniques using especially Artificial Neural Networks and decision trees to model ecological data.

Jason Link - NOAA, USA

During his 15-year career with NOAA Fisheries, Link's work has revolved around the scientific underpinnings for ecosystem-based marine resource management. His expertise in food web dynamics and his exemplary work with the Ecosystem Assessment Program at NOAA's Northeast Fisheries Science Center in Woods Hole has led to his and NOAA's acknowledgement around the world, resulting in comparable programs in other countries. Dr. Link's work has moved more towards applied ecological modeling and practical fisheries science for management. Recent efforts have focused on essential fish habitat, multi-species models, ecosystem models, and developing resource management tools and systems with a strong ecological basis.

Andrea Saltelli - JCR, European Commission

He has worked on physical chemistry, environmental sciences and applied statistics, publishing over 80 peer reviewed papers and three books. His main disciplinary focus is on sensitivity analysis of model output, a discipline where statistical tools are used to interpret the output from mathematical or computational models. A second focus is the construction of composite indicators or indices. Presently leads the Econometric and Applied Statistics Unit of the European Commission at the Joint Research Centre in Ispra.

Karline Soetaert - NIOZ, NL

She is head of the Department of Ecosystem Studies, Royal Netherlands Institute of Sea Research (NIOZ-Yerseke). She studies marine sediments that are very active environments with their own peculiar characteristics and they may have a profound impact on the water column functioning. She is involved in several projects investigating the nitrogen and phosphorus cycle in sediments, and their implications on the water column, for coastal and deep sea areas.

ECEM2014 Conference Program

		27 October 2014		28 October 2014		29 October 2014	30 October 2014
09:00	09:15	**Conference Opening**		**Keynote - Andrea Saltelli** (What do I make of your latinorum? Sensitivity auditing of mathematical modelling)		**Keynote - Icarus Allen** (Towards next generation ocean biogeochemical and ecosystem models)	**Keynote - Sovan Lek** (Potential of the use of Marchine learning in Ecological and Environmental Modelling)
09:15	09:30						
09:30	09:45	**Keynote - Micheal Doebeli** (Adaptive diversification and evolutionary dynamics in high-dimensional phenotype spaces)					
09:45	10:00			Meet societal challenges		Models for operational ecology	Meet societal challenges
10:00	10:15						
10:15	10:30	Incorporating ecological evolution and adaptation in modelling					
10:30	10:45			speed poster presentation (3 min each)		speed poster presentation (3 min each)	speed poster presentation (3 min each)
10:45	11:00	speed poster presentation (3 min each)					
11:00	11:15			Mint tea break		Mint tea break	Mint tea break
11:15	11:30	Mint tea break					
11:30	11:45					**Keynote - Soetaert Karline** (Direct coupling of 600 m deep-water corals to surface productivity)	
11:45	12:00	Session A Incorporating ecological evolution and adaptation in modelling	Session B Other ecological modelling applications	Session A New developments and emerging fields	Session B Meet societal challenges		Session A New developments and emerging fields / Session B Other ecological applications
12:00	12:15						
12:15	12:30					Modelling across phases	
12:30	12:45						
12:45	13:00						
13:00	13:15	Lunch (with posters)		Lunch (with posters)		Lunch (with posters)	Lunch (with posters)
13:15	13:30						
13:30	13:45						
13:45	14:00						
14:00	14:15	**1st SEJ Lecture - Sven Erik Jorgensen** (Application of Ecological Models for Assessment of Sustainability)		**Keynote - Jason Link** (Challenges facing ecosystem models to meet societal needs)		**half a day field trip to Ourika Valley**	**Keynote - Antoine Guisan** (Modelling species distributions: from understanding to predictions)
14:15	14:30						
14:30	14:45						
14:45	15:00	Meet societal challenges		Meet societal challenges			Session A Macroecology and spatial processes / Session B Models for operational ecology
15:00	15:15						
15:15	15:30						
15:30	15:45						
15:45	16:00	speed poster presentation (3 min each)		speed poster presentation (3 min each)			
16:00	16:15						
16:15	16:30						
16:30	16:45	Mint tea break		Mint tea break			**Closing ceremony and mint tea**
16:45	17:00						
17:00	17:15	Session A Meet societal challenges	Session B Modelling across phases	**social dinner with Fantasia**			
17:15	17:30						
17:30	17:45						
17:45	18:00						
18:00	18:15	**ISEM meeting & African Chapter**					
18:15	18:30						
18:30	18:45						
18:45	19:00						

The First 'S.E. Jørgensen lecture'

Application of Ecological Models for Assessment of Sustainability.

Sven Erik Jørgensen

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There has lately been an increased interest in sustainability assessment and models have been developed to assess the sustainability of ecosystems, a natural area for instance a landscape and of a well defined area that includes not only ecological processes but also socio-economic activities. Our experiences with sustainability assessment projects are still very limited, but from many sides it has been proposed which key variables to include in such an analysis. The use of work energy as a sustainability indicator that includes expressions of natural and socio-economic activities has been proposed and also tested with a reasonable success. The efficiency of the use of work energy in general and the amount of work energy needed to maintain the various subsystem and their capacity of work energy were included in this analyses. It is, however, clear that one indicator is insufficient to assess a sustainability of a very complex system. It has therefore been proposed to supplement the use of work energy as indicator with development of models of the most important cycles for natural and socio-economic systems, namely the cycles of carbon, nitrogen and water. Two ecological factors are in focus when it is discussed what is important to include in a sustainability analysis, namely the services offered by the ecosystems and the biodiversity, that is important for the spectrum of resistances to possible impacts on the systems. It is probably important to include these two ecological factors as direct indicators in the sustainability analysis, although they are both to a certain extent covered by the work energy analysis. Socio-economic indicators are of course also needed but it is beyond the scope of this presentation.

The result of use of models for the assessment of the global sustainability by use of a "limits to growth"- like model will be presented. The model has been used to assess the global development in the case of 1) more support to the developing countries by the industrialized countries 2) more green tax 3) more invest ment in pollution control 4) more investment in education and research. It can be shown that these investments lead to a win-win situation. The model has also been used to calculate the ecological footprint by various scenarios, which will be presented.

Adaptive diversification and evolutionary dynamics in high-dimensional phenotype spaces

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Adaptive dynamics is a general framework to study long-term evolutionary dynamics. It is typically used to study evolutionary scenarios in low-dimensional phenotype spaces, such as the important phenomenon of evolutionary branching (adaptive diversification). I will briefly recall the basic theory of evolutionary branching and present a well-studied empirical example. Because birth and death rates of individuals are likely to be determined by many different phenotypic properties, it is important to consider evolutionary dynamics in high-dimensional phenotype spaces. I will present some results about evolutionary branching in high-dimensional phenotype spaces, as well as results about more general types of non-equilibrium evolutionary dynamics, such as chaos. Finally, I will compare the deterministic adaptive dynamics in high-dimensional phenotype spaces to individual-based simulations of the underlying stochastic birth-death process.

What do I make of your latinorum? Sensitivity auditing of mathematical modelling

Andrea Saltelli

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JRC, European Commission

Sensitivity analysis, mandated by existing guidelines as a good practice to use in conjunction to mathematical modelling, is as such insufficient to ensure quality in the treatment of uncertainty of science for policy. If one accepts that policy-related science calls for an extension of the traditional internal, peer review-based methods of quality assurance to higher levels of supervision, where extended participation and explicit value judgments are necessary, then by the same token sensitivity analysis must extend beyond the technical exploration of the space of uncertain assumptions when the inference being sought via mathematical modelling is subject to relevant uncertainties and stakes. We thus provide seven rules to extend the use of sensitivity analysis (or how to apportion uncertainty in model-based inference among input factors) in a process of sensitivity auditing of models used in a policy context. Each rule will be illustrated by examples.

Challenges facing ecosystem models to meet societal needs.

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Key words: theoretical, technical , procedural, political, perceptual, challenges

Ecosystem modeling is a growing discipline with multiple applications. These models have been used to meet a myriad of societal needs for a wide range of ecosystems. Yet there remain significant challenges for ecosystem models to be more fully used and to more completely address societal concerns about natural systems. Some of these challenges are technical, some are theoretical, some are procedural, while others are political or are even perceptions from historical constraints. Here I note these challenges and specific facets of them from a wide range of examples. But more salient, I also note possible solutions to these challenges, using examples from systems with which I am most familiar. The objective is to collectively agree that there are challenges facing the applied ecosystem modeling community, but even more to stimulate a dialogue regarding possible solutions across a broad suite of applications. The aim will be to elucidate common sets of best practices to better facilitate the use and uptake of ecosystem models to meet these societal needs.

Towards next generation ocean biogeochemical and ecosystem models.

Icarus Allen

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Marine ecosystems provide a range of important services to mankind including food production, climate regulation through the cycling of carbon and other macronutrients, and a range of cultural values (e.g. recreation, tourism). They are in serious decline, primarily as a result of over-harvesting, pollution, and the direct and indirect impacts of climate change. Dynamic models that link the physical, chemical and biological processes through food web interactions provide a means of understanding how human impacts on different parts of the ecosystem interact and of predicting the consequences of management actions in one sector on other sectors. One challenge is to how to clearly model the scales of interactions and emergent properties ranging from ecosystem processes (e.g. production), through intermediate services (e.g. Nutrient cycling), through to final services (e.g. fisheries). The traditional approach to modelling marine plankton has generally been to build modelling frameworks by coupling bulk biomass functional type (FT) models to 1D and 3D hydrodynamic models. To enhance our capacity to assess

trophic and spatial controls on the structure of marine ecosystems requires the improvement of the representation of biodiversity and ecosystem function in model. To achieve this requires the development of a traceable hierarchy of models of different complexity using a modular approach with consistent process descriptions based on size, function (autotrophy, heterotrophy, decomposition), and biological traits (e.g. feeding strategy, motility, physiology). Through species-neutral process descriptions, the approach will allow scalable representation of diversity within and between functionally similar “guilds” of species. The talk will both review the state of the art and propose future directions.

Direct coupling of 600 m deep-water corals to surface productivity

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Deep-water Corals are amongst the most productive deep-water habitats. Although they obtain their nutrition from surficial waters, the hydrodynamic controls that enable growth of corals and associated fauna is not yet fully understood.
We combined a hydrodynamic, biogeochemical, habitat suitability and ecotrophic model to infer flows of organic matter in the Logachev deep-water coral mound province, (SW of Rockall Bank, NE Atlantic). A 3-Dimensional reactive transport model describing the transport and decay of organic matter (OM) in an area 80 * 60 km large, is driven by velocity fields generated by a hydrodynamic model.
The habitat suitability model is used to estimate coral cover, and this is combined with food uptake rates inferred from a previously published ecotrophic model. The coupled model allows to estimate the origin of OM that reaches the bottom and the impact of corals on the OM degradation and distribution in the area. The model simulations show on several occasions a vertical and direct drawdown of fresh OM from the surface toward the coral mounds, more than 600 m deep. This OM delivery towards the coral mounds contrasts sharply with other, non-coral regions that exhibit a more regular down welling of shelf water

Modelling species distributions: from understanding to predictions.

Antoine Guisan

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Species distribution models (SDMs) are increasingly used in ecology to answer basic questions and address applied issues in conservation, ultimately providing support to decisions. But the way they are built in a study can influence the resulting conclusions and applications. Here, taking the SDM perspective, I will review some elements of our understanding of what drives species distributions that can influence the way SDMs are built, how their predictions are interpreted, and ultimately how they are applied to assist conservation. I will ask how much SDMs are used in practice to support conservation decisions, and suggest some remaining questions and challenges.

Potential of the use of Marchine learning in Ecological and Environmental Modelling

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Machine learning is a branch of artificial intelligence that employs a variety of statistical, probabilistic and optimization techniques that allows computers to “learn” from the examples and to detect characteristic patterns from large, noisy or complex data sets. This capability is particularly well suited to ecological modelling, especially those that depend on number of variables measured and their often nonlinear relationships.
As a result, machine learning is frequently used in population and ecosystem studies. More recently machine learning has been applied to pattern the community structure and prediction. This latter approach is particularly interesting as it is part of a growing trend towards personalized, predictive ecology. In assembling this review we conducted a broad survey of the different types of machine learning methods being used, the types of data being integrated and the performance of these methods in ecological prediction and diagnosis. A number of trends are noted, including a “older” technologies such artificial neural networks (ANNs) instead of more recently developed or more easily interpretable machine learning methods such as tree family models.
A number of published studies also appear to lack an appropriate level of validation or testing. Among the better designed and validated studies it is clear that machine learning methods can be used to substantially improve the accuracy of predicting population, community and ecosystems. At a more fundamental level, it is also evident that machine learning is also helping to improve our basic understanding of ecosystems and its evolution.

Understanding hermaphrodite species through plasticity.

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Key words: sex allocation, size structure, hermaphrodite, Game, ODE, PDE

Although mammals have a relatively limited repertoire of reproductive patterns, in many other organism's gender is more flexible affair, like hermaphrodite species. For these species, it arises a fundamental and fascinating question: is a hermaphrodite simply splitting its time between maximizing its reproductive fitness as a female and maximizing its reproductive fitness as a male, or is evolutionary fitness as a hermaphrodite optimized by an entirely different, longer-term strategy? This leads us to an evolutionary analysis of these species. More precisely, we suggest evolutionary game theoretical models to investigate on the effect of cost of changing from one sex to the other, of gamete production and male-male competition on sex role of the hermaphrodite. By mathematical analysis of the model, conditions on stability of the equilibrium state and the asymptotic behavior of the solutions were obtained and interpreted. We prove that sequential vs. simultaneous is a matter of sex changing cost.

Modelling plankton succession and evolution in the world ocean.

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Key words: succession, evolution, adaptation, climate change, plankton, biodiversity

In nature, some of the impact of environmental change on ecosystem functioning is cushioned by changes in species composition and by genetic evolution. These responses can reduce the sensitivity of mass and energy fluxes to change – a key parameter in climate change research. The potential impact of these responses is greatest in the ocean, where the cycling of mass and energy is dominated by small, fast reproducing species.
However, the models that routinely predict the response of marine systems to climate change do not describe species diversity and evolution in any detail, and are not easily amended to do so. While recent "trait-based" approaches provide a conceptual framework for the modelling of species diversity, their implementations remain computationally expensive and unsuitable for the dynamic introduction of new types, implicit in genetic evolution. I discuss how these problems can be alleviated by concepts and methods from the field of adaptive dynamics. By describing the intra- and interspecific diversity in terms of the distribution of a few key traits, the structure of the ecosystem can be modelled with a few variables. As shown with a canonical ecosystem model in a spatially resolved world ocean, this approach remains viable in the presence of advective and diffusive transport of biota, and smoothly incorporates genetic evolution as another source of biodiversity, linked to reproductive effort. While these methods are not suitable for all traits and all types of diversity, they offer a starting point for the modelling of species diversity and evolution in computationally efficient manner.

Modeling the thermophilic cyanobacterium Synechocystis salina biomass dynamics depending on the concentration of phosphorus and nitrogen of the nutrient medium.

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Key words: cyanobacteria, Synechocystis, nutrients, growth, model

Cyanobacteria are photosynthetic organisms responsible for primary production in aquatic environments. Some cyanobacteria produce toxins called cyanotoxins that disrupt the functioning of aquatic ecosystems and pose a significant risk to animal and human health.
Monitoring of cyanobacterial dynamics and environmental conditions that may be involved in their growth is essential to understand the determinism of their blooms. However, given the complexity of this dynamic, it is difficult to explain using simple indicators or reports. To clarify the role of the many variables in algal growth and to predict the use of mathematical models proves the preference tool to achieve this goal.
In this study, a mathematical model simulating the growth of a strain of thermophilic cyanobacterium (Synechocystis salina) and the tracking algal biomass, depending on the concentration of nutrients (nitrogen and phosphorus) in the reaction medium (Z8), was developed. The development of equations simulating the dynamics of algal biomass from the assimilation of N and P as well as the calibration and validation of the model were made from several series of experiments carried out under controlled conditions of temperature and light.

Impact of mesoscale variability on spatial and temporal patterns of phytoplankton communities in the Iroise Sea (N-E Atlantic)

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Key words: Tidal front, Phytoplankton, Diversity, Adaptation, Model

It is now recognized that marine producers biodiversity can strongly affect primary production and, as a consequence, carbon cycling in the ocean. Variability of environmental conditions (physical processes) governs the composition of phytoplankton assemblages. At a regional scale, the Iroise Sea (west coast of Brittany, France) is an interesting coastal region to study phytoplankton dynamics since it presents a tidal front which is a one of the main feature of temperate coastal seas. The "Ushant" tidal front undergoes a very pronounced seasonal cycle, with a marked signal during summer. It separates offshore thermally stratified waters from tidally well-mixed areas over the continental shelf. The frontal zone is therefore a strongly dynamic area that sustains a high-intensity phytoplanktonic bloom (>2mg Chla.m-3) with high autotrophic biomass maintained throughout the whole summer season due to diapycnal mixing across the frontal zone. The resulting mesoscale heterogeneity (jets, eddies) may create ecological niches and thus enhance the observed biodiversity.
Using a regional ecosystem model, this study aims at assessing the impact of the physical environment and the mesoscale processes on the coastal phytoplankton communities in the Iroise Sea. We present a realistic hydrodynamic simulation (ROMS-AGRIF, 1.5 km resolution) coupled with an innovative and adaptive modelling approach that focuses on plankton diversity by allowing community self-assemble through competition amongst large numbers of phytoplankton types (the MIT-Follows "DARWIN" model). Using an annual simulation, the seasonal succession of species, as well as their spatial gradient (from coastal to open ocean crossing a strong front), will be analysed at regional scale,, and the impact of the phytoplankton biodiversity on the primary production and carbon fluxes will be presented.

A simple trait-based model for describing the adaptive dynamics of cooperation.

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Key words: cooperation, trait, adaptive model, evolution, coral-algae, symbiosis

The existence of altruistic behaviour in nature has posed a major controversy to Darwin's theory of Natural selection. Many individuals of different species have been observed compromising their own well being to the benefits of another individual. How could such behaviour evolve within a population?
This dilemma has been partly solved by Hamilton with the theory of kin selection in which he demonstrated that by helping relatives, an individual might indirectly increase its own reproductive fitness because the shared genes are passed into the next generations. However, kinship theory cannot explain altruism amongst non-relatives. Game Theory represents one of the major tools for exploring alternative mechanisms. Nevertheless, despite Game Theory models have greatly advanced our knowledge in the last decades, they often lack the possibility to dynamically link strategies with environmental factors, which are in many cases crucial in understanding mutualistic relationships in nature. Here we present an adaptive, trait- based model that can describe the evolution of traits defining cooperative behaviour. The model assumes the rate of change in the mean trait to be proportional to the fitness gradient of the system. The fitness gradient, in turn, relates traits (i.e. strategies) with environmental factors. We investigate the adaptive dynamics of partner species under changing environmental conditions. Our modelling framework represents a theoretical abstraction of the coral-algae symbiotic relationship.

Comparative study of subjective and objective weighted water quality indices in uMngeni Basin, South Africa.

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Key words: Subjective, Objective, Water Quality, Freshwater, Indices

Proper evaluation of the overall water quality status in a catchment is an essential task for meeting the goals of sustainable water resources management. For example, a suitable water quality index (WQI) counteracts the ecological need to

sum up the bulk water quality examination results and provides a single value that is understandable to non-technical stakeholders.
However, the choice of a suitable indexing method is challenging and adoption of a wrong method might result in biased conclusions. While the evolution of water quality indices has resulted in various methods, close inspection suggests that these methods could be basically categorised as subjective or objective. These broad classification methods depend on whether the weight factors and rating curves are developed based on professional opinion (subjective) or compulsory standards (objective).
For this paper, a comparative modelling approach based on subjective and objective weighted arithmetic Water Quality Index (WAWQI) and weighted geometric mean (WGM) methods, was applied to an eight-year water quality data-set for six stations along uMngeni River Basin, South Africa. The major objective was to determine the more suitable approach among the two for assigning weight factors and developing rating curves. The model results showed that the WGM method tended to be more sensitive to change in concentration of a parameter than the WAWQI. However, both index approaches produced similar trend patterns, with maxima in the wet season and minima in the dry season. Escherichia coli, ammonia and algae were significant parameters for lowering index scores on both methods.
It can be concluded that indices serve as effective tools for compressing bulk monitoring data. While considering the detrimental effect of gradual change in the concentration of given parameters such as pH to aquatic animals, the study recommended adoption of the WGWQI in assessing the overall water quality in uMngeni Basin.

An ecological-genetic approach to mathematical modelling of a natural evolution in a limited population.

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Key words: evolution, population size, dynamics, genetics, selection

The main problem of a dynamic theory of populations is the description of the nature and explanation of the mechanisms of fluctuating behavior of populations. This problem is near an important applied problem to develop an optimal strategy for exploitation of commercial species (optimization of the “harvesting”).
Another branch of the population dynamic theory - the mathematical population genetics investigated a number of models of evolutionary change of populations’ genetic structure. Features of population dynamics in this case are usually not analyzed.
The combining of population-ecological and population-genetic approaches has highlighted two types of problems that may be considered under this theory.
First, there was a natural development of the study of evolutionary factors (in the first place, natural selection) to change the genetic structure and the behavior of population dynamics living in conditions of limited environmental resources. Investigation of evolutions in uniform populations in the frame of the conception of K and r-selection gives us new understanding of nature of fluctuating in biological population number. There is wide variety of dynamical regimes even in uniform population: from stable dynamics to fluctuations of population number with stable genetic structure, and simultaneous fluctuation of genetic structure and population number.
Consideration of population age structure gives us new insight in evolution of structured populations.
The second one is necessity of analyses of harvest consequences. 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 model investigation shows us that unselected harvest can change dynamic regime as well as genetic structure in the population.

Use of Population Viability Analysis for conservation management of Endangered Wildlife: case studies from Morocco.

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Key words: Viability, Population, Extinction risk, VORTEX, Conservation, Wildlife

Population viability analysis (PVA) has become a commonly used tool in conservation biology and in the management of threatened or endangered species. The ready availability of generic computer packages for running PVAs has increased its use. It is often used to gain a better understanding of the population biology of a threatened species, identify gaps in knowledge of its life history, and estimate the relative risks and conservation values of alternative management options. PVA models begin essentially with the basic stock and population dynamics of the study species, such as birth and death rates, migration, sex ratio and age structure of the population. To this may be added effects of spatial structure (e.g. the amount, quality, and availability of suitable habitat), environmental and demographic uncertainty, dispersal, catastrophes, inbreeding and genetic effects, and external deterministic processes such as habitat loss or hunting that impinge on a species’ chance of persistence. PVA simulation programmes use these input parameters to project forward through the years to determine the fate of each individual in the population at each stage of its life cycle.

Most life events modelled in a PVA are probabilistic events (i.e. the probability that an individual lives or dies, reproduces or fails to reproduce). The probabilities of different events happening are not always independent. For example, the survival or reproduction in each year may be directly related to the severity of simulated catastrophic events such as drought, flooding or severe food shortages. Alternatively, other models include genetic variation as affecting survival of an individual. Such an approach is tested and would be useful for species recovery groups in Morocco. Case studies from Morocco are provided using VORTEX programme on two endangered mammals, the Moroccan Dorcas gazelle and the Barabary Macaque and a vulnerable reptile species, the Souss Valley tortoise.

Food webs of pastoral ecosystems: complexity and size.

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Key words: food web, complexity, linkage density, connectance, ecosystem

Linkage density (LD) and connectance (C) play a key role in community ecology and are basic for many theories of community stability. Linkage density is a function of number of nodes (N) and links (L): LD=L/N, while connectance counts all possible interactions: C=L/N2. Both of LD and C correspond to the network complexity.
There is an inconsistency in a literature according the relationship among network complexity and size. Fonseca and John (1996) report a hyperbolic decrease in connectance with increasing system size. However, some studies show (Martinez 1992, Garlaschelli 2004) that connectance values in different-sized food webs remain almost constant. Sugihara et al. (1989) promote an idea that link density tends to remain constant across networks of varying sizes. However, the findings of Martinez (1992) do not support the size invariance of linkage density.
In a current research we make an attempt to assess the interrelations among network complexity measures (LD and C) and network size measures (N and L) using the 31 empirical food webs of pastoral ecosystems located at Chernivtsi Region in Ukraine.
Our findings confirm the “constant connectance hypothesis” as pairs C <–> N and C <–> L show no significant correlations underlying our dataset.
However, our data do not confirm the scale invariance of LD across the studied networks.
Multivariate analysis indicated LD and L to be the most essential in defining of network topology. These results confirm the theoretical studies of importance of feeding relations in a system. L can be considered as Odum’s (1953) amount of choice energy has when flowing through a trophic network. Due to Link (2002) LD reflects how stable a food web may be.
Current findings are consistent with our previous results of food-web study of 7 pastoral ecosystems of Carpathian Mountains in Ukraine (Buzhdygan et al. 2012; 2014).

Marine and terrestrial systems – How does system organisation influence theory and modelling practice?

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Key words: Marine , terrestrial, Systems, Connectivity, Food web models

Marine and terrestrial ecological systems differ with respect to physical environmental conditions, chemical fluxes and life history of their organisms. Also, there are clear distinctions in system organisation e.g. trophic and biomass relationships, size relations as well as temporal changes and fluctuations. Identifying the complex relationships between these patterns and processes is a crucial task in ecology. Over the last decades modelling has proved being vital for understanding the different ecological systems and their dynamics. However, also in modelling we have to acknowledge realm specific differentiation of approaches. In the marine and aquatic context there has been a concentration on steady state food web models and models of plankton dynamics. A comparable specific concentration of modelling approaches is not apparent for terrestrial applications. Thus, how fundamental modelling terms and notions are applied obviously differs between terrestrial and marine modelling approaches. The concept of landscape connectivity, for example, which was derived in the terrestrial realm has different implications in the marine context. Similarly, the terms bottom-up and top-down processes may have deviating interpretations. Denotations of model-specific limitations hence strongly depend on the observer specific assignments bearing a high potential for misunderstandings between the terrestrial and marine model and theory worlds.
Currently, we are seeing a strong diversification of approaches in both systems which are often combined with coupling of specific model types that relate to different organisational levels. With different examples from the marine and terrestrial context we demonstrate the current developments and show how different system processes and their appreciation can lead to different predominating modelling paradigms. Finally, we will discuss how the different concepts can be applied across system boundaries and can be used for a both-way stimulation to overcome the existing separations.

Modelling diel fish movement behaviour with different perception abilities across a heterogenous seacape

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Key words: IBM, movement, reef fish, sensing, memory

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 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 connect coastal systems like seagrass beds and coral reefs. To identify essential habitat properties for key species and anticipate their behavioural responses to changing environmental conditions is therefore critical to successful conservation.
Despite this, guidance mechanisms for fish moving between habitats are not well understood and few studies have investigated possible environmental drivers of movement patterns. To test and understand potential causal mechanisms and spatiotemporal patterns of movement we link movement decision-making with two main functional landscape features (food availability and predation risk) in an idealized IBM. The IBM integrates diel movement behaviour of a populations of a typical reef fish species with its key life history features and a spatial representation of the underlying habitats. By explicitly modelling different levels of perceptional abilities we compare consequences of different movement behaviours. We evaluate how much impact relatively sophisticated behavioural rules have on overall population dynamics and viability in fragmented landscapes.

Ecotoxicological diagnosis of two fish species along the south Moroccan Atlantic coast.

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Key words: Trace Metal, Metallothionein, Atlantic coast, Fish species

In the frame of a project on the evaluation of micro-contaminants transmission risk from the marine environment to the fishing industry, at the south Moroccan Atlantic area. The aim of this work is to study biological responses in different species of fish using the biomarker Metallothioneins, Trace Metal Elements and especially Cadmium revealing enzyme. To evaluate the toxicological risk to top predators, the proposed method is therefore to perform Metallothioneins assays in liver and mussel of different fish species: Merluccius merluccius and Zeus faber, along the Moroccan southern Atlantic coast (from Cape ghir to Cape Blanc). The sampling concerned 10 stations where fish samples were collected using a bottom trawl on summer 2013. Results showed a clear increase in the Metallothioneins concentration, confirming the presence of a high concentration of chemical contaminants which could come from metallic source.

Modelling the state of the Mediterranean Sea under contemporary and future climate

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Keywords: models, cllimate, biogeochemistry, habitat

A three-dimensional coupled transport-biogeochemical model is used to assess the impact of future climatic and management scenarios on biogeochemical and ecological properties of the Mediterranean Sea. Results are discussed in terms of temporal and spatial distribution of parameters and indicators related to the carbonate system and the cycles of carbon and inorganic nutrients through dissolved and particulate phases, as simulated by a multi-nutrient multi-plankton numerical model under current and future climate conditions. Simulations span the period 1990-2040 and are performed by forcing a three-dimensional off-line coupled eco-hydrodynamical model (BFM and OPA-tracer model) with current fields produced by ad-hoc implementation of the NEMO modelling system and with river input of nutrient and freshwater computed in recent European FP7 projects (such as Persus and MedSeA).
The model properly describes available experimental information on contemporary seasonal dynamic and spatial distribution at the basin and sub-basin scale of major biogeochemical parameters, as well as primary production and carbon fluxes at the air-ocean interface. Model projections suggest that future Mediterranean Sea will be as a whole warmer, more productive, and more acidic, but with significant space variability. Implications in terms of ecological and higher trophic level organisms dynamics are discussed, with reference to aquaculture activity and biogenic habitats (Posidonia oceanica seagrass, coralligenous formations, maerl beds).

Effects of climate change-related mortality on trophodynamics along the western Antarctic Peninsula.

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In the present study we predicted changes that may occur to western Antarctic Peninsula primary productivity through alterations in water circulation as well as ocean acidification-related reductions in thecosome pteropod productivity, individually and together, using a series of linear forcing function scenarios in an Ecopath with Ecosim model to anticipate their effects to the marine ecosystem over the next 40 years. We focused on predicting changes in primary and secondary production, because these trophic levels are likely to cause significant alterations to the entire western Antarctic Peninsula's marine ecosystem; in particular changes in biomass, ecosystem biodiversity and/or mean trophic level through additive, synergistic or antagonistic interaction effects. Biomass was predicted to decrease more severely in co-occurring circulation and acidification forcing-functions scenarios, than would have been predicted for an individual scenario. This would indicate the possibility of synergistic dynamics in the ecosystem. Organismal groups in the model that emerged as losers or winners in the climate change scenarios corresponded to predicted ecosystem shifts. For example, the model indicated that with a decline in the biomass of ice algae, cryptophyte biomass would increase, and with a decline in krill biomass, salp biomass would increase. Pteropods, historically included in aggregated planktonic groups within other Ecopath with Ecosim models, when considered as individual species in the present study, demonstrated significant influences to the marine ecosystem, particularly in ocean-acidification scenarios.

Combined modelling of fish behaviour and fishing operation in Ise Bay

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Key words: fish migration, fishing operation, Conger myriaster, Ise Bay

For the purpose of realizing sustainable coastal fisheries, simulation tools to evaluate the effects of fishery management will be useful. In order to simulate the resource condition for a bottom trawling in Ise Bay, a typical semi-enclosed bay in Japan, a fish model is developed which considers the migration effect as well as the growth and the population change. The model is coupled with a hydrodynamic model and a lower-trophic ecosystem model which predict environmental conditions such as water qualities. As the target fish of modelling, Conger myriaster is chosen because it is one of the representative species due to its high market value. In the migration model, the direction of the fish movement is determined by the preference strength for the environmental factors such as water temperature, dissolved oxygen, and so on. The population change is calculated by a general population dynamics model considering natural and fishing mortalities. At the first step, the fishing mortality is estimated by the actual fish catch data to validate the model. The results of fish behaviour simulation showed that the areas with high resource density in the simulation correspond to high CPUE areas in the real world. It is also clarified that the dissolved oxygen has large influence on migration and distribution of Conger myriaster in summer season and the effect of water temperature is dominant in winter. In the next step, the fish model is combined with a fishing operation model, which predicts the behaviour of trawling boats based on economic conditions and resource distribution. The combined model well reproduced the fishing location of the boats and their fish catch amounts. The model is applied to evaluate the effects of fishery management, and clarified that the control of fishing gear is effective to increase the profit.

Decadal reanalysis and seasonal assessment of key ecosystem indicators in the North-West European Shelf.

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Key words: marine model, sea ecosystem, assimilation, ocean colour

Coastal areas and shelf-seas provide goods and services to humankind, such as fisheries, aquaculture, tourism and climate regulation. Assimilation of biogeochemical data into marine models has the potential to support the understanding and operational prediction of anthropic and climate impacts on these crucial ecosystems.
This work assessed the skill of a decadal simulation and of seasonal predictions of marine ecosystem indicators provided by an ocean colour data assimilation system of the North West European Shelf.
Chlorophyll concentrations measured from satellite were assimilated into a physical-ecosystem model (POLCOMS-ERSEM) of the North West European Shelf, by using the Ensemble Kalman filter (EnKF). In situ monitoring data of chlorophyll, nutrients, dissolved oxygen, temperature and salinity were used to evaluate skill metrics of the assimilation performance, i.e. root mean square error, bias, Pearson correlation. The assimilation system was applied in the long-term reanalysis of the ecosystem biogeochemistry in the years 1998-2009, as well in "up-to-date" seasonal assessments of biogeochemical indicators, through iterative

assimilative simulations in the years 2012-13.
The reanalysis improved markedly the simulation and forecast of the satellite chlorophyll data. The assimilative simulation had also some skill in reproducing the spatial-temporal patterns of oxygen, nitrate and silicate. However, nutrients remained overestimated in the reanalysis. Up-to-date assessments of the chlorophyll distributions were improved by assimilation, but beneficial effects were less evident for the seasonal prediction of nutrients. Uncertainties in the model initial conditions for nutrients, as well as model and satellite data errors explain the limits of the assimilation performance.
Assimilation of satellite ocean colour data into marine ecosystem model can support the current scientific and policy efforts to enhance the understanding and operational capabilities for the sustainable management of marine ecosystems.

A metabolic scope based model to predict future thermal habitat suitability of native and invasive fish species that occupy a similar ecological niche.

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Key words: Metabolic scope, Numerical model, Climate change

Global increase in sea temperatures is considered to be facilitating the incoming and spread of tropical invaders. The increasing success of these species may be partly related to the fact that their optimal temperature (i.e. maximizing aerobic performance) is higher than that of indigenous species. Here, we determined the effect of temperature on the aerobic metabolic scope (MS) and the consequent thermal habitat suitability (THS) of two herbivorous fish species that occupy a similar ecological niche in the Mediterranean Sea: the native Sarpa salpa, and the invasive Siganus rivulatus, Our results demonstrate a large difference in the optimal temperature for aerobic scope (Topt) between S. salpa (i.e. 21.8°C) and S. rivulatus (i.e. 29.1°C), highlighting the importance of water temperature in shaping the energy availability of these two species. A modelling approach based on present–day and future scenario for oceanographic conditions was used in order to make predictions on the thermal habitat suitability of the two species both at the basin level (the whole Mediterranean Sea) and in the Sicilian Channel

(SiC), a key area the determines the inflow of invasive species from the Eastern to the Western Mediterranean. For the present-day scenario, our basin–scale model shows higher THS of S. rivulatus in the Eastern compared to the Western Mediterranean. According to our model, in the next 40 years, the THS of S. rivulatus in the Western Mediterranean will increase and will reach values currently found in the Eastern Mediterranean.
As a consequence, S. rivulatus might expand westwards in the near future, along with the expected increase of water temperatures. Our SiC-level model, however, suggests that, in the next 40 years, the thermal conditions of Western Sicily may remain relatively unsuitable for S. rivulatus compared to S. salpa. It is therefore possible that these local conditions will delay the introduction of S. rivulatus into the Western Mediterranean.

Assessing the impact of global changes on the surface water resources of Southwestern Nigeria.

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Key words: hydrological, modeling, water stress, climate change, land-cover, estimation

Understanding the relative impact of Land use land cover and climate change patterns on basin runoff is necessary in assessing basin water stress. This assessment requires long-term observed rainfall time series and LULC spatial data. However, there are challenges with the availability of spatio-temporal data, particularly limited range of available historical hydro-meteorological measurements. In order to assess the likely water stress, the study used long-term (1961 - 2007) rainfall data to drive the Pitman monthly rainfall-runoff model to assess changes to the water resources of three selected basins in Nigeria – Asa, Ogun, and Owena. Three CGCMs - CSIRO Mark3.5, MIROC3.2-medres and UKMO-HadCM3 dynamically downscaled to a 60km by 60km grid using the Conformal-Cubic Atmospheric Model (C-CAM) – are used to simulate impacts of future climate changes on water resources. These 3 models found suitable for simulating rainfall-runoff based on the insignificant differences of models' mean with mean of observed rainfall and temperature for pre – 2010 data compared to other downscaled C-CAM models (GFDL-CM2.0, GFDL-CM2.1, and ECHAM5/ MPI-Ocean Model). The model results show increases in the runoff coefficient with decreases in forest cover between 1981 and 2007 with average runoff coefficients of 5.32%, 12.0% and 6.4% for Asa, Ogun and Owena basins respectively. Based on CSIRO, MIROC, and UKMO predicted negative annual reduction in rainfall trend, the future scenarios resulted in a low runoff coefficient for the three basins – Asa (CSIRO 6.04%, MIROC 5.98%, and UKMO 5.87%), Ogun (CSIRO14.58%, MIROC 14.57%, and UKMO 14.43%), and Owena (CSIRO 8.54%, MIROC 8.70%,

and UKMO 8.87%). The predicted decrease is much higher for Asa basin in all scenarios, when compared to Ogun and Owena basins, indicating that future water stress in Asa basin would be much higher.

Predicting at African country level the potential climate induced changes in areas of suitability for survival of malaria vectors

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Key words: Climate change, Eco-climatic , Country, Anopheles

Predicting anopheles vectors' population densities and boundary shifts is crucial in preparing for malaria risks and unanticipated outbreaks. Although shifts in the distribution and boundaries of the major malaria vectors (Anopheles gambiae s.s. and An. arabiensis) across Africa have been predicted, quantified areas of absolute change in zone of suitability for their survival have not been defined. In this study, we have quantified areas of absolute change conducive for the establishment and survival of these vectors, per African country, under two climate change scenarios and based on our findings, highlight practical measures for effective malaria control in the face of changing climatic patterns. We developed a model using CLIMEX simulation platform to estimate the potential geographical distribution and seasonal abundance of these malaria vectors in relation to climatic factors. The model yielded an eco-climatic index (EI) describing the total favourable geographical locations for the species. The EI values were classified and exported to a GIS package. Using ArcGIS, the EI shape points were clipped to the extent of Africa and converted to a raster layer using Inverse Distance Weighted (IDW) interpolation method. Generated maps were transformed into polygon-based geo-referenced data set and their areas computed and expressed in square kilometers (km2). Five classes of EI were derived indicating the level of survivorship of these malaria vectors. Angola, Ethiopia, Kenya, Mozambique, Tanzania, South Africa and Zambia appear most likely to be affected in terms of absolute change of malaria vectors suitability zones under the selected climate change scenarios. The potential shifts of these malaria vectors have implications for human exposure to malaria, as recrudescence of the disease is likely to be recorded in several new areas and regions. Therefore, the need to develop, compile and share malaria preventive measures, which can be adapted to different climatic scenarios, remains crucial.

Modeling climate change and variability effects in the Bay of Biscay ecosystem using end-to-end model.

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Key words: modelling, end-to-end, climate change, ecosystem, stratification, fish communitie

An end-to-end model is developed for the Bay of Biscay in order to assess the impact of hydro-climatic variability and changes upon the structure of the marine ecosystem. The hydrodynamic-biogeochemical 3D model ROMS-N2P2Z2D2, forced by detailed atmospheric and hydrologic forcing, has been implemented in the Bay of Biscay. This low-trophic-level model has been coupled to the high-trophic-level 2D model OSMOSE, which takes into account 8 fish species in the Bay of Biscay: anchovy, sardine, mackerel, horse-mackerel, hake, blue whiting, Bluefin tuna and albacore tuna. The both models have been validated with a 12-years hindcast simulation 1998-2009. Thus, two climate scenarios have been performed using atmospheric IPSL-CM4 model outputs: "present day" 1980-2000 and future climate scenario 2080-2099. The climate change signal is characterized by a general increase of the SST and a modification of the both annual cycle of phyto- and zoo-plankton biomass with a time advance of two months for the both. Sub-regional differences of change are also simulated. The phytoplankton biomass decreases on the French shelf and the central plain, while it increases along the slope and on the West part of the domain. The zooplankton biomass increases in the major part of the domain, except on the French shelf. The effect of the changes in stratification and thus nutrients availability are studied. The trophic role of plankton produces variable responses in fish communities depending on the species.

Modelling the physiological response of benthic organisms to carbon leakage from sub-seabed storage sites.

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Key words: CCS, ERSEM, Zoobenthos, Metabolism, Carbon dioxide, Modelling

Anthropogenically generated carbon dioxide emissions can potentially be reduced by the implementation of sub-seabed Carbon Capture and Storage (CSS). However, a concern exists about the potential of CO2 leakage, its fate and

environmental impacts. As part of QICS and ECO2 projects, which aim to developing best practices for management and monitoring of CCS sites, response of benthic fauna to carbon dioxide leakage is investigated with an aid of coupled pelagic-benthic ecosystem model (ERSEM-GOTM). Benthic organisms can adopt different strategies involving behavioural and physiological modifications in an attempt to cope with adverse surrounding conditions.
Observed up-regulating and down-regulating metabolic responses to low pH have been implemented in the model and applied to the major zoobenthic functional types (deposit-feeders and suspension feeders). Advantages and drawbacks of the different strategies adopted by benthic organisms are analysed under several leakage scenarios differing by duration and severity of the leak.
The impact of the leakage on benthic ecosystem is assessed by analysing the changes in the community (biomass, community composition and trophic relations) as well as the biogeochemical cycles (e.g. nutrient recycling and carbon sequestration).

Benthic-Pelagic coupling in the Black Sea northwestern shelf and its implication in the long term dynamics of hypoxia.

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Key words: Benthic-pelagic, Black Sea, Hypoxia, 3D models, Eutrophication, Global warming

A 3D coupled model (hydrodynamics-biogeochemistry) has been implemented to study the urging issue of seasonal hypoxia that affects the Black Sea northwestern shelf since the late 70s.
We first review the technical developments required to resolve the dynamics of hypoxia in such large and shallow shelf environment, in particular, the set-up of an efficient and detailed description of the exchanges across the sediments/water interface.

The enhanced model accounts for the variability of early diagenetic processes in response to bottom water biogeochemical signature and for the impact of bottom currents and waves on the sedimentation dynamics. It allowed us to appreciate the long term role of the sediment layer in the eutrophication and recovery processes following variations of the nutrients inputs.

The model results are then analysed to assess the variability of the seasonal hypoxic event and its impact on marine resources. Aiming to support an efficient management of hypoxia, we present an H-index that quantifies hypoxia as an environmental pressure on benthic populations and intend to derive the relationship that links this index to the quantity of nutrient delivered by the rivers.

We evidence:

- that the recovery after reduction of the nutrient loads is delayed by the accumulation of organic matter in the sediments during the eutrophication period,
- that the actual status of this recovery process can be overestimated if assessed only on the basis of the sparse monitoring data, and
- that climatic factors impact almost as much on hypoxia than eutrophication factors, which enhances the threat of hypoxia in the coming decades.

Determination of metal accumulation and translocation factor of (Cu, Fe and As) in some aquatic plant species in River Gomti, Lucknow, India

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Key words: Heavy metals, Translocation , Factor, Accumulation , Aquatic Plants, Macrophytes

Gomti, one of the major tributaries of the river Ganges serves as an important source of drinking water for the Lucknow City, the State capital of Uttar Pradesh with a population of about 4.58 million (2011 census). The river, also receives untreated effluent from sugar factories, distilleries and domestic waste water and sewage from habitations. Aquatic plants have ability to remove or accumulate heavy metal such as Copper (Cu), Nickel (Ni), Iron (Fe), Arsenic (As), Cadmium (Cd) etc. from water bodies provide a novel model for study. Thus investigations were carried out using Atomic Absorption Spectrophotometer and physic-chemical tests to determine the levels of heavy metals viz copper (Cu), iron (Fe) and arsenic (As) in four aquatic plants viz Ranunculus sceleratus, Hydrilla virticillata, Sagittaria japonica and Mimulus glaberatus collected from 10 different sites of river Gomti. The highest concentration of all four metals were found in Hydrilla verticillata at different location viz Fe (435.56 μg g-1) at site Gomti barrage, Cd with (60.16 μg g-1) at site Mohan Meikin, Cu (56.52 μg g-1) at site Gomti barrage, As (22 μg g-1) at site Daliganj pul. The concentrations of heavy metals varied from plant species to species as well as tissue. The differential accumulation and further translocation of heavy metals among the studied macrophytes and their parts was found higher in the roots than in shoots. The highest metal translocation factor was found in Hydrilla verticillata while the lowest was seen in Sagittaria japonica. Determination of metal accumulation and translocation factor provide compelling evidence of degraded sub Gangetic ecosystem.

Evolution of the Black Sea Ecosystem through the Post Eutrophication Period.

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Key words: Black Sea, biogeochemistry, modeling, euthrophication

The Black Sea ecosystem has experienced major transformations due to the synergistic effects of strong decadal-scale climatic variations, over-exploitation of fish resources, intense eutrophication, invasions by non-indigenous species, and their density-dependent internal feedback processes within the food web since the 1960s. As a result, the ecosystem was transformed to a low-energy, trophically inefficient food web structure that is characterized by the absence of top predators and controlled mainly by jellyfish and other opportunistic plankton species. These changes took place in the form of abrupt regime shifts almost at all trophic levels of the food web and the vertical biogeochemical structure of the water column, indicating the highly nonlinear characteristic of the ecosystem. The ecosystem state after the early 1990s exhibits an unstable character settling towards neither of the previous pre-eutrophic or eutrophic states. The complexity and the inherent nonlinear response of the ecosystem to external drivers and their internal feedbacks make unclear how the presently unstable pelagic and benthic ecosystems will evolve and be stabilized. Further complication arose by the interaction of ecosystem properties with complex eddy-dominated circulation systems. Using a fairly complex ecosystem model incorporating from biogeochemical processes to higher trophic level predatory relationships as well as fisheries and coupled with a mesoscale-resolving circulation model, we have investigated 20 years of the evolution of the food web structure for 1990-2010 and assessed the evolution of the ecosystem in terms of its stability characteristics, relative importance and functioning of the muscular versus jellyfish and microbial food webs.

Exploring education for sustainable development (ESD) in non-formal sector in Reservoir Hills residents to enhance resilience against climate change.

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Key words: Education for sustainable development, sustainable development, climate change, disaster risk, biodiversity loss

This study intends to look at ESD strategies to mitigate current and future challenges affecting the world such as climate change, biodiversity loss as well as natural disasters. It will mainly focus at one area in Durban which is Reservoir Hills. ESD is the guiding principle for the future development of the education system at various levels. Sustainable development is about meeting the needs of present without compromising the ability of future generations to meet their needs. ESD for is a vision that seeks to empower people to take responsibility for creating a sustainable future. ESD facilitators will play a vital role in raising awareness of sustainable development to Reservoir Hills residents. ESD and lifelong learning are necessary for the implementation of a comprehensive policy for sustainable development. Thus, education is only the means for developing a more effective education model whether formal or non-formal. ESD can contribute to making education systems not only responsive to, and prepared for, current and emerging challenges, but also a truly proactive force in triggering market and political pressures to move the sustainable development agenda forward by empowering people to make informed decisions as citizens, workers and consumers. ESD needs to be adapted and formulated in the local context.
ESD is a useful tool for changing behaviours and choices. Citizens are faced with degradation of natural resources and natural disasters. ESD will enhance citizens' knowledge, skills, attitudes and ability to adapt to a changing physical environment, while providing a mechanism to promote and support the use of facilities-based environmental solutions. Relevant theory as well as quantitative paradigm will be utilised.

A phenotype-genotype model of a population and observation of the evolution of virtual populations

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Key words: evolution, model

A phenotype-genotype model of a population is a natural generalization of a simple model of the population (a birth-death model in discrete time) with Mendelian model of heredity including:

- the possibility of arising of new alleles by mutation;
- the influence of genotype on phenotype;
- the influence of phenotype on fitness (probability of birth, probability of survival, the number of offspring of one individual born at the same time).

These assumptions define the populations with various kinds of natural selection. The evolution of such a population appears alone.
In this paper a phenotype-genotype model of a population was used to analyse the rate of the evolution: the phenotype variation amounts 100 generations.
This rate depends on:

- the probability of mutation;
- the size of the influence of genotype on phenotype;
- the size of the influence of phenotype on fitness;
- the mean population size;
- the degree of overlap of generations at each other.

The most interesting result of these observations is a non-linear course of phenotypic changes during evolution. The alleles increasing the fitness displace worse alleles and the population size increases. If the population size increases, then the rate of evolution increases but at the same time the size of the influence of phenotype on fitness decreases. If the influence of phenotype on fitness decreases, the rate of evolution decreases. The rate of evolution can increase to some optimum and then decrease. As a result the curves showing the size of phenotype changes during the evolution resemble the logistic or/and logarithmic curves.

Analysis of Coastal Upwelling at the north of Gulf of Guinea from operational model and observations.

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Key words: modeling, observations, upwelling index, coastal waves, sea level

Nonlinear principal component analysis (using a neural network model) is used to detect and characterizes low-dimensional nonlinear structure in monthly SST and Current data from tropical Atlantic (Gulf of guinea), collected between 1982 and 2005. Atlantic cold tongue (ACT) is detected as main mode, and its asymmetric variability with other area is shown like coastal upwelling. Composite analysis is used to confirm those results and also point out two types of ACT; which we may introduce as small Atlantic Cold tongue and large Atlantic cold tongue. Those two events are perfectly anti asymmetric, and we have caracterized coastal upwelling area along the coast.

Valuation of carbon sequestration in ecosystems of the region of Marrakech-Tensift-Al Haouz - Morocco

Evaluation de la séquestration du carbone dans les écosystèmes de Marrakech Tensift Al Haouz

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Key words: carbon sequestration, Valuation, ecosystem service, regulation

Photosynthesis is an important function in plant's ecosystems. It removes CO2, a potent and long lasting greenhouse gas, from the atmosphere while simultaneously diffusing water vapor into it. The aim of this study is to evaluate, in the present and future, the exchange of carbon in the different ecosystems of the region of Marrakech-Tensift-Al Haouz. The study will include two components: i – A quantitative component that will quantify the amount of carbon sequestered in each ecosystem; ii – An economic component: in which we determine, based on the international market, the economic value of the carbon sequestered. We will use the NASA's Simple Biosphere model (SiB2), forced by local land use, the soil types and climate data of the study area.

Phytoplankton-zooplankton interactions under fluctuating environmental parameters in the area near Cape Juby.

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Key words: Phytoplankton, Zooplankton, Interaction, Hydrology, Cape Juby

In this study, we investigate the effect of spatial and temporal fluctuations of some environmental parameters on the interaction of phytoplankton and zooplankton in the Cape Juby (28° N) filament in 2009. Along a transect oriented east-west, phytoplankton and zooplankton were sampled in five stations at different depths from the surface up to 150 m. Simultaneously, temperature, salinity and nutrients contents data were collected at different periods: February, April, June and October. During the four periods surveyed, Copepods showed high diversity as a dominating group in zooplankton population (Acartia clausi, Euterpina acutifrons, Oithona similis, Oithona nana, Oncaea venusta and Paracalanus parvus). Diatoms group (Cylindrotheca closterium, Leptocylindrus danicus, Leptocylindrus minimus, Melosira sp, Navicula sp, Nitzschia spp Proboscia alata, Pseudonitzschia delicatissima, Pseudonitzschia seriata, Thalassiosira spp and Alexandrium sp) were dominating the phytoplankton community. Inputs of nutrients, especially phosphates (PO4) and ammonium (NH4) are well marked on the continental shelf due to the pronounced upwelling activity in April and June. A multivariate analysis was performed to investigate the relationship between zooplankton, phytoplankton and environmental parameters.

Dynamical Behaviour of a Two Prey and One Predator System with intrinsic growth of the prey populations

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Key words: Ecologicalmodel, Stability, bifurcation, Limit Cycle, Center manifold

We have developed a two prey one predator population model. The interaction between first prey and predator is assumed to be a Bedington-DeAngelis functional and that with the second prey is assumed to be a Lotka–Volterra type functional response. Both the preys grow with intrinsic growth rate having fixed carrying capacities. We have studied the systems to find out the dynamical behavior. Fixed points, boundedness of the solutions and stability (local and global) of the system at critical states are carried out. We show that the system is sensitive to the system parameters and initial population volume. We found the threshold value of a parameter for which the system admits a Hopf bifurcation. We also found the criteria for determining the stability, direction and other properties of bifurcating periodic solutions using the normal form and the central manifold theory. Numerical illustrations are performed in order to verify the analytical results. The Biological implications of our analytical findings are addressed.

A simple spatial model of belowground competition in mixed stands

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Key words: competition, process models, root systems, mixed forest

A new spatially-explicit and multi-layered discrete model of belowground competition is proposed. It allows simulation of root system growth and both intra- and inter-specific competition between trees for water and nutrients.

Each tree has exact spatial location, with zone of nutrition represented as array of cells. The average and maximal distance of lateral root spreading is calculated on the basis of stem diameter. As maximal and average root spreading distances decrease with increasing soil fertility and moisture, these parameters have site-specific modifiers. The model calculates potential rooting area as square of circle with radius equal to the average root spreading distance. Then, for each cell the probability of occupation is calculated, which is positively related to the amount of available nitrogen in the current cell and inversely related to the distance between this cell and stem base and the mass of roots of other plants. The distance from each cell to the rooting cell cannot be more than maximal root spreading distance for the given tree. All cells in rooting area of individual tree must be arranged in continuous connected contour. Vertical distribution of roots depends on species-specific features, soil characteristic and strength of belowground competition. It is calculated as decreasing exponential function of depth. Model also calculates horizontal distribution of biomass of coarse and fine roots as a function of distance from stem base. The uptake rate for water and nutrients is depended on biomass of fine roots in each cell, tree age, and species-specific modifier. The model was validated with experimental data, and the sensitivity analysis was also carried out.
The work was supported by the Russian Foundation for Basic Research, grant number 12-04-31635; Programme 4 of the Presidium of Russian Academy of Sciences, and the Academy of Finland, project numbers 140766 and 257845.

Evaluation and modeling of the effect of Bacillus thuringiensis Moroccan strains for controlling red flour beetle Tribolium castaneum (Herbst) (Coleoptera: Tenebrionidae).

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Key words: T.castaneum, B.thuringiensis, Microbial , control, modeling

The red flour beetle Tribolium castaneum has been reported to cause both quantitative and qualitative damage to wheat and other seeds (Ahmedani et al., 2008). Microbial control of insect pest of crops using entomopathogens is one of pest management strategy. Bacillus thuringiensis (Bt) has a great potential for this purpose.
The focus of the present study was to determine the effect of some Moroccan strains of B. thuringiensis such as a biological insecticide against larvae of T. Castaneum and to determine the relationship between mortality rates in function of Bt toxins concentration for the tested stains.
Sixteen B. thuringiensis strains were tested at different concentrations: 28μl/g, 56μl/g, 84μl/g and 111μl/g, and compared to the reference strain, B. thuringiensis subsp. israelensis HD567 “code 4Q1”, and the commercial product “Skeetal”. The mortality was observed against third larvae after 15 days of application of Bt toxins (mixtures of spores and crystals).
The larvae were susceptible to Bt 18.3 ; Bt 3.3 and Bt 26.5 strains with 90%, 80%, and 80% of mortality respectively (Lethal at a dose of 111 µL/g). The Bt 20.1 strain was also highly toxic to larvae with 63% of mortality. This study demonstrated that some of our collection Bt strains can contribute to integrated T. castaneum management system with strong biological control components. Furthermore, we noted the relationship between mortality and tested concentrations: Y = mortality= f (Bt toxins concentration) was assimilate to a polynomial function of order 3: Y= a X3 + b X2+ c X+d. The coefficients a, b, c and d depend to the tested strain, although some strains showed linear behavior.

Estimations of future water quality in Tyligulskyi Liman lagoon (Ukraine) using climate change scenarios.

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Key words: lagoons, Black Sea, climate change, salinity, eutrophication

The Tyligulskyi Liman lagoon located between the Dnieper and Danube rivers on the northwestern coast of the Black Sea. The lagoon has valuable natural resources, its coasts are included in a nature conservation stock of Ukraine.
A water exchange with the sea is implemented during 2–3 months every year by an artificial channel.
There currently are two main hydroecological problems disturbing a stability of lagoon ecosystem: (i) gradual increase of water salinity as a result of both decreasing freshwater inflow from the drainage basin and sea water inflow through the connecting channel, and (ii) summer phytoplankton and bottom-living macrophytes blooms. The present water management regime transforms the Tyligulskyi Liman into stagnant reservoir. This results in the long-term accumulation of salt and biogenic matter in the lagoon.
Using the ENSEMBLES Project climate scenarios as an initial data for both the water-salt balance model and the 3D ecological model based on the hydrothermodynamical model MECCA (Model for Estuarine and Coastal Circulation Assessment), we forecast the water salinity and trophicity in the lagoon for some periods of 21-th century. The inflows of water and biogenic matter into the lagoon from the drainage basin were calculated by the SWIM model (Soil and Water Integrated Model). The model runs considered different operating conditions of the connecting channel together with different scenarios of water and ecological management at the drainage basin.
It is shown that the management at the basin will not be effective owing to the climatic changes will result in the significant decrease of freshwater inflow into the lagoon. On the other part, the year-round water exchange with the sea through the modernized channel will be more efficient. The water salinity in the lagoon will increase from current 20–23 ‰ up to 50–75 ‰ to the end of the century.

Inter-sectoral greenhouse gas emissions in Beijing: who gives, who takes?

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Key words: Greenhouse gas, input-output, Beijing, pull effect, push effect

Cities are responsible for more than one third of total greenhouse gas (GHG) emissions globally. Beijing is the capital of China which is the biggest emitter of GHG in the world and one of the world's largest metropolises with high population density, urbanization level and per capital Gross Regional Products (GRP). We utilized an input-output subsystem model to study emission patterns through which major GHG (carbon dioxide, methane and nitrous oxide) pollutions are generated and transmitted within the production system. Our analysis reveals GHG emissions generated directly by each sector's productive process and caused by the final demand of each sector.
Furthermore, pull effect and push effect of sectoral emission have been evaluated in order to identify who is the giver and who is the taker in GHG emission process. From the look of direct emissions, the CO2 emissions were the largest component of total GHG emissions that lead to climate warming, followed by N2O and CH4 emissions. Specifically, two sectors, the Production and distribution of electricity, gas and water and the Transportation, played the most important role in GHG emission process. However, for total emissions generated by the final demand of each sector, the Construction sector was the biggest GHG emitter. With the pull and push effect, it can be found that most service sectors were Taker and played a huge role in pulling the manufacturing sector and the agricultural sector to emit GHG. For the Giver side, the biggest Giver was the Production and distribution of electricity, gas and water, followed by the Transportation, storage, posts and telecommunications and the Mining and processing of metal ores. Therefore, sectoral policies for energy conservation and emission reduction will be proposed for Beijing, especially for the services.

Lattice model of herbs and dwarf shrubs.

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Key words: herbaceous, plants, population, dynamics, interspecies, competition

The lattice simulation model consists of two blocks: computer interactive designer of plant life forms and model of the population dynamics of plants of different life forms. Designer can code and keep different life forms of plants. The model is analysing conditions of self-maintenance of plant populations taking into account parameters of seed and vegetative reproduction and inter- and intraspecies competition. The model also allows for investigation of influence of heterogeneity of a habitat on invasion of different plant species. Development of each plant is coded by 10 stages.
Plants at different stages differ in development of main morphological structures. The user can define stages of development of a plant, the size and shoot type at each stage of ontogenesis. The plant consists of aboveground part: vertical and horizontal shoots, and belowground part: rhizomes and fine roots. The time step is 1 month. The size of a cell is 5 x 5 cm, the size of a lattice isn't limited. One cell can be occupied with only one plant or part of plant of one species. Common dynamics of community consisting of creeping perennial plant Lysimachia nummularia L., bunchgrass Deschampsia caespitosa (L. P. Beauv.) and dwarf shrub bilberry (Vaccinium myrtillus L.) have been simulated as examples.
The model can be applied to the analyzing of practical questions of restoration of plant populations after destructions of their habitat.

How edaphic factors change in space? Using modelling techniques to predict soil changes.

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Key words: edaphic factors, modelling techniques, species distribution, heterogeneous environments

Soil properties have been widely shown to influence organism, in particular plant grow and distribution. In low managed terrestrial ecosystems, biotas coexist with soil as part of a feedback system, in which an edaphic factor not only influence biota development, but is also influenced by it. However, edaphic factors are rarely taken into account as predictors of species distribution models in an edaphically heterogeneous landscape. Or, when it happens, interpolation techniques are used to project in space soil properties. However in heterogeneous landscape, such as in the Alps regions, interpolation techniques bring bias in predict soil properties due to the abrupt changes in environmental conditions over short distances. In these cases to be able to efficiently apply interpolation techniques it is needed to have a huge quantity of samples which is costly and time consuming.
In this study we aimed: 1) to assess the efficiency of modelling techniques in spatially project edaphic properties; 2) to understand which environmental factors influence soil properties; 3) to compare spatial projection made by using modelling with spatial projection made by using interpolation techniques.
For our study, we collected 242 soil samples in the Western Alps in Switzerland for the period 2012-2013. The analysis carried out in laboratory allowed us to obtain for each sample: pH, mineralogy, granulometry of the samples, determination of the mainly elements, isotopic ratios of carbon and nitrogen, electroconductivity.
We used ensemble forecasting techniques, combining together several models techniques, to build models for edaphic factors and project them in our whole study

area. As predictive factors we used high resolution variables: climate (temperature, precipitation, solar radiation), topology (slope, convexity, orientation), NDVI, geology, land use. We used kriging as interpolation technique.
Among the set of edaphic factors modelled, pH showed the highest evaluation value, followed by isotopic ratios of carbon. NDVI plays an important role as predictive variable for several edaphic factors. In general modelling techniques allowed having better spatial projection of the edaphic factors then interpolation techniques.

Multiple states and threshold processes in biosphere-climate system.

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Key words: multiple states, thresholds, biosphere

Forecasting the response of the biosphere and regional ecosystems to observed and expected climate change in different scenarios of man-made impact is a fundamental problem with obvious practical significance. Fundamental non-linearity of the biosphere-climate system (BCS) and multiple feedback loops among its subsystems forced us to focus on the feasibility of implementing multiple states and threshold processes in in response to impulse impact (volcano eruption, destructive logging, etc.) or uniformly growing disturbing impact, e.g. man-made carbon dioxide emission. As an example, presently observing pause in global temperature growth can be considered as a result of switching the climate system. Another possible variant of non-linearity manifesting is threshold irreversible response to gradual increasing of global temperature. In the paper a set of possible feedbacks that could potentially lead to multiple climate regimes and the threshold switching between them is considered. Among them there are: ocean carbonate – terrestrial vegetation interactions, vegetation-evaporation-cloude system, permafrost-atmospheric carbon system. Corresponding versions of small-scale models of BCS were built and investigated. Conditions of abrupt switching between different states of BCS were considered and the worst scenario evaluation of their feasibility was obtained. The possibility of positive feedback between local temperature increase and the rate of carbon release processes (self-heating of soil) was estimated. It was shown that observing intensive warming of Polar Regions poses a potential danger of autonomous positive feedback initialization and further activation of global positive feedbacks.

One-dimensional model for distribution and trophic role of phytoflagellates in meromictic lake Shunet

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Key words: Chemocline, microbial loop, Nutrition, Cryptomonas

One-dimensional model of phytoflagellates in the chemocline zone of meromictic lakes and their interaction with other components of microbial loop is designed. Verification of model is based on long-term monitoring of ciliates and phytoflagellates dynamics for Lake Shunet (the Republic of Khakasia, Russia). Main plankton components of chemocline community are included in the model. The growth rate, death rate, sedimentation, consumption of phytoflagellates by other components and respiration/excretion (optionally) are calculated. The model reflects the processes of phytoflagellates and ciliates nutrition of purple and heterotrophic bacteria in chemocline zone, as well as predators' consumption of phytoflagellates – by Rotifera and Copepods. The abilities of ciliates and phytoflagellates migration are also considered in the model.
Model is used for testing hypothesis on partly heterotrophic nutrition of Cryptomonas sp. In the model were built-in two nutrition potentialities of Cryptomonas - only autotrophic and combination of autotrophic and heterotrophic nutrition. It was a comparison of model calculations with these two mechanisms and the experimental data obtained in the microcosm. These results suggest the combined nutrition of Cryptomonas.

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Marine copepods shift in seasonal amplitude and synchronicity in the northwest Iberian shelf driven by meteo-hydrographic forcing.

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Key words: Marine copepods, Time-series, Wavelet, Iberian Shelf

We have investigated marine copepods temporal dynamics in the northwest Iberian shelf, a temperate ecosystem subject to coastal upwelling-downwelling processes. To this aim, we have applied wavelet analysis, a methodology able to cope with non-stationary dynamics, to monthly time series of copepods abundance acquired between 1995 and 2011 and to environmental variables known to affect functioning

of this ecosystem (wind regime, Ekman transport and river outflows).
The seasonal signal of total copepod abundance and of the main species showed an abrupt increase in amplitude around 2001 that persisted until the end of the series in 2011. Concurrent with the change in amplitude, there was a phase synchronization of the seasonal cycle of abundance among copepod species, which persisted for several years although it decreased at the end of the series. Between 2001 and 2004, significant changes in wind regime patterns, linked to variability of the North Atlantic Oscillation, were observed: westerly winds became predominant, river outflow increased and offshore Ekman transport decreased. This meteo-climatic configuration favors retention mechanisms over across-shelf exchange processes due to the reinforcement of the western Iberian buoyant plume (WIBP) and the prevalence of downwelling. We hypothesized that the observed changes in zooplankton dynamics are governed by the amplification of the seasonal signal of environmental drivers, mainly due to the enhancement of retention phenomena in winter.

North Sea – Baltic Sea ecosystem model, NEMO-Nordic-Scobi.

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Key words: ecosystem model, North Sea, Baltic Sea, River nutrients, NEMO-Nordic, SCOBI

The coupled ecosystem model was developed and applied for the North and the Baltic Seas. Physical model used in this work is the previously published NEMO-Nordic configuration based on the NEMO ocean engine. The biogeochemical part of the model is based on a continuously developing SCOBI (Swedish Coastal and Ocean Biogeochemical model). This model was successfully used in several studies on the ecosystem investigation of seas surrounding Sweden. In the current study model was extended with silicon related processes that are needed for proper description of the North Sea ecosystem dynamics. Also, model was extended with iron-phosphate-complex in the water column and in sediments to achieve more detailed description of phosphate dynamics in area with low oxygen concentrations. In this work we analyzed and compared with existing observations the model run for the period from 1961 to 2007. Comparison of model results with mean seasonal fields based on data from ICES data base shows good agreement for the surface seasonal spatial dynamics of the model. At the same time model shows good performance while comparing model results for main simulated parameters with observed time series on a selected stations in both North and Baltic Seas. Based on the results of new model we investigate the effect of change of river loads on the ecosystem of the North Sea. Resulted model will be used for performance of ensemble simulations for 1961-2100 forced by different river loads and regional climate scenarios.

Influence of short-term fine physical processes on the Southern Benguela/Agulhas Bank connectivity.

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Key words: Anchovy , recruitment, Southern, Benguela, Short-term fine, scale processes

Small pelagic fisheries in the Southern Benguela play an important role both economically and ecologically. Hydro-acoustic surveys of the area, since 1983 have shown that there is inter-annual variability in the anchovy abundance.
The recruitment of fish larvae, namely their transport form their spawning region on the Western Agulhas Bank to their nursery region in Saint Helena's bay may explain part of that variability. This study aims to establish whether short-term fluctuations of the atmospheric wind can have an impact on the connectivity between the Agulhas Bank and the Southern-Benguela Shelf. We compare two ROMS simulations forced with different wind fields; one considers seasonal monthly climatology winds and the other 6-hourly winds.
Passive particles, mimicking fish larvae behaviour, are randomly released over the western Agulhas Bank, and followed during 60 days. Our results show a marked seasonal signal, with an increase of recruitment success in summer and a great loss occurs during the first 15 days following their release. The presence of short-term fluctuations in the wind field triggers greater variability on the pathways taken by the passive particles. Different routes can be indentified, one following the shelf edge and one located more offshore.

Sensitivity analysis techniques for the identification of sensitive pathways and parameters in a food-web model – Application to chemical bioaccumulation in the Venice lagoon.

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Key words: sensitivity, bioaccumulation, food-web model, Venice lagoon

In order to assess potential bioaccumulation and effects of toxicants at the ecosystem level, extrapolations from single-species effect data are usually used. But such approaches fail to account for the interactions that inevitably exist among the component species. Alternately, modeling at the whole ecosystem level reveals

to be a powerful tool by considering species interactions, and by predicting both direct and indirect bioaccumulation from water and diet.
The aims of our work are:

- to develop a mathematical model which comprehensively describes a whole aquatic ecosystem accounting for species interactions;
- to perform a sensitivity analysis, i.e., to highlight parameters having the greatest influence on calculated target endpoints in order to simplify further calibration;
- to test the model on a real case study related to chemical bioaccumulation in a food web of the Venice lagoon.

The final aim is to priority pathways in the bioaccumulation food chain, to identify functional groups at risk and finally to predict potential toxic effects on populations.
A main feature of ecological complex models is however the great number of parameters involved in the modelling system. These parameters are generally highly uncertain because of natural variability and incompleteness of knowledge. In these cases, sensitivity analysis (SA) are essential tools that can be used to identify non-influential vs influential parameters/pathways.
The purpose of this study was to test both screening qualitative (but computationally cheap) SA methods (Morris design) able to identify non-influential parameters and more robust approaches (EFAST). These approaches were tested on a real case study related to PCB bioaccumulation in organisms of the Venice lagoon.

Phytoplankton characteristics in Oualidia Lagoon (Moroccan Atlantic).

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Key words: Phytoplankton, Oualidia lagoon, Modelling

In this study we will focus mostly on phytoplankton abundance and composition in the Oualidia lagoon. Simultaneously, measured physical (salinity, temperature, conductivity) and chemical parameters (nutrients, dissolved oxygen) were assessed together with phytoplankton data.
The ranges of values of surface water temperature (°C), salinity (psu) and dissolved oxygen (mg l-1) were: 15.3-24.2; 26.6-40.8; 6.1 – 11.1, respectively. The values (µmol l-1) of nutrients were: nitrite 0.33-16.21, phosphate 4.37-104.37 and ammonia 5.47-3.44. A total number of 127 species of phytoplankton representing two classes viz: Bacillariophyceae (81) and Dinophyceae (46) were recorded. Bacillariophyceae appeared to be the dominant group in respect of total species and cell numbers.
By investigating interactions between nutrient uptake, temperature dependence and phytoplankton growth, we aim to build a predictive model of this aquatic system.

Mesozooplankton diversity and biomass between Cape Blanc and Dakhla (21°N -24°N)

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Key words: Southern Atlantic coast; Mesozooplankton; Copepods; Biomass; Upwelling and environmental parameters.

This study forms part of CCLME program (Canary Current Large Marine Ecosystem) financed by the Global Environment Facility (GEF) in collaboration with INRH of Casablanca (Institut National de Recherche Halieutique). The survey was carried out in this area during November 2011 abroad the Norwegian ship 'Fridjof Nansen'. During the cruise, mesozooplankon where collected from one to five levels along the water column (0 - 200 m). Some environmental parameters were measured in situ using a multiprobe CTD : cholorophyll, temperature, salinity and dissolved oxygen. This area is well known by a permanent upwelling activity and submitted to the met of both Atlantic Central Waters (NACW and SACW) [1, 2] which make it the most productive zone of Moroccan shore. Vertical profiles of temperature have shown a cooler temperature in shallower stations. Both mesozooplankton densities and Chlorophyll 'a' concentration are higher in coastal stations. Copepods constitute the highest fraction (more than 90%) in all stations with a total of 62 species. Cosmopolitan species are dominant. Biodiversity is decreasing from Cape Blanc to Dakhla, while biomass is particularly maximal in Cape Blanc and Dakhla.

Ecological modelling of the Oualidia lagoon

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Key words: modelling, Moroccan, Atlantic, Oualidia lagoon, phytoplankton, nutrients

The Oualidia lagoon is a very important area of the Atlantic Moroccan coast and it has been subject to an increasing anthropogenic pressure for several decades, which contributed to the degradation of the water quality in the basin. A descriptive model has been developed to study the variability of the nutrient concentration

in the surface water throughout the lagoon. Six state variables (zooplankton, phytoplankton, nitrite, ammonium, orthophosphate and dissolved oxygen) are used to characterize the surface water. The model is forced by two environmental parameters: temperature and light. A comparison between simulations and observed data shows that the model reproduces the observations in a satisfactory way. The seasonal variation of nutrients is simulated properly: high and low concentrations are simulated in summer and spring, respectively.

Thermophilic species invasion and changes in the functioning of marine ecosystems

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Key words: food web, NIS, climate changes, Adriatic Sea

In the context of global warming, the Northern Adriatic Sea (NAS) can be regarded as a vulnerable ecosystem. Relative to its specific geography this ecosystem contains glacial relicts such as sprat (Sprattus sprattus), flounder (Platichthys flesus) and brown shrimp (Crangon crangon). Thus this ecosystem isan interesting case study to assess possible effects of warming-induced modifications to the structure and functioning of the marine ecosystem. To better understand the possible ecosystem dynamics under climatic changes, and to develop and test scenarios which can be helpful for decision support, a food web model was developed using Ecopath software. The model structure is based on native and invasive functional groups. For each functional group of native species, where there was evidence of possible
future establishment of invasive and similar thermophilic species, a matching group comprised by invasive thermophilic species was added (at the lowest initial biomass). In order to simulate the warming effect, the growth rates of different groups were linked to temperature by means of a Lassiter function, the parameters of which were inferred from the latitudinal distribution and from the ecological traits of the species comprising each group. After a preliminary sensitivity analysis, different simulations were performed using projections of water temperature increases based on the IPCC A2 (worst case) scenarios. Effects of the adaptive capability of native species was also explored. Results confirmed the high vulnerability of the biotic community in the NAS, with changes both in terms of structure (e.g. effects on diversity) and functioning. Moreover, negative consequences for the fisheries were projected detected, due to the possible arrival of new species that will probably not sufficiently replace the decrease in biomass of natives.

Properties of network structures along the adaptive cycle.

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Key words: adaptive cycle, networks, succession, ecosystems, complexity

During the stages of ecological growth and development, certain trends of properties can be observed regarding the structural and functional aspects of the system. Previous research found that total biomass, energy storage, work capacity, cycling, etc. increase during the stages from early to late succession. Here, we elaborate on the two-stage successional model using the conceptual model of Holling's adaptive cycle including growth, equilibrium, collapse and reorganization. The resilience of a system is its ability to navigate through all four stages continuously, sustainably. In the growth stage, an imperative for the system is to build storages and pathways in order to maintain higher level of throughflow for a given amount of input.
However, the dominant system goal function changes during the various stages of the adaptive cycle and therefore so does the appropriate network structure. We identify network structure presumed best to cope with each stage and investigate the network properties associated with those structures. Learning the best structures from theory and nature has useful application for the design and management of socio-ecological systems.

Ecosystem modelled from the outside.

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Key words: food-web, stochastic, ecosystem, mass-balanced

It is often thought that modelling the dynamics of marine ecosystems requires a high level of details to portray the many underlying processes in a realistic way. Because ecosystems are complex, adaptive, and non-linear, ecosystem models are highly sensitive to approximations and simplifications.
This results in a race for complexity in which additional processes are constantly added to existing models in order to better reproduce the complex dynamics observed in the real world.
An alternative approach is to acknowledge the complexity, adaptability and non-linearity of ecosystems without trying to explicitly model the underlying complex processes. Rather than modeling from the 'inside', i.e. by representing the intricate processes within the ecosystem, one can model from the 'outside' by focusing on the constraints that limit the system dynamics. In this modeling approach, complex processes and their interactions are simulated with stochastic (i.e. random) processes whilst the system dynamics is constrained by simple rules.
We show an application of this approach, using a non-deterministic network dynamic model (NDND) for the Barents Sea food web. This simple model displays many features of more complex foodweb models, including apparent regime shifts. The NDND can serve as a reference to study the resilience of marine ecosystems.

Assessing the health of the Antarctic region using an integrated socio-ecological framework.

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Key words: Antarctic, coupled systems, management, integrated, fisheries, indicators

In marine systems across the globe the human footprint is growing. In order to achieve healthier oceans there is a pressing need to understand how social end biophysical systems interact, and evaluate multiple, often conflicting societal goals simultaneously.
Even one of the most remote corners of the ocean, the Antarctic system, is no longer pristine, due to fishing, tourism, scientific research, and climate change. The Southern ocean is a unique region in its multi-national governance structure, offering opportunities for large-scale integrated management across multiple activities and objectives. However, the rules for this cooperation are evolving, and the increase in human activities requires an integrated assessment that can evaluate tradeoffs among the desired societal benefits and potential threats, in order to address concerns for the future of conservation and management in the area. The Ocean Health Index offers such an integrated framework. It was developed to be a flexible approach for a variety of contexts and spatial scales, and was previously applied to obtain a map of ocean health across the world's Economic Exclusive Zones, and several country-based case studies. However, this is the first application in a region where societal benefits are not related to local human communities, with a complex multi-national governance structure, and where climate change may have the most dramatic effects.
We explore how the Ocean Health Index framework can help map tradeoffs and synergies across ecological and social dimensions of ocean health in Antarctica, making use of the best currently available science, and we explore how these may change in the future by exploring multiple scenarios.

Theoretical analyses to gain insight from a simple savanna dynamics model.

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Key words: tree-grass, system dynamics, stability

Understanding the tree-grass continuum dynamics of southern African savannas is important because savannas are an important ecological biome. This fact is particularly true for arid areas which are more vulnerable to environmental fluctuations. We consider an arid region of southern Africa, that dominated by the mopane tree (Colophospermum mopane). The system dynamics are investigated using a simple model of the interactions of the dominant players, namely elephant, other browsers, other grazers, mopane trees, perennial grasses, and mopane worms (Imbrasia bellina). To gain an initial understanding of this system we perform qualitative or mathematical analyses on the model and discuss the implication of our results for insight into the actual dynamics. Possible generalisations of the approach will also be discussed.

Stability and bifurcation synthesis in a nonlinear chemostat model

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In this paper, we explore a aerobic model including substrate, bacteria and oxygen evo-lutions. We rstly, explore the equilibriums and there stabilities. It appear that there exist always a boundary equilibrium whereas, under some conditions on parameters, there exists an interior equilibrium, biologically interesting (no-washout). We exhibit suitable conditions for local asymptotic stability of the no-washout equilibrium. The second aim in this work concerns the bifurcation behavior of the system. Our goal is rstly, to conrm rigorously, the transcritical bifurcation with respect to the residence time and thereafter, to provide a qualitative study on the change of the stability, summarizing the all situations, that can occur if we proceed to variation of the tree parameters, namely, the residence time σ, the air/liquid oxygen transfer coecient K_d and the dissolved oxygen saturation coecient C_s.

Sampling library of domain knowledge for learning ensembles of process-based models.

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Key words: ensembles, process-based , modeling, aquatic, ecosystems, Domain

Ensemble methods are machine learning methods that construct a set of models and combine their outputs into a single prediction. The ensemble constituents 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. We develop approaches for learning ensembles of process-based models (PBMs) of dynamic systems. We build upon existing equation discovery systems for automated learning of PBMs, which integrate the empirical and theoretical approaches to modeling, i.e. employ both measurements and domain knowledge. Our previous research showed that ensembles of PBMs yield improved predictive performance. The results of the previous experiments indicate that the ensemble constituents obtained by using different subsamples of the measurements have only modest diversity, thus limiting the potential predictive performance of the ensemble. To tackle this problem, we develop methods for learning diverse sets of PBMs by using different subsamples of the library of domain knowledge. Different sets of PBMs are learned using the measurements and different samples of the library. From each of the sets a model is chosen as constituent of the new ensemble. To simulate the subsequent behavior of the observed systems, each of the constituents in the ensemble is simulated and their predictions combined. We apply the proposed approach and evaluate its performance on a set of problems of automated modeling of population dynamics in aquatic ecosystems. Data on three lake ecosystems are used, together with a library of process-based domain knowledge. First we identify the key design principles for learning such ensembles. Second, we evaluate their predictive performance by comparing them to the performance of individual PBMs learned from the whole library of domain knowledge. Finally, we compare them to other ensembles of PBMs learned on different subsamples of the measurements (bagging and boosting).

High resolution Large Eddy simulation (LES) of mixing and dispersion in closed or semi-closed basins

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Closed and semi-closed basins (i.e. lakes, harbors, lagoons etc.) are essential economic sources for a wide range of sectors, extending from leisure to commercial activities. On the other hand, they constitute very delicate ecosystems sensitive to anthropogenic stresses and small variation of the forcing conditions. These basins are usually characterized by a combination of physical and geometric complexities, making difficult a reliable quantification of mixing and dispersion, which, in turr, rule transport of pollutants and nutrients. Wind forcing and heat fluxes at the free surface together with Coriolis force govern the surface current which, in turn, affects the circulation at the deeper layers along complicate three-dimensional patterns ruled by the geometric characteristics of the basin. Further, vertical stratification contributes to dramatically alter turbulent mixing and dispersion within the water body.
Most numerical models currently in use for prediction of water circulation and mixing of scalars (nutrients, pollutants, dissolved oxygen etc) are derived from Large Circulation Models (LCM) which are usually calibrated for open-sea circulation and use constant values of horizontal and vertical eddy diffusivities. Recently, availability of High Performance Computing (HPC) and progresses in numerical modelization of turbulent fields have made high-resolution, eddy-resolving simulations attractive for the study of fluid- dynamic processes in water bodies having typical horizontal dimensions of 15-20 x 15-20 km.
Over the latter years the group of Environmental Fluid Mechanics of the University of Trieste has been working on the development and application of a high-resolution Large-Eddy Simulation (LES) model for closed and semi-closed basins. The model (LES-COAST) resolves the Boussinesq form of the three- dimensional, unsteady, primitive-variable formulation of the Navier-Stokes equations, together with the transport equations of salinity temperature and n-different passive scalars (pollutants, nutrients etc.) [1].Complex geometry is managed through the use of a combination of curvilinear coordinates and immersed boundaries [2]. Over the open boundaries the model creates synthetic turbulence and calculate mean velocity and scalar field through information derived from LCMs (like MITgcm and POM), and turbulent stresses are reconstructed at the solid boundaries. The typical resolution is of 10 meters on the horizontal and 0.5 to 1.0 meters in the vertical, for regions of 10km x10km x 50 m, and the number of grid cells employed is of the order of 20-40 x 106 . The model directly resolves the anisotropic and energy- carrying turbulent structures up to the cell sizes and parameterizes the subgrid scale (SGS) fluxes of momentum and scalar using a novel two-eddy viscosity SGS model. LES-COAST uses MPI paradigm for parallelization and is run on supercomputers using typically 32-to-64 processors. The model has been employed for the analysis of mixing and dispersion in the harbor area of Trieste (the Muggia bay) [3] and of Barcelona [4]. Currently the circulation of the Ledro lake (Trentino, Italy) of the Gulf of Taranto (Puglia, Italy and of the Kanehoe bay (Ohau, USA) is under investigation. At the conference some details on the numerical model will be given and some examples of applications will be shown also discussing potential applications for ecological purposes.

Three-dimensional hydrodynamic model of the Nador lagoon (Morocco)

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Keywords: Nador lagoon, Morocco, 3D model, tide, marine circulation, residence time.

The Nador lagoon, located on the Mediterranean Moroccan coast, is among the biggest lagoons in the country. An hydrodynamic, 3D model has been implemented for this lagoon since 2005 (Hilmi et al., 2005) with the configuration including one “old” inlet. Water exchange between inside and outside the lagoon was low and a “new” inlet was built in 2010-2011. In order to investigate its physical functioning, the 3D hydrodynamic model has been implemented with an updated configuration including this “new” inlet. Since in the Mediterranean Sea tides are very small in amplitude, the surface circulation inside the lagoon is mainly wind driven. Bottom currents show a reverse direction compared to the surface. The “new” integrated residence time of the whole lagoon is estimated to be less than 80 days while the “old” integrated residence time (“old” inlet configuration) was estimated around 80 days.

Wind-driven circulation and dispersal in a shallow estuarine lake – Lake St Lucia, South Africa.

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Key words: mixing, residence times, colonisation

Lake St Lucia is a large shallow system with complex morphology. It is part of a UNESCO World Heritage Site and RAMSAR wetland of international importance. The system is highly variable in terms of water level and structure. During periods with low freshwater input Lake St Lucia can divide into individual subsystems. Areas that become isolated from the rest of the system can experience extreme environmental conditions unsuitable for many species, whereas other parts can serve as refugee areas. Periods with high freshwater inflow lead to high water

levels and a more homogenous fully connected lake system. Wind driven circulation is the main factor influencing the exchange between lake basins. We use a 2DH hydrodynamic model to simulate these circulations to provide insights into their role in transport and mixing processes. A strong diurnal pattern of wind speeds together with directional switching between two dominant directions, drives intermittent water exchanges and mixing between the lake basins. Mixing time scales are non-homogeneous with some basin extremities having relatively long residence times. Coupling the circulation model with a particle transport model gives insights into the re-colonisation potential of e.g. macro-zoobenthos and other groups after disturbances such as extreme hypersalinity and desiccation. Further coupling with primary production module can also predict potential areas of algal biomass accumulation.

Modelling the future socio-economic services of the Black Sea.

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Key words: Black Sea, socioeconomic, modelling

In this work, we provide the results of such a holistic approach to the Black Sea ecosystem, one of the European Regional Seas, with a coupled modelling scheme incorporating hydrodynamic (BIMS-Cir), biogeochemical (BIMS-Eco) and higher-trophic-level (Ecopath with Ecosim) models of the Black Sea. First, we investigated the historical evolution of the Black Sea ecosystem with a hindcast simulation between 1960-1999 in order to quantify the structure and functioning of its food web under multiple environmental and anthropogenic drivers and proved the skill of the modelling scheme to capture the characteristics of the ecosystem. A forecast simulation between 2080-2099 were invoked based upon the IPCC A1B carbon emission scenario and the changes in the ecosystem structure of the Black Sea were explored to develop optimum 'precautionary' fisheries management strategies considering ecosystem health and socio-economic services that the ecosystem serves to the society together for different IPCC scenarios. Further, these changes were quantified by means of socioeconomic indicators and analysed comparatively against the quality of the contemporary socioeconomic services.
The results delineated that as a consequence of significant environmental change predicted by the future scenario, the capacity of the socioeconomic services of the Black Sea will diminish significantly. This decrease was envisaged to cause a significant reduction in the employment in this sector of Turkish economy. These detrimental impacts showed that, considering the future GES of the Black Sea, it is quite unlikely to be able to develop a management strategy which balances on the edge to optimise profits, social benefits and ecosystem structure concurrently. This indicated that, for the sake of the Black Sea ecosystem, a considerable economical compromise should be made for the long-term sustainability of its structure, which in turn, will lead to economic turnaround by the end of the 21st century considering future generations.

How well are protected areas in South Africa conserving their bird species?

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Key words: Urban Ecology, Spatial, Conservation, Abundance model

Protected Areas are landmarked as biodiversity conservation areas. However, their effect of conserving biodiversity is suprisingly poorly understood.
This is especially true for very mobile species, such as birds. Here, we use an extension of newly developed statistical models, abundance models, to determine the relative abundances of bird populations within and outside of protected areas, comprised mostly of Savanna or Grassland vegetation, in South Africa. This gives us an indication of how well protected areas are conserving bird species.
We use data collected from the South African Bird Atlas Project 2 (SABAP2; 2007-ongoing) and analyse only South African resident species, most of whom were either granivorous or insectivorous feeders. We found that feeding guild type, habitat specialist, and average body mass were important variables affecting the abundance of bird species within and outside of protected areas, although these effects are not linear.
Generally, granivorous birds were more abundant within protected areas than outside, which is in agreement with similar studies done around the world. Middle sized birds were more abundant in protected areas, and surprisingly, species that were Savanna or Grassland specialists were on average less abundant than non-specialists birds. This can be partially attributed to the proximity of the protected area to different landscapes, such as cities, and farming areas. This illustrates that protected areas in this particular area of South Africa protect certain types of birds, and that protection is uneven over all bird species. Additionally, landscapes other than Protected Areas, such as cities and farmlands, provide an essential role in bird conservation in South Africa. This work is of conservation importance and interest to conservation managers and planners.

A new Ecosystem Network Model under human activity.

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Key words: ecosystem use, pastoralism, forest logging, network type, sustainability

Most ecosystems on earth have become seriously degraded due to human activities. To understand the mechanism of the degradation by ecosystem overuse, we introduced the concept of the Ecosystem Network to cope with the complexity of interactions among ecosystems and human societies. For case studies we address two environmental problems under contrasting ecological settings: degradation of pastures in Central Asia (Mongolia), and loss of tropical rainforests in Southeast Asia (Sarawak, Malaysia)*. From the comparison between these two types of the ecosystem network we found a clear difference in the relationship among the ecosystem resource users (i.e., local people and enterprises), that is, cooperative in the former type and competitive in the latter. The following questions arise:

1. What makes the difference in the network structures?;
2. What are the key mechanisms of the degradation and the essential conditions for the sustainability of ecosystems in both cases?

To consider these problems, we developed a set of simple mathematical models for the dynamics of ecosystem resources, local peoples' population and enterprise size. From the analysis, it was suggested that the ecosystem properties about utility (e.g., primary production and accessibility) is the key to determine the network structures. In the grassland type network (with poor utility) the resource use is mostly under negative feedback control by the local users and thus is more sustainable against increased demand. On the other hand, in the tropical forest type (with rich utility) it is unlikely to sustain both of the ecosystem resource and local people unless introducing strong negative feed back mechanism for the enterprise use. For further discussion, we expand the typology of the ecosystem network including aquatic ecosystems to provide a general theoretical framework.

* "Collapse and restoration of Ecosystem Networks under human activities" (Research Institute for Humanity & Nature project endorsed by GLP, 2008-2012)

Entity-based landscape modelling to assess the impact of different incentives mechanisms on the argan forest dynamics.

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Key words: Entity-based, MC analysis, Markov chain, Argan forest, landscape model, stakeholder

Argan forest has long been central to the livelihoods of local populations in a rural area with precarious conditions. The current context witnesses an increase of illegal occupation of forested areas by users due to the weakness of traditional common control systems and to the boom of the argan oil price.
The scope of this work is to anticipate the current trend in terms of land possession by the users and its impact on forest stand degradation. It tries to establish a decision support system based on dynamic spatial modelling. The model simulates, for the next 30 years, the expected change of land possession by locals, as well as forest stand degradation levels, according to three private/public partnership scenarios based on land tenure policy and economic incentives.
The methodological approach combined a Markov chain analysis with a survey on stakeholder's preferences for land possession. Firstly, potential transition quantities of parcels were computed using the Markov chain analysis. Secondly, a possession suitability map was derived using multi-criteria evaluation procedure (AHP) from biophysical and socio-economic data. Finally, for supporting socio-economic diversity and non-mechanistic human behavior, the approach takes into account uncertainties in simulation based on probabilistic analysis.
The modelling approach was found relevant as a decision making support system and highlighted promising forest management scenarios. The three simulated scenarios provided contrasted results showing significant differences in the forest stand conservation level. This projective capacity of the elaborated system provides three kind of answers:

- order of magnitude of the on-going process and the possible alternative future landscape scenarios (how much);
- anticipating possible land competition induced by new policies (feedback) and
- pinpointing the priority areas, either with high potential for land conservation or degradation hot-spots(where).

Water distribution optimization for gravity irrigation networks using satellite images and evolutionary strategy algorithm.

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Key words: Irrigation, Optimization, remote sensing, water

Water sharing has become a serious problem around the world especially in the agricultural sector which represents the main consumer of water resources.
This is particularly the case in arid and semi-arid areas which occupy currently more than 30% of the globe and have irregular water resources whilst water demand is increasing. Therefore, it is necessary to develop effective solutions to ensure agricultural water use efficacy and to adopt efficient strategies of their distribution in the most reasonable way.
The objective of this work is to introduce a method for scheduling irrigation, which optimizes the water supply according to real needs of each crop. It consists in defining the sequence of irrigated plots and the corresponding water amount to be applied in order to satisfy all crops water requirements. We focus on the Haouz plain near Marrakech (Morocco) taken as a typical example of irrigated agriculture in semi-arid areas, and especially in the southern Mediterranean countries. In this region, gravity irrigation is the most widely used irrigation delivery method. However, applying the right amount of water at the correct time with a lower cost and lower water losses, taking human and technical constraints into account, remains a complex problem.
The irrigation scheduling method introduced here aims to rationalize the water distribution in a classical gravity network based on:

- remote sensing time series images to estimate water requirements;
- an Irrigation Priority Index (IPI) that we developed to characterize the priority irrigation of each plot, taking into account the crop water stress; and
- an evolutionary algorithm to solve the optimization problem taking into account the main technical and human constraints of the irrigation.

The obtained results demonstrate that this approach can be considered as an efficient tool for planning irrigation schedules by taking the crops water needs into account.

Hydrological model application for water resources management under a changing climate

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Key words: hydrological , modelling, water resources, management, uncertainty

Managing water resources revolves around quantifying and allocating water for various uses in addition to building water resources infrastructure. As in any other parts of southern Africa, the socio-economic well-being of the Zambezi basin is largely dependent on rainfed agriculture. Ensuring water and food security in the basin is, however, faced with challenges due to an inherently high variability in climate. It is now common knowledge that the global climate is changing and that many of the impacts will be felt through water resources. If these predictions are correct then the Zambezi basin is most likely to suffer under such impacts. The importance of water in the socio-economic development of the Zambezi basin justifies the need to understand how changes in the global climate will impact the availability and reliability of water resources. Appropriate predictions and early warning signals are also required that will allow adequate and timely adaptation strategies and prevent the risk of making wrong decisions that are based on insufficient information. Hydrological models are frequently used for the purpose of water resources assessment with regard to current and future conditions of environmental and climatic change. To assess future water resources availability the modified Pitman rainfall-runoff model has been calibrated for the Zambezi basin and then forced with downscaled and bias corrected GCM data. It is acknowledged that any hydrological modelling process is fraught with uncertainties. Some of these uncertainties have been embraced in the calibration process by incorporating an uncertainty version of the Pitman model. Predictions show that future changes in streamflows are likely to remain within the historically observed ranges of variability but with no clear indication as to how or by how much these changes will occur.
It is recommended to incorporate variability and uncertainty in planning for the basin's future water resources.

The nutritional signature of thiamine in aquatic food webs: linking individual organisms to ecosystem processes

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Key words: Food web , Thiamine , Top predators, Fisheries, Resilience

Some top predators have been shown to suffer from low levels of vitamins (i.e. thiamine) causing deficiency syndromes. The aim of this study was to develop a model for simulation of thiamine pathways in marine aquatic food webs, from primary producers to fish. The model is based on physical constraints, which govern the availability of nutrients and prey. Simulating in 1 or 2 spatial dimensions allows the same model to be used to analyze biofilms and boundary layers as well as homogeneous systems. Benthic and water column models can be coupled together. Classes of bacteria, phytoplankton, zooplankton and fish are included in the model. The basic processes in the model are osmotrophy, primary production, bacterial production, respiration, and predation. Thiamine production, limitation, and break-down are also included in the model. Thiamine is transferred through the food web by predation. The model allows testing variations of nutrient concentrations, light, and different food web structures on thiamine related processes. The results of the model simulations applied to the Baltic Sea ecosystem showed the potential of this approach as an exploratory tool for providing useful information regarding mechanisms related to thiamine uptake, their influences on fish populations and on the complexity associated with nutritional pathways in aquatic food webs.

From population-level to community-level connectivity in seascapes: Lagrangian simulations in the Adriatic and Ionian seas.

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Key words: MPAs, movement, dispersal

Modelling studies on connectivity between marine habitat patches usually use theoretical particles (“water larvae” released in continuous time) and deal with single-species populations. To understand the peculiar role played by each suitable marine location in sustaining the entire metacommunity, it is however necessary both (1) to quantitatively describe the species-specific biological traits of dispersing organisms, and (2) to use multi-species rather than single-species approaches. Here we assess the degree of connection – measured in terms of intensity, efficiency, temporal persistence and distance of propagules’ exchange -- across the Adriatic and Ionian seas. We use four model species: the primary habitat former in the Mediterranean Sea (Posidonia oceanica) and three fish species (Sarpa salpa, Symphodus ocellatus and Scorpaena porcus). Such species were selected because they occupy different trophic levels and reproduce in different spatio-temporal contexts. Also, their propagules – that are either pelagic or benthic – have different larval duration. These biological characteristics of the species life cycles interact in a complex manner with the outputs of oceanographic models. By properly summarizing the results of multi-annual simulations, we therefore identify which of different areas in our seas are better inter-connected not only at a single-species level, but at a community-level. Our modelling exercise can thus serve as a basic tool to ecosystem-based marine spatial planning.

Genes of Ecological Networks.

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Key words: Network, Systems ecology, Machine, learning, transform

Abstraction of an ecosystem using an ecological network often leaves much to be desired. Sometimes even obvious changes, such as seasonal differences, may not be reflected clearly in flow rates, storage values, or network based measures (e.g. cycling index, indirect effect index). Analyzing the 16 models of the Neuse River Estuary, for all for seasons from 1988 to 1992, one can barely figure out the season given the flow or storage data of a specific model.
While bioinformatics has the luxury to mine the abundant data afforded by high throughput experimental techniques such as microarrays, ecosystem ecology has to make the most of its hard earned little data available.
Motivated by mathematical transforms such as Fourier and Laplace, we ask the following question: Is there a transform that takes the little data available (flow rates among compartments, inputs and outputs) and maps it to a much larger data set that we can mine and interpret using advanced machine learning techniques. In other words, are there any hidden constituents that make up a flow rate between two compartments?
In this talk, we identify these constituents that are analogous to genes in living organisms, and describe how they work to produce an ecological network. Furthermore, we show how to map an ecological network to what is considered an analogue to a gene expression data set. While this mapping is not unique, it is possible to use machine learning to extract useful information by identifying which constituents (genes) of the ecosystem model are responsible of a specific trait, such as response to an environmental impact, climate change, or a regime shift. We demonstrate our methodology on the Neuse River Estuary model, which has only 7 compartments, 34 flows, but 640 constituents. While it is rather difficult to extract the seasonal variations from flow or storage values, we were able to identify only 3 constituents (out of the 640) that determines the season of the specific model with 100% accuracy.

Trophodynamic indicators and ecosystem changes: an application for invasise species in the Northern Adriatic Sea

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Key words: trophodynamic , indicators, food web, climate changes, Adriatic Sea

An Ecosystem-based approach to Management (EBM) for the marine environment and recent EU Directives, such as the Marine Strategy Framework Directive (MSFD), require appropriate indicators to determine the ecological status and ecosystem effects of natural and anthropogenic stressors. In this context, much salient effort has been devoted to the development of new indicators, particularly those encompassing energy-flow. Among these, a new method has been proposed, based on the analysis of biomass accumulation across trophic levels (TL). The cumulative distribution function results in a sigmoidal pattern when plotting cumulative Biomass (cumB) against trophic level. Here we describe the CumB vs TL curve and four derived properties: the basal biomass, the projections of the inflection point of both axes, and the slope of the tangent passing through the inflection point. Theory predicts that a perturbed marine ecosystem should lower the stored, cumulative biomass and "stretch out" the sigmoidal cumulative curve. The method has been applied to the outputs of a food web model of the Northern Adriatic Sea, simulating the effects of a thermophilic species invasion due to water temperature increase. In this simulation, it was possible to delineate the behaviour of these indicators in relation to structural modifications. Results showed that these indicators are sensitive to changes in ecosystem structure and functioning, as simulated by the modelled scenarios, particularly denoting how invasive species can alter energy flow and food web structure. We place our results in the context of MSFD and EBM, particularly noting how these cumulative biomass-based indicators could be used to elucidate ecosystem status and response.

Massive proliferation of peridinuim quinquecorne abé and kryptoperidinium foliaceum in Sidi Moussa Lagoon (Atlantic Moroccan Coast).

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Key words: phytoplankton , blooms, harmful , endosymbiont , dinoflagellates

Harmful algal blooms are naturally occurring events, but they appear to be increasing in intensity and frequency. About 2% of the total flora, can be harmful and most of these species belong to the group of dinoflagellates. Their presence require watchfulness and toxicity control, because under other conditions or at highest concentrations, these species can become dangerous for human health through the trophic chain.
To prevent the proliferation of certain species of dinoflagellates, monthly monitoring of phytoplankton species was carried out in the lagoon of Sidi Moussa (Morocco) from September 2012 to August 2013. Phytoplankton samples were collected at five sampling sites around the lagoon, environmental parameters and nutrients were monitored for surface waters.
However, during the field study two massive proliferation occurred. They concern two species of dinoflagellates not toxic, it comes to: Peridinium quinquecorne which a threshold value was arrived to 4.104 cells ml–1, and cell densities of Kryptomeridinium foliaceum have reached as high as 1.107 cells ml–1.
These two species had a similar type of endosymbiont which may explain their proliferation at the same environmental conditions.

The use of biomarker "Lysosomal membrane stability in mussel *Mytilus galloprovincialis*" to evaluate the environmental quality

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Key words: pollution, general stress, lysosome, stability, mussel, environment

The evaluation of biological effects of anthropogenic activities is an important element in marine ecotoxicology designed to assess health of the coastal marine environment, in order to highlight the relationship between contaminants and ecological responses. It is also used to define the areas in which environmental quality has decreased.
Biological markers are used to inquire on the degree of exposure to chemicals pollutants and/or their effects on the organisms.
Lysosomes are ubiquitous cellular organelles involved in cellular detoxification sequestering metals and other contaminants which are causing a lysosomal destabilization. The main reactions of the lysosomes to pollutants include the loss of the integrity of the membrane. This response using neutral red technique has been used in this study to assess the effects of the stress generated on the mussel *Mytilus galloprovincialis* exposed to pollutants. This study concerned some sites along Mediterranean and Atlantic Moroccan coast, the results highlight a high level stress in coastal zones receiving industrial effluents and a harbour area.

Seasonal variability of the Oualidia lagoon (Morocco) between 2011 and 2012

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Key words: Oualidia lagoon, seasonality, hydrology, sedimentology

The study conducted on the Oualidia lagoon has an objective to understand the state of the waters of this ecosystem after the construction of the artificial basin and the ecological functioning of this lagoon. For this effect, several oceanographic campaigns have been realized between February 2011 and October 2012 and have been the subject of a seasonal monitoring for the collection of principal parameters (biotic and abiotic environment).
During the period of the construction of the artificial basin (2011), the hydrological variability has been marked in summer by low oxygen levels and a maximum variation of the temperature between the two tides. Since the construction of the artificial basin, we recorded a significant increase of nutrients, mainly in nitrogenous elements and also an increase of the turbidity, caused by strong marine hydrodynamic. This hydrodynamic accentuated at the entry of the lagoon (down area) and caused a morphological change in this area and shifted to the south by creating a new structure in the principal channel. Also, this hydrodynamic is marked in the end of the lagoon (up area) by a decrease of organic matter, due to the entrapment of fine sediment in the artificial basin. At the up area, and with the presence of the slikkes and saltmarsh, low hydrodynamic has undergone a change, which has decreased the rate of sedimentation at this area of the lagoon. Consequently, the aquaculture at this area of the lagoon would be protected from any containment of the ecosystem.

Systematic data-model analysis of diverse mesocosm experiments

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The burning of fossil fuels is responsible for the observed increase of carbon dioxide (CO2) in the atmosphere. This continuous increase enhances the net CO2 flux from the atmosphere to the sea, thereby altering ocean biochemistry and likely affecting marine life. CO2 influx decreases sea water pH. A continuous drop in pH and changes of the oceans' chemical state are expected in the future (Caldeira and Wickett, 2003). As a consequence of ocean acidification dynamics of biogeochemical cycle are significantly affected. Various biogeochemical models are introduced, which predominantly aims at meaningful inter- and extrapolations in time and space and/or for estimation of mass fluxes, which cannot be measured directly and then attributing model results to the global climate change. Whether biogeochemical models are meaningful or not depends on their ability to explain field observations/experimental data. Studies suggest that plankton dynamics in marine ecosystem changes, owing to variability in physical and biological-, and chemical environment. Investigations of ocean acidification effects on plankton were conducted with mesocosms, where enclosed water volumes were exposed to different CO2 concentrations, e.g. Pelagic Ecosystem CO2-Enrichment Studies (e.g. Riebesell et al., 2008, Biogeosciences 5, 1157–1164). In our study, we investigate different model approaches to resolve and explain plankton responses to variation in pH/CO2 and to temperature, which were observed in mesocosm experiments. Main technical objective of my project is to setup a mesocosm-modelling workbench for data-model synthesis that: a) facilitates mass budget calculations and meta-analysis of mesocosm experiments, b) statistical analyses of different ecosystem models and parameter optimizations. Model performance will be judged on the basis of parameter uncertainties and model complexity/ redundancy. Model parameter optimizations are achieved with minimizations of cost functions that quantify the misfit between model results and observations.

Modelling plankton dynamics with aggregation of the predator groups.

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Key words: ecosystem, aggregation, biomass, phytoplankton, zooplankton

The paper presents nutrient-phytoplankton-zooplankton model with different ways of zooplankton description. During construction of model of aquatic ecosystems, we often are in a situation of lack of information about the object. Estimates of

component's biomass of the same system, but by various authors, may diverge. It is difficult to make forecasts about the quantitative state of the system in the future according to these models.
The use of the multimodal approach on research of ecosystems makes better use of available information about the object. We present zooplankton as homogenous group and dividing into groups according to grazing pattern.
Our objective is to obtain insight in the dynamical properties of the system by reducing the dimension. We are interested in the following items. Does the way of description of zooplankton group influence the qualitative behaviour of the system?
The system in our description is considered as a closed object. All biological processes take place without the influence of the environment. The total mass of the components remains constant, since there are no substance overflows across the border. This idealized description of the system allows getting a general idea about it, and gives a qualitative picture of the interaction of system parts.
We analyzed the behaviour of the system near the equilibriums. A comparison of the solutions of the models is performed.

Trophic interactions in the Atlantic Moroccan coastal ecosystem: An ECOPATH preliminary approach.

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Key words: Trophic , interactions, ECOPATH, Moroccan , Atlantic

This study attempts to assemble and summarize existing information in order to build a general representation of the trophic interactions within the Atlantic ecosystem of Morocco. A multispecific ecosystem-based approach on trophic relationships and their possible variations was performed using ECOPATH. Twenty-six functional groups were considered representing all trophic levels in the food web grouped by size and commercial importance. The balancing process is described and highlights knowledge gaps. The Ecopath model presented here summarizes much of the information that is available on the Moroccan marine ecosystem. It gives an indication of the relationships between the functional groups and of the influence that fishing has on the ecosystem.

Characterization of the state of pollution of sediments in Lake Afourgagh, Middle Atlas, Morocco.

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Key words: Heavy Metals, Igeo, CF, PLI, Middle Atlas, Morocco

The Afourgagh lake was one of the most important natural lakes in the Middle Atlas. This tectono-karstic lake was the seat of charophytes; but recently, and with the development of agriculture around Lake, it became almost azoic.
The major objectives of the present study were to investigate the impact and origine of heavy metals in sediments of the Afourgagh lake.
Surface sediments, short core sediments and soil samples (from the watershed) were collected from Sixty-eight locations and were analysed for As, Ba, Co, Zn, Cu, Pb, Ni, Cd, Mn and Cr with Atomic Absorption Spectrophotometer.
Contamination factor, Contamination degree, Pollution load index (PLI) and Geo-accumulation index (Igeo) were used to assess the degree of accumulation of heavy metals in the sediments.
The important findings of the study are: (1) A close relationship was obtained between organic carbon and metal content in lake sediments; (2) All sampling sites displayed PLI values ≥ 0 but < 1; (3) Igeo values for metals at the sampling sites were ≤ 0 except for Cd (>5).
The results indicated lake sediments are unpolluted and ecologically suitable excepted Cd (extensive use of phosphatic fertilizers). Absence of major anthropogenic influence in the region was primarily found to be responsible for the unpolluted nature of sediments by heavy metals. But we need to use more analysis of pesticides and perform the same analysis for lake water and well water in order to dissect the main origin of degradation of this lake.
This study can be used as reference to monitor the status of quality of lake water and sediments in this region of North Africa very sensitive to the effects of aridification caused by global climate change.

Physical modeling of Moroccan Upwelling System

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Keywords: Upwelling, Physical Oceanography, modeling, ROMS model

The Eastern Boundary Upwelling Systems (EBUS) (California, Humboldt, Canary and Benguela Upwelling System) constitute high productivity regions of the world Ocean, these EBUS represent 20% of the catches with only 1% of the global surface.
We suggest in this paper to establish a numerical climatologic simulation with two principal goals: firstly to obtain a preliminary Numerical Climatology of the Canary Current System, secondly to validate with satellites images and in-situ data.
To attempt these goals, we use ROMS hydrodynamic model (Regional Ocean Modeling System) with 2-WAY Nesting Capability. Our configuration spans from 23°N to 37°N and from 20°W to 5.5°W with embedded domain around Cape Ghir and Agadir Bight, it has à horizontal resolution going up to 1/12. This simulation is run for 20 years with monthly outputs. Its spin up is performed over 7 years because the model needs a few years to reach a stable annual cycle.
The model results are as a horizontal distribution of physical parameters: Temperature, Salinity, and Speed of Current… This result will be approved by r=the in-situ/satellite data to explain the spatiotemporal variability of the upwelling

Morpho-sedimentological analysis in mining pollution monitoring and assessment. Case of study: Hammam Zriba locality (Zaghouan, Tunisia).

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Key words: Mine deposit, air pollution, DTM, dune, grain size, Tunisia

The aim of this study is a spatio-temporal monitoring of the morphology of mining deposits in the area of Hammam Zriba (Tunisia) in order to evaluate their impact on the environment. Field measurements, including topometric survey (January / May 2012) and sedimentological analysis have been used to monitoring the dune evolution from dams. The DTM (Digital Terrain Model) mapped during the winter season, show a dune deposits morphology. The workfield is divided into a succession of mobile dune ranges intercepted by blowouts and deflation corridors. Superposition of the two DTM shows a positive sediment budget which is an accumulation of 30. 10m3. Deposits zones are located at the fields of olive trees and at existing dunes. The temporal morphological evolution of mineral accumulations shows a sandy progression in cascade through the rows of mobile dunes, from the direction NW / SE to the fields of olive trees. The sedimentological study confirms that it is a behavior of a dune sedimentary unit. Indeed, the transversal grain size sorting is indicative of a selective transport agent, in particular wind. Bimodality and heterogeneity of deposits indicate the presence of multiple sources of supply and/or transport mode.

Food web models for ecosystem status monitoring and assessment: examples from North African transitional ecosystems.

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Key words: foodweb funct, inverse models, ecol netwk anal, lake Burullus, Nador lagoon

The estimation of energy fluxes at the community level is becoming an important issue in applied ecology, since these fluxes allow one to calculate indicators of food-web functioning, which can contribute to the assessment and monitoring of ecosystem status. This is particularly true in the case of Mediterranean transitional ecosystems which are located in urbanized areas: these systems often provide access to a wide range of goods and services but are also subjected to a range of anthropogenic pressures.
The model studies here presented concern two North African transitional ecosystems, and were carried out in the framework of the MEDINA project (EU 282977). Burullus is the most central of the Nile delta lakes. After the Aswan dam completion the lake became subjected to strong inputs of drainage waters, experiencing very few exchange with the sea. Main resources include: fishery, agriculture, fish farming, reeds harvesting, tourism. The Nador lagoon is located in the oriental region of Morocco. The lagoon, which receives inland waters from many wadis, has a very high flora/fauna biodiversity and is a wintering and migration spot to more than 150 species of birds. Artisanal fishing activity is still relevant for the local economy, although touristic infrastructures are being developed. At each site we identified the most important macrohabitats and applied steady-state food-web models for each of them. The models were identified and balanced on the basis of existing site-specific data from the 2000s, and new complementary field data on benthic macrofauna, acquired within the present project. The mass-balance equations were therefore solved, by using a constrained optimization methodology, and the estimated fluxes provided the input for estimating a set of indicators of ecosystem functioning. Models were used for comparing the current situation with long-term scenarios of change resulting from the action of both manageable and unmanageable drivers.

Impact of oceans' temperature changes on Bluefin tuna production-"Structural Vector Error Correction" modelling.

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Key words: Temperature, Bluefin tuna, biomass, Extinction, SVECM

Climate change caused by carbon dioxide emissions contributes to ocean's temperature warming and thus affects marine ecosystems and disrupts biodiversity. Migratory fish species such as Bluefin tuna are the most affected by this problem. Water temperature changes, among other causes, may disrupt their reproductive cycle and lead to a decline in their biomass.
Through this work, we aim to highlight, using modeling, the causal link stated above and to simulate its long-term consequences.
Used methodology belongs to a dynamic multivariate framework. Using an SVEC (Structural Vector Error Correction) model, we intend to capture short-term and long -term dynamics that link Bluefin tuna production to CO2 emissions.
Cyclical component in the identified model is supposed to inform us about the effects of short-term shocks on both variables. "Trend" component will be used as a long-term medium in order to inform on the permanent implications of CO2 (and thus global warming) on biomass and production of Bluefin tuna.

Maximisation of the fishermen's profits exploiting a fish population in several fishery zones.

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This work presents a mathematical study of a bio-economic model on several fishing zones. Every zone is exploited by several fishermen and in correspondence by migration with a zone of free stock which is defined as a not exploitable free fishing zone. This mathematical analysis allows us the implementation the sustainable development to keep the ecological balance.
The objective of this work is to maximize the profit of fishermen according to the efforts of fishing at biological equilibrium. This model contains three parts, a biological part connecting captures with the sites of biomasses, a exploitation part connecting captures with efforts of fishing and finally an economic part connecting efforts of fishing with profits.

Trends of change of trophic structure of the Hooghly Matla estuarine ecosystem due to overexploitation analysed by mass balanced network approach.

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Key words: ENA, , keystone group, MTI, ECOPATH, exploitation, stability

Hooghly Matla estuarine ecosystem with its highly rich aquatic resources has a great importance in costal landscape of India. But available ecosystem information shows that this ecosystem is gradually exploited by tremendous increase in anthropogenic stress during recent years and this is believed to alter its food web structure by changing the biodiversity profile of this ecosystem. So the current status of ecosystem health should be examined to evaluate actual impact of overexploitation on the trophic structure of this ecosystem. For this purpose, two mass balanced trophic models of Hooghly Matla estuarine ecosystem for two different phases (1985-90 and 1998-2003) are constructed using Ecopath to compare the trends of the rapid ecosystem changes over a period of time. In this study, twenty functional groups are selected including different commercial fish groups, benthic invertebrates and other groups such as marine mammals, zooplankton, phytoplankton and detritus. Two models are based on a data set obtained from the existing literature and scientific reports from different sources with preference to local and regional data. Interactions among different components and different pathway of energy transfer are clearly understood from the analysis of model output with a focus on energy flow and response to perturbations. Elasmobranchs are considered as the main keystone group of this ecosystem. Mixed trophic impact (MTI) analysis showed the direct and indirect impact of one group on the other groups in this ecosystem. This study also indicates the shifting of fishing target from higher to lower trophic level i.e. fishing down the food web. Comparative analyses of several ecosystem maturity indices and ecological network analysis (ENA) indices from the model output of both phases indicate that although this estuary still appears to be relatively mature, but overexploitation results into stressful situation and some degree of instability of this ecosystem.

Obesity models: a short review of literature.

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Key words: Obesity, Simulation, Modeling, review

Modelling has become one key approach to better understanding and responding to complex real world problems in many fields including public health. For this reason, different modelling approaches exist which handle on different facets of a problem's complexity. One of the most important public health problem in the latest decades is the obesity epidemic and its implications in other diseases (blood pressure, type 2 diabetes ...).
So many research tend to understand this phenomena using mathematical, statistical and simulation models. The purpose of this work is to present an overview of some models using ODD (Overview, Design concepts, Detail) protocol.

Application of the E2E model atlantis in the Strait of Sicily.

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Key words: E2E modeling, Ecosystem, Sicily Strait

The Strait of Sicily is a complex ecosystem characterised by high productivity and habitat heterogeneity and sustains one of the most important fisheries in the Mediterranean. Ongoing work on the development and implementation of a preliminary version of the E2E model Atlantis for the North Strait of Sicily is presented. Atlantis is an ecosystem box-model intended for use in management strategy evaluation, which has been applied to multiple marine systems around the world. The central part features a deterministic biophysical submodel spatially-resolved in three dimensions.
The model grid is made up by polygons representing the major geographical and bioregional features in the Strait of Sicily. The physical environment is represented explicitly by using hydrodynamic fields of water flow between the polygons and depth layers of the model. The model tracks the biomass flows through the main biological groups of the Strait of Sicily, which are represented as functional groups,

although the main commercial stocks were modeled at species level. The primary ecological processes considered are consumption, production, waste production and cycling, migration, predation, recruitment, habitat dependency, and mortality. Atlantis features detailed dynamics of fishing fleets, allowing for multiple fleets, each with its own characteristics (regarding gear selectivity, habitat association, targeting, effort allocation and management structures). The model is being developed in order to reproduce the structure and functioning of the ecosystem, with particular focus on commercially important species, to model the effect of climatic or man-induced changes on marine habitats and ecosystem, and to provide a management tool for scenario testing and trade-offs evaluation related to the application of different management scenarios (e.g. gear restrictions, spatial or temporal closure schemes, etc.) and their potential impact on the marine ecosystem and on the socio-economic compartment of the Strait of Sicily.

Trophic impact of lizardfishes in a small trawling ground from southeast coast of India.

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Key words: EwE, EBFM, Parangipettai, Net efficience, omnivory index

Ecosystems are balanced by nature and each component in the system has a role in the sustenance of other components. Change in one component would invariably have an effect on others. Lizardfishes (Synodontids) are common and ecologically important predatory fishes in tropical marine waters. The ecological role of lizardfishes and their impacts in a marine ecosystem were estimated using Ecopath with Ecosim (EwE) Version 5.0 software, by constructing a mass balanced model of Parangipettai ecosystem. Based on fisheries information from the region, 23 ecological groups were defined including lizardfishes. Both primary and secondary data in biomass, P/B, Q/B
and diet composition were used as basic inputs. The mass balanced model gave a total system throughput of 35,556 t km-2 year -1. The gross efficiency of 0.000991 indicated higher contribution of lower food chain groups in the fishery though the mean trophic level was 3.09. The immature and developing stage of the ecosystem was indicated by the ratio of total primary production and total respiration (1.954) and net system production (2961.56 t km-2 year-1). Key indices (flow to detritus, net efficiency and omnivory index), split mortality rates and mixed trophic impact of various ecological groups were obtained from the model. A flow diagram was constructed to illustrate the trophic interactions, which explained biomass flows in the ecosystem with reference to lizardfishes. A temporal simulation was made, with 5 year durations in the mass balanced Ecopath model by using ecosim routine incorporated in EwE software. The effect of altered biomass of lizardfishes in the ecosystem was well defined. The biomass of benthic omnivores showed a drastic increase of 54% at the end of 5 years. Cephalopods, tunas and large pelagic had a biomass decrease by 22%, 12% and 7%. There was a 10% increase of biomass in elasmobranchs. Small benthic carnivores, small benthopelagics, clupeids, crabs and lobsters and shrimps had increase in their biomass at the end of 5 years simulation.

Biodiversity and spatial distribution of planktonic communities in the south coast of Sfax city (Tunisia).

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Key words: Sfax coast, phytoplankton, ciliate, copepods, speciesrichness

In order to study the spatial variation of three planktonic communities (ciliates, phytoplankton and copepods) in relation with physico-chemical parameters, a sampling at 20 stations in the south coast of Sfax (Central eastern coast of Tunisia) has been conducted in February 2008. Phytoplankton assemblages were dominated by Dinophyceae (69.99%) and Bacillariophyceae (15.88%). Ciliate was presented by Spirotrichea with dominance of Tintinnopsis beroidea (57.69%). The zooplankton community was dominated by copepods representing 66.12% of total zooplankton. Oithona nana shown high frequency spread with 66.86% and 64.65% in station 9 and 10, respectively.
Some toxic phytoplankton species were recorded in the present site study, so their occurrence may have an attention to prevent the eventual imbalance in marine ecosystems. The species richness indexes applied for phytoplankton, ciliate and copepods showed that the south coast of Sfax can be placed in class as less healthy ecosystem.

Evaluation of the accumulation of heavy metals in the agricultural soil and the corn in Algeria

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Key words: Heavy metals, soil, corn, total, extraction

The development of the industrial activity (metallurgy and chemical industries) and the agricultural activity (pesticides, fertilizers) for the last century sometimes caused intensive contributions of these elements which have become pollutants for the environment. Even in low concentrations, they canconstitute a severe problem

Contribution to the assessment of the impact of industrial waste on the environment: determination of the degree of contamination of agricultural areas located near an industrial site in Ghzaouet, Algeria.

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Key words: Industrial wastes, heavy metals, lead, cadmium, pollution, contamination.

This study deals with the pollution from agricultural soils by metals (Cd, Zn, Pb, Ni and Mn) around the landfill of the ALZINC's industrial company located in the city of Ghazaout, west of Tlemcen in Algeria. The work is based on sampling and analysis of soil conducted in 2005-2006, and aims to establish the concentrations of pollutants in the soil with a total extraction method by aqua regia. Three sites were sampled different regions corresponding to vegetables (peppers and artichokes) and fruit (grapes), each collected five different plots spread over varying distance from the discharge, composite soil were mixed and quartering to obtain a representative sample of soil. The total content of Cd, Zn, Pb, Ni and Mn were determined by atomic emissionspectroscopy with inductively coupled plasma [ICP-AES] and expressed in mg.kg-1. Other determinations (organic matter, CEC, pH, carbonate) were used to characterize the soil.

The results of the analysis showed that soils were collected contents Pb, Ni and Zn below international standards for contaminated soils and worth [100-400]; [1-110] and 300 mg.kg-1, respectively. Although higher than those of Cd [1-3] mg.kg-1 and Mn 60 mg.kg-1 for contaminated soil.

For plant species studied concentrations of metallic trace elements are located primarily in the roots of different percentages, the content Cd, Zn and Ni were found at levels exceeding the thresholds of contamination or phytotoxicity [0.01-1], [100 - 400] and [1-5] mg.kg-1, respectively, in addition, the values are between the mean cation exchange capacity [31.78 to 32. 01] C+mol.L-1 (because levels means these agricultural soils organic matter) attached to values that are basic pH [7.39 to 8.66].

Ecotoxicological assessment of organophosphates and carbamates effects in different bivalves species in Moulay Bouselham lagoon.

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Key words: AchE activity, Pesticides, Lagoon, Moulay Bouselha, Bivalve

In this study, the ecotoxicological assessment of organophosphates and carbamates effects was performed on different bivalves populations using the Acetylcholnesterase activity as a biomarker of exposure to neurotoxic agents.The sampling concerned different points of Moulay Bouselham lagoon during 2014. The assay of enzyme activity was performed on different organs (hepatopancreas, gills and muscle) to demonstrate the accumulation levels between organs. The dosage of this biomarker also allowed to assess, the organophosphates and carbamates impact on different species (mussels, clams and cockles). And to highlight the relationship between physical parameters (temperature), the protein assay and enzyme activity.

Using of logistical model in estimation of the growth curves of populations.

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Key words: logistic growth, bacteria, modelling, ecological footprint

One of the most important characteristics of quantitative microbial growth culture is the constant of the maximum specific growth rate at which the culture grows in the exponential phase. This constant determines the total population density, which is the main characteristic of the ecological pressure (ecological footprint) on the environment. Therefore the precise determination of the population growth is important in the ecological modeling.
Usually, this characteristic is determined graphically from the slope of the linear section of the exponential growth on a log scale. It devalues the role of the deceleration phase in growth curves analysis. Cultures harvested during the so-called “late exponential growth” phase are actually located in the deceleration phase with a substantially decreased specific growth rate determination method proposed in the article is based on a comparison of the logistical and exponential models of growth. The moment of the statistically confident divergence of these functions determines the end of the exponential phase. It allows for the calculation of the key characteristics of culture more precisely and for the minimization of possible errors in the determination of the kinetic constants of the studied strains.
This work was supported by the Russian Foundation for Basic Research, project № 13-06-00060.

Coastal water quality models guide resource management across multiple sectors.

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Key words: biogeochemistry, model scenario, water quality, IMTA, estuary, fish farm

A fine-scale (200 - 500 m spatial resolution) 3D hydrodynamic, sediment and biogeochemical model has been used to quantify the impact of anthropogenic nutrient loads on temperate estuarine and coastal water quality in southeast Tasmania. The model cycles carbon, nitrogen, phosphorous and oxygen through dissolved and particulate organic and inorganic forms, including multiple phytoplankton, zooplankton, detritus, and macrophyte pools. Hind-cast simulations were validated against observations collected throughout the region, and the model also runs in near-real-time with web display of results. Scenario simulations demonstrate the impact of catchment, sewerage, industry and fish farm nutrient loads under alternate future management trajectories. Model results have guided the regulation of fish farm expansion, the prioritisation of wastewater treatment plant upgrades and identified the optimal locations for a monitoring program, which has since been implemented. Our current focus is on the bioremediation potential of macroalgae in the context of integrated multi-trophic aquaculture and the use of emulators to provide management tools which optimise fish farm lease assignment.

Phytoplankton diversity affected by oceanic dispersal, mesoscale eddies and submesosacle fronts

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We explore the role of oceanic dispersal in setting patterns of phytoplankton diversity, with emphasis on the role of mesoscale turbulence, in the context of numerical simulations that resolve mesoscale eddies, submesoscale fronts and a diverse set of phytoplankton types whose physiological traits are randomly assigned from ranges defined by field and laboratory data. This flexible representation of community structure is used to explore the role of the physical environment on resource competition. In this model, the community structure and diversity are not imposed, but emerge from a wider set of possibilities. More specifically, we examine how phytoplankton diversity is affected by the physical dispersion induced by ocean currents, over spatial scales ranging from O (1000) km to O (10) km, using a set of numerical simulations where we progressively account for different classes of motion. We found that with the progressive inclusion of mechanisms of dispersal, the population becomes dominated by a smaller number of types but with larger degree of co-existence, in larger home range areas. Co-existence occurs preferentially over sub-mesoscale fronts. In contrast, the number of species able to co-exist decreases with time in the core of retentive eddies.

The continental shelf pump in the northern Adriatic Sea: modeling the interaction between physical processes and the biogeochemical carbon cycle

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Key words: Adriatic Sea, continental shelf pump, coupled physical-biogeochemical-carbonate model, carbon cycle, dense water formation.

The northern Adriatic Sea (eastern Mediterranean Sea) is both a highly productive shelf area and a dense water formation site. The combination of productivity and dense water formation (i.e., the continental shelf carbon pump) enhances the vertical transport of carbon into the interior of the Mediterranean Sea contributing to the sequestration of anthropogenic CO2.
In this study, we investigate the air-sea exchange and the continental shelf pump process by coupling the Massachusetts Institute of Technology general circulation model (MITgcm) with a biogeochemical model of intermediate complexity (AdriBIO) that includes a carbonate dynamics module. AdriBIO resolves 2 inorganic nutrients (C and P), 2 groups of phytoplankton, 2 groups of zooplankton, bacteria, dissolved and particulate carbon and phosphorus.
The results of the numerical simulations show that the northern Adriatic Sea is currently a CO2 sink, with an annual flux of about 30 mg/m2/d, and that the C-rich dense water is accumulated in the deep layers of the southern Adriatic Sea. However, CO2 fluxes and transport show significant temporal and spatial variability due to the interaction of several factors that affect the efficiency of the continental shelf pump. We investigate the role of these governing factors by means of an uncertainty analysis. Biological processes (net primary production and sinking) play a major role in sequestering surface inorganic carbon, which is transformed into particulate organic carbon and then transported southward off the continental shelf

by the dense water flow. However, the winter cooling of the northern continental shelf is the most important factor influencing the solubility pump of CO2 and the vertical transport of carbon out of the shelf into the deeper layers of the southern Adriatic Sea. In case of warm winter conditions, the mitigation of the solubility pump and the reduced dense water formation results in a significant reduction in the sequestration of atmospheric CO2 and in the transport of carbon along the continental slope.

Modelling of belowground system in forest ecosystems.

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Key words: forest, soil biota, C turnover , hierarchy, complexity

Experience in development and applications of different models of soil organic matter (SOM) dynamics shows that belowground system (SOM, roots, roots exudates, mycchoriza, and different groups of soil biota) should be modeled as a whole for description of main processes of biological turnover of carbon and other elements. Complexity of the system requires consistent hierarchy of the processes linked with the modeling aims. For example, rough evaluation of carbon dynamics in stable conditions can be done using simple regression models, but the same system at climate changes requires at least simple mechanistic model with dependencies of rates of SOM decomposition on temperature and moisture. More complicated models should be elaborated for non-stable conditions after strong external impacts such as forest fire, clear-cut etc. Response of vegetation and soil biota after strong external impacts could be more complicated and unpredictable. For instance, ground vegetation after forest fire increases production and nitrogen uptake due to developing of nitrophillous species. Its litter is decomposing fast and transforms organic matter to more rich in nitrogen humus type and supports development of soil microbes and animals. A new extension of the ROMUL model of soil organic matter dynamics is discussed, which is based on successive stages of mineralization and transformation of fresh litter, which correspond to SOM pools in horizons L, F and H of forest floor, and in horizons Ah and B in mineral soil. The dynamics of SOM pools in the ROMUL model is described by a system of ordinary differential equations with variable coefficients depending on temperature, moisture, nitrogen, ash and lignin contents in litter fractions, pH etc. General scheme of the model allows for description of dynamics of nitrogen and other elements and incorporation of other processes of belowground system.

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Comparative study of robustness in pristine and reclaimed islands of Sundarban mangrove ecosystem, India

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Key words: Network, estuary, mangrove, virgin, reclaimed, robustness

Robustness is a universal feature of ecological systems which promotes sustainability over time. Robustness of an aquatic ecosystem, specifically an estuarine system, is investigated here using indicators derived from ecological network analysis. Estuaries provide us with many ecosystem services and these are consequently prone to face anthropogenic stresses. Sundarban mangrove estuarine ecosystem is one of the best known detritus based ecosystems of the world. Presently this mangrove ecosystem is under serious threat for different anthropogenic activities. Many islands of this ecosystem are either totally reclaimed, or partially reclaimed, but about 30% of the islands are still virgin. Two islands are selected, one is from virgin forest and another is from reclaimed part for comparative study of benthic food webs of these two islands by using Network based Ecopath software for possible human impacts. Selected island with virgin forest is almost free from human interference however the island with reclaimed forest fully disturbed due to almost all sorts of anthropogenic stresses. The results demonstrate a dramatic difference between these two islands. Virgin ecosystem is dominantly controlled by detritus, supplied from the litter fall of mangroves. Unlike the most benthic system the bottom community of reclaimed island receives a large contribution from the phytoplankton populations. Detritivory and herbivory ratio is markedly varied in these two systems, about 1:12 in virgin ecosystem and almost 1:1 in reclaimed system. The number of pathways of recycle can be identified much higher in undisturbed system in comparison with that of the reclaimed. Finn cycling is also very low in disturbed part. Litter fall comprises only 16% in reclaimed island where as in virgin island it is about 70%. Pathway redundancy is rather high in disturbed system, indicating the surviving system is probably highly resilient to further perturbation, as one might expect for highly impacted system. However in virgin forest the ascendancy value is much higher than the redundance, showing the system is healthly and almost free from any anthropogenic stress.

Diagenetic modelling of organic matter recycling in temperate eutrophicated estuaries.

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Key words: Diagenetic , modelling, biogeochemical, sediment, estuaries, Organic matter

The spatial and seasonal variations of organic matter recycling at the sediment-water interface were studied in two small temperate estuaries Elorn and Aulne (Brittanie, France), in order to understand the forcing on organic matter mineralization in these contrasted estuaries. Both experimental data and steady-state simulations were used to investigate the coupling between carbon, oxygen and nitrogen cycles in the two estuarine sediments during four seasons (February, May, July and October). A numerical model of early diagenetic processes (FEMME-OMEXDIA) was used in this study which includes oxic and anoxic mineralization. This model was developed to reproduce the sediment-depth profiles of carbon, oxygen, nitrogen and other chemical species. Organic carbon was modelled as two degradable fractions with different first-order degradation rates and nitrogen:carbon ratios. The values of several parameters (bioturbation coefficients, porosities, sedimentation rate, temperature, the bottom water concentrations of O2, NO3, NH3, ...) were constrained using field measurements and literature values.
The distributions of different chemical species predicted by steady-state calculations were compared to observed data sets on 3 different sites for each estuary and at four seasons. After adjustment of the critical parameters, the degradability rate constants for two fractions of carbon, the organic matter flux and the fraction of fast-decaying organic carbon deposited at the sediment–water interface, the model showed a good agreement between predicted and measured C, O2 and NO3 profiles for each data set at different seasons and localisations.

Forest insect population dynamics: fluctuation and “field” mechanisms of outbreaks in phase transition model

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Key words: insect , population, dynamics, outbreaks, models

A model of insect-phyllophages outbreak proposed based on phase transitions model in physical systems. The proportion of sampling units without insect used in model as order parameter, population density of insect pests used as a control variable, and a weather indicators (in particular, the ratio of seasonal rainfall to the average air temperature during the season) used as an external “field”. It’s shown that the behavior of the model system is described by a potential function with two minimal stable states – state then population density is low and a state with maximal value of density on the outbreak peak. The potential barrier’s height between the minima of the potential function determines the probability of transitions between states in population.
We consider two possible mechanisms of transition from one state to another, leading to the development of both the outbreak and population depression - a mechanism associated with the fluctuations of the order parameter, and the mechanism formed by the external “weather field” and leads to the transformation of bistable potential function into function with one minimum.
The proposed theoretical model is verified on the data of insect-phyllophages population dynamics - gypsy moth Lymantria dispar L., pine looper Bupalus piniarius L., Siberian moth Dendrilimus sibiricus Tschetv., spruce bud worm Zeiraphera griceana Hbn.

Modeling of the Pine looper population dynamics: two different approaches.

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Key words: population, dynamics, simulation, modeling, forest, insects

Pine looper (Bupalus piniarius L.) belongs to the types of forest insects that provide significant outbreak. This leads to severe damage or destruction large forest stands. This species is widely distributed in Eurasia, from Switzerland and Germany to the Central Siberian taiga. The task is set to create a model describing the dynamics of population density and allowing to estimate the probability of mass outbreaks in the future.
Analysis of field data showed that there are significant regional differences in population dynamics for eastern Europe and central Siberia. The European subspecies has a distinct cyclical and minor increase in density that do not usually lead to the destruction of the stand.
Siberian subspecies of insect has significant fluctuations in the period between outbreaks and fluctuations in maximum values of the increasing population density. In Siberia pine looper outbreaks often lead to the complete destruction of coniferous stands. The difference between populations is defined as a complex parasites and predators of specie and weather conditions.
Different approaches were used for modelling and prediction population dynamics of European and Siberian subspecies. For European race simulation software was created. This program is based on the autoregressive distributed lags (ADL) model with exogenous weather factors. Input time series have been modified to a stationary form. Reliable simulation results and short-term (1-3 years) forecast of change of population dynamics were obtained.
It was found unacceptable to use a similar model for the Siberian race. For the Siberian race was proposed simulation model using information of biological interaction between population and set of regulatory factors (parasites and predators of species) and the modifying influences (weather).
Using a simulation approach, it was possible to obtain estimates of the big outbreaks probability in the short term for the Siberian race of Pine Moth.

Using Line-transect Distance Sampling to estimate population densities of endangered wildlife in West central Morocco.

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Key words: Line transect, Distance , Models, Survey, Abundance, Wildlife

Line transect distance sampling has been used extensively to survey wildlife, by observing animals or their signs, in various habitats. This method is regarded as simple, economical, and relatively precise. It requires that animals are counted while an observer moves along a transect line, and the density estimate is based on the detection probability estimated from the linear distances between detected animals and the observer. The line-transect distance sampling (LTDS) was successfully used to survey the last surviving Moroccan dorcas gazelles Gazella dorcas massaesyla in M’Sabih reserve, and the Southermost population of the endangered Barbary Macaque, Macaca sylvanus in the High Ourika valley, Morocco. Data were analyzed using DISTANCE software and 12 different models tested. The selection of the adequate model was based on the shape of the

curve describing the probability of detecting animals in relation to the recorded perpendicular distances, the Akaike information criterion (AIC) value, and the value of a χ2 goodnessof-fit test. The best models have a curve showing a reduction in the probability of detection with increase in distance between the observer and the animal, and the lowest AIC value. The efficacy to survey populations was tested for over different seasons and in both lowlands and mountainous areas. The robustness of programme DISTANCE to changes in the density, distribution, and detection of animals across sampling areas and transects was then investigated. The LTDS is highly recommended as a tool of monitoring endangered populations of large wild mammals.

Conceptual Establishment of Land use-based Ecological Storage Model in a Mining Area.

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Key words: land use, ESP, mining, information, judgment

A mining area, rich in resources and energy, is intensively developed and disturbed by human activities, which causes an obvious change of land use and environments. Generally speaking, the services of an ecosystem always go towards degradation without positive intervention of human beings. On that, one idea that weather a conceptual model can be established to alter the degraded operation of an ecosystem as a guidance for land use planning and optimal allocation. Inspired by the theory of energy conservation and transformation, one land use-based ecological storage model, named “Ecological Storage Pump (ESP)”, is established. The model pumps in and out land use information and ecological information in the process of land use transformation, composed of input terminal, output terminal, pumping carrier, pumping power, with a closed loop and bidirectional exchange of information.
In the model, the external positive power is emphasized to mitigate the possible degradation caused by mining activities, including governmental management, land use engineering, etc. Correspondingly, the conceptual simulation is created to measure the operational process and effects of ESP, quantitatively and qualitatively. Finally, the model is used in a study case to verify its applications. The research results indicate that the ESP model can describe ecological storage of a mining area and its overall process of information transformation.

Consumption of food and fertility of forest insect: optimization model.

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Key words: forest insect, food , consumption, fertility, optimization , model

A consumption of food by caterpillars of forest insects described in the framework of the optimization model. The characteristics of food conversion price, the biomass synthesis price and effectiveness of food consumption by individuals were introduced in the model. To verify the model, we used laboratory experiments with caterpillars of Aporia crataegi L., Lymantria dispar L., Dendrolimus sibiricus Tschetv. It’s shown that the optimization model is in good agreement with the experimental data. It’s founded that a high efficiency of consumption can be achieved using one of two possible extreme strategies - the consumption of food with a high price of food conversion price and low price of caterpillars biomass synthesis (L.dispar and D.sibiricus), or use a food with low conversion price, but with the high price of biomass synthesis (A.crataegi). It’s shown that female fertility correlated with indicators of insect food consumption. It allows to evaluate the changes in the population density using data on efficiency of food consumption by caterpillars.

A first ecosystem model of shallow Lake Sidi Abderrahman (Safi-Morocco).

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Key words: Ecosystem model, artificial lake, SidiAbderrahman, Morocoo

The aim of our study was to create an initial conceptual view of the lake Sidi Abderrahman (Safi-Morocco) ecosystem, exploring the structure and functioning of this ecosystem. We use an ecosystem model, which simulates three functional groups of phytoplankton (diatoma, green algae, cyanobacteria), zooplankton, in addition to organic and inorganic nutrient (N, P) in the water column. Global sensitivity analysis is used as an initial screening test to identify the most influential model parameters. We evaluate the influence of forcing function uncertainties (water temperature, solar radiation, external and internal nutrient loading) on the model results. Some of the model parameterizations are quite common and

have been well documented in the modeling literature. We will emphasize special features of the model and site-specific modifications.

Application of the agricultural non-point source pollution model on Oum Rbiaa watershed.

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Key words: Watershed, Oum Rbiaa, modelling, pollution, AGNPS

The mean of this study is to use a non-point source pollution model (AGNPS model) in order to evaluate the long term impact of non-point source pollution within Oum Rbiaa watershed. The AGNPS pollution model simulates the behavior of runoff, sediment, nutrient and chemicals transport, this will allow us to better understand the behavior of Oum Rbiaa watershed and also propose solutions for the managers to assist in the creation of best management practices and other planning-related decisions.

Simulation of the ecological model in the coastal solar saltern (Sfax, Tunisia)

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Key words: Solar saltern, Ecological mode, Phytoplankton, Nutrients

The wetland particularly, the solar saltern is a demanding area to model realistically, therefore, numerical models, namely ecological ones, need to be implemented. Ecological models may be considered as the synthesis of knowledges about the ecosystem behaviour. In order to predict result of a scenario consisting in possible future global changes in the solar saltern of Sfax we have describe an ecological model for estimating primary production of phytoplankton. Data from an enriched pond of the solar saltern of Sfax were used to train, validate and test the model. The application of this biogeochemical model was tested by scenario which describes future changes in this hydrosystem. This study was conducted in the solar saltern of Sfax located on the central eastern coast of Sfax (Tunisia, 34° 39' 0.1" N and 10° 42' 35" E). One pond of mean salinity ranging from (42.6 ± 2.3PSU) to (45.2 ± 5.3PSU) was sampled (48 dates from January 2000 to December 2003). The temporal dynamics of phytoplankton and nutrients in the pond A1 of the solar saltern of Sfax are discribed by three differential equation. The first application of this model to this ecosystem is described and validated with the data acquired by the monthly surveys of plankton abundance in the pond A1 during the years 2000 to 2003. Biogeochemical modelling, as used here, refers to modelling the biological and chemical processes affecting nutrients (usually nitrogen and phosphorus) and primary production. It contains three variables: Phytoplankton, Total Nitrogen and Total Phosphorus. Based on hypothesis, a scenario was tested to predict the evolution of phytoplankton biomass dynamic. The hypothetic scenario takes into consideration global changes, especially temperature increase. The result of this test shows a considerable variation into phytoplankton biomass dynamic. Moreover, two peaks of important phytoplankton biomass are observed.

Managing change: an agent-based model of adaptive forest management at the landscape scale

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Key words: silviculture, ecosystem model, agent based, adaptation, landscape

The structure and composition of forest landscapes is not only driven by climate and soil conditions but also to a large degree determined by human interventions and management. Forest landscapes are thus increasingly recognized as coupled human and natural systems. However, many current forest ecosystem models focus largely on ecological processes and include forest management – if at all – only via static prescriptions, with limited capacity to adapt to changes in climate and natural disturbance regime.
In order to improve the modelling of forest-human interactions, we have developed ABE, a new Agent Based forest management Engine, integrated into the forest landscape and disturbance model iLand. ABE addresses two main goals: First, to simulate forest management decisions at the tree-level in silicio, and to implement realistic silvicultural activities such as planting or harvesting. And second, to mimic forest management decisions of different owners and managers (i.e., different types of “management agents”) at the enterprise to landscape scale, including the scheduling of the management activities under the constraints of legal and economic boundaries, and the adaptation of agents to observed changes in forest growth and/ or disturbance patterns. The parameterization of agents with specific behavioural rules and response functions is based on an extensive empirical database of forest managers in Austria.
Here we introduce the concept and implementation of the agent based forest management engine ABE. In addition, we present results of model evaluation exercises at the stand, planning unit, and landscape level: First, addressing the stand level, we demonstrate the realism of individual management activities performed by the model. Second, we show the potential of the scheduling algorithm to mimic realistic management patterns at the level of planning units. Finally, we present results of simulations at the landscape scale focusing on the long term interactions between forest dynamics and management agents.

Food web structure and trophic interactions of the tropical highland lake Hayq, Ethiopia.

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Key words: Food web, Ecopath, Mass balance, Trophic efficie, Tropical lake

We generated a mass-balance model to figure out the food web structure and trophic interactions of the major functional groups of the Ethiopian highland Lake Hayq. Moreover, the study lay down a baseline data for future ecosystem-based investigations and management activities. Extensive data collection has been taken place between October 2007 and May 2009. Ecotrophic efficiency (EE) of several functional groups including phytoplankton (0.8) and detritus (0.85) was high indicating the utilization of the groups within the system. However, the EE of Mesocyclops (0.03) and Thermocyclops (0.30) was very low implying these resources were rather a ‘sink’ in the trophic hierarchy. Flows based on aggregated trophic level sensu Lindeman revealed the importance of both phytoplankton and detritus to higher trophic levels.
The computed average transfer efficiency of 11.5% for the first four trophic levels was within the range for highly efficient African lakes. The primary production to respiration (P/R) ratio (1.05) of Lake Hayq indicates the maturity of the ecosystem. Wealso modeled the food-web by excluding Tilapia and reduced phytoplankton biomass to get insight into the mass balance before Tilapia was introduced. The analysis resulted in a lower system omnivory index (SOI = 0.016) and a reduced P/R ratio (0.13) that described the lake as immature ecosystem, suggesting the introduction of Tilapia might have contributed to the maturity of the lake. Tilapia in Lake Hayq filled an ecological empty niche of pelagic planktivores, and contributed for the better transfer efficiency observed from primary production to fish yield.

Relationship between goal functions of ecosystem development derived from network analysis.

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Key words: Ecol. networks, Information, AMI, Flow diversity, goal functions

Several descriptors of ecosystem development and health have been put forward as so-called “goal functions”, i.e. measures that exhibit a certain direction during ecosystem development. Such descriptors have their origin in theoretical constructs and have been tested on a limited type and number of theoretical

networks. From these studies, there is an implication that the number of trophic levels in an ecosystem, extent of recycling, and types of organisms (short versus longer turnover) are important in determining values of exergy, information, ascendency and other organisational attributes. Although the concepts of these indices have been dealt with in detail on a conceptual basis, or a limited number of theoretical case studies, it is as yet unclear whether generalities can be seen from empirical systems.
For this study we analysed ecological networks and chose one biomass based and two trophic flow based indices that have been described previously as goal functions. These constituted a component of exergy, the Structural Information, as well as Flow Diversity and Average Mutual Information (AMI). We used generated, simple networks to ascertain their ranges and responses to changes in flow values and size of networks. Thereafter, we investigated a number of empirical networks in order to ascertain the derived response patterns.
For the theoretical networks, a big range in values resulted, with some (not always corresponding) trends for the Structural Information, AMI and flow diversity with increasing number of nodes, biomass and throughflow. Although some patterns were found by plotting the results, strict relations between the three indices could not be derived. On the other hand, the empirical networks showed good relationships between the indices not for their overall systems value, but for their individual node values whose sum provides the systems value. Therefore the previously postulated theoretical relationship for the indices could be ascertained for empirical networks.

Does data prevalence matter when modelling habitat suitability using data-driven species distribution models?

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Key words: habitat model, suitability, data-driven, data prevalence

Habitat suitability modelling is one of the major approaches to illustrate species-environment relationships in ecology. For better modelling, machine learning methods have been applied as data-driven habitat suitability models.
However, predictive models are often recognised as black-box models and thus cannot be used for habitat suitability evaluation. In this study, three data-driven methods, namely a fuzzy habitat suitability model (FHSM), random forests (RF) and support vector machines (SVMs) were applied to demonstrate how habitat information such as habitat suitability curves (HSCs) can be retrieved from a species distribution model (SDM) and to assess the effects of data prevalence on model accuracy and habitat information retrieved from these SDMs. Virtual species data with different data prevalences were generated using field-observed habitat conditions and hypothetical HSCs between habitat variables when computing habitat suitability for a virtual species. The effects of data prevalence on species distribution modelling were evaluated based on model accuracy and habitat information such as HSCs.
Data prevalence affected both model accuracy and habitat suitability evaluation, with a stronger influence on the latter. The effects on model accuracy were less pronounced in the case of RF and SVMs which showed a higher performance. Whereas the HSCs were similar among the three models, data prevalence markedly affected the HSC shapes within a model, emphasizing the importance of accounting for data prevalence in habitat suitability evaluation. In practical implementation, data prevalence should be taken into account when interpreting the model results.

Exploring the impact of the optimizer's curse in systematic conseration planning.

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Key words: conservation, decision theory, optimization, surprise, uncertainty

Decision theory requires estimates of value, such as expected utility, and a procedure to determine decision alternatives likely to produce the greatest value. In many fields, and particularly in conservation, these value estimates are subject to significant amounts of error. It has been shown that when using decision theory without accounting for uncertainty, the outcomes are more likely to be worse than expected. This occurs even when the errors in the value estimates are unbiased. It simply results from choosing alternatives that maximise value, as alternatives that are overestimated become more likely to be selected. This phenomena has been called the "optimizer's curse", as on average, chosen alternatives are likely to result in a "negative postdecision surprise". While this point has long been emphasised in decision science, it is not often acknowledged within the growing use of decision theory for conservation applications. Here we explore the optimizer's curse in the context of systematic conservation planning, a procedure for determining the location of conservation management actions to promote the persistence of biodiversity features. As conservation planning often ignores uncertainty and usually involves optimization techniques to choose from a large set of alternatives, negative postdecision surprises are likely. We analyse the impacts of the optimizer's curse for a range of conservation planning problems using both real and simulated data. In each case the conservation problem is to select a set of locations for new conservation areas that maximize some aggregate function of species representation for a given area (or cost). We explore the implications of the optimizer's curse for varying levels of biased and unbiased uncertainty.
Finally, we discus the implications of the curse for conservation decision making, options mitigating the curse by explicitly incorporating estimates of uncertainty and explore how this relates to the efficiency/robustness trade-off in decision-making.

Continuous-flow cultivation systems and principles of stable organization of microbial communities: theory and application.

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Key words: chemostat, theorems, coexistence, population, stabilization, auto

The report presents the experimental and theoretical basis of research on mechanisms of stability of microbial communities in continuous-flow cultivation systems. The ways of continuous cultivation of microorganisms simulating the basic principles of organization in natural ecosystems (selection, continuous trophic flow, etc.) are presented. The report is focused on the search and study of the physical-chemical mechanisms of action of density-dependent growth-controlling factors (DDGCF) and patterns of sustainable coexistence of laboratory and natural populations of microorganisms. In this area, the following results were obtained for chemostat systems (with constant flow rate):
1) it was proved that there is a connection between the maximum number of coexisting species (n) and the number of DDGCF (m): n m;
2) based on changes in the input DDGCF, rules for formation of the community structure with predetermined species composition and DDGCF search methods were proposed;
3) the fundamental phenomenon of DDGCF autostabilization was discovered: independence of DDGCF background levels from their input flows (i.e. the zero values of the sensitivity coefficients (SC) of DDGCF); the generalized theorem of “quantization” was proved and experimentally tested: the sum of all SC is always an integer (!) and is equal to the difference between the number of DDGCF and the number of populations in a community (ΣSC = m-n);
4) a new classification criterion was proposed for microbial interactions based on the response of the growth rate acceleration of one population to the change in the size of the other;
5) microalgal, bacterial and yeast communities were used to demonstrate the total adequacy of experimental and theoretical mechanisms of stability and controllability of community composition.
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A simple continual model of soil organic matter formation.

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Key words: continual model, soil, organic matter

A simple phenomenological continual model of soil organic matter (SOM) transformation is presented. In the model the processes of SOM mineralization and humification are described as a continual decelerating motion of organic matter along a scale of humification degree when some part of SOM being mineralized during the motion. Humification rate coefficient is used as a scale of humification degree. The humification and mineralization processes are represented phenomenologically without detailed description of microbiological mechanisms of SOM transformations. The model is presented in the form of one partial differential equation of first order. The equation has an analytical solution describing time dynamics of distribution of SOM along the humification scale. It allows evaluating steady state SOM stocks and the time of accumulation of given fraction of total steady state mass of SOM. The equation includes only two empirically fitted parameters and requires small number of field data for model verification. Namely, input rate and initial decomposition rate of each fraction of plant litter are required to calculate SOM distribution and evaluate SOM stocks by model calculation.
For verification of the model and fitting the model parameters field data on SOM stocks are also required. In the present work verification of the model and test calculation was performed for different ecosystem types: taiga, steppe, cerrado, wet tropical forest. The ability of the model to predict SOM stocks for different types of ecosystems under essentially dissimilar climatic conditions shown in this study proofs the validity of this model.

Lattice model of herbs and dwarf shrubs.

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Key words: herbaceous, plants, population, dynamics, interspecies, competition

The structure and the principles of developed lattice model of functioning of populations of herbaceous plants and dwarf shrubs is considered. Plants ontogenesis is described by 10 developmental stages on the base of morphological structures. Modeling of types of different vital forms is possible.
The lattice simulation model consists of two blocks: computer interactive designer of plant life forms and model of the population dynamics of plants of different life forms. Designer can code and keep different life forms of plants. The model is

analysing conditions of self-maintenance of plant populations taking into account parameters of seed and vegetative reproduction and inter- and intraspecies competition. The model also allows for investigation of influence of heterogeneity of a habitat on invasion of different plant species. Development of each plant is coded by 10 stages. Plants at different stages differ in development of main morphological structures. The user can define stages of development of a plant, the size and shoot type at each stage of ontogenesis. The plant consists of aboveground part: vertical and horizontal shoots, and belowground part: rhizomes and fine roots.
The time step is 1 month. The size of a cell is 5 x 5 cm, the size of a lattice isn't limited. One cell can be occupied with only one plant or part of plant of one species.
Common dynamics of community consisting of creeping perennial plant Lysimachia nummularia L., bunchgrass Deschampsia caespitosa (L. P. Beauv.) and dwarf shrub bilberry (Vaccinium myrtillus L.) have been simulated as examples.
The model can be applied to the analyzing of practical questions of restoration of plant populations after destructions of their habitat.

Ecosystems: A Quantum Information Fractal Field Approach

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Keywords: Quantum information fractal field; the life-organizing principle; maximum action principle; eco-genesis; field equations.

Life is neither reducible to ordinary physics nor it is independent of physics. Life is subject to a new discovered fundamental physical property that distinguishes life from nonlife. Thus life (genome) is a quantum information fractal field (QIFF) which generates, in addition to electromagnetic vibrations, self-sustained bio-information oscillations for successive generations. The bio-information is a measure of developmental functional complexity, has the dimensions of energy and information, and represented by vitality function. The bio-information oscillations are represented by a generalized Schrodinger type of system that is nonlinear, non-conservative and irreversible. The generalized Schrodinger type of system is called the life-organizing principle, i.e., bio-information attractor. The life-organizing principle is a minor attractor when describing cellular dynamics, a major attractor when describing multi-cellular organism dynamics, and an eco-attractor when describing ecosystem dynamics. A cell type is an example of a minor attractor which belongs to a basin of a major attractor, and both minor and major attractors belong to a basin of an eco-attractor. In consequence ontogeny and phylogeny are processes that generate and organize minor attractors, whereas eco-genesis (ecosystem growth and development) is a process that generates and organizes minor, major and community attractors. Thus a QIFF is a set of bio-information attractors or attractor toward which a bio-system develops or evolves. Morphogenesis, developmental homeostasis, and eco-genesis provide the necessary empirical underpinning for the notion of QIFF. Moreover, the first and second laws of self-organization are derived on the basis of the life-organizing principle.
The following results are empirically falsifiable:

- The ecosystem rate of action increase is proportional to its developmental functional complexity.
-The eco-complexity is a product of its maximum rate of change of action and its species' genome physical information.
- Total vitality, a universal biological goal function, is a product of the ecosystem's total action, mean genome physical information and mean lifespan.
- Ecosystem dynamics is subject to the conservation of its species' genome total bio-information and maximum action principle.
- The ecological law of thermodynamics is the time derivative of the maximum action principle.
- Evolution is punctuationistic transition from a lower attractor to an upper attractor governed by the second law of self-organization.
- Simulation of ontogenetic development as well as the tree of life using the second law of self-organization.

Challenges in modeling Prochlorococcus with the classic Droop formulation – limitations and sensitivity

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Key words: model, Droop, autotrophy, Prochlorococcus, mortality, excretion

Understanding the dynamics of complex microbial communities in nature requires mathematical models, which typically are first built and tested on laboratory cultures. More importantly, mathematical models help highlight gaps in understanding and identify future experimental approaches. Here, we apply a classic internal stores (Droop/Caperon) model to study the dynamics of Prochlorococcus, a globally abundant marine primary producer, in laboratory batch culture. While the model reproduces well the initial, growth phase of Prochlorococcus cultures, it fails to recapitulate the dynamics as the cultures approach steady state and decline. Several processes, which are not well represented in the current model structure, may contribute to these shortcomings, including excretion, mortality, the ratio of labile to refractory cellular material and the potential for self-inhibition at high cell densities. We present an approach to systematically identify model parameters which strongly affect different measurements (variables) of model outcome, thus highlighting phytoplankton traits which are under-studied and for which concerted experimental studies may provide important data for better modeling.

Numerical modeling on the effects of pollutants in the ecosystem of Kamaishi Bay (Japan) by coupling MEC and ECOPATH model

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Key words: Simulation, pollutants, tsunami, ecossytems, MEC and ECOPATH, Model

A coupled ECOPATH and 3-D Marine Environmental Committee (MEC) model was conducted to describe the specific circulation patterns of hydrodynamics of water quality and ecosystems driven by climate change forcing in Kamaishi Bay in the Great East Japan. The major concern of this study is the diffusion of pollutants caused by 2011 Earthquake and Tsunami disaster impacts on marine ecosystem. In this study, we simulate the changes of water quality and ecosystems structure from January 2009 to December 2012. The MEC and ECOPATH model has been used to predict the distributions of various key water quality indicators and tide flow in the different layer of Kamaishi Bay. High correlation is obtained between simulation derived and measurement derived tidal characteristics. We also simulated the effects of breaking water effects on the tide, currents and integrating aquaculture and fisheries. The wind driven flow using mean seasonal wind forcing (NE, SE, and SW) creates different circulations over Kamaishi Bay. Similarly, the temperature and salinity distribution of Kamaishi Bay waters is characterized by strong seasonal variations. The water quality is intensely affected by pollutants and has continually deteriorated due to increased discharges of domestic and industrial waste as well as an increased loading in anthropogenic contamination into the Bay. The results were found that measured and simulated contaminations of radioactive materials were under the environmental standards in Japan. Observed and simulated DO, T-N and T-P concentrations were not so large different from those before the disaster.
This coupled modeling of a marine ecosystem food web illustrates some of the interrelationships or ecological pathways between the species that make up the community and pollutants structures of each trophic level. Applying the MEC and ECOPATH model helps ecologists better understand the significance of both upper and lower tropic level species and pollutants concentration relationships to the overall ecosystem of Kamaishi Bay.

An individual based growth model for the jellyfish *Pelagia noctiluca*.

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Key words: jellyfish, zooplankton, biophysiology, ecophysiology, growth model

In the last decades, there have been increasing reports about extensive jellyfish blooms around the world. At the same time many fish top predators' populations are decreasing due to fishery, habitat degradation, pollution and global changes. These two phenomena could indicate that a shift in the marine ecosystems is underway, the jellyfish slowly but steadily occupying the ecological niches left empty by the disappearing fish populations. Thus, it is of great importance to understand the potential impact of jellyfish population on the food webs of marine ecosystems.
We set up laboratory experiments designed to estimate the respiration and clearance rate of Pelagia noctiluca, a common holopelagic jellyfish, in different life stages. Field sampling were used to assess P. noctiluca population in the Strait of Messina (Sicily, Italy) and to measure sea water temperature and plankton concentrations. We used experimental data and measures to build an individual growth model for the species in three life stages (ephyrae, juveniles, adults). In this way we were able to estimate the food consumption of P. noctiluca organisms during its life time. Results showed that this species is a voracious feeder, efficient in exploiting the available food resources (zooplankton, but also both smaller and bigger preys) for its needs. As far as we know this is one of the first attempts in modelling the growth of a jellyfish through its entire life cycle.

Identifying drivers that influence the spatial distribution of woody vegetation in Kruger National Park, South Africa.

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Key words: disturbance, protected areas, distribution, structure, composition

Understanding the dynamics of woody tree species distribution in savanna systems remains a challenge despite considerable attention the topic has received in recent years. Disturbances such as fire and elephant effects on woody vegetation are well documented, yet the influence of these factors on emerging landscape-scale patterns such as height and species distributions continue to be poorly understood. The aim of this study was to identify how a suite of environmental variables (rainfall, temperature, aspect, slope, geology, fire frequency and elephant density) and their relative contributions, may affect woody species distribution in relation to structural height classes. Using the Maximum Entropy model for three structural height classes of the fifteen most frequently occurring woody species in the Kruger National Park (South Africa), the environmental variables best explaining each species distribution were identified. The three structural classes were defined to capture canopy height categories of specific management interest, namely Shrub (0.75m-2.5m), Brush (2.5m-5.5m) and Tree (over 5.5m). The weighted contributions of environmental variables for each species and its associated size class were further analysed for similarities using a resemblance matrix based on the Bray-Curtis similarity index coupled with a hierarchical clustering test. Using a combination of these techniques, our main findings suggest that the patterns and processes driving woody composition and structure are largely decoupled and that the distribution of different structural classes of a particular species may not be driven by the same environmental variables. It is highly essential that future studies take cognizance of this as ignoring one or the other may lead to confounding results.

A multiscale distribution model for of the seagrass Posidonia oceanica along the North African coast.

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Key words: P. oceanica, North Africa, SDM, multiscale, Satellites, Mediterranean, salinity, Bayesian, Downscaling, Water transparency

Posidonia oceanica (L.) Delile, 1813 is a seagrass species endemic to the Mediterranean sea, which is considered as an indicator of environment quality in coastal areas. This species forms large meadows, which are sensitive to several anthropogenic pressures, as a result the decrease in their extension is considered a priority issue for the Mediterranean sea. The aim of this study was to develop a multiscale Species Distribution Model for P. oceanica, to be applied to the Mediterranean North African coast, in order to obtain an estimation of the potential distribution of this species in the region. As the study area is a data-poor zone with regard to seagrass distribution, the Species Distribution Model was calibrated using high resolution data from 5 Mediterranean sites, located in Italy and Spain and validated using available data concerning the North African coast. The probability of presence of the species in a given area was modelled using a hierarchical bayesian approach as a function of the bathymetry and some water characteristics (i.e. water transparency; dissolved organic matter; sea surface temperature; salinity) mainly obtained from Earth Observations (EOs). Water transparency plays a major role, but also other variables, such as salinity, are important in explaining meadows distribution. The availability of high resolution time-series of input data allowed us to apply the validated model to the whole NA coast. The main results highlight how the downscaling procedure can help in improving the prediction of the distribution even for broad scale applications when high resolution environmental inputs are available.

Investigating the importance of spatial pattern on the stability of the rocky intertidal ecosystem.

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Key words: Spatial, System, dynamics, feedback, pattern, intertidal

The aim of this study is to develop a model to describe how the location of components in space affect the processes and distribution of components over time. The model was applied to the rocky intertidal ecosystem to investigate how the spatial pattern of the components of the intertidal ecosystem affect the processes that occur within the ecosystem. The rocky intertidal community is known to have different community patterns depending on the environmental conditions that it experiences. It is usually seaweed dominated in sheltered environmental conditions and barnacle dominated in exposed environmental conditions. We investigate if the spatial pattern has a significant effect on the size of seaweed or barnacle patches residing on the intertidal shore by forcing the model with several climate change scenarios and comparing the outputs. The spatial pattern is considered in the model by synchronous coupling of a non-spatial System Dynamics model with GIS, in which the spatial state, represented in GIS, is at each time interval considered in the calculation of state variables.

Mathematical modeling of the tundra soil ecosystem of Eastern Siberia

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Key words: methane, tundra, global carbon, permafrost, emission

One-dimensional mathematical model of the tundra soil ecosystem of Eastern Siberia was developed. The aim of this model is to predict future tundra ecosystem behavior caused by the global climate change. The model describes the following basic processes: photosynthesis of tundra phytomass, soil respiration, seasonal changes of tundra phytomass, methane synthesis and degradation, effect of light intensity, temperature, solar illumination and water balance. The important part of this model is a physical-chemical component describing the dynamics of permafrost depth, freezing and melting of soil and microlakes. The model allows us to calculate the balance of emission and sink of carbon cycle components between the tundra soil ecosystem and atmosphere, in the first place CH4 and CO2.
This work was supported by Russian Foundation for Basic Research (RFBR) and Krasnoyarsk region Science Foundation grant No 13-04-98119.

Assessing environmental requirements for Corbicula fluminea worlwide distribution using ensembles of distribution models.

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Key words: C. fluminea, BIOMOD2, Ensemble models, AUC, TSS

Corbicula fluminea (Müller, 1744) is considered one of the most efficient freshwater invaders. It is able to tolerate a wide range of physical conditions allowing it to colonize a variety of habitats and has large economic and ecological impacts in several aquatic ecosystems. Distribution models have been used to assess the spreading potential of invasive species, allowing scientists to prioritize biodiversity conservation plans or mitigate invasiveness deterrent impacts. Ensemble of distribution models have been used recently combining single models in ensemble analysis using for example model averaging. The aim of this study was to model the potential worldwide distribution of C. fluminea using several different correlative algorithms implemented in the BIOMOD2 modelling framework, by building an ensemble of Niche Based Models (NBMs). Species occurrence data was coupled with randomly generated worldwide pseudo absences data. Several climatic variables were included as well as a number of environmental variables representing landscape characteristics.
Results suggest that environmental variables such as annual mean temperature (climatic) or altitude (landscape) are determinant for the calculus of the suitable areas for the species. Comparisons between model evaluation methods indicated that the evaluation by the area under the receiver operating characteristic curve (AUC) may be considered excellent, whereas if we consider evaluation by true skill statistics (TSS) models predictions of species distribution range can be considered good to excellent. The use of an ensemble of predictions allowed us to clearly identify areas with potential to be invaded by the bivalve, in which records were not yet detected. Ensemble predictions may allow the establishment of measures to delay or prevent invasions, as well as the identification of the environmental variables that favour that invasive potential.

Plant-anthophilous insect ecological network along a glacier foreland choronosequence.

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Key words: climate change, network, plant-insect, succession

Climate change was observed during the past century and glacier retreat documented this warming period. Glacier forelands are ideal models to study community dynamics along a chronosequence. Nevertheless, knowledge about how plants and flower-visiting insects interact along a primary succession is still scarce. To fill the gap we performed network analysis focusing on insect ecological role to evaluate the changes in community structure and the relative importance of both direct and indirect weighted links in the interaction networks. We selected Saxifraga bryoides and Leucanthemopsis alpina as focal plant species ubiquitously distributed throughout plant communities colonizing Amola debris-covered glacier foreland (Italian Alps).
At five sites representing chronological gradient of deglaciation, anthophilous insects were sampled during two flowering seasons. Insect community structure showed an increase in functional diversity along the chronosequence. Pollinators dominated on the debris-covered glacier and in the early successional stages, whose abundance is positively related to entomophilous plants density. Parasitoids, predators and opportunists increased in the late successional stage following plant communities cover development.
S. bryoides and L.alpina weighted topological importance increased from debris-covered glacier surface to community dating back Little Ice Age (i.e. about 200 years old), followed in late successional stages located outside the LIA moraines by decrease and steady state, respectively. Pooled network density increased while degree centrality strongly decreased during succession. This reflect higher connection in early successional community network and loss of both centralization and interaction richness in late successional network. Our results show how plant-insect relationship reacts to glacial retreat dynamic during primary succession, suggesting possible enhanced extinction risks of some species due to loss of central role along glacier foreland.

Modelling the biogeography of Antarctic phytoplankton.

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Key words: SDM, diatom, phytoplankton, Southern Ocean

Marine pelagic diatoms are coined to be strong drivers of the Southern Ocean silicate pump. Their growth and sinking dynamics substantially affect silicate supply in lower latitude surface water masses of the world ocean. We have explored the use of species distribution modeling (SDM) to investigate the potential responses of a few key diatom species to climate change.
These models describe the response of a species to its environment by combining occurrence and environmental data using statistical or machine learning approaches. Subsequently, the species' potential distribution is mapped by projecting the model on gridded environmental layers, also for future scenarios.
This methodology became a standard approach in biogeography as well as conservation and climate change science, though with a strong bias towards terrestrial organisms. Marine organisms are clearly underrepresented and there is little experience with the applicability of SDMs for planktonic organisms.
Taxon occurrence records were harvested from public resources like the GBIF network, and extended by additional samples from the literature and from the Hustedt Collection, a large diatom herbarium located at the AWI.
Environmental parameters included nutrient concentrations and oceanographic variables like sea surface temperature and salinity.
Results of this study will be presented focusing on the current availability of taxon observation records and environmental parameters, model evaluation and projection on expected environmental conditions predicted for future climate scenarios.
In summary, the resulting current potential distribution maps of the models agree well with species distributions expected based on background knowledge, although the nature of a distribution boundary in the pelagial poses some challenges for interpretation. Projections on IPCC scenarios suggest that the distribution range of the main silica carrier of the Southern Ocean might shift polewards and substantially shrink during the upcoming decades.

Numerical modelling and network science tools to study ecological connectivity in the Great Barrier Reef.

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Key words: oceanography, connectivity, coral, dispersal, networks

The process of coral larval dispersal is vitally important for coral reef ecosystems, but remains poorly understood and hard to gauge. We employ a spatially explicit numerical modelling approach to simulate larval dispersal through a large section

of Australia's Great Barrier Reef (GBR), comprising over 1,000 reefs, and use a novel community detection approach from network science to look for patterns in the resulting connectivity network.
Water circulation in the GBR is modelled using a high-resolution finite-element ocean model (SLIM), whose multi-scale capabilities make it ideal to model topographically complex areas such as the GBR. Larval dispersal is then modelled using an Individual Based Model which accounts for simple biological functions such as mortality and competency acquisition and settlement. Connectivity matrices, quantifying the strength of larval dispersal between each pair of reefs, are then obtained.
We show how we can use a community detection method from network science to partition reefs into clusters – so-called "reef communities" – which are weakly connected with each other. This allows us to infer the presence of boundaries to larval dispersal, and to study connectivity at different length scales. By fine-tuning a resolution parameter in the community detection method, we can find dispersal barriers of varying strength.
We find and compare the reef communities for various species of coral, and show that many dispersal barriers are species-specific and depend primarily on the development rates of the species. We suggest how these findings could be used to inform the optimal placement of Marine Protected Areas (MPAs) to maximise connectivity with surrounding reefs. Finally, we also attempt to quantify the impacts of climate change on future connectivity patterns in the GBR by modelling larval dispersal for 50-100 years in the future, and showing the resulting evolution in the size and shapes of reef communities in the GBR.

A system dynamics approach to modelling multiple drivers of the African penguin populations on Robben and Dyer Islands, South Africa.

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Key words: Spheniscus, Benguela, system dynamics, conservation

The African penguin (Spheniscus demersus) population in southern Africa experienced a rapid decline in the 20th century, and the species is now classified as endangered. There is an urgent need for decision support tools to enable effective colony management. We present a system dynamics modelling approach to penguin population dynamics in South Africa's breeding colonies, which combines a demographic simulation with the modelling of multiple pressures including prey availability and competition for prey with commercial fisheries, oil spills, predation by terrestrial and marine predators, and extreme climate events. The model is stochastic, stage-specific and resource-driven, and incorporates both quantitative field data and qualitative expert opinion. For the first implementation to Robben Island, demographic data were adapted from field data and earlier models to create a stable simulated population used in a variety of scenarios and sensitivity tests. The modelled population was found to be strongly driven by food availability and to a lesser degree by oiling and marine predation, while climate events and terrestrial predation had low impacts. Food biomass levels in the penguins' foraging area around the island (used during nesting) and further afield (used during the rest of the year) had an equal influence on population development in the short and long term. The impact of short-term fishing restrictions around the island was found to be generally beneficial to the modelled population, but easily masked by food-driven variability in population growth. Results suggest that improving food availability and mitigating the impact of oiling would have the highest beneficial impact on this penguin population. The model is being adapted to the Dyer Island colony to investigate population dynamics and the relative effect of management strategies in reversing the strongly decreasing trend in this colony. Progress will be presented comparing the lessons learnt from both implementations to date.

Long-term model study of detritus dynamics in the Baltic Sea.

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Key words: eutrophication, detritus, oxygen, num. modelling, Baltic Sea

The Baltic Sea is a brackish inland water body with a limited water exchange with the North Sea through narrow and shallow Danish Straits. It receives large freshwater runoff and riverine nutrient loads, which in 2006 comprised 638,000 t of total nitrogen and 28,370 t of total phosphorus. Eutrophication resulting from direct and indirect input of nutrients is still considered one of the major environmental problems in the sub-basins of the Baltic Sea.
Stronger eutrophication is manifested through the frequent occurrence of oxygen depletion in the near-bottom waters of the Baltic Sea. It has been recognized that nutrient load, increased primary production and nutrient fluxes between sediments and overlaying water column play a key role in the eutrophication of the Baltic Sea. Still, there is no direct knowledge about detrital particles increase in the sediment pool.
Our study aims at describing spatial detritus pool dynamics during the period of 40 years in the Baltic Sea. Model simulations were performed using a three-dimensional free-surface hydrodynamic model GETM coupled with the ERGOM biogeochemical model. The model domain covers the entire Baltic Sea area and the period modelled is 1966-2006. The main source of detritus is primary production/phytoplankton, which varies between years. Oxygen concentration on the sea bottom is the most important factor influencing detritus dynamics.
Under oxic conditions detritus pools become nutrient source for the water column through mineralization, which in turn could intensify eutrophication processes. Mineralization process, however, consumes near-bottom oxygen, which can lead to hypoxia under certain conditions. Physical processes which ventilate the sea

bottom also play an important role in detritus spatial distribution. Describing spatial and temporal variation of detritus enables us to determine areas, which are prone to eutrophication in the Baltic Sea.

Biogeochemical parameters in the Southern Baltic Sea simulated by a 3D coupled ecosystem model.

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Key words: Baltic Sea, Coupled Model, Ecosystem

3D-CEMBS is a fully coupled model adopted for the Baltic Sea based on CESM1.0 (Community Earth System Model). It has two active components (ocean and ice) driven by central coupler (CPL7). Ocean (POP version 2.1) and ice models (CICE model, version 4.0) are forced by atmospheric and land data models.
Atmospheric data sets are provided by ICM-UM model from University of Warsaw. Additionally land model provides fresh water runoff and nutrient deposition from 71 rivers. Ecosystem model is based on an intermediate complexity marine ecosystem model for the global domain (J.K. Moore et. al., 2002) and consists of 11 main components: zooplankton, small phytoplankton, diatoms, cyanobacteria, one detrital class, dissolved oxygen and the nutrients (nitrate, ammonium, phosphate and silicate). The model is configured at 2km horizontal resolution and the bathymetry is represented as 21 vertical levels. Currently model works in a operational state providing 48-hour forecasts. Prognostic variables such as temperature, salinity, ice cover, currents, sea surface height and phytoplankton concentration are presented online on a the model website. Comparison with in-situ data (mainly from r/v Oceania cruises) has been done for the southern part of the Baltic Sea.

A mechanistic model coupling tree physiology and demography of sap-feeders pests.

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Key words: agroecology, plantphysiology, pest control, peach tree, aphids

In a world demanding high agricultural yields and less use of chemicals, a better understanding of the mechanisms governing the interactions between crops and pests is crucial. Growth models describing the cycling of carbon within a plant as the result of a dynamic balance between carbon uptake and allocation to different plant compartments have attracted much attention in the biological and ecological literature. However, they have been rarely coupled with demographic models for pests, such as aphids.
We built a mathematical model of carbon uptake and storage into different tree compartments (leafy shoots, roots and fruits) which allows predicting the effect of environmental variables (temperature, light and humidity) and cultural practices (pruning, thinning and irrigation) on the dynamics of plant organs. We then coupled it with a model of aphid demography, in which aphids are considered to feed on non-structural carbohydrates directed towards leafy shoots.
We calibrated the model using data from an economically important pathosystem, the interaction between the peach tree Prunus persica and its aphid Myzus persicae. We compared model predictions with experimental and literature data. The model well predicts observed patterns relevant to plant organs growth and aphid abundance under different environmental and management scenarios and also provides original insights on possible bottom-up regulation of pest abundance via cultural practices.

Ecosystem structure, trophic link and functioning of Lake Ziway, Ethiopia

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Key words: Ecopath, Ecosim, Trophic , modeling, Exotic , introduction

A trophic model was constructed for Lake Ziway ecosystem using Ecopath with Ecosim application software. This model was used to evaluate and analyze the food web structure and other properties of this ecosystem to gain a better insight into the structure and functioning of the ecosystem and to assess the impacts of different fishing simulations. The model consisted of 12 functional groups, each representing organisms with a similar role in the food web. The trophic levels of Lake Ziway ecosystem were between 1.0 and 3.29. It was found that the biomass flow of the ecosystem was highly restricted to I and II trophic levels which contributed 99.76%. The mean transfer efficiency was only 4.4%. The fishery catch consumed 2.5% of the primary production in the lake. Low ecotrophic efficiency (EE) of 0.47 was noted for the phytoplankton showing that most of the production remains unutilized within the system. In Lake Ziway all fish groups were highly constrained by a combination of fishing and predation mortality which explain the high EE. Management scenario using Ecosim analysis indicated that moderate decrease in the beach seine effort could be helpful for the thriving of carp abundance. Carps in Lake Ziway are under the pressure of beach seine with high harvest rate (EE=0.9). Decrease in fishing effort by beach seine by fifty percent would increase their biomass to six times the current biomass during a ten years' period. The food web of Lake Ziway is consumer exercised top-down control with low EE of primary producers and herbivore zooplankton.

The total analysis indicated that Lake Ziway ecosystem has an open niche which can be filled with obligate herbivores to increase the energy transfer efficiency of the lake.

The data assimilation scheme in operational forecasts and reanalysis of the Mediterranean Sea biogeochemistry

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Key words: data assimilation, Mediterranean Sea, biogeochemistry, operational forecast, reanalysis, skill assessment

The coupled physical-biogeochemical OPATM-BFM model, which uses a variational scheme to assimilate satellite chlorophyll observations, has been used in the framework of the FP7 European projects OPEC and MyOcean2 to produce gridded data sets of Mediterranean Sea biogeochemistry with different temporal scales, from weekly operational short-term forecasts to seasonal and multi-annual reanalysis.
The assimilation scheme is based on the decomposition of the model error covariance matrix in three operators. Each operator accounts for a specific aspect of the covariance: two operators accounts for the spatial covariance (vertical and horizontal) and one for the covariance among the biogeochemical variables. The three operators were defined in order to describe the error covariance aspects specific of the Mediterranean Sea biogeochemistry.
The assimilation scheme has an affordable computational cost both in the operational and in the reanalysis applications, and the results show that the assimilation improves the model skill at different spatial and temporal scales. In particular, using parametric and non-parametric skill assessment techniques, it is proved that the operational framework improves the model capability to simulate the spatial and temporal characteristics of local events (e.g. the phytoplankton blooms in the northern western region during winter and spring). Improvement in simulating phytoplankton dynamics are also evident for the seasonal chlorophyll signal at sub-basin scale in the reanalysis data set. Other biogeochemical variables (nutrients and oxygen) have been compared with available data sets showing that the assimilation scheme generally improves the model performance at the basin and climatological scales.

Towards a coupled physical-biogeochemical model for the Gulf of Gabes (Tunisia, Eastern Mediterranean Sea)

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Key words: Mediterranean, Sea, Gulf of Gabes, Biogeochemical , Model

A three dimensional hydrodynamic model coupled with an idealized biogeochemical model was used to simulate the evolution and the spatial distribution of nutrients, plankton and detritus in the golf of Gabes (Tunisia, Eastern Mediterranean Sea).
The hydrodynamic model is free surface oceanic model based on the primitive equations of circulation and thermodynamics. The Boussinesq approximation and the hydrostatic balance are used. The model is forced by winds stress, heat and water fluxes from the Comprehensive Ocean-Atmosphere Data Set (COADS, Da Silva et al., 1994). The monthly climatology with a spatial resolution of 0.5°C is used. The model initial conditions for temperature and salinity are obtained from World Ocean Atlas (WOA) database (Conkright et al., 2001; Song and Haidvogel, 1994).
The biogeochemical sub-model is based on nitrogen and phosphorus, in interaction with the phytoplankton and zooplankton. The results show that the hydrodynamic model realistically simulates the water circulation in the Gulf of Gabes including the tidal dynamics. The model also satisfactorily simulates the seasonal variation and spatial distribution of phytoplankton. The phytoplankton bloom is simulated at spring season when the nutrients are available, the light is sufficient and the water is warming. The phytoplankton bloom is followed by the development of the zooplankton.

Net primary production of forest stands: estimation by "ecoSolow" model.

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Key words: forest stands, biomass, NPP

Net primary production (NPP) is the integral value characterizing the efficiency of absorption of solar energy by plants in the process of photosynthesis for a certain period of time (month, year) over a certain area. NPP values are very important for understanding the mechanisms of production processes in plant ecosystems, monitoring and forecasts. In the present paper we have compared two approaches to the estimation of tree's NPP. Traditionally NPP estimated using the balance equations based on the measurement the aboveground parts of the tree (trunk, branches and leaves/needles). Authors have modified balance method and now we can calculat the root's phytomass for NPP's estimation.
In the second approach for estimating NPP we have used an economic model R.M. Solow (1956). In this case the photosynthetic processes are considered as an analogue of a production process. The authors suggest to consider a tree as a production system and this system consumes solar energy. The result of this activity is NPP. It is assumed that the production of tree's photosynthetic apparatus depends on the total biomass of a tree (capital) and on biomass of the photosynthetic apparatus (labor). To describe the tree's production function we have used the modified Cobb – Douglas's function.
It is shown that the proposed approach to NPP's estimate with "ekoSolow" model can increase the accuracy of the calculations and reduce the amount of field data needed for the calculation .
Basic Research Program of the Presidium of RAS "Searching basic research for the development of the Russian Arctic" Project 12.

Special software package for designing of cellular automata models of plant communities dynamics based on the concept of discrete description of plant ontogenesis.

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Key words: Cellular, automata, ontogeny, life forms

Cellular automata models are well-known as a tool of modelling of plant populations and communities dynamics. Usually they are developed as a special computer program with detailed description of concrete species vegetative propagation and rules of competition. We developed a special multipurpose computer program which can simulate community of different life forms of plants in terms of the concept of discrete description of plant ontogeny with arbitrary geometry of vegetative propagation of daughter plants. Growth and development of plants itself can be described for different types of ontogeny (annual, perennial, short-rhyzome, long-rhyzome etc.).
The model is realized on the integer-valued two-dimensional lattice which is rolled up into torus.
Designer of ontogenetic stages allows for description of growth and development of the plant (either genet or ramet) in terms of ten successive ontogenetic stages and corresponding plant below- and underground structures (foliage, shoots, rhyzomes and fine roots) for each species.
Bresenham's line algorithm is realized for specifying of rhyzome or stolon branching at any angle.
Constructor of matrix of transition probabilities from one ontogenetic state to another with accounting of rejuvenation of daughter plants typical for many plant species is developed. Probability of death due to external impacts is also included.
Constructor of spatial inhomogeneities allowing for setting of different accessibility of lattice cells is applied. Pattern of inaccessible (with probability) cells can be arranged as random, regular (lines or quadrats) or cluster (using the technic of lattice Markov fields).
The program has a user-friendly interface with saving all outputs: dynamics of numbers (or projective cover), ontogenetic stages (or age) structures for all species.
The program is intended for applications as a separate unit and for incorporating to complex models of forest and meadow ecosystems. An example of simulating of population of bilberry is presented.

Exploring potentials of a data-intensive approach for quantifying the sustainability of socio-environmental systems

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Key words: Data-intensive research, sustainability quantification, robustness, resilience, economic resource flow networks

Research towards the quantification of factors determining the sustainability of socio-environmental systems can help clarify the concept, track its progress, and assist policy makers to objectively make decisions. This paper develops and explores a data intensive approach to quantifying the intensive dimensions

of sustainability using the ecological information-based approach. Contributions include an evaluation of the effectiveness of the approach to available data on several trade networks, and an assessment of how the accuracy and validity of this approach towards sustainability quantification can be increased as more data becomes available. We demonstrate that actual human socio-economic networks show a pattern of commonality when viewed through the introduced metrics and that an intensive dimension of sustainability can be explained through a phenomenological rationale. Specifically, we show how the network metrics of effective connectivity and effective number of roles can convey boundaries where economic resource networks are robust. Furthermore, the temporal trends of these metrics suggest multiple basins of attractions and provide clues on the resilience of these networks. The accuracy and validity of the approaches presented in this paper can be increased in the near future with the availability of more data. Specifically, the spatial and temporal granularity and also the cycling of flows within the networks can further improve our understanding of the intensive dimensions of sustainability. We hope that this paper will help to establish a quantification of sustainability that integrates these intensive dimensions with conventional external dimensions.

Mapping the distribution of tabulate and digitate Acropora corals in selected reefs of Zanzibar

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Key words: Mapping, Acropora corals, Distribution, Zanzibar

Reef coral species diversity and growth forms have a significant influence to climate change vulnerability and resilience of reef ecosystems. Thus, mapping boundaries of coral reefs and distribution patterns of coral growth forms is important for management. In this study an attempt to map the boundaries of coral reefs and distribution of digitate and tabulate Acropora corals was undertaken in reefs around Bawe and Mnemba Islets off the main Island of Zanzibar. The results were compared with environmental parameters, exposure status, sediment type, turbidity and depth. Data were collected by manta tow technique, line intercept transect, belt intersect transect, Global Positioning System unit and underwater camera. Geo-referenced data was processed using Arc Map 9.3 software. At the boundaries, corals are intermixed with seagrasses, sand, rock and algal mats; the border line was set where live coral cover was above 5 %. The total area of coral reefs was 1.9 km2 at Bawe Island and 20 km2 at Mnemba Island. In both reefs digitate and tabulate Acropora corals were randomly distributed, where digitate Acropora corals dominated more than tabulate Acropora corals. Size frequency distribution revealed high proportion of small sized colonies of digitate and tabulate Acropora corals on reef flat and slope on both sites. The results also reveal a link between the distribution of tabulate and digitate Acropora corals with environmental parameters. This study provides baseline information for managers and researchers on the location and distribution of digitate and tabulate Acropora corals and provides recommendations for future studies on ecosystem changes and vulnerability.

Environmental niche modeling of the Stripe-necked terrapin Mauremys leprosa reveals low level of ecological differentiation among Moroccan populations.

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Key words: Niche, Geo-reference, Climate, Modelling, MAXENT, Turtles

Spatial distribution of taxa can be predicted using Ecological Niche Modeling (ENM). This method based on spatially-explicit environmental information and geo-referenced data, provides an estimate of the ecological niche; the multi-dimensional environmental space within which a species can persist. ENM can be effectively used to assess lineage delimitation, showing great utility in groups that exhibit low levels of molecular differentiation and little morphological divergence. By performing a climate niche analysis and developing ENM based on confirmed records of six putative subspecies of the Stripe-necked turtle, Mauremys leprosa, from Morocco we aimed at: (i) assessing whether they inhabit different climatic niches, (ii) assessing whether they fulfill the required conditions to be considered different incipient evolving lineages under low genetic and morphological differentiation. On the basis of 156 geo-referenced specimens, we developed ecological niche models using Maxent programme and spatially explicit climate data to examine historical and ecological factors affecting variation in M. leprosa, across its range in Morocco. Overall, we found little support for the recognized subspecies as either independent evolutionary lineages or geographically circumscribed units and conclude that although some genetic and niche differentiation has occurred, most populations assigned to M. leprosa appear to represent a single, widespread species. However, additional sampling and application of nuclear markers are necessary to clarify the status of the southernmost populations. Even climatic niche differentiation among populations was detected, only two subspecies were revealed by climate niche analyses and ecological niche models. However, each population should be considered as a unit for conservation and management.

Modeling of traffic air pollution – a case study for the region of Skopje.

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Key words: dispersion mode, traffic mon.sys, visualisation, air pollution

Our primary interest in this study is modelling of air pollution and the relationship with the health status of the people. The majority of the European population lives in urban areas, and their daily and economic activities are concentrated in or around that area. Traffic of motor vehicles across the road infrastructure close to the residential buildings is the main source of air pollution.
Air quality dispersion models can be used to provide information about the impact of individual emission sources or source categories on the air quality and to predict air quality as a result of changes in emissions such as increase of traffic, emission parameters etc. Dispersion models can be used to complement the data gained by monitoring (which is often limited) as the spatial coverage of air quality information. They are also an important tool for providing air quality improvement plans and programmes.
In this paper, based on combination of few existing air pollution models, we are presenting, as a main contribution of this paper, the most appropriate model for the first of this-kind study for the region of Skopje. This study uses measurements for emissions of many physical and chemical parameters from traffic sources in order to produce the general picture of the pollution on annual level. By visualizing the pollution of the main streets in the region of Skopje on annual basis, we can easily identify the months where certain parameters exceed the limit values.
Our experimental results for the region of Skopje show the air pollution parameters (such as CO, CO2, SO2, PM10, PM2.5) on different locations. They are provided by modeling, verified by measurement sensors and visualized by using the GIS ESRI software.
The main results show significantly increased values (beyond the EU standards for air pollution limits) for PM10 and PM2.5.

Water quality of tow river in the high Atlas central.

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Key words: water Quality, surface water, pollution, ecosystem

Oukaimeden and ourika are too river in the central high atlas in Morocco (valley of ourika). this valley is characterized by a very significant human activity(residential and tourism), where a sizable disruption of this ecosystem.

This study is part of fight against the pollution of surface waters with the primary purpose is the study of physico-chemical characteristics of these two rivers for:
1. Making a diagnosis of the quality of surface water.
2. Determining the source and nature of the pollution.
3. Propose alternative to minimize the growth of this pollution.

Diffusion of heptane in polyethylene vinyl acetate: modelisation and experimentation

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Key words: Packaging, Plastic, Modelisation, Finite D.M, Diffusion

The aim of this work is to describe the mass transfer in food packaging in fact, when the plastic is brought into contact with food, certain transfers of chemical occur according to a complex process. In this work, we coupled modeling with experimental approach in order to understand the transfer through the plastic interface of food packaging.
The numerical model takes into account the result obtained in an experimental study. The kinetics of diffusion transfer and diffusivity of heptane in our model was determined. The analytical and numerical model has been developed in order to give better information on the concentration of liquid inside the package (PEVA) and simulate in a few hours the transfer that occurs several months.

Two-dimensional hydrodynamic model of the Oualidia lagoon (Morocco)

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Keyword: Oualidia lagoon, Morocco, 2D model, leaky lagoon, tide, current, residence time.

Oualidia lagoon is located on the Atlantic coast (-9.02°W, 32.44°N) and is one among the traditional lagoons in Morocco where oyster related activities were developed since 1950. In order to investigate its physical functioning, a 2D model has been implemented for this lagoon. Outside the lagoon, tides are semi diurnal

with dominance of the M2 component (amplitude around 0.90 m), followed by the S2 (amplitude 0.35 m), the N2 (amplitude 0.20 m) and the K2 (amplitude 0.10 m) components. Inside the lagoon, due to its morphology and to the bottom friction, tidal amplitude reduces from the inlet (around 0.9 m amplitude) to the upstream end (around 0.8 m amplitude), suggesting that the Oualidia lagoon is a “leaky” lagoon. The currents are very strong near the inlet, they decrease upstream, and large changes in velocity can be observed during neap and spring tides. Recent work shows that the local residence time is estimated to be 1 day near the inlet and around 20 days upstream. This time is very important for oyster and aquaculture activities in the lagoon.

Anthropogenic impacts and biophysical interactions in Lake St Lucia, South Africa.

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Key words: St Lucia, human impacts, biophysical, interactions

Food web structure and function in ecosystems are a reflection of environmental conditions, this is especially apparent during extreme circumstances. The St Lucia estuarine-lake system in South Africa is part of a UNESCO World Heritage site and a Ramsar wetland of international importance. It has recently experienced an unprecedented prolonged period of desiccation and hypersaline conditions caused by climatic variability and anthropogenic impacts. This has had a significant impact on species diversity, abundance and biomass. Questions regarding its sustainability have motivated a re-evaluation of management decisions made in the past and of options for the future. To understand the functioning of the system, it is necessary to analyse it holistically in terms of the physical processes and their interaction with the biology. This study focusses on aspects of the biophysical interactions in the estuarine complex, and aims to provide new knowledge to underpin the development of improved models for predicting the response of the system to anthropogenic interventions.
Water and salt budget models were used to investigate various scenarios in terms of past anthropogenic interventions and the associated risks of hypersalinity and desiccation. Integrating these modelled scenarios with observed biological responses to physicochemical changes suggested that large long-term changes in the biological structure can be expected in the different management scenarios. To validate this, the ecosystem response to changing environmental responses was quantitatively assessed using ecological network analysis. The biomasses and trophic exchanges of various biotic species were estimated and used to establish ecological networks from which several ecosystem indices were calculated. Results indicate that the water level, salinity and mouth state have a significant impact on the total system biomass and productivity and the number and weight of energy flow pathways.
These influence the biological structure and functioning of the St Lucia

How long Greek tortoise (Testudo graeca) could be exposed to solar radiation in open habitat before overheating?

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Many tortoises' species inhabit arid habitat where the availability of thermally buffered refuges is a limiting factor. Lethal overheating can theoretically occur within a few hours if the tortoise cannot reach a thermally buffered refuge. Determining the maximal distance between refuges that individuals can safely traverse during the active season is thus essential. We examined the relationship between body temperature variations and movement patterns in adult Testudo graeca in the arid steppes of Morocco. Using physical and mathematical models, our results suggest that during the active season adults cannot travel more than1 km without serious risk of overheating. However, radio-tracking suggests that free-ranging individuals are behaviourally limited to 0.5 km trips between refuges. Overall, maintaining a distance less than 0.5 km between refuges (e.g. through bush planting) is essential to limit fragmentation and to retain healthy populations

POSTER

Towards obesity modeling based on its essential parameters in the population of Marrakech.

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Key words: obesity, model, parameters, epidemiology

Today, obesity has become a major concern worldwide and especially in our country. Its adverse effects on human beings threaten our social protection system and involve the development of certain chronic diseases such as cardiovascular disease, hypertension, certain cancers, diabetes, etc. The World Health Organization has classified obesity as a disease that is a real problem of global public health and prevention in developed countries remains very complicated. Factors associated with the evolution of this phenomenon are multiple and their interaction is complex. They can be genetic, environmental, psychological or economic. These determinants of obesity affect intake and energy expenditure and lead to a society where the number of obese people is increasing.

Synthesis of β-Tricalcium phosphate by using eggshell and phosphoric acid.

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Key words: Eggshell , Recycling, β-Tricalcium , phosphate, XRD, FTIR

Everyday millions of tons of eggshells are produced as biowaste around the world. Most of this waste is disposed of in landfills without any pretreatment. Eggshells in landfills produce odors and promote microbial growth as they biodegrade. The present study suggests the eggshell as a possible material-recycling technology for future waste management and ecology. Also, eggshell is a potential material for the synthesis of calcium phosphate ceramics for biomedical applications.
β -Tricalcium phosphate Ca3(PO4)2 is frequently used as bone graft substitutes in many surgical fields like the orthopedic, dental, plastic surgeries. Its chemical composition, near to the bone, confers to its excellent biocompatibility and osteointegration properties.
In this work, provides a simple wet method to obtain high-purity β -Tricalcium phosphate (β-TCP) nanoparticles from eggshells, a raw eggshell was easily turned to CaO by the calcining process at 900°C and the calcined eggshell was mixed with phosphoric acid by the wet method. The observed phases on the powder synthesis process were dependent on the mixing ratio (wt.%) of the calcined eggshell and phosphoric acid, and values pH. We investigated the influence of pH on the variation of the phase composition.
These synthesized nanoparticles have been characterized by X-ray diffraction, Fourier transform infrared spectroscopy and Transmission electron microscopy.

On the network description of ecosystems.

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Key words: ecological , networks, modelling

One of the widely used approaches to describing ecological systems is their representation in the form of food webs. However the use of network representations for modeling ecosystem dynamics faces several challenges. So the network description assumes that species (except autotrophs) included in the ecosystem consume biomass of at least two species of preceding trophic level.

But the direct constructing of a mathematical model of the food web by combining the equations in the style of traditional Lotka-Volterra model is not possible due to Gause principle. So the need to modify the description of individual species and their interactions appears. It is shown the probability of sustainable coexistence of species, and hence the existence of branched ecological networks is significantly increased by using a combined formula Mono, considering the dependency of dying on hunger, and adaptive variation consumption coefficients. Nevertheless the representation of populations via their total size is a serious oversimplification. In the course of growth an organism changes the food base and its predators are also changing. This means instead of the numerical coefficients of population interactions the consideration of two-dimensional distributions of the ages is required. Staying in the scope of the network representations we can talk about a kind of “continual” or “distributed” networks. The model of an ecological system accounting the age distribution of species number and average mass of individuals is built It is shown the stationary distribution for the size of terminal predator populations and the average mass of basic types (producers) do not depend on the structure of the ecosystem. The distribution of individuals in the case of the population admitting cannibalism (lakes with bass, as the only type of fish) is obtained.
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Population dynamics of Temora longicornis in the southern Baltic Sea – numerical results.

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Key words: Population, Model, Temora, Baltic Sea

The ecosystem model 3D CEMBS connected with the population model, described in this paper, was used to determine the temporal distributions of T. longicornis in the Gdańsk Basin (the southern Baltic Sea) divided into the coastal zone P2 (the Gulf of Gdańsk) and the open sea P1 (Gdańsk Deep). The population model for T. longicornis consists of twelve equations for twelve states of variables, six for the mass Wi and six for the abundance Zi, i.e. two states of variables Wi and Zi, for each of the six model stages of the development; the stages were grouped as follows: eggs – Egg, stages not taking food – NI-NII, subsequent stages of nauplii – NIII-NVI, two copepodid stages – CI-CIII and CIV-CV and the last stage of adult organisms – CVI. Seasonal dynamics of T. longicornis is described by average changes in the total biomass as a sum of biomass of the examined ontogenesis stages, which are the sum of the products of the mass Wi and the abundance Zi of individual organisms at a given stage.
The empirical verification of the population model based on in situ data obtained from the analysis of biological material collected in 2010-2011 in the region of Gdańsk Deep (P1) and in the western part of Gdańsk Bay (P2), and in 2006-

2007 – only in Gdańsk Bay (P2). The highest values of the modelled T. longicornis biomass occurred in the period of high temperatures, i.e. in summer, in June 2010 and July 2011 in the Bay of Gdańsk – at station P2, and between late June and early July, and for almost the whole summer in Gdańsk Deep – at station P1, and amounted to respectively ca. 5200 mgw.w. m-2 and 6300 mgw.w. m-2 at station P2 and 24500 mgw.w. m-2 and 27800 mgw.w. m-2 at station P1.

Ecosystem services provided by Posidonia oceanica in the North African coastal area.

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Key words: mapping, seagrasses, InVEST, Mediterranean, GIS

The ecosystem services (ESS) approach provides a valuable framework to link the functioning of ecosystems to human well-being, and thus to highlight the dependence of socio-economic development on a proper management of natural resources. The purpose of this work is to provide a first mapping of the ESS provided by the Posidonia oceanica meadows along the North African coastline, through the integration of different modelling approaches. P. oceanica is one of the most important seagrass species in the Mediterranean sea, and it has been reported to provide several ESS, such as provisioning, regulating and cultural ones. Although P. oceanica is widespread in the North African coastal area, its occurrence is described on coarse resolution and very little is known about its fine grain distribution and about the ESS it provides in that area.
This work provides a first geographical representation of the ESS provision, obtained by overlaying maps of potential ESS supply and demand, and by defining the spatial linkages between them. The supply-side mapping is based on the potential spatial distribution predicted by a P. oceanica Species Distribution Model developed for the Mediterranean sea. The demand-side mapping encompasses a variety of aspects, i.e. human activities and environmental characteristics that define the demand for each ESS. This mapping is done by integrating a qualitative coastal vulnerability model (InVEST), an estimation of the main fishing grounds, based on qualitative modelling which takes into consideration the major ports, and information about touristic activities, marine protected areas and urban areas.
The resulting ESS spatial distribution could be useful to better understand how different human activities are linked, directly or indirectly, with the presence and functioning of P. oceanica beds. This highlights the importance of implementing monitoring activities and management actions aimed at protecting the existing beds, and thus their ESS, from further deterioration.

Hazardous wrecks and meteorological monitoring systems : its impact on navigation and marine safety in West Africa

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Key words: Wreck, Coastal area, , Meteorology, Coastal degrada, Navigation

The high rate of abandoned shipwrecks all over the country's coastal waters has become a major source of headache to both the government and Nigerians, especially regionally in Africa (West Africa). The attempt in this study is however to highlight and examine the role of hazardous wrecks and the meteorological monitoring systems along the coastline of West Africa, Nigeria in particular is discussed. Also considered has been given to the factors affecting developments in the maritime transports by ships, vessels etc by hazardous wrecks and its impacts on navigation and marine safety.
The paper conclude by drawing the attention and stimulation of the private sector, urged the relevant stakeholders to expedite action on plans to remove the vessels, causing navigational hazards to other vessels entering the ports, just as it might trigger flooding of the nation's shorelines. Also developing the markets for viable maritime activities, obtaining the necessary finance for viable maritime technologies in the African continental coastlines.

Interplay between prey refuge and allee effect in predator-prey interaction

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Key words: Stability, Limit Cycle, Hopfbifurcation, Heteroclinic, Transcritical

Foraging efficiency of predator largely varies with the refuge strategy of prey population. There also exists a positive correlation between population density and the per capita growth rate of population, popularly known as Allee effect. In this study, we propose and study a predator-prey system in presence of prey refuge and Allee effect. The objective is to establish the interrelationship between prey refuge intensity and Allee effect. The system exhibits different realistic dynamics observed in natural prey-predator system viz. extinction of both species, only predator extinction, stable coexistence and coexistence in oscillatory state. Applying Sotomayer's Theorem, we show that the system experiences Hopf and transcritical bifurcations for different strength of prey refuge. Numerical computation is also performed to visualize different theoretical results.

Treatment and reuse wastewater of sale city in irrigation horse bean

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Key words: Wastewater, irrigation, biological

In Morocco, arid to semi-arid climate, agriculture consumes more than 80% of water resources exploited. To fill the water deficit, the use of treated wastewater for irrigation in agriculture is particularly useful and beneficial. However, continuous irrigation and uncontrolled by raw sewage causes several adverse impacts on the environment and on human health.
This study is to track the performance of the use of raw wastewater and biologically treated and well water as a witness on the culture of the bean.
The results show that irrigation with raw wastewater and biologically treated has positive effects on the crop yield of the bean. In fact, monitoring the size and number of stems per plant leaves knows a significant increase in time. We find that plants irrigated by well water (50 ± 11 cm) have a very large thickness compared to irrigate by raw sewage (37 ± 8cm) plants and biologically treated water (46 ± 4cm). However, the average number of sheets per irrigated been treated wastewater (105 ± 32) is larger than those irrigated by raw waste water (38 ± 8) and well water (87 ± 10) during the two month follow-up . On the other hand , leaf length Bon irrigated by raw waste water (5cm) is large compared to that of the biologically treated waste water (4.6 cm) and the water well (3.7 cm) which confirms the bioavailability of nutrients due to the biodegradation of organic matter by bacteria in such treatment.

Observation And Study Of Landslide At The Motorway Between Tangier and Ouer R'mel.

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Key words: landslide, stabilization, risk, modeling

The section of Highway Tangiers Oued Rmel has known since the early work, instability and landslides caused by several parameters related to hydrogeological and geotechnical geological context of formations encountered.
Landslides that we observed remains poorly explained, despite of existing studies on this section.
The target of this study is to identify new ways to explain the phenomenon responsible of landslides, taking into account the geological context geotechnical and hydro-geological. This analysis will be enhanced by a synthesis of previous studies and the processing of data obtained from in situ geotechnical investigations. These studies will be complemented by a digital processing using Plaxis software (finite element) for better visualization problems encountered landslides in this region, and the solutions for the stabilization of these shifts.

Contribution a l'étude de la flore bactrienne des poissons destinés à la consommation au Maroc

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Keywords: Fish; Quality fish; Bacterial flora.

Fish is an important source of animal protein. It is characterized by a very high species diversity and heterogeneity of indigenous microflora, the composition is essentially linked to the origin of the fish and their environment.
In order to assess the microbiological quality of fish, microbiological study of 40 samples representing in all four fish species: sardine (Sardina pilchardus), Sole (Solea vulgaris), mackerel (Scomber scombrus), horse mackerel (Trachurus trachurus) collected from different outlets Casablanca.
We identified the bacterial flora and classified germs isolated in fresh fish for consumption. In this case the description of 23 bacterial strains belonging to the families Enterobacteriaceae "E. coli, Citrobacter Braakii, Cloaceae Enterobacter, Serratia fonticola, Raoutella terrigena".
These results suggest that efforts should be pursued to improve the microbiological quality of fish.

Preparation and electrical properties of zinc oxide layers.

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Key words: Oxide detection

The presence of a foreign element on the surface of a semiconductor material may be indicated by an adsorption which can lead to a change in the surface electric conduction. This property is closely related to the nature and conditions of preparation and treatment of the material. We have elaborated the ZnO oxide layers by the vacuum evaporation technique of zinc layers on different substrates and then made their thermal oxidation in oxygen at 450°C.
The adsorption and desorption of oxygen at different temperature, create significant variations in the electrical resistance R of the sample. The isotherm desorption made at the same temperatures show that the adsorption layer can be regenerated but for relatively long periods. In case of failure, the samples are subjected to temperature programmed desorption by scanning the temperature at relatively low speed of 3°C/mn.

Simulation of the nutrient uptake for four primary producers in the bay of Calvi (Corsica, France).

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Key words: model, nutrient, primary produce

The objective of this model is to simulate the nitrogen incorporation of (gN m-2) for four primary producer of the bay of Calvi (Corsica, France) (phytoplankton, macro-algae, the Posidonia Oceanica leaves and their epiphyte). The effect of the intensity of the light, the temperature and the concentration in internal and external nitrogen on these incorporations is modeled. The model was able to respect the relative importance of the incorporations of the various producers. The incorporations of NO3 and NH4 by the phytoplankton are more important than those of the benthic producers. The macro-algae incorporations present an intermediate values between the phytoplankton one, the P. oceanica leaves and their epiphyte. The incorporations of NH4 by the phytoplankton are higher than the incorporations of NO3.

Modelling the nitrogen uptake of the seagrass Posidonia oceanica

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Keywords: Seagrass, P. oceanica, Uptake model, Light, Nitrogen

One of the general purposes of this paper is to get a better understanding of the factors influencing nitrogen cycling (uptake kinetics) for the P. oceanica in the Mediterranean Sea. The specific objective of this paper is to present a compartmented ecological model to investigate the P. oceanica nutrient uptake and its partitioning between leaves and roots in the Bay of Calvi (Corsica, France). Furthermore to test this model in relation to different scenarios of nutrient and light availability. The results showed that ammonium is a more important nitrogen source than nitrate for the entire plant. The model demonstrated that the plant roots are slightly more important than the leaves in the overall nitrogen acquisition (57% and 43% respectively), in most light and nitrogen conditions encountered in the Bay of Calvi and that the minimum light requirement of P. oceanica growth is at 15.7% of surface irradiance.

Caracterisation, application of agro-waste for sustainable construction materials.

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Key words: agro-industrial, agro-waste, energy

The rapid urbanisation is creating a shortfall of conventional building construction materials due to limited availability of natural resources. On the other hand energy consumed for the production of conventional building construction materials pollutes air, water and land. In order to meet the ever increasing demand for the energy efficient building construction materials there is a need to adopt cost effective, environmentally appropriate technologies and upgrade traditional

techniques with available local materials. Agro-industrial and other solid waste disposal is another serious issue of concern in developing countries. The present paper explores the potential application of agro-waste as the ingredient for alternate sustainable construction materials. Based on the availability of agro-waste materials, sustainable construction materials are evaluated for their physico-mechanical properties, methods of production and environmental impact. The application of agro-waste for sustainable construction materials provides a solution which offers reduction in natural resource use as well as energy.

Evaluation of energy expenditure by free-ranging Northern Bald Ibises (Geronticus eremita) in Southwest Morocco, using time-energy budget analysis and allometric models.

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Key words: Time-activity, Energy budget, Allometry, modelling, Endangered, Bald Ibis

The Northern Bald Ibis is the most threatened bird species in all of Europe, North Africa and Middle East. It is a critically endangered bird species (IUCN, 2012). Almost all of the world’s population subsists only in two main colonies on the Atlantic coastal band of Southwest Morocco, the Souss-Massa National Park and Tamri. Although numbers of nests at Tamri have increased during the last years, breeding success (mean fledged young per pair) has been consistently lower than in the Souss-Massa National Park. This could result in differences in the energy required during the nesting period among the two areas. The use of modeling appears as an excellent option allowing energetic studies as field data collection in such a highly vulnerable species is challenging. Among the most appropriate energetic models commonly used in endothermic animals, are time–energy-budget analyses and empirical allometric equations. We compared the practicability and the accuracy of these two methods to determine energy requirements of the Northern Bald Ibis colony at Tamri. The daily energy expenditure of Northern Bald Ibis was estimated from the time-activity budget and multiples of metabolic rates predicted by specific body mass based allometric equations. The Northern Bald Ibis (mean adult body mass of 1200 g) at Tamri required 747 kJ/bird/day which is 30% lower than the Field Metabolic Rate (FMR) predicted from the allometric equation for non-passerine birds of similar body mass. Lower limit to energy requirements during growth were estimated by Kirkwood’s model.
The total energy required by the nesting colony during the breeding season was evaluated and compared to the food availability within the foraging areas. Empirical measurements, using the Doubly-labeled water (DLW) method, should be carried out to test for the accuracy of these modeling approches in predicting actual daily energy expenditures by free-ranging Northern Bald Ibises.

Modelling ocean-lagoon interactions in a sub-tropical coastal lagoon affected by upwelling

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Keywords: 2-D coupled physical-biogeochemical model, coastal upwelling, San Quintin Bay

Coastal regions affected by wind-driven upwelling are among the most productive areas of the world. Even if they cover only 5% of the global ocean surface, they provide about 25% of the total catch of marine fish. Given the high ecological and economic value of these systems, understanding the phenomena that govern their dynamics is of crucial importance and needs specific studies, in order to resolve the processes at scales of interest for a suitable ecological and economic management.
In the present study, we illustrate the results of the numerical modelling of the San Quintin Bay (SQB), paying special attention to the effects of the upwelling conditions on the biogeochemical dynamics of the basin. SQB is a Mediterranean-type coastal lagoon, in the Pacific coast of northern Baja California (30.45˚N, 116.00˚W), Mexico, covering an area of ~42 km2 with an average depth of 2 m. SQB ecology is strongly influenced by the presence of extensive meadows of the eelgrass Zostera marina and large mats of Ulva spp.. The Pacific oyster Crassostrea gigas has also been cultivated commercially in the western arm of the lagoon. The main external physical and biogeochemical forcing in SQB originates from the neighbouring coastal ocean, which is strongly influenced by upwelling. The frequency of the upwelling pulses and tidal exchanges control the temporal variability of primary production and nutrients near the mouth of the bay. To investigate these processes, we used a 2-D coupled hydrodynamic-biogeochemical model forced by tides, wind stress and heat fluxes. The hydrodynamic model has been compared with experimental data of current velocity, temperature and salinity, while the biogeochemical model has been compared with experimental data of nitrate, ammonium, phosphate and phytoplankton, collected during May and August 2004, in order to tune the model parameters and to assess its ability to simulate the major biogeochemical dynamics in the lagoon. We suggest that the ability of this ecosystem to assimilate nitrate to through primary production is the result of the advection of newly upwelled waters from the adjacent coastal ocean, which are brought into the lagoon through tidal advection-diffusion processes.

Preparation of plastic films based on biopolymers: cellulose carboxymethyl (CMC) and lignin.

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Key words: biopolymers, films, CMC, Lignin

Over recent years, a number of renewable biopolymers derived from natural resources have been widely studied as biodegradable packaging materials. The improved properties of these polymers for new applications are of high interest in the scientific community, particularly in the development of bio-films. Some films were synthesized based on the starch (Muscatet al., 2013), chitosan (Bostan MS et al . 2014) , alginate (N. Khuathan and T. Pongjanyakul 2014).
The aim of this study is to prepare biofilms from two natural polymers: cellulose as a carboxymethyl, and lignin extracted from the Moroccan bagasse. This compounds mixed in different proportions are dispersed in distilled water and the obtained solution was poured into plastic molds and dried in the ambiant air.
The film properties were then evaluated by physical and chemical characterization. Several proprieties are identified, such as permeability to water vapour, density, moisture content, the transparency, the degree of swelling, morphological texture by scanning electron microscopy, mechanical proprieties and biological proprieties. The obtained results are promising and allow us to enhance our investigations in the field of biodegradable plastics in focusing on the valorization of lignocellulosic compounds, specially the exploitation of the lignin.

Modelling of the relative humidity of 76% in the timber: Unidirectional transfer.

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Key words: humidity, Modelling, timber, transfer

Wood is a material whose role has always been crucial in the history of mankind. The development of technology nowadays allows us to study the physical and chemical properties of wood.
Indeed, the timber is a hygroscopic material. It has the ability to absorb and release moisture naturally and achieve a state that corresponds to equilibrium with its surroundings. When the relative humidity reaches 100%, the water content in the wood in equilibrium with the outside corresponds to the saturation of the active sites capable of absorbing water (FSP or Fiber Saturation Point).This is associated with the FSP concentration on the order of 20% to 30% depending on the nature of the wood and the temperature, and decreases when the temperature is high.
The method used is a coupling between the experimental and theoretical study of the way of the absorption relative humidity equal to 76% by the timber at a constant temperature of 20 ° C in order to determine the parameters that govern the process. This part is based on two additional steps: collecting experimental data and analysis of these data. We then compare the numerical results obtained by mathematical models with the experimental results.

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