Ghent University
Belgium

ISEI 7

7th International Conference on
Ecological Informatics

13 – 16 December 2010
Ghent, Belgium

UNIVERSITEIT GENT

Faculty of Bioscience Engineering

In cooperation with

B-IWA

Belgian Committee
of the International Water Association

Centre for Environmental Sanitation

Seventh International Conference on Ecological Informatics:

Unravelling Complexity and Supporting Sustainability

13-16 December 2010
't Pand Conference Building, Ghent, Belgium

Book of abstracts

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Acknowledgments

First of all, I like to thank the board of Ecological Informatics, and in particular the Editor-in-Chief, Prof. Friedrich Recknagel, to enable the organization at the Ghent University. It was a terrible amount of work, and sometimes this dream was a real nightmare when deadlines of the conference started wrestling with other commitments inherent to the daily lab management, but we are very glad to have received this opportunity to bring people from universities, research institutes, government, agencies, companies, … together to share and discuss new fundamental as applied insights in ecological informatics here in Ghent. In this context, I also like to thank the Belgian Committee of the International association, in their involvement to organize these sessions of the Green Water Week, and in particular I like to make use of the opportunity to thank Mrs. Nicole van Eylen, to always be there for B-IWA and do everything quick, efficient and with care! This conference and B-IWA sessions will for sure lead to a broader dissemination of these new ecological insights and helps to put this in the light of 'sustainability', and in particular, what the roles (services) of ecosystems can be/are/have to be… to support society in the short and long run.

I am in particular pleased and feel honored that five respected keynote speakers share their visions during this conference. Thank you very much Friedrich, Bruce, Saso, Sven and Chon for spending your time and presenting your insights in Ghent during this conference. I was very surprised that –although you are all very busy- the communication went very smooth when I needed information concerning your input in the conference and travelling. I hope you all enjoy the conference and this city.

I am grateful to the different chairs, who played an important role in both setting up the sessions, but also in taking care of the timing of the sessions, as this is of crucial importance to enable people to attend presentations in the different parallel sessions in a convenient manner. In this respect, I am in particular grateful to Paulo and Bert, who did a very great job with their sessions on 'education and training' as well as 'qualitative reasoning'.

This year, also valuable courses are offered. Many thanks to Ans, Matthias, Jan, Sven, Gert, Ine, Javier, Bert and Paulo, for these extra efforts and sharing our expertise both to students as professionals.

Very important are the platform presentations, and we are glad that more than 100 researches on ecological informatics are presented during the different sessions. Thank you very much for your contributions, and we hope to meet you at the ecological informatics conferences in the next years.

Last, but for sure not least, I like to thank my team. Sigrid, you did a really very great job to keep track of the registrations and payments, and your editing work of the abstract book was extremely crucial (and also a hell of a job…). I am also very grateful for your contribution to the development of the badges, and in this context I like to thank also Marianne very much, to always be there when things get difficult and help is needed! You are both great and valuable women for the lab, and are able to combine professionalism with the needed patience to deal with a too busy prof... Another major element in the success of this conference is the contribution of Nancy. Taking care of truckloads of food and drinks for the conference, and planning everything in detail with the needed respect for other people and technical detail, you are the technical guardian angel of the lab. In this context, I am also grateful to Katrien, to support the logistics and serving of the food! Also I like to thank Gert, Ine, Pieter and Koen, very

much, as their high labour force was crucial to deal with the blend and very numerous set of challenges (scientific, technical and social but also 'alcoholical') 'offered' by the organization of this conference… Ine, very nice bags you have chosen! I also like to thank everybody who presents one or more of his research results, in particular the new students, as this is for sure a very stressing moment. Thank you Pieter, Rob, Gert, Javier, Koen, Ans, Ine, Phuong, Seid, Katrien, Viet Anh, Yensy and Steffie, you do a great job! To conclude, Pieter, I am very curious how exotic your world cocktails will be… and I am sure I am not alone in this respect…

Peter Goethals
Ghent, 9 December 2010

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Introduction

After a series of successful conferences in France, Australia, Italy, Korea, United States and Mexico, the 7th edition of the Ecological Informatics conferences is organized in Belgium. The theme of this edition is 'Unravelling complexity and supporting sustainability', highlighting the two major pillars of ecological informatics. Ecological informatics has been contributing to the analysis of the complexity of nature and the functioning of ecosystems both at small as large scale.

Nowadays, management of databases, data mining and visualisation, GIS and remote sensing, model development and integration, as well decision-support systems have become crucial in the sustainable management of ecosystems and the environment in general. Many applications in biodiversity assessment, river management, climate studies, ... are based on the integration of insights and instruments from ecological informatics. Both these theoretical developments as applications in the field of ecological informatics will be presented during this conference edition, during which also education and training in ecological informatics is highlighted during the conference sessions as well as several courses.

We are pleased with the numerous and diverse set of presentations and are grateful to the participants in making this edition again to a success by delivering and sharing new insights to the field of ecological informatics. We hope you enjoy your time in Ghent during the conference, but also in the evenings in some of the many cosy restaurants and pubs.

Peter Goethals
on behalf of the organizers

Sessions' overview

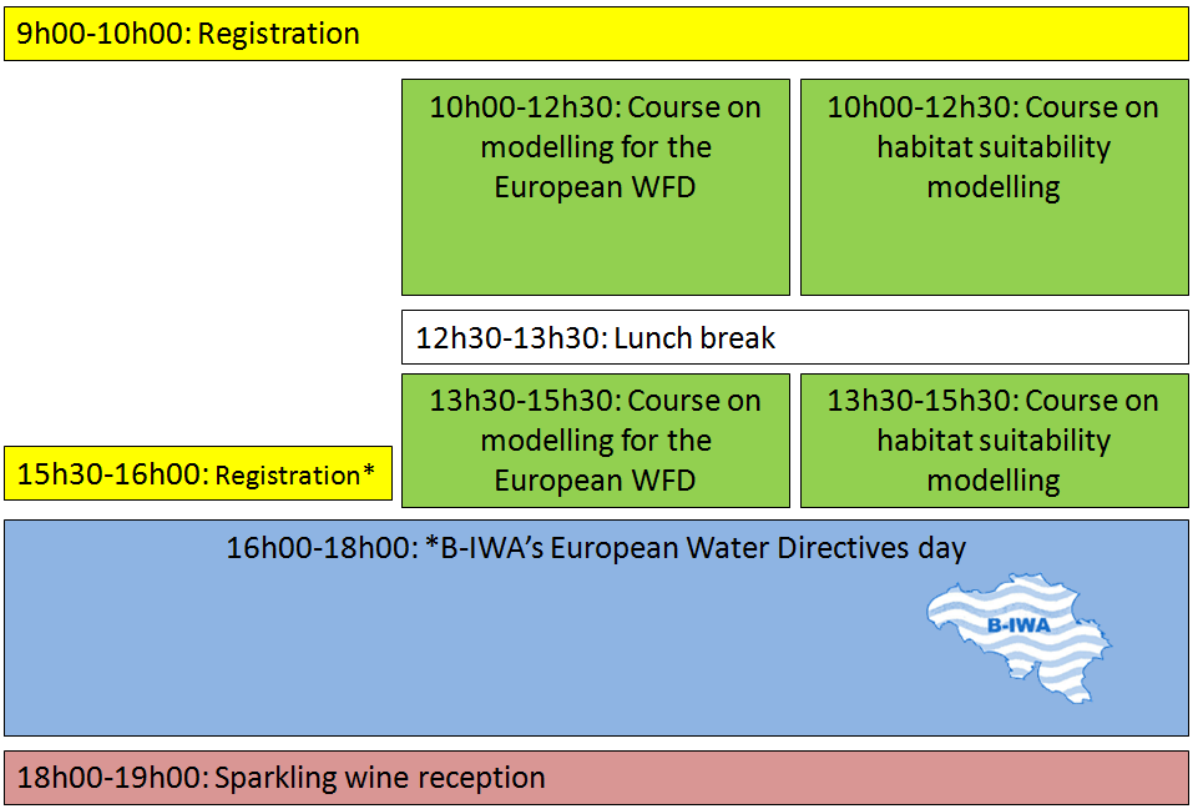
Monday, 13 December 2010

09h00-10h00: Registration

10h00-12h30: Course on modelling for the European Water Framework Directive **(Vermeylen)**
10h00-12h30: Course on habitat suitability modeling **(Prior)**

13h30-15h30: Course on modelling for the European Water Framework Directive **(Vermeylen)**
13h30-15h30: Course on habitat suitability modeling **(Prior)**
15h30-16h00: Registration (B-IWA's European Water Directive Day)
16h00-18h00: B-IWA's European Water Directive Day **(Vermeylen)**

18h00-19h00: Sparkling wine reception



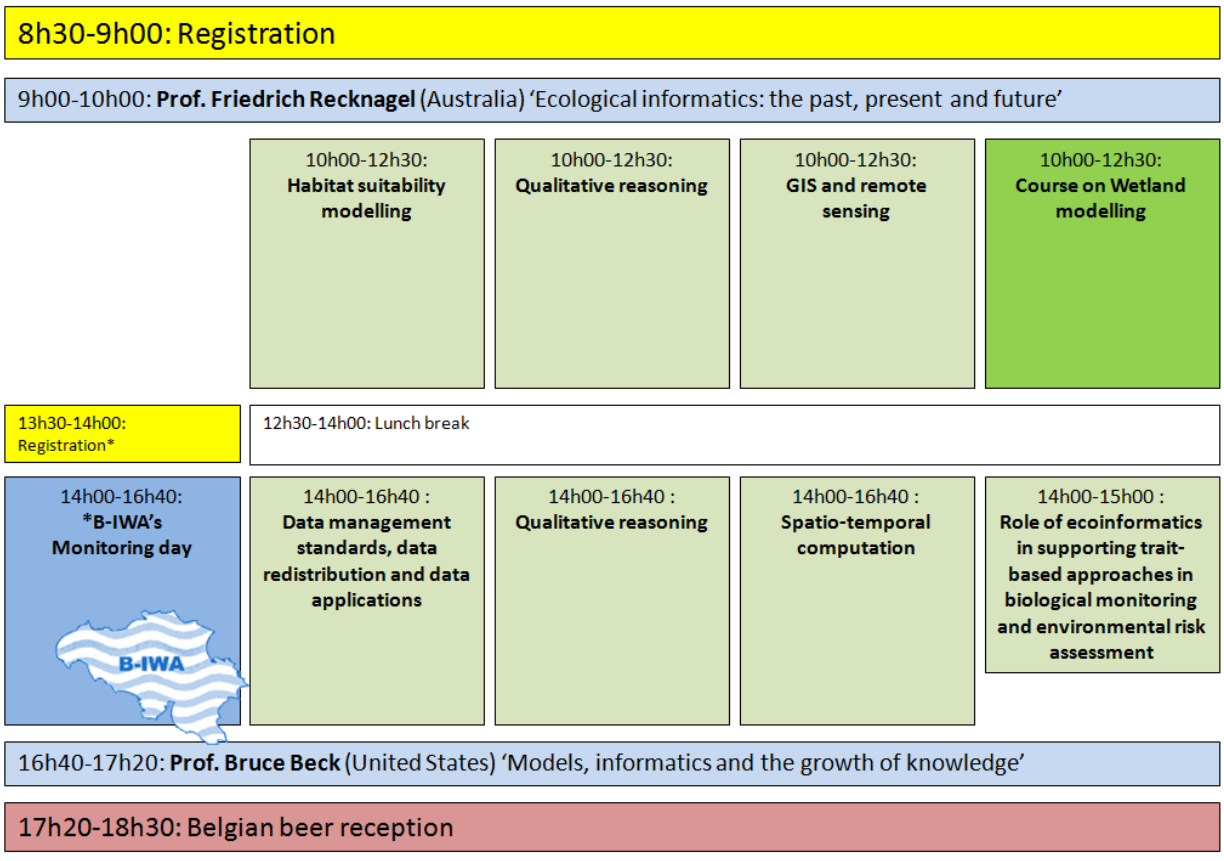
Tuesday, 14 December 2010

08h30-09h00: registration

09h00-10h00: Keynote session: 'Ecological informatics: the past, present and future' **(Vermeylen)**
10h00-12h30: Habitat suitability modeling **(Oude Infirmerie)**
10h00-12h30: Qualitative reasoning **(Blancquaert)**
10h00-12h30: GIS and remote sensing **(Gillis)**
10h00-12h30: Course on wetland modelling **(Prior)**

13h30-14h00: Registration (B-IWA's Monitoring Day)
14h00-16h40: B-IWA's Monitoring Day **(Vermeylen)**
14h00-16h40: Data management standards, data redistribution and data applications **(Oude Infirmerie)**
14h00-16h40: Qualitative reasoning **(Blancquaert)**
14h00-16h40: Spatio-temporal computation **(Gillis)**
14h00-15h00: Role of ecoinformatics in supporting trait-based approaches in biological monitoring and environmental risk assessment **(Prior)**
16h40-17h20: Keynote session: 'Models, informatics and the growth of knowledge' **(Vermeylen)**

17h20-18h30: Belgian beer reception



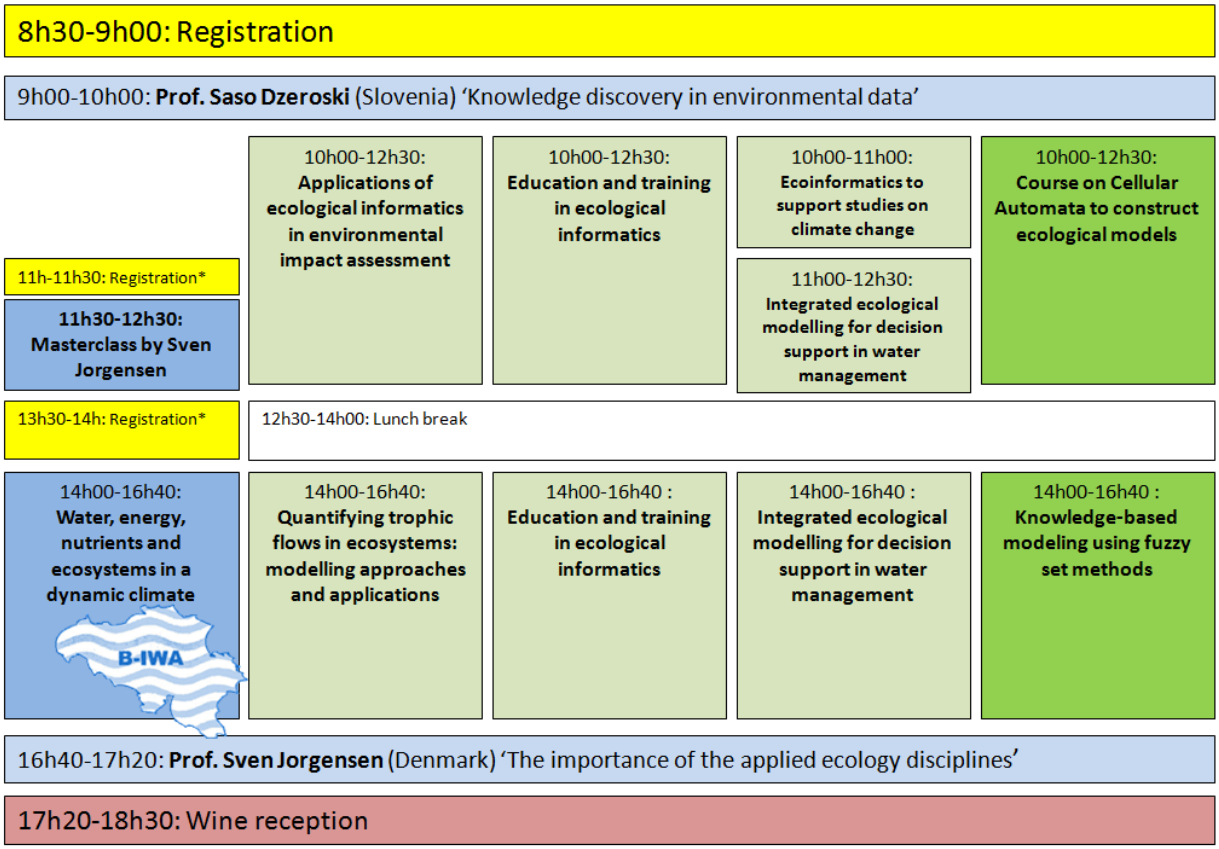
Wednesday, 15 December 2010

08h30-09h00: registration

09h00-10h00: Keynote session: 'Knowledge discovery in environmental data' **(Vermeylen)**
10h00-12h30: Applications of ecological informatics in environmental impact assessment **(Oude Infirmerie)**
10h00-12h30: Education and training in ecological informatics **(Persconferentie Room)**
10h00-11h00: Ecoinformatics to support studies on climate change **(Gillis)**
10h00-12h30: Course on Cellular Automata to construct ecological models **(Prior)**
11h00-12h30: Integrated ecological modelling for decision support in water management **(Gillis)**
11h00-11h30: Registration (masterclass by Sven Erik Jorgensen)
11h30-12h30: Masterclass by Sven Erik Jorgensen **(Vermeylen)**

13h30-14h00: Registration (B-IWA 'Water, energy, nutrients and ecosystems in a dynamic climate')
14h00-16h40: B-IWA session on 'Water, energy, nutrients and ecosystems in a dynamic climate' **(Vermeylen)**
14h00-16h40: Quantifying trophic flows in ecosystems: modelling approaches and applications **(Oude Infirmerie)**
14h00-16h40: Education and training in ecological informatics **(Persconferentie Room)**
14h00-16h40: Integrated ecological modelling for decision support in water management **(Gillis)**
14h00-16h40: Knowledge-based modelling using fuzzy set methods **(Prior)**
16h40-17h20: Keynote session: 'The importance of the applied ecology disciplines' **(Vermeylen)**

17h20-18h30: Wine reception



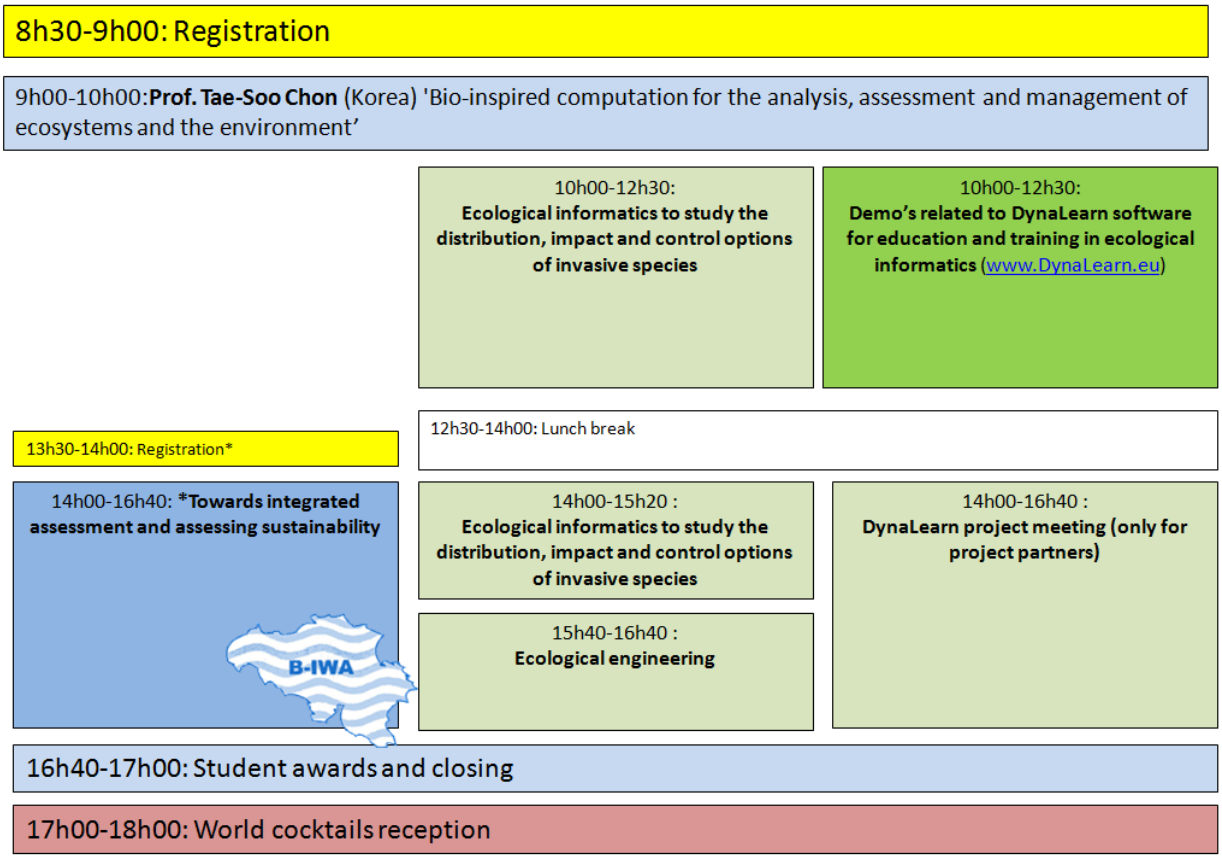
Thursday, 16 December 2010

08h30-09h00: registration

09h00-10h00: Keynote session: 'Bio-inspired computation for the analysis, assessment and management of ecosystems and the environment' **(Vermeylen)**
10h00-12h30: Ecological informatics to study the distribution, impact and control options of invasive species **(Oude Infirmerie)**
10h00-12h30: Demo's related to DynaLearn software for education and training in ecological informatics **(Prior)**

13h30-14h00: Registration (B-IWA 'Towards integrated assessment and assessing sustainability')
14h00-16h40: B-IWA session on 'Towards integrated assessment and assessing sustainability' **(Vermeylen)**
14h00-16h40: DynaLearn project meeting (only for project partners) **(Prior)**
14h00-15h20: Ecological informatics to study the distribution, impact and control options of invasive species **(Oude Infirmerie)**
15h40-16h40: Ecological Engineering **(Oude Infirmerie)**
16h40-17h00: Student awards and closing **(Vermeylen)**

17h00-18h00: World cocktails reception



Location of the rooms in ‘t Pand conference building

Address and how to get there

Onderbergen 1, B-9000 Gent (Belgium)
tel. 0032 9 264 82 62
fax 0032 9 264 83 96
email: pand@UGent.be

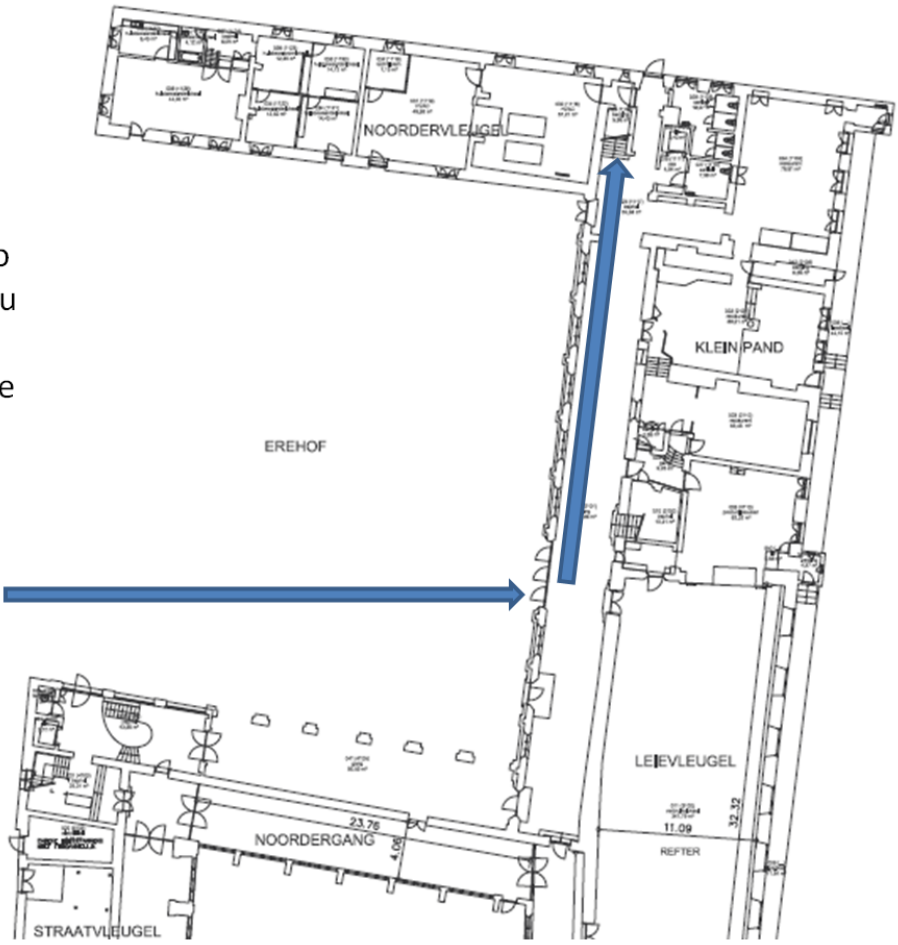
How to get there:
Due to traffic works, it is best to take a taxi from the train station (conference center is about 4km from Gent Sint-Pieters train station, and costing about 10-15 EUR)

For people coming by car:
A car park is available in front of the conference building

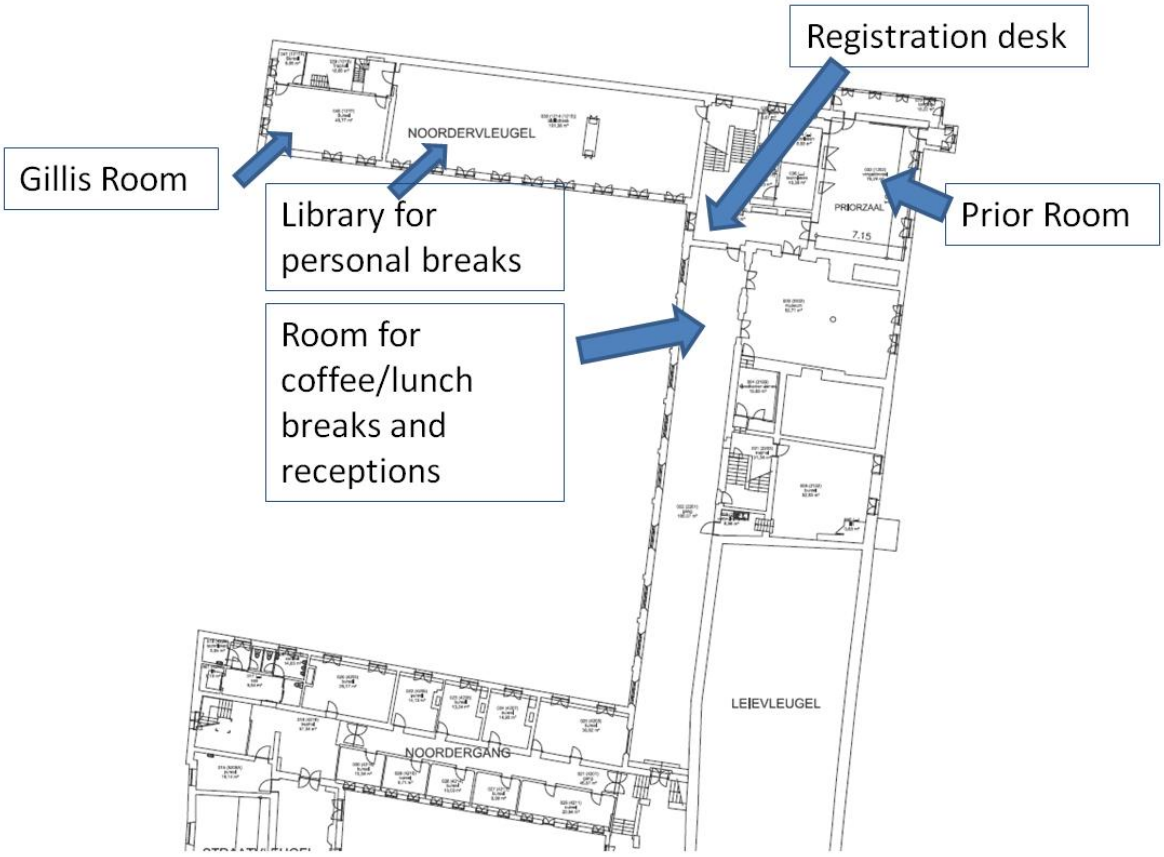
Ground level

By entering via the garden, go to the left when you entered the building. Take the stairs to the first floor

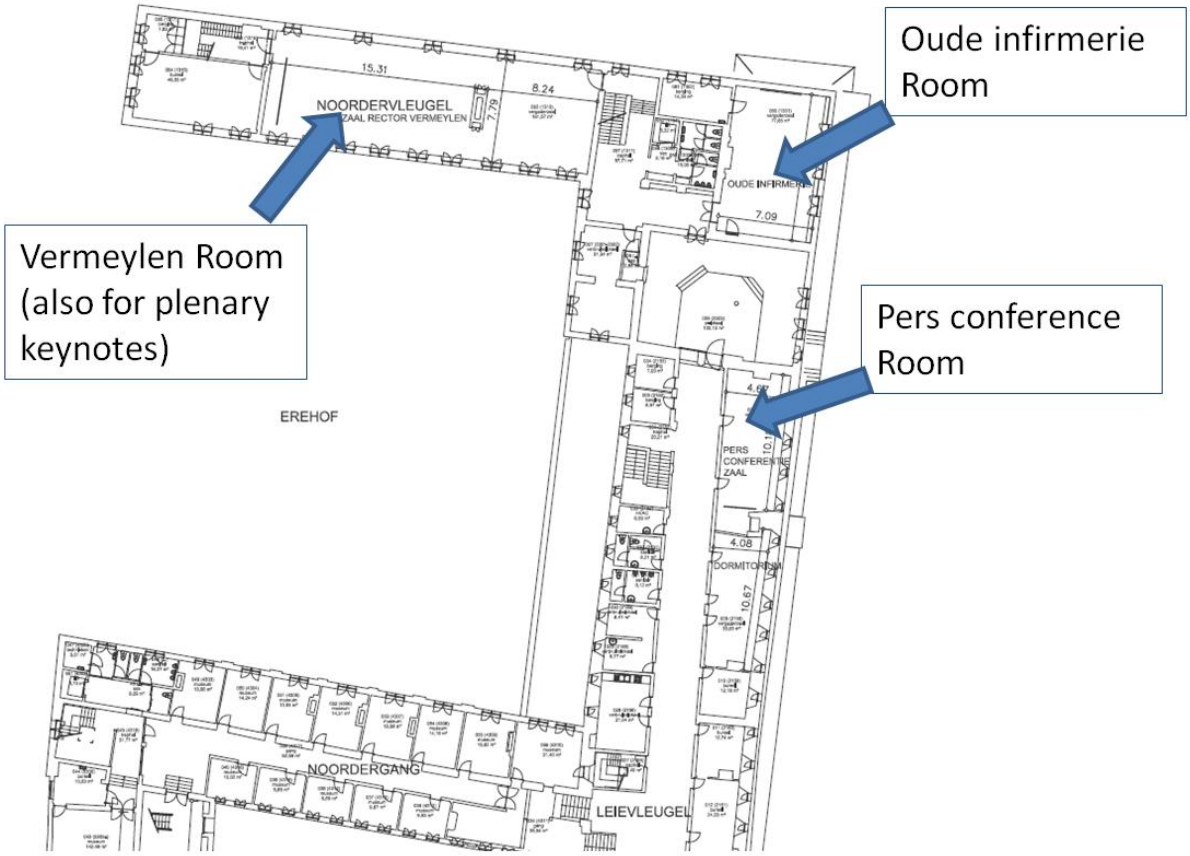
Entrance



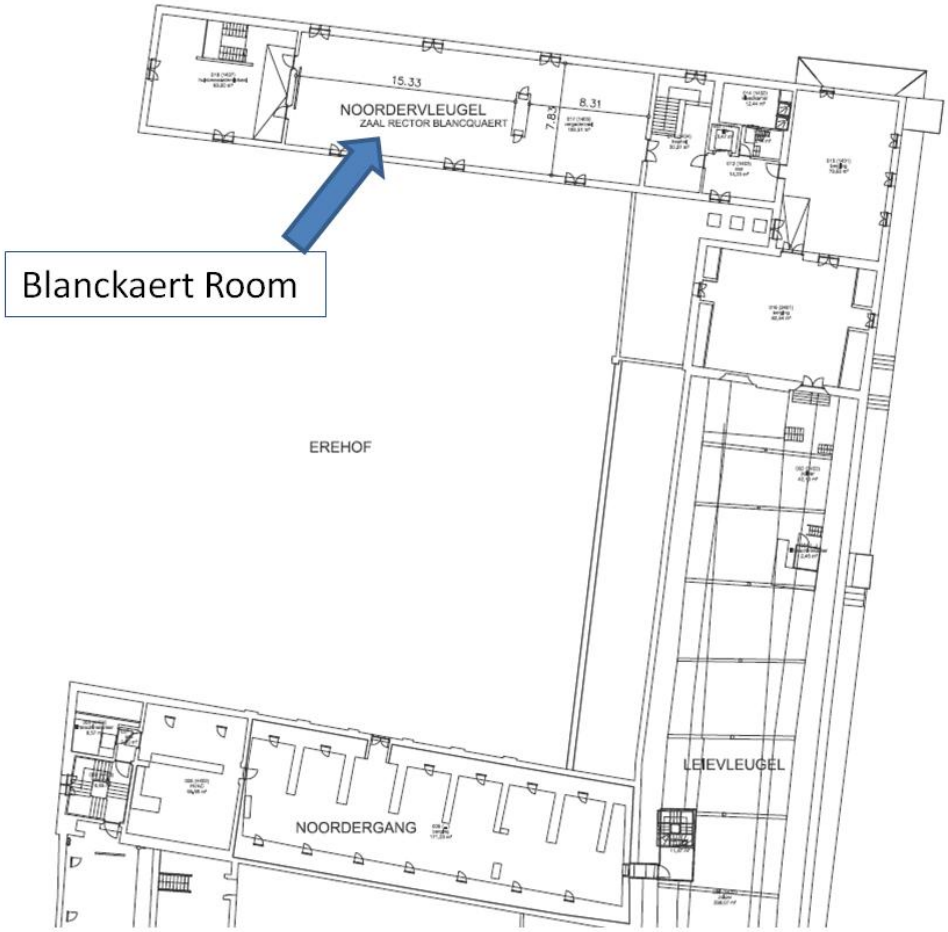
First floor (for registration and breaks)



Second floor



Third floor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ZAAL RECTOR BLANCQUAERT
8.31
7.83
Blanckaert Room
EREHOF
NOORDERGANG
LEIEVLEUGEL

WiFi use in the conference building

Make a wireless connection with "UGentGuest". If you have set up to request an IP address automatically, you will receive an IP address starting with 193.190.8x.

Now you are connected, but not yet authenticated. You should start a webbrowser and you will be redirected to a logon screen. Enter the username and password:

Username : guestPeterg
Password : xQtuThuE

After correct authentication you can use the Internet connection.

Your connection to this wireless LAN is not encrypted. To protect your personal data, please use encrypted connections like https, imaps, ssh etc. or a VPN client.

You're not allowed to pass on the login information to others.

Detailed session programme

Keynotes (in Vermeylen Room)

Prof. Friedrich Recknagel (Australia) 'Ecological informatics: the past, present and future' (Tuesday 14 December 2010, 9h15-9h55)

Prof. Bruce Beck (United States) 'Models, informatics and the growth of knowledge' (Tuesday 14 December 2010, 16h40-17h15)

Prof. Saso Dzeroski (Slovenia) 'Knowledge discovery in environmental data' (Wednesday 15 December 2010, 9h15-9h55)

Prof. Sven Jorgensen (Denmark) 'The bridge between ecology and environmental management' (Wednesday 15 December 2010, 16h40-17h15)

Prof. Tae-Soo Chon (Korea) Bio-inspired computation for the analysis, assessment and management of ecosystems and environment: Self-organizing map application from molecules to ecosystems' (Thursday 16 December 2010, 9h15-9h55)

Monday, 13 December 2010

B-IWA's European Water Directives Day

P. Goethals (Gent, Belgium)

Vermeylen Room

16h00-16h10 EU 1:	'Introduction of the European Water Directives day' *P. Goethals*
16h10-16h40 EU 2:	'Setting the scene on the European water related directives' *D. Krol*
16h40-17h00 EU 3:	'The European water framework directive: biomonitoring methods, methods for artificial and strongly modified water bodies and intercalibration' *W. Gabriels, G. Verhaegen & H. Maeckelberghe*
17h00-17h20 EU 4:	'Assessing risk of chemicals according to REACH: an industrial perspective' *F. Verdonck & P. Van Sprang*
17h20-17h50 EU 5:	'Practical implementation and integration of European water directives in Flanders: overview and challenges ' *H. Maeckelberghe*
17h50-18h00 EU 6:	'General discussion and conclusions' *P. Goethals*

Tuesday, 14 December 2010

Habitat suitability modelling

M. Schneider (Germany) and A. Mouton (Belgium)

Oude Infirmerie Room

10h00-10h40 HSM 1:	Session keynote 'Development, optimisation and application of habitat suitability models' *A. Mouton, J. Coeck, B. De Baets & P. Goethals*
10h40-11h00 HSM 2:	'Classification and regression trees for habitat analysis of macroinvertebrate taxa in the natural wetlands of south-western Ethiopia' *S. Tiku, A. Ambelu Bayih, P. Boets, L. De Meester & P. Goethals*
11h30-11h50 HSM 3:	'Habitat suitability modelling for mayflies (Ephemeroptera) in Flanders (Belgium)' *K. Lock & P. Goethals*
11h50-12h10 HSM 4:	'New approach for habitat simulation of hydropeaking effects' *M. Schneider & I. Kopecki*
12h10-12h30 HSM 5:	'Comparison of data mining methods for Pike (*Esox lucius* L.) habitat suitability modelling in rivers' *R. Zarkami, I. Pauwels, G. Everaert, A. Mouton & P. Goethals*

Qualitative reasoning

Prof. B. Bredeweg (The Netherlands)

Blancquaert room

10h00-10h20 QR 1:	Session keynote 'Qualitative reasoning in ecological informatics: setting the scene' *P. Salles (Brazil)*
10h20-10h40 QR 2:	'The use of the DynaLearn learning environment to construct qualitative models of fundamental concepts in ecological sciences' *R. A. A. Noble*
10h40-11h00 QR 3:	'Hypothesis assessment with qualitative reasoning: modelling the intermittent Fontestorbes fountain' *K. Kansou & B. Bredeweg*
11h30-11h50 QR 4:	'What is needed to create a low carbon society? A qualitative reasoning approach to modeling the role of biofuels and the carbon market' *A. Souza, G.F.M. Leite & P. Salles*
11h50-12h10 QR 5:	'Integrating direct and indirect ecological impacts of cooling water on surface waters based on qualitative models' *P. Goethals & K. Töpke*
12h10-12h30 QR 6:	'Understanding and predicting time-lags in the response of birds to agricultural intensification using qualitative models' *F. Goulart, P. Salles & C. H. Saito*
14h00-14h20 QR 7:	'A Qualitative Model of Diving Pressure in Coral Reefs' *R. Barankin, L. Yosef, D. Zurel, M. Leiba, H. Benayahu, D. Mioduser & R. Zuzovsky*
14h20-14h40 QR 8:	'Construction of a qualitative foodweb based dynamic habitat suitability model to describe pike populations in rivers' *S. Van Nieuland, I. Pauwels, A. Mouton & P. Goethals*
14h40-15h00 QR 9:	'How agricultural matrix intensification may affect understory passerines that inhabit forest patches?' *F. Goulart, P. Salles & R. Bomfim Machado*
15h00-15h20 QR 10:	'Qualitative Models of Global Warming Amplifiers' *U. Milosovic & B. Bredeweg*
15h40-16h00 QR 11:	'Using qualitative reasoning to model life cycle assessment of wind energy' *A. Souza & P. Salles*

16h00-16h20 QR 12: 'Bird communities in the transition Amazon – Cerrado, Brazil: a qualitative model to predict the richness of trophic guilds according to the structure of vegetation' *R. de Souza Yabe, P. Salles & G.F.M. Leite*
16h20-16h40 QR 13: 'Qualitative models about metapopulation dynamics' *I. Gontijo de Sá & P. Salles*

GIS and remote sensing
G. Foody (Nottingham, UK)

Gillis Room

10h00-10h40 GIS 1: Session keynote 'GIS and remote sensing in ecological informatics: trends and applications' *G. Foody (UK)*
10h40-11h00 GIS 2: 'Use of GIS and RS in the development of a Policy Support System for the Oum Zessar river basin' *H. Van Delden*
11h30-11h50 GIS 3: 'Crossing utopia: estimating species diversity by remote sensing spectral heterogeneity' *D. Rocchini, N. Balkenhol, G.A. Carter, G.M. Foody, T.W. Gillespie, K.S. He, S. Kark, N. Levin, K. Lucas, M. Luoto, H. Nagendra, J. Oldeland, C. Ricotta, J. Southworth & M. Neteler*
11h50-12h10 GIS 4: 'Remote sensing for niche-based epidemiological modelling' *J. Peters, J. Van doninck, E. Ducheyne, E. De Clercq, B. De Baets & N.E.C. Verhoest*
12h10-12h30 GIS 5: 'Beyond classification? Mapping floristic patterns of ecotones in a heterogeneous landscape' *H. Feilhauer, U. Faude & S. Schmidtlein*

B-IWA's Monitoring Day
I. Nopens (Gent, Belgium)

Vermeylen Room

14h00-14h20 MO 1: 'New water monitoring techniques: opportunities in water management and challenges for data (quantity and quality) management and use' *P. Goethals*
14h20-14h40 MO 2: 'Prototype early warning system for cyanobacteria blooms in warm-monomictic eutrophic lakes in Queensland' *H. Zhang, H. Cao, F. Recknagel & J. Udy*
14h40-15h00 MO 3: 'Safety and Quality of Water Resources: Vision of a Specialist Manufacturer of On-line Sensors' *E. Coolsaet & D. Laurier*
15h00-15h20 MO 4: 'Impact of air flow rate and frequency of influent data on full-scale dynamic model calibration' *I. Nopens, S. Plano, K. Cierkens, L. Benedetti, A. van Nieuwenhuijzen & S. Weijers*
15h20-15h40: Break
15h40-16h00 MO 5: 'Telemetry techniques to study fish migration and habitat use' *D. Buysse, A. Mouton, M. Stevens, T. Van den Neucker, H. Verbiest & J. Coeck*
16h00-16h20 MO 6: 'Influence of alien macroinvertebrates on species assemblages and ecological water quality assessment in Flanders (Belgium)' *P. Boets, K. Lock & P.L.M. Goethals*
16h20-16h40 MO 7: The use of passive sampling in integrated risk assessment of micropollutants' *M. Claessens (Ecotoxicology – UGent), E. Monteyne, P. Roose & C.R. Janssen*

Data management standards, data redistribution and data applications
F. Hernandez (Belgium) and K. Deneudt (Belgium)

Oude Infirmerie Room

14h00-14h40 DAT 1: Session keynote 'Terms and concepts of ecological data management in a marine context' *F. Hernandez*
14h40-15h00 DAT 2: 'Standards in marine biodiversity data: benefits and applications' *S. Claus*
15h00-15h20 DAT 3: 'How the integration of marine ecological data from different sources can create added value to data and science' *L. Vandepitte*
15h40-16h00 DAT 4: 'Estimating missing data in stream flow time series' *M. Arias-Hidalgo, G. Villa-Cox & A. E. Mynett*
16h00-16h20 DAT 5: 'Validating ecological regions in European seas based on the European Ocean Biogeographic Information System (EurOBIS)' *K. Deneudt*
16h20-16h40 DAT 6: 'When is a habitat suitability model a reliable model? Randomization techniques in habitat suitability modelling' *B. Merckx, M. Steyaert, A. Vanreusel, M. Vincx & J. Vanaverbeke*

Spatio-temporal computation
Q. Chen (Beijing, China)

Gillis Room

14h00-14h20 ST 1: 'Spatio-temporal ecological modelling' *Q. Chen, R. Han & F. Ye*
14h40-15h20 ST 2: 'Applications of spatial-temporal modelling methods for decision-support in environmental management' *H. Van Delden*
15h40-16h00 ST 3: 'Spatial-explicit dynamic habitat modelling of pike (*Esox Lucius* L.) in rivers' *I. Pauwels, A. Mouton, J.M. Baetens, B. De Baets & P. Goethals*
16h00-16h20 ST 4: 'Study on the parameter uncertainty of a catchment water quality model through Monte-Carlo fuzzy α-Cut approach' *Q. Chen & Y. Wu*
16h20-16h40 ST 5: 'A discrete, spatially explicit and GIS-coupled model for epidemic spread' *J.M. Baetens & B. De Baets*

Role of ecoinformatics in supporting trait-based approaches in biological monitoring and environmental risk assessment
Dr. K. Lock (Belgium)

Prior Room

14h00-14h20 T 1: 'PCTs for Hierarchical Classification of Diatom Images' *I. Dimitrovski, D. Kocev, S. Loskovska & S. Džeroski*
14h20-14h40 T 2: 'Relating taxonomy-based traits of macroinvertebrates and sediment pollution by means of statistical analyses on field observations' *K. Töpke, E. Van De Vijver, K. Lock, O. Thas, W. De Cooman, C.R. Janssen & P. Goethals*
14h40-15h00 T 3: 'Application of the Fourth-Corner method to test biological trait-environment hypotheses' *B. Gallardo*

Wednesday, 15 December 2010

Applications of ecological informatics in environmental impact assessment
T.-S. Chon (Korea) and F. Recknagel (Australia)

Oude Infirmerie Room

10h00-10h20 AS 1: 'Computational bioindication of wetland habitat conditions by assemblages of benthic diatoms and macroinvertebrates' *F. Recknagel, H. Cao & S. Wells*

10h20-10h40 AS 2: 'Aquatic macroinvertebrates as bioindicators for the assessment of the quality of the Guayas river basin (Ecuador)' *G. Alvarez, A. van Griensven, M. Arias, P. Goethals & A. Mynett*

10h40-11h00 AS 3: 'Integrated and model-based ecological assessment of the Cauca river (Colombia)' *Y. Paz Cortez, J. Holguin, A. Galvis & P. Goethals*

11h30-11h50 AS 4: 'The devil is in the details: overcoming the challenge of implementing consistent ecosystem indicators for cross-scale ecosystem understanding' *J.W. Karl & D.P.C. Peters*

11h50-12h10 AS 5: 'Computational bioindication of wetland habitat conditions by assemblages of benthic diatoms and macroinvertebrates' *F. Recknagel, H. Cao & S. Wells*

12h10-12h30 AS 6: 'Integrated urban water system modeling of the Drava river (Varazdin, Croatia) for cost-efficient wastewater treatment selection to meet the requirements of the European Water Framework Directive' *J. Holguin, L. Benedetti, Y. Amerlinck, P. Goethals & D. Van der Steede*

Ecoinformatics to support studies on evolution and climate (change)
K. De Schamphelaere (Belgium)

Gillis Room

10h00-10h20 CL 1: 'Does genetic adaptation to chemical pollution prepare natural populations of Daphnia for climate warming?' *K. De Schamphelaere*

10h20-10h40 CL 2: 'Individual based model applied to macro-invertebrate communities in response to climate change' *W.-S. Cho, T. Van Nguyen, S.-H. Park, H.-Y. Kim, T.-S. Chon & Y.-S. Park*

10h40-11h00 CL 3: 'Application of Self-Organizing Maps to Grass Community Patterns in Response to Temperature Change' *Y.-S. Kwon, W.-S. Cho, H.-S. Kim, M.-H. Kim, Y.-E. Na, Y.-S. Park & T.-S. Chon*

Education and training in ecological informatics

P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands)

Persconferentie Room

10h00-10h20 ET 1: Session keynote 'Education and training in ecological informatics' *Bert Bredeweg (The Netherlands)*

10h20-10h40 ET 2: 'Progressive knowledge representations for learning conceptual knowledge of system behaviour' *B. Bredeweg, J. Liem, W. Beek, P. Salles & F. Linnebank*

10h40-11h00 ET 3: 'Design decisions for virtual characters in the DynaLearn Interactive Learning Environment' *R. Bühling, M. Wißner, M. Häring, G. Mehlmann & E. André*

11h30-11h50 ET 4: 'DynaLearn in school: introduction to qualitative reasoning modeling for secondary school teachers' *P. Salles, I. G. Sá, Adriano Souza, L.H. Wilhelms & P. A. Costa e Silva*

11h50-12h10 ET 5: 'Issues and opportunities for learning by conceptual modelling: a pilot case study of the new DynaLearn integrated learning environment' *R. A. A. Noble, P. Salles, D. Mioduser & R. Zuzovsky*

12h10-12h30 ET 6: 'Learning by modeling: an attractive approach to learning environmental systems knowledge for secondary school students' *I. G. Sá, A. Souza, L.H. Wilhelms, P.A. Costa e Silva & P. Salles*

14h00-14h20 ET 7: 'A new curriculum for teaching conceptual systems understanding of river catchments' *A. Zitek, M. Poppe, M. Stelzhammer, A. Jung, M. Zacharias & S. Muhar*

14h20-14h40 ET 8: 'Semantic enrichment of models in DynaLearn learning environment' *E. Lozano, J. Liem , J. Gracia, A. Gómez-Pérez & B. Bredeweg*

14h40-15h00 ET 9: 'Development of ecological assessment models for the European Water Framework Directive: key issues for trainers in datadriven modeling approaches', *G. Everaert, I. Pauwels, P. Boets & P. Goethals*

15h00-15h20 ET 10: 'Habitat suitability modeling for Master of Science students: case of pike modeling in Flanders' *P. Goethals, R. Zarkami, I. Pauwels, P. Boets, K. Lock & A. Mouton*

15h40-16h00 ET 11: 'Learning by qualitative modeling: undergraduate students' conceptual understanding of ecological systems' *R. Zuzovsky, D. Mioduser, Y. Benayahu, D. Zurel, M. Leiba, R. Nachmias & Y. Ram*

16h00-16h20 ET 12: 'First evaluations of the effect of the DynaLearn software on conceptual systems understanding of river catchments' *A. Zitek, M. Poppe, M. Stelzhammer, A. Jung, B. Bredeweg & S. Muhar*

16h20-16h40 ET 13: 'A survey on education and training in ecological informatics' *P. Salles, B. Bredeweg & P. Luiz Pizzigatti Correa*

B-IWA's and IWA-Benelux Young Water Professionals' Masterclass (Vermeylen Room)

11h30-12h30 MAC 1: 'New Possibilities in Ecological Modelling: Structural Dynamic Modelling' *Prof. Sven Jorgensen*

Integrated ecological modelling for decision support in water management
A. van Griensven (The Netherlands), H. Duel (The Netherlands) and P. Goethals (Belgium)

Gillis Room

11h30-12h10 DSS 1:	Session keynote 'Integrated environmental modelling for decision support in water management' *A. van Griensven*
12h10-12h30 DSS 2:	'WFD Explorer: information system to design effective restoration programmes in the context of WFD implementation' *E. Meijers & J. van den Roovaart*
14h00-14h20 DSS 3:	'Toolbox for assessing ecological response to changes in hydromorphology and water quality' *M. van Oorschot & H. Duel*
14h20-14h40 DSS 4:	'Modelling diatom species co-occurrence to assess the importance of biotic relationships, neutral dispersion and meta-community processes in river communities' *M. Bottin, J. Rosebery, D. Alard, S. Lek & M. Coste*
14h40-15h00 DSS 5:	'Integrated modelling of ecological state and biodiversity in lakes in reponse to eutrophication and climate change' *J.H. Janse, S. Schep & W.M. Mooij*
15h00-15h20 DSS 6:	'Performance Analysis of Machine Learning Algorithms in Biodiversity Modeling' *F. Augusto Rodrigues, E. Silva da Cunha Rodrigues, P. Luiz Pizzigatti Corrêa, R. Luis de Azevedo da Rocha & A. Mauro Saraiva*
15h40-16h00 DSS 7:	'Integrating hydrodynamic, physical-chemical and ecological models for decision support in water management of the Cuenca river in Ecuador' *J. Holguin, A. Alvarado, I. Nopens & P. Goethals*
16h00-16h20 DSS 8:	'MDL-based Clustering for Modeling of Species Geographic Distribution' *E. Silva da Cunha Rodrigues, F. Augusto Rodrigues, R. Luis de Azevedo da Rocha & P. Luiz Pizzigatti Corrêa*
16h20-16h40 DSS 9:	'Early warning system for harmful algal blooms' *H. Duel & D. Burger*

B-IWA session on 'Water, energy, nutrients and ecosystems in a dynamic climate'
E. Volcke (Gent, Belgium) & P. Goethals (Gent, Belgium)

Vermeylen Room

14h00-14h10 WE 1:	'Needs for an integrated vision on Water, energy, nutrients and ecosystems as a basis for sustainable environmental management' *P. Goethals*
14h10-14h30 WE 2:	'COST 869: a European research approach on tackling the N&P eutrophication and leaching problems to waterbodies' *S. De Neve & S. De Bolle*
14h30-14h50 WE 3:	'Optimization of WWTPs: An integrated modeling approach' *E. Remigi, Y. Amerlinck & L. Benedetti*
14h50-15h10 WE 4:	'Nutrient Recovery Systems: enabling the recovery of phosphorus and nitrogen from waste water' *W. Moerman & C. Dewaele*
15h10-15h40:	Break
15h40-16h00 WE 5:	'Manure processing to reusable water using constructed wetlands' *E. Meers, E. Michels, D. Huits, A. Pollentier & F.M.G. Tack*
16h00-16h20 WE 6:	'Transition from cleaning solutions to cleantech' *C. Broux (VITO - FCA)*
16h20-16h40 WE 7:	'General discussion and conclusions' *P. Goethals*

Quantifying trophic flows in ecosystems: modelling approaches and applications

F. De Laender (Belgium) and D. van Oevelen (The Netherlands)

Oude Infirmerie Room

14h00-14h20 TM 1:	Session keynote 'Quantifying trophic flows in ecosystems: modelling approaches and applications' *F. De Laender & D. van Oevelen*
14h40-15h00 TM 2:	'Using EcoTroph (ET) to diagnose fishing impacts in marine ecosystems: application to the Southern Benguela' *L. Gasche, D. Gascuel, L. Shannon & Y. Shin*
15h00-15h20 TM 3:	'Ecosystem Models for fisheries management: What is the best model for Vietnam's fisheries management?' *P. Viet Anh, F. De Laender, P. Goethals & C. Tien Vinh*
15h40-16h00 TM 4:	'Analysis of the role of macroinvertebrates in degradation and nutrient removal processes in constructed wetlands for wastewater treatment' *P. Thu Pham, H.Thi Thu Huong, S. Haesaert & P. Goethals*
16h00-16h20 TM 5:	'Modelling trophic flows in ecosystems to assess the efficiency of Marine Protected Area (MPA): a case study on the coast of Senegal' *M. Colléter & D. Gascuel*
16h20-16h40 TM 6:	'Dynamics of microbial interspecies competition in nitrifying reactors' *E.I.P. Volcke, O. Sanchez, J.-P. Steyer, P. Dabert & N. Bernet*

Thursday, 16 December 2010

Ecological informatics to study the distribution, impact and control options of invasive species
S. Worner (New Zealand), P. Boets (Belgium) and P. Goethals (Belgium)

Oude Infirmerie Room

10h00-10h40 IS 1:	Session keynote 'Need for modelling to predict the distribution and impact of invasive species' *S. Worner*
10h40-11h00 IS 2:	'Modelling approaches to analyse and predict invasive species behaviour in aquatic ecosystems' *P. Goethals*
11h30-11h50 IS 3:	'A comparative study on the genetic diversity of an invasive plant, *Lonicera japonica* in its native and introduced ranges' *H. Jiang, E. Zimmerer & K.S. He*
11h50-12h10 IS 4:	'Predicting presence, species richness and abundance of alien macrocrustaceans in surface waters in Flanders (Belgium) using decision trees' *P. Boets, K. Lock & P.L.M. Goethals*
14h00-14h20 IS 5:	'Application of Bioclimatic Models coupled with Network Analysis for risk assessment of aquatic invasive species' *B. Gallardo, D. Aldridge & M. Paz Errea*
14h20-14h40 IS 6:	'The ability to predict species presence is made conspicuous by the quality of absence: therein lies a dilemma' *S. Worner, T. Ikeda and G. Leday*
14h40-15h00 IS 7:	'Habitat analysis of invasive crustaceans based on datadriven approaches applied on recently and long-term colonized habitats' *J. Holguin, P. Boets, K. Lock & P. Goethals*

B-IWA's session 'Towards integrated assessment and assessing sustainability'
P. Goethals (Gent, Belgium)

Vermeylen Room

14h00 -14h10 IA 1:	'From biomonitoring, to integrated ecological assessment, economic valuation of ecosystem services towards... assessing sustainability?' *P. Goethals*
14h10-14h30 IA 2:	'The multidisclipinary research partnership: Biotechnology for a sustainable economy ' *T. Hennebel & W. Verstraete*
14h30-14h50 IA 3:	'Water Stewardship: a vision on Sustainable Water Management in agriculture ' *S. von Wiren-Lehr & R. D'hondt (European Water Partnership)*
14h50-15h10 IA 4:	'Disentangling urban sustainability. The *Flemish City Monitor acknowledges complexity' J*. Van Assche & T. Block
15h10-15h40:	Break
15h40-16h00 IA 5:	'Sustainable water management through water pricing?' *D. François, A. Correljé, M. De Clercq & J. Groenewegen*
16h00-16h20 IA 6:	'Increasing the financial carrying capacity for water management by coupling of infrastructures ' *J.J. Bouma*
16h20-16h40 IA 7:	'General discussion and conclusions' *P. Goethals*

Ecological Engineering
G. Everaert (Gent, Belgium)

Oude Infirmerie Room

15h40-16h00 EE 1: 'Towards a sustainable management of pond diversity at the landscape level' *K. Martens et al.*
16h00-16h20 EE 2: 'Development of datadriven models to analyze relations between ecologically sound bank quality and biological communities' G. Everaert, I.S. Pauwels, E. Verduin, M.A.A. de la Haye, C. Blom & P.L.M. Goethals
16h20-16h40 EE 3: 'Hybrid ecosystem simulation system for model structure and parameter optimisation of lakes' *S. Martin & F. Recknagel*

Posters (in coffee and lunch break room)

PO 1 'Predicting changes in ecosystem services with Bayesian Belief Networks' *K. Van der Biest, P. Goethals, S. Jacobs, J. Staes & P. Meire*

PO 2 'Application of the Fourth-Corner method to test biological trait-environment hypotheses' *B. Gallardo*

PO 3 'Education about the EU Water Framework Directive using qualitative models' P. Borisova, J. Liem & Y. Uzunov

PO 4 'The Multimetric Macroinvertebrate Index Flanders (MMIF): a new method for evaluating rivers and lakes compliant to the WFD' W. Gabriels, P.L.M. Goethals & N. De Pauw

PO 5 'Linking PEGASE with classification tree models predicting the ecological status in the watercourses of the river Nete (Flanders, Belgium)' E. Dakou, P.L.M. Goethals & N. De Pauw

PO 6 'The Water Framework Directive Explorer for decision support in integrated water management' A. Maes, P.L.M. Goethals, A. Mouton & N. De Pauw

Abstracts

Keynotes

ISEI 7
7th International Conference on Ecological Informatics
13 – 16 December 2010
Ghent University
Ghent, Belgium

Models, informatics and the growth of knowledge

Prof. Bruce Beck & I. Demir (United States)

Warnell School of Forestry & Natural Resources
University of Georgia, Athens, Georgia 30602, USA
(mbbeck@uga.edu)

Tuesday 14 December 2010, 16h40-17h15, Room Vermeylen

Abstract

A recent White Paper prepared for the US National Science Foundation (NSF) sets out thirteen "Grand Challenges for Environmental Modeling" (Beck et al, 2009). It argues, if there must be one such challenge that might assume the rank of primus inter pares, then it should be that of model structure identification: the reconciling of very high order models (VHOMs) with high volume high quality (HVHQ) field observations. In line with the NSF's program on Cyber-enabled Discovery and Innovation, model structure identification is ultimately about core scientific discovery and the growth of knowledge. The presentation examines the prospects for an environmental cyber-infrastructure, alongside data-generating Environmental Observatories, that might support model structure identification. From 1997 through 2008, the University of Georgia operated the (mobile) Environmental Process Control Laboratory (EPCL), a platform for real-time monitoring of water quality in a variety of aquatic environments, with the express objectives of accessing as much information as possible about the nutrient dynamics of microbiological systems. All the data bases gathered with the EPCL are stored in the Georgia Watershed Information System (GWIS; www.georgiawis.org) and are publicly and freely available for downloading and analysis. The experience of having the EPCL was transforming for the way in which the generic challenge of model structure identification could be conceived of and addressed. The presentation illustrates the scope of GWIS, by way of introducing and motivating the need for vastly improved procedures for model structure identification. After four decades of addressing this problem, current research is being directed at the potential for combining the use of advanced algorithms of recursive estimation (mathematical filtering theory) with scientific visualization of model structure based on the rapidly developing field of software associated with biomolecular dynamics/graphics. The presentation will illustrate how this informatics system should function, such that one can visualize and analyze individually the success/failure of a complex model's many constituent hypotheses, when that model (a VHOM) is tested against HVHQ field data.

Beck, M B, Gupta, H, Rastetter, E, Shoemaker, C, Tarboton, D, Butler, R, Edelson, D, Graber, H, Gross, L, Harmon, T, McLaughlin, D, Paola, C, Peters, D, Scavia, D, Schnoor, J L, and Weber, L (2009), "Grand Challenges of the Future for Environmental Modeling", White Paper, National Science Foundation, Arlington, Virginia (ISBN: 978-1-61584-248-3).

ISEI 7 7th International Conference on Ecological Informatics 13 – 16 December 2010 Ghent University Ghent, Belgium	The bridge between ecology and environmental management **Prof. Sven Jorgensen** (Denmark) Dept. environmental chemistry, Copenhagen University, Copenhagen, Denmark.

Wednesday 15 December 2010, 16h40-17h15, Room Vermeylen

Abstract

The first green wave started in 1962 with Rachel Carson's book "A Silent Spring". Before the publication of this book environmental problems was not at all a topic in the political debate.

The scientific discipline ecology was also completely unknown, while than man on street knows today what the focus of ecology is. The book emphasized that a good understanding of nature and it many interacting and complex processes was necessary to solve the emerging environmental problems. A much wider application of our ecological knowledge was therefore needed. As a result a number of ecological sub-disciplines have been developed during the last forty years. The presentation reveal how the development of these sub-disciplines has taken place and how they have interacted and inspired each other. They form today a solid bridge between ecology and environmental management. Without these sub-disciplines, environmental management would have been much less developed to day.

ISEI 7 7th International Conference on Ecological Informatics 13 – 16 December 2010 Ghent University Ghent, Belgium	**Bio-inspired computation for the analysis, assessment and management of ecosystems and environment: Self-organizing map application from molecules to ecosystems** **Prof. Tae-Soo Chon** (Korea) Division of Biological Sciences, Pusan National University, Pusan 609-735 Republic of Korea

Thursday 16 December 2010, 9h15-9h55, Room Vermeylen

Abstract

Analysis of ecosystem data is essential for providing a comprehensive view of the complexity of environment-organism relationships. Ecological data, however, are considered difficult to analyze because numerous biotic and abiotic components are involved in ecosystem processes at all hierarchical levels of life. The Self-Organizing Map (SOM) has advantages for information extraction along with the efficiency of presentation and has been implemented broadly in ecological sciences. Recent applications of the SOM are outlined in molecular, organism, population, community, and ecosystem scales. Further development of the SOM is discussed regarding network architecture and spatio-temporal patterning in ecological sciences.

Abstract

Masterclass by Prof. Sven Jorgensen

ISEI 7 7th International Conference on Ecological Informatics 13 – 16 December 2010 Ghent University Ghent, Belgium	**New Possibilities in Ecological Modelling:** **Structural Dynamic Modelling** Prof. Sven Erik Jørgensen *Dept. Environmental chemistry at Copenhagen University, University Park 2, 2100 Copenhagen, Denmark*

Wednesday 15 December, 11h30-12h30, Room Vermeylen

Abstract

Models of ecosystems attempt to capture the characteristics of ecosystems. However, ecosystems differ from most other systems by being extremely adaptive, having the ability of self-organization and having a large number of feedback mechanisms. The real challenge to modeling is: How can we construct models, that are able to reflect these characteristics. This paper is devoted to how to develop what is denoted structurally dynamic models (SDM) or variable parameter models. The presentation will give the advantages and disadvantages of this new model type and where it is most recommendable to consider to apply SDM. Two illustrative examples of structurally dynamic models will be presented.

This model type will most probably be used increasingly the coming years in our endeavor to make better prognoses, because reliable prognoses can only be made by models with a correct description of ecosystem properties including the ability to change the structure and the properties of key species. If our models don't describe properly adaptation and possible shifts in species composition, the prognoses will inevitably be more or less incorrect, the structurally dynamic models attempt to overcome these shortcomings. SDM seems to be important to use in our endeavor to make prognoses of what will change in our ecosystems due to the climate changes.

Abstracts

Courses

ISEI 7 7th International Conference on Ecological Informatics 13 – 16 December 2010 Ghent University Ghent, Belgium	**Modelling to support the implementation of the European Water Framework Directive** *Ine Pauwels, Gert Everaert, Javier Holguin & Peter Goethals* *Department Applied Ecology and Environmental Biology, Ghent University, Gent, Belgium*

13 December 2010 – whole day – Vermeylen room

Abstract

This course provides insights in datadriven model development for decision support in water management, in particular in the development of ecological assessment models for the implementation of the European Water Framework Directive. This course consists of two parts.

In the first part of the course participants will gain insight in the use of WEKA (Waikato Environment for Knowledge Analysis) which is a popular machine learning software written in Java. Participants will make use of classification and regression trees to develop simple predictive ecological assessment models. Topics such as the importance of data pre-processing and model optimisation will be highlighted. Participants will simulate and evaluate the impact of several management options on the ecological water quality and decide what the most optimal solution for river managers is, based on the models. As several hands-on-exercises will be provided, participants should bring their own laptop and install WEKA from the website: http://www.cs.waikato.ac.nz/ml/weka/ .

In the second part participants will gain insight in the use of XLSTAT (Addinsoft, 2010), which is a statistical analysis software implemented as a toolbox for Microsoft Excel. Participants will make use of simple and multiple logistic regressions to build habitat suitability models that allow predicting the presence of macroinvertebrates. Topics such as the variable selection and discrimination capacity of the models will be highlighted. Participants will simulate and evaluate the ecological water quality impact of different river management options, in order to determine environmental water requirements, considering different river conditions (hydraulic and physical-chemical). In order to perform some practical exercises about logistic regression, participants should bring their own laptop and install XLSTAT from the website:http://www.xlstat.com/en/home/ .

ISEI 7 7th International Conference on Ecological Informatics 13 – 16 December 2010	**Habitat modelling and simulations in Casimir** *Dr. Matthias Schneider*
Ghent University Ghent, Belgium	*(sje - Schneider & Jorde Ecological Engineering GmbH, Stuttgart, Germany, http://www.sjeweb.de)*

13 December 2010 – whole day – Prior room

Abstract

This training offers a discussion of the basis of habitat modelling and its application using the connections between structural, hydraulic, and biological paramters. A focus on fish and macrozoobenthos modelling is provided, given their relevence to the application of the CASiMiR software suite. After the theory has been covered, an introduction to the CASiMiR software packages is given, followed up by hands-on excercises using real-world case study data. Following discussions cover the methods necessary to collect the field data and other model inputs used in running the CASiMiR software. The goal of our workshops is to teach our participants how to successfully apply the CASiMiR software to a variety of water resources related problems.

ISEI 7 7th International Conference on Ecological Informatics 13 – 16 December 2010 Ghent University Ghent, Belgium	**Constructed wetland modelling** *Prof. Sven Erik Jørgensen* *Dept. Environmental chemistry at Copenhagen University, Copenhagen, Denmark*

14 December 2010 – morning – Prior room

Abstract

An overview of wetland ecology and wetland modelling will be presented, followed by a presentation of the software Sub-wet developed to design constructed wetlands or use of natural wetlands for the treatment of waste water or agricultural drainage water. The application of the software will be presented. A copy of the software is free of charge and will distributed to make it possible for the participants of the course to follow on own lab top the demonstration. The users of Sub-wet are exchanging experience and knowledge by internet to facilitate the use of the software on new (and different?) case studies. The participants are invited to join this network.

ISEI 7 7th International Conference on Ecological Informatics 13 – 16 December 2010 Ghent University Ghent, Belgium	**Cellular automata: an exquisite framework for constructing ecological models** *Drs. Jan Baetens and Prof. Bernard De Baets* *KERMIT, Department of Applied Mathematics, Biometrics and Process Control, Ghent University, Gent, Belgium*

15 December 2010 – morning – Prior room

Abstract

As a consequence of their rigorous formulation of macroscopic phenomena, as well as their rich history which can be traced back to the development of modern calculus during the 17th and 18th century, and during which their efficacy has been proven manifold, partial differential equations (PDE) are generally resorted to for describing spatio-temporal (a)biotic processes. Unfortunately, for most PDE only approximate solutions can be found. Furthermore, they make abstraction of spatially explicit relations by assuming mean field approximations, while their relative simplicity can be largely attributed to the simplifying assumptions under which they were derived. Of course, these shortcomings limit their usefulness for describing real-world phenomena. For these reasons other model types are increasingly explored, further stimulated by the growth of computational power during the last decades. Among these model types, the most promising are cellular automata (CA). Their success can be explained by their intrinsic simplicity, though not hindering their applicability, which comes forward in the large number of articles in prominent journals wherein CA are used to describe, among others, biofilm dynamics, groundwater flow, biological competition and tumor growth

Nonetheless von Neumann conceptualized CA already in the first half of the 20th century, it lasted until the previous decade before CA caught the attention of the academia. A cellular automaton is a spatio-temporal modeling paradigm based upon a discretized time, space and state domain, while its dynamics is governed by simple, spatially explicit rules. Despite this intrinsic simplicity, CA are able to evolve complex spatial temporal patterns that resemble patterns observed in a natural environment, such as forest fires, chemical reactions and microbiological interactions.

In this session we will elaborate on the CA concept in all its aspects, and we will exemplify some representative CA-based ecological models.

ISEI 7 7th International Conference on Ecological Informatics 13 – 16 December 2010 Ghent University Ghent, Belgium	**Knowledge-based modeling using fuzzy set methods** *A. Mouton[1], B. De Baets[2] & P. Goethals[3]* [1] *Research Institute for Forest and Nature Research, Brussels, Belgium* [2] *KERMIT, Department of Applied Mathematics, Biometrics and Process Control, Ghent University, Gent, Belgium* [3] *Department Applied Ecology and Environmental Biology, Ghent University, Gent, Belgium*

15 December – afternoon- Prior room

Abstract

Fuzzy modelling techniques are especially suitable to analyse and predict the distribution of species since they are easily interpretable and take into account the ecological gradient theory. As these models (e.g. CASiMiR) apply expert knowledge to link abiotic characteristics to ecological variables, the need for expert knowledge may be one of the bottlenecks in the application of fuzzy species distribution models. The collection of expert knowledge is not only often difficult and tedious, but various authors also doubt the consistency of this expert knowledge. Recent research showed that the combination of fuzzy systems with data-driven techniques may resolve this issue.

However, to develop reliable data-driven models, correct model training and evaluation is needed. The assessment of the model performance is a crucial step in these processes and is based on the criterion that quantifies the model performance. A review of the most commonly applied performance criteria for the optimisation and evaluation of species distribution models showed that different performance criteria evaluate a model differently, which results from the relation between these criteria and the prevalence of the evaluation dataset.

To test these results empirically, a data-driven optimisation method for fuzzy species distribution models was developed. Specifically, a hill-climbing algorithm was applied to optimise the fuzzy rules of the model, while the impact of different performance criteria on the optimisation result was analysed.

This course aims to provide insights into data-driven development of fuzzy rules and sets that may be applied in fuzzy systems (e.g. CASiMiR). Further, general habitat modelling issues and the impact of the training performance criterion (CCI, Kappa, ...) on the model results will be discussed. Hands-on excercises based on artificial data and real-life case studies will demonstrate these issues and will allow the participant to gain experience with FISH, a toolbox designed to develop a fuzzy knowledge base from ecological data. The theoretical part of this course will be explained shortly, but further theoretical background will be provided during the

HS session on Tuesday (10.00-10.40). Participants should bring their laptop and install FISH on beforehand (download from ftp://ftp.inbo.be/Users/Ans_Mouton/ ; if the program does not work, the .net framework should be installed as well: http://www.microsoft.com/downloads/en/details.aspx?displaylang=en&FamilyID=9cfb2d51-5ff4-4491-b0e5-b386f32c0992 , however, this is standard on most laptops). If any problem should occur, please contact Ans.Mouton@INBO.be

ISEI 7
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Ghent, Belgium

Demo's related to DynaLearn software for education and training in ecological informatics (www.DynaLearn.eu)

P. Salles[1] & *B. Bredeweg*[2]

[1] *University of Brasília, Institute of Biological Sciences, Brasília, Brazil*
Email: psalles@unb.br
[2] *University of Amsterdam, Informatics Institute, Amsterdam, Netherlands*
Email: B.Bredeweg@uva.nl

16 December – morning – Prior room

Abstract

Conceptual knowledge about systems behaviour (physical, biological, social, etc.) is crucial for society to understand and be successful while interacting with the environment. The EU funded project DynaLearn (www.DynaLearn.eu) aims at developing an interactive learning environment to support secondary school and undergraduate students to learn by building models. This goal is achieved by means of integrating three types of technology: Qualitative Reasoning, Pedagogical Agents and Ontology Mapping. In this session different qualitative ecological models will be used to explore the main functionalities of the software.

Abstracts

Habitat suitability modelling

(14 December 2010 – HSM)

ISEI 7
7th International Conference on Ecological Informatics
13 – 16 December 2010

Ghent University
Ghent, Belgium

Development, optimisation and application of habitat suitability models.

A. Mouton[1], J. Coeck[1], B. De Baets[2] & P. Goethals[3]

[1] Research Institute for Nature and Forest (INBO), Kliniekstraat 25, B-1070 Brussels, Belgium
[2] KERMIT: Research Unit Knowledge-based Systems, Ghent University, Coupure links 653, B-9000 Ghent, Belgium
[3] Laboratory of Environmental Toxicology and Aquatic Ecology, Ghent University, J. Plateaustraat 22, B-9000 Ghent, Belgium

Email corresponding author: ans.mouton@inbo.be

Session: Habitat suitability modelling (Chairs: M. Schneider (Germany) and A. Mouton (Belgium))

Timing: 14 December 2010, *Oude Infirmerie Room*, 10h00-10h40 (Code HSM 1)

Abstract

Despite tremendous efforts to improve chemical water quality, the physical habitat quality of many European rivers is still insufficient, often leading to a stagnation of the ecological quality. Consequently, small-scale efforts, such as channel remeandering, restoration of floodplains and the construction of fish passages are needed to achieve the aims of the European Water Framework Directive and are now being planned or executed. To efficiently allocate these small-scale efforts, however, a thorough analysis is needed of the impact of these efforts on river ecology. Species distribution models enable such analysis and the identification of the bottlenecks in a river basin.

Fuzzy modelling techniques are especially suitable to analyse and predict the distribution of species since they are easily interpretable and take into account the ecological gradient theory. As these models apply expert knowledge to link abiotic characteristics to ecological variables, the need for expert knowledge may be one of the bottlenecks in the application of fuzzy species distribution models. The collection of expert knowledge is not only often difficult and tedious, but various authors also doubt the consistency of this expert knowledge. Recent research showed that the combination of fuzzy systems with data-driven techniques may resolve this issue.

However, to develop reliable data-driven models, correct model training and evaluation is needed. The assessment of the model performance is a crucial step in these processes and is based on the criterion that quantifies the model performance. A review of the mos commonly applied performance criteria for the optimisation and evaluation of species distribution models showed that different performance criteria evaluate a model differently, which results from the relation between these criteria and the prevalence of the evaluation dataset.

To test these results empirically, a data-driven optimisation method for fuzzy species distribution models was developed. Specifically, a hill-climbing algorithm was applied to optimise the fuzzy rules of the model, while the impact of different performance criteria on the optimisation result was analysed.

The applicability of the presented method in integrated water management was assessed based on 5 datasets describing ecological case studies in Belgium, Switzerland and New Zealand. The

results confirm that each performance criterion focuses on different aspects of model performance and that these aspects are reflected in the final model that is obtained after model training based on this performance criterion. Consequently, river managers and modellers should consider the different focus of performance criteria during model training and evaluation.

This approach may lead to more reliable predictions of the effect of restoration on river ecology and may thus enable river managers to select the optimal restoration option. As such, it may provide a valuable decision support tool for river managers and enhance communication between different stakeholders. Due to the universality and flexibility of the models applied, they could be easily applied on other species or ecosystems, and thus may be promising for ecosystem management in general.

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Classification and regression trees for habitat analysis of macroinvertebrate taxa in the natural wetlands of south-western Ethiopia

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Session: Habitat suitability modelling (Chairs: M. Schneider (Germany) and A. Mouton (Belgium))

Timing: 14 December 2010, *Oude Infirmerie Room,* 10h40-11h00 (Code HSM 2)

Abstract

In Ethiopia, wetland resources play a vital role in the lives of adjacent communities by helping them to achieve food security and livelihoods. However, many wetlands throughout the country have come under extreme pressure as high population growth rate motivated a need for more fertile agricultural land. Information and methodological gaps underpin for the weak consideration of wetland ecosystems by country's development planners. This fact has fostered the development of methods for predicting species-environment relationship. In this paper, decision tree models were used to predict the relationship between wetland characteristics and macroinveretebrates taxa. The developed model allowed identifying the most important variables to be considered for wetland monitoring. We selected sixteen macroinvertebrate taxa and twenty environmental variables for model development. This was applied on a data set of 109 samples collected from 57 sites located in seven wetlands in southwest Ethiopia. We evaluated the models predictive performance based on Correctly Classified Instance (CCI) and Cohen's Kappa statistic. We applied sensitivity analysis and significance test to understand which input variables are the most important ones for building the decision tree model. Overall, the models had moderate to good prediction performance. The highest performance of CCI and Cohen's Kappa was observed for Notonectidae. Based on Cohen's Kappa, prediction of common taxa such as Chironomidae were irrelevant, even though their CCI was high. The most common wetland characteristics predicting the occurrence of benthic macroinveretebrates were vegetation coverage, water depth, magnitude of habitat alteration and water extent. Thus, it can be concluded that a combination of input variable selection as well as sensitivity analysis can contribute to the development of reliable decision tree models and get an understanding about the major elements that steer the biological conditions in the wetlands. The models developed in

the present study can be used as a decision support tool in wetland resources management in the Ethiopia.

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Habitat suitability modelling for mayflies (Ephemeroptera) in Flanders (Belgium)

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Session: Habitat suitability modelling (Chairs: M. Schneider (Germany) and A. Mouton (Belgium))

Timing: 14 December 2010, *Oude Infirmerie Room*, 11h30-11h50 (Code HSM 3)

Abstract

Logistic regressions, artificial neural networks, support vector machines, random forests and classification trees were used to predict habitat suitability for mayflies in Flanders on basis of physical-chemical water characteristics, dominant land use type and structural parameters. The used dataset consisted of 4289 samples containing mayflies (presences) and 3315 samples from waters were mayflies were never encountered (absences). For all techniques, data were randomly divided in a training set (two thirds) and a test set (one third). Models were calibrated using a tenfold cross-validation on the training set and subsequently validated using the test set. All techniques delivered good models that were able to discriminate sites with and without mayflies and performance (expressed as percent correctly classified instances and kappa-statistics) was in all cases similar for the training and the test set. Artificial neural networks performed slightly better compared to the others techniques. Samples with mayflies contained significantly more oxygen, a better developed river structure, higher values for sinuosity and steeper slopes, while samples without mayflies had significantly higher values for ammonium, nitrite, Kjeldahl nitrogen, total phosphorous, orthophosphate, biological and chemical oxygen demand, pH and conductivity. Also land use differed significantly, with mayflies usually present in forests but absent in industrial areas. The prevalence of mayflies gradually increased during the nineties from about 20 to 40 %, which corresponded with an improvement of the chemical water quality. During the last decade, however, water quality did not further improve and as a result, mayflies prevalence did not continue to increase. To meet the requirements of the European Water Framework Directive, which states that all surface waters should obtain a good ecological quality by the end of 2015, extra efforts will be needed to decrease nutrient concentrations and to improve habitat quality.

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New approach for habitat simulation of hydropeaking effects.

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Session: Habitat suitability modelling (Chairs: M. Schneider (Germany) and A. Mouton (Belgium))

Timing: 14 December 2010, *Oude Infirmerie Room,* 11h50-12h10 (Code HSM 4)

Abstract

The increasing share of undpredictiable and weather dependent wind and solar energy is one of the main reasons why energy production is becoming more volatile. The higher demand in peak energy has caused an increase of its economic value and caused a high interest in its production. Currently the most common technique to satisfy peak energy demand is hydropeaking. In the European Alps, but also increasingly in Scandinavian Countries many reservoirs are used for this purpose. However, the rapid flow fluctuations due to hydropeaking operation have strong impacts on river ecology, but so far little research has been performed to address this problem. Habitat modelling can be a suitable method to identify the main drivers and responses related to hydropeaking effects.

On the basis of the habitat simulation model CASiMiR a fuzzy-rule based approach integrating additional hydraulic and morphologic parameters has been developped. Different flow scenarios representing alternative hydropeaking regimes are investigated related to their impact on habitats of juvenile fish and spawning grounds as well as macrobenthic habitats. Whereas for juveniles the stranding risk during downramping is of particular importance, for spawning habitats the changing flow and water depth conditions during fast flow changes and the stability of substrate seem to be of major importance. For macrobenthic habitats maximum shear stress and increased embeddedness seem to be crucial for habitat suitability.

The example of the Alpenrhein as one of the largest alpine rivers in Europe is presented. First results of the fish habitat investigations and preliminary conclusions related to the applicability of the approach are illuminated.

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Comparison of data mining methods for Pike (*Esox lucius* L.) habitat suitability modelling in rivers

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Session: Habitat suitability modelling (Chairs: M. Schneider (Germany) and A. Mouton (Belgium))

Timing: 14 December 2010, *Oude Infirmerie Room*, 12h10-12h30 (Code HSM 5)

Abstract

On the basis of the data monitored in the six river basins in Flanders (Belgium), the habitat suitability of pike was predicted based on a set of data driven modelling techniques: classification trees, artificial neural networks, support-vector machines and logistic regressions in combination with genetic algorithms. All 4 modelling techniques were developed and applied in Weka software and the used data were collected in 6 river basins: Demer, Dender, Dijle, Ijzer, Nete and upper Scheldt in Flanders (Belgium) during the period 1991-2002. The biotic data (based on presence/absence of pike) were provided by the Research Institute for Nature and Forest (INBO). Additionally, some chemical data were provided by the Flemish Environment Agency (VMM). In total 21 variables (20 abiotic and 1 biotic variables) were used for the model development.

The best results (according to CCI and Kappa) were obtained with artificial neural networks and support-vector machines. The lack of illustrative power of ANNs (known as black box methods) is a major concern to ecologists since the interpretation of a model is desirable for gaining knowledge about the system that is studied. Moreover, genetic algorithms were combined with the 4 modelling techniques to analyse the contribution of environmental variables to predict the presence/absence of pike in a reliable manner and to detect the major river characteristics determining the habitat suitability of pike. In total, 14 out of 21 variables were selected to predict the pike's habitat suitability in 6 river basins in Flanders. These variables were a combination of structural-habitat and pollution variables. This implies that in addition to structural-habitat variables, pollution variables also can limit the survival of pike populations in the river basins of Flanders.

These models can in such a way support the proper selection of sustainable management options and help to persuade stakeholders to make the necessary investment and activity changes by society. The developed models were applied to support decision-making in water management in Flanders.

Abstracts

Qualitative reasoning

(14 December 2010 – QR)

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The use of the DynaLearn learning environment to construct qualitative models of fundamental concepts in ecological sciences.

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Session: Qualitative reasoning (Chair: B. Bredeweg (The Netherlands)

Timing: 14 December 2010, *Blancquaert room*, 10h20-10h40 (Code QR 2)

Abstract

Qualitative conceptual modelling, a computer-based Artificial Intelligence approach, has been promoted as modelling approach that could be applied in an educational setting to develop students understanding about ecological systems. The qualitative modelling approach enables modellers to build mechanistic models and develop explanatory and predictive reasoning about systems behaviour without the need for numerical or empirical models. The EU-funded FP7 project DynaLearn is developing a learning environment and curricula that both furthers the technological capabilities of conceptual qualitative modelling and explores the requirements and opportunities for learning by modelling within the domain of environmental sciences. Within the DynaLearn system a number of learning spaces are available for students to develop models and model expressions at different levels of complexity using different modelling primitives. The software enables students to build models ranging from traditional concept maps, through formalised representations of systems structures and basic notions of causal relations, to qualitative models that utilise hierarchies of re-usable knowledge fragments and multiple scenarios.

This paper presents a number of qualitative models (or model expressions) highlighting how the qualitative modelling approach can be used to develop students' understanding of fundamental concepts and topics in ecological systems. The models presented highlight that qualitative models can be used to represent both domain specific knowledge and ecological concepts that can be observed in many systems.

Example models are shown relating to the topics of photosynthesis and respiration. The model expressions show how the different learning spaces of DynaLearn can be used to represent different views and levels of complexity for the same topic. Furthermore, the models show how qualitative modelling can be used to build mechanistic explanations for the phenomena of diel fluctuations in dissolved oxygen concentrations in shallow lakes related to the fluctuations in the rates of photosynthesis by aquatic plants. This model shows how qualitative models can be used to develop causal explanations and predictive reasoning for systems behaviours that are regulated by a number of different processes.

A second suite of model expressions are presented for the topic of cellular osmosis and diffusion. The models highlight how qualitative representations of osmotic flows can be used to

address common misconceptions regarding the exchange of water and solutes across semi-permeable membranes along concentration and water potential gradients.
The topics and models here highlight the flexibility and range of possibilities available for qualitative reasoning modelling available within the DynaLearn learning environment. In particular the models highlight how qualitative reasoning models provide a framework for developing mechanistic models explaining aspects of causality in ecological systems, develop predictive capabilities based on simulation of scenarios and enable modellers to explore ambiguity in systems behaviour.

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Hypothesis assessment with qualitative reasoning : modelling the intermittent Fontestorbes fountain.

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Session: Qualitative reasoning (Chair: B. Bredeweg (The Netherlands)

Timing: 14 December 2010, *Blancquaert room*, 10h40-11h00 (Code QR 3)

Abstract

Keywords: qualitative reasoning, conceptual modelling, intermittent springs, siphon

The ecological knowledge about a natural phenomenon can be sparse and the structure of the system hidden and not accessible. In such conditions the system appears more or less like a black box, for which only the inputs and the outputs are known. Most of time several hypothesis can be envisaged to explain the phenomenon, and there is a need to investigate only the ones that are causally sound and that can really explain the observed behaviour.
Conceptual models are commonly used to formalise an hypothesis about a mechanism. They are build prior to experimentations, mathematical models or small-scale models to represent and clarify the idea (Jorgensen and Bendorrichio, 2001). However the soundness of these conceptual models, and then of the hypothesis, can hardly be discussed if the consequences of these representations cannot be simulated and explained.
Qualitative reasoning (Weld and de Kleer, 1990) provides means to capture the conceptual knowledge of experts as qualitative models can in turn be used to run qualitative simulations and provide explanations of the results (Bredeweg and Salles, 2009). Qualitative simulations allow to assess the correctness of a conceptual model from a causal point of view and assess whether the model can exhibit the expected behaviours or not. Therefore qualitative models can support a critical assessment of the hypothesis.

In this work we illustrate the use of qualitative models to test an hypothesis about the functioning of a system. We have developed a qualitative model of the intermittent rate of flow of the Fontestorbes fountain (Ariège, France) using Garp3, a qualitative reasoning modelling environment (Bredeweg et al., 2009). The fountain is a re-emergence that comes out of a mountain. The mechanism behind this surprising phenomenon is hidden, since the inner part of the mountain is not accessible. Besides the regular intermittence of the rate of flow, the fountain has the following characteristics (Mangin, 1969):

1. the draining outflow and the inflow are of the same order of magnitude,
2. the duration of the phases of the cycle are close.

Since the middle of the 19th century scientists have proposed different models to explain the phenomenon. Until the work of Mangin in 1969, the fountain was compared to a siphon, i.e. a reservoir fed continuously by an inflow and drained by a channel with an inversed U shape. Under specific conditions the siphon behaves as a permanent oscillator and the outflow is intermittent.
We have developed a qualitative model of a siphon which exhibits the intermittent behaviour if the conditions are fulfilled. The qualitative model shows that the behaviour of a siphon is controlled by the value of the difference: Inflow-Outflow. In particular, the intermittent behaviour occurs when the inflow is lower than the minimum value of the outflow that can come out when the siphon is full.
Nevertheless the qualitative model provides also a reason to refute the hypothesis of the siphon. With a siphon, the fact that the duration of the two phases of the cycle are close (point 2 cf. above) implies that the value of the draining outflow has to be greater than twice the value of the inflow, which is not consistent with the point 1 (cf. above). Then we envisage the mechanism proposed by Mangin (1969), a more complex mechanism still based on siphons, which is the hypothesis commonly accepted so far.

The qualitative model is used to refute hypothesis only on the basis of facts and conceptual reasoning. We are able to reproduce a substantial part of the reasoning performed by the scientists about the mechanism of the fountain of Fontestorbes using qualitative models and accessible information.
Qualitative reasoning provides means to formally build a conceptual model from an hypothesis and then assess its consistency from the analysis of the simulations. If the qualitative model does not exhibit the expected behaviour then the hypothesis should be rejected. If the general features of the behaviour are simulated but certain conditions are not respected, as it is the case in our example, then the hypothesis can probably be adapted accordingly. The assessment of an hypothesis using a qualitative model leads the modeller to consider different aspects of the phenomenon; this provides a firm ground for the next steps, experimentations or mathematical modelling.

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What is needed to create a low carbon society? A qualitative reasoning approach to modeling the role of biofuels and the carbon market.

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Session: Qualitative reasoning (Chair: B. Bredeweg (The Netherlands)

Timing: 14 December 2010, *Blancquaert room*, 11h30-11h50 (Code QR 4)

Abstract

The concentration of atmospheric CO_2 began to increase at the end of the 18th century, with the Industrial Revolution. During that period large quantities of mineral coal and petroleum were burned as energy source. Since then, the CO_2 concentration has increased from 280 ppm (parts per million) in the year 1750, to 393 ppm today, and this increase has been associated to global warming. Nevertheless, greenhouse gases (GHG) emissions (such as CO_2) derived from fossil fuel and the destruction of natural areas, as tropical forests, replaced by human-tailored areas, continues to be high, aggravating a multitude of environmental problems, including climate variations.

The work described here presents qualitative models that focus on two approaches taken to handle the situation: replacement of fossil fuels by alternative sources of clean energy, and the use of economic instruments to stimulate actions to reduce GHG emissions.

Consider, as a working example, the dilemma of a community of farmers that holds a piece of land covered with natural vegetation, and need to make money out of the land. What should the farmers do, in order to find a balance involving engagement in productive activities without emitting CO_2 in excess and preserving the natural vegetation that stabilizes the climate and contributes to remove the GHG from the atmosphere? This paper shows how qualitative models may inform the decision making process of the farmers.

There is an increasing interest in alternative sources of energy, mainly in those that replace pollution-intensive sources and promote the decrease of CO_2 and other GHG emissions. An option is to use biofuel (also biological fuel) such as wood, vegetal coal, bio-ethanol and biodiesel produced by the etherification of vegetal oils. Methanol and ethanol are seen today as probably the most viable alternatives. As a consequence, large extensions of agricultural areas are being transformed into 'energetic plantations' (e.g. sugar cane), increasing the capacity of producing biofuel.

The *Biofuel* model aims at answering the following questions:

(a) How is biofuel produced?

(b) What are the advantages of producing and using biofuel when compared to non-renewable sources of energy?

In answering the questions, the model shows that, by absorbing atmospheric CO_2 via photosynthesis, plants assimilate the carbon and transform it in vegetal biomass, which is further transformed into fuel. Used in transport and by the industry, combustion releases CO_2 into the atmosphere again. All in all, it is possible to have a balance between the two processes, resulting in energy being generated and used without additional release of carbon dioxide to the atmosphere. The farmers mentioned above could spare part of their land to invest in agriculture to produce biofuel betting on the carbon balance between photosynthesis and combustion.

A landmark in the efforts towards the low carbon society was the Kyoto Conference, held in 1997 in Japan, when important concepts such as carbon sequestration was established and economic mechanisms have been created to compensate those who contribute with the reduction of GHG. The carbon market may have interesting offers for the farmer. Accordingly, the *Carbon Market* model should be able to answer the following questions:

(c) How does work the mechanism that defines the balance between carbon assimilated and released both by natural vegetation and by agricultural plants?
(d) How can carbon credits promote a sustainable use of land for both conservation of natural vegetation and agriculture and be reverted into economic gain for the local people?

The model shows the complexity involved in the Carbon market: the trade-off between conservation of natural vegetation and agricultural projects may produce positive outcomes, in which both the biomass of natural vegetation and biomass of agricultural production reach dynamic equilibrium, leading to similar equilibrium between revenue from carbon credits and profits for the community of farmers. However, these favourable conditions may change and result in an unbalanced situation, where the more carbon is being introduced in the atmosphere and revenues from carbon credits go down.

Playing with the model, the farmers could see the possibility of reaching a situation in which carbon assimilation and release are in equilibrium in a system where natural vegetation and agricultural land coexist. Based on the results of the two models, the community of farmers may conclude that it would be possible to combine farming, biofuel production and natural vegetation conservation to generate revenues without increasing the CO_2 concentration in the atmosphere. However, it would be also clear that more knowledge is required to solve ambiguities in the model and explain what should be done to obtain the desired results.

The combination of the two models provides an overview of basic aspects of a low carbon society, and as such becomes a powerful tool for learning activities mediated by the DynaLearn workbench. More than producing prescriptive solutions, the models offer causal explanations of the fundamental mechanisms operating in complex systems and, in doing so, contribute for the user to run an informed decision making process.

Integrating models and simulations about alternative sources of energy and economic mechanisms for the control of GHG emissions in educational contexts are ongoing work. It includes combining the two models described here into a single model, producing didactic materials and evaluating the whole set with experts and students.

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Integrating direct and indirect ecological impacts of cooling water on surface waters based on qualitative models

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Session: Qualitative reasoning (Chair: Prof. Bert Bredeweg (The Netherlands))

Timing: 14 December 2010, *Blancquaert room*, 11h50-12h10 (Code QR 5)

Abstract

Qualitative Reasoning modeling has been used as a tool to investigate and conceptualize knowledge in on the effect of increasing water temperature on ecological systems in estuaries. Often, a high amount of river water is used for cooling industrial processes. There are several potential negative effects on the receiving ecosystems, as some invertebrates and fish cannot stand high temperatures. On the other hand, also indirect effects can be important, for instance the reduced solubility of air leading to lower oxygen concentrations and a higher microbial activity, leading to an additional deficit in oxygen. Moreover, the flow plays a high role in the dilution effect, but this is related to both precipitation as the tides. The complexity of this type of processes is presented on the basis of qualitative models, that can help river managers, policy makers as well as industrial companies in their search for a minimal impact on ecosystems while guaranteeing a good cooling process.

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Understanding and predicting time-lags in the response of birds to agricultural intensification using qualitative models.

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Session: Qualitative reasoning (Chair: B. Bredeweg (The Netherlands)

Timing: 14 December 2010, *Blancquaert room*, 12h10-12h30 (Code QR 6)

Abstract

Ecological systems hardly immediately respond to disturbance. Time-lags are common from the population to the ecosystems level. In a pioneer work, Tilman and colleagues modeled the impact of habitat loss on multiple species based on their competition ability. Results showed that there is an ecological debt defined as the present ecological cost of former habitat destruction. Taking this insight one step further, it has been shown that some ecosystems, such as in the case of the Atlantic Forest hotspot, the ecological debt have not been paid for bird species. This may explain why, even thought having less than 7% of forest cover, no extinction of avian species have been recorded for the biome. Considering that the threshold for habitat loss (minimum area for species survival) is somewhere around 40% of the original area, we shall expect extinctions in the near future. As experimental designs for studying time-lags are often unfeasible, modeling the ecological debt is necessary for ecologists and managers to understand, predict and take conservation actions before it`s too late.
Considering that agricultural intensification is one of the major threats to biodiversity, the work described here explores time-lag responses related to agricultural intensification-induced decline of bird species using qualitative reasoning models. Aware that effect of agricultural intensification on both farmland and nearby natural patches is slow and have non-trivial dynamics, we built a qualitative model to understand and predict the time-lag between causes and the effects on the community.
Qualitative reasoning (RQ) is an area of Artificial Intelligence (AI) engaged in describing physical and biological systems in order to derive behavior from system structure, and in doing so, to ground the dynamics of such systems in causal relations, when numerical data and precise information about the reality are unavailable. According to Forbus' Qualitative Process Theory, the behavior of a given system is determined by active processes. They are seen as mechanisms that affect objects' properties, the effects of which propagate to other compartments of the system over time and space. Therefore, the consequences of processes being active may be explained by means of causal relations involving relevant quantities. The model presented in this paper shows a landscape in which forest patches (source and target) are embedded in an agricultural matrix in which intensification takes place. In order to capture relevant elements of the system being modeled, a qualitative model is built around entities (the objects) and quantities (object properties). This way, Target forest patch properties are represented by the quantities *species variation rate*, *species richness* and *abiotic border effect*. Farmed matrix, by the quantities *bird predation and parasitism*, *spatial heterogeneity*, *food*

resources, *tree density*, *microclimatic alteration*, *nest site abundance*, *species variation rate*, *species richness* and *permeability*. Intensive Agriculture, by *agricultural intensification rate*, *mechanization level* and *pesticide*; Forest Species source, by *propagules quantity*; and Emigration, by *migration rate*.

Permeability is defined in terms of physical and biological characteristics that facilitate or render the flux of propagules (fruits, seeds, larvae etc.) and individuals through it. In the model described here, permeability should be equal or greater than a threshold value as a condition for propagules to cause positive influence on *species variation rate* of natural patches. Although many variables affect *permeability* such as *spatial heterogeneity*, *bird predation* and *tree density*, the model assumes that *permeability* changes in the same direction as *tree density*.

Intensification leads to the decline of matrix *species richness* (farm-birds) directly by the use of *pesticides* and indirectly by decreasing *tree density* and increasing *mechanization level* which leads to *nest site abundance* decrease. Pesticides also affect *species variation rate* indirectly by decreasing *food resources*. Forest patches species decline occurs because many of these species feed on the matrix and thus are affected by decrease of food resources. Decrease in permeability prevents colonization from forest species source and rescue effect leading forest *species richness* to decline.

Time-lags are also explained by the functional response of bird populations to food resource. Typically, consumption increases but rapidly decelerates and reaches a plateau with no change in consumption over wide high abundance of food resources. In the model, if the quantity *food resources* is lower than or equal to the value *medium*, then it affects positively *species variation rate*. If *food resources* is greater than *medium*, the model assumes it doesn't affect *species variation rate*. A number of model fragments represent similar trends for other variables. For instance, if *microclimatic alteration* is greater or equal to *medium*, than *microclimatic alteration* positively affects *border effect* in the forest patch, causing *species variation rate* of forest birds to decrease. This causal relation also induces a time-lag response.

In the model, relaxation time is the lag between intensification and the stabilization of *species variation rates* of both matrix and forest patches, which in turn lead to the stabilization of species richness in value small for both areas. Understanding time-lag in ecological responses should not be done without explicit representation of causality. Qualitative Reasoning appears as an important tool to support understanding, teaching and researching about time-lag.

In the present model both farmed matrix and target fragment took four qualitative time stages to happen. The quantification of this delay still uncertain and this depends on the intensification intensity, in the case of farm-land biodiversity and depends on the forest patch characteristics. One must notice that knowing the exact time-lag depends on the landscape and agricultural circumstances. For the moment, we argue that any study concerning agricultural intensification must be done under a specific time scale and that any study that do not consider a relaxed landscape (a system that still has an ecological debt to be payed) may underestimate the impacts of agricultural intensification on forest patch and matrix biodiversity. Considering that most studies don't consider the agricultural timing, most of known impact of intensification might appear to be smaller than it really is.

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13 – 16 December 2010

Ghent University
Ghent, Belgium

Qualitative models to investigate the influence of human activities on the biotopes of Pirá-Brasília - *Simpsonichtys boitonei* - in Brasília, Brazil.

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Session: Qualitative reasoning (Chair: B. Bredeweg (The Netherlands)

Timing: 14 December 2010, *Blancquaert room*, 14h00-14h20 (Code QR 7)

Abstract

Pirá-Brasília (*Simpsonichtys boitonei*) is an endemic annual fish found in the Brazilian Federal District area. Annual fishes complete their entire life cycle in temporary aquatic environments, being found in adult stage only in brief annual periods. The Pirá-Brasília distribution is restricted to temporary ponds in the lowland southern part of the Paranoá river basin.
The annual fishes typical biotopes – temporary ponds on floodable areas, lowlands, "veredas" and marshes of different types – have high environmental importance, and are one of the target areas of the Ramsar Convention on wetlands. Despite the importance of these areas, temporary marshes or lagoons have been drastically destroyed by deforestation, drainage and landfill, both by the expansion of farming and urbanization areas. For this reason, 52 species of annual fishes, including the Pirá-Brasilia, represent the most threatened group of the Brazilian ichthyofauna.
The work described in this paper shows the results of a modeling effort aiming to represent the annual fish Pirá-Brasília life cycle and environmental factors that contribute to increase the vulnerability of this species, in order to justify measures that should be taken to support conservation proposals. Qualitative reasoning modeling allows to confront different views and to harmonize existing knowledge about the Pirá-Brasilia and other annual fish species, usually scattered in studies carried on in different areas of biology, and empirical knowledge stored in the common sense of fish breeders. The models were implemented in Garp3 workbench (www.garp3.org), following a compositional modeling approach, in which simulation models are created by the combination of model fragments among those available in a library created by the modelers.
Two models were built in order to answer the following research questions:
(a) How knowledge about the interactions of the Pirá-Brasilia and the environment where it is regularly found would contribute to the understanding of relevant aspects of these fish survival?
(b) What would be the main effects of the changes caused by human communities on biotopes occupied by Pirá-Brasilia populations?
The first question was answered by the Life Cycle model, which explores the most relevant biotic and abiotic factors acting on the Pirá-Brasilia life cycle. The second one, by the model Biotope, that captures aspects related to the water quality, forests and human actions.
The Life Cycle model represents the effects of the precipitation/evaporation balance during alternance of a rainy and a dry seasons The amount of water on the soil and the oxygen

concentration have strong influence on the development of the embryos left in the previous year (in diapauses III). Some of these embryos develop into fingerlings and then into adults, which in turn put a negative feedback on the development of new embryos.
If the habitat does not become dry before the fishes reach sexual maturity, the spawning process is active and generates embryos in diapause I. With the beginning of the dry season and the gradual loss of water by the habitat, oxygen in the substrate increases again, inducing the development of the embryos into diapause II. The development stops until the photoperiod increases again. Increased photoperiod combined with the presence of oxygen in the substrate, lead the development of embryos into diapause III.
Relevant environmental problems addressed by the Biotope model include the transportation of garbage by floods, the deforestation of riparian forests (treated in Brazil as Permanent Preservation Areas – APP) and soil erosion. Among human interventions that completely destroy habitats, the model includes damming of streams and rivers to water supply and electricity generation, the occupation of APP by unregulated urban expansion and suppression of wetlands to farming purposes.
With the qualitative models support and aiming at the biotope conservation and the protection of the Pirá-Brasília populations, the following measures were proposed:
1. search, in a systematic way, new species populations, mainly outside the conservation areas of strictly protection;
2. carry out conservation actions with the human population in direct contact with the biotopes, as well as the periodic monitoring of the environmental conditions of the occurrence areas to the species;
3. improve the control by the environmental policies on maintaining the integrity of Permanent Preservation Areas (specific areas protected by Brazilian legislation), with potential use by the species as a guidance to periodic inspections and samples;
4. use the Pirá-Brasília´s image as a flag-species, as a way to attract the media attention to the environment and to rise the knowledge and public awareness on benefit of regional biodiversity of aquatic organisms;
5. stimulate de development and implantation of new practices and technologies, capable of supply the water demands to human provision and irrigations, reducing the needed of new dams on the species distribution area;
6. invest on environmental education and public awareness, mainly on the rural areas, about the importance of the temporary water environments, and the potential problems generated by the construction of successive dams, even small ones, on small creeks.
Model validation was realized by four environmental analysts of the Brazilian Institute of Environmental and Sustainable Use of Natural Resources (IBAMA) that work with fishery resources management and answered to more general questions; and with a biologist of the University of Brasília that, as a specialist with previously knowledge about the Pirá-Brasília, answer to more specific questions about the model. All the participants manifested a very positive impression about the approach of Qualitative Reasoning, the software Garp3 and the models presented. In the words of one of them: the qualitative model showed the knowledge in a fairly visual and intuitive way, allowing a quick understanding. The evaluators consider valid the proposal to use the models to plain and define conservation measures to Pirá-Brasília and other annual fish species, with some adaptations to regional realities.
Qualitative modeling of ecosystems showed to be a promising tool for use in the process of governmental management and decision making, as they allow for the insertion of a wide range of qualitative data, integrating socio-economic and cultural factors with the environment. Their use becomes particularly interesting when it is considered the huge number of situations in which decision makers have to do their job without the support of numerical data.

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Construction of a qualitative foodweb based dynamic habitat suitability model to describe pike populations in rivers

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Session: Qualitative reasoning (Chairs: Prof. Bert Bredeweg (The Netherlands))

Timing: 14 December 2010, *Blancquaert room*, 14h20-14h40 (Code QR 8)

Abstract

Qualitative Reasoning modeling has been used as a tool to integrate, investigate and conceptualize knowledge in ecological systems. A qualitative model was developed in Garp3 in which all the expert knowledge about pike's ecology is brought together and formalized. Information is integrated about the life cycle of pike and the different environmental factors that influence the survival of individuals from one life stage to another, including the quantity of the food resource and the density of lower trophic levels. The aim of the model is to visualize all the possible relations between pike and its environment. The model was built in preparation of the development of a quantitative, habitat suitability and migration model about pike and illustrates the difficulty of formalizing complex ecological interactions. The compositional approach to qualitative modeling allowed a nice representation of the knowledge about the ecology of pike, but some ambiguities are still encountered in integrating these components in simulations of some specific scenarios.

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How agricultural matrix intensification may affect understory passerines that inhabit forest patches?

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Session: Qualitative reasoning (Chair: B. Bredeweg (The Netherlands)

Timing: 14 December 2010, *Blancquaert room*, 14h40-15h00 (Code QR 9)

Abstract

Most studies about habitat fragmentation tend to consider the landscapes as binary scenarios because “natural areas” embedded in a “hostile matrix” compose them. This black-and-white view is dominant in biology education books, research and management practices and has its theoretical basis on the Island Theory. Despite of this, terrestrial landscapes often fall off this insular pattern, mostly because terrestrial matrix is often a heterogeneous mosaic in which human communities interact and interfere on landscape’s quality for biodiversity. Therefore, understanding how different managed matrix affects organisms that inhabit patches seems to be crucial for biological conservation.
Considering that most of the tropical area is composed by agricultural land and that most of this land is either intensified or in the way to, we have asked the following questions: How agricultural intensification of the landscape matrix of an Atlantic Forest region (a biodiversity hotspot) may affect the dynamic of populations of understory endemic passerines? Secondly, how can we communicate these results to decision makers and local stakeholders? Focal species in this study are *Sclerurus scansor*, *Pyriglena leucoptera*, *Conopophaga lineata, Chiroxiphia caudata*, *Xiphorhynchus fuscus, Lepidocolates squamatus*.
We built a qualitative model using the Theory of Qualitative Process, which is based in a compositional approach that combines model fragments to obtain simulation models. The model is implemented in GARP3, a software that express causal relationship either by direct influences (I+ and I-), that represents processes, or qualitative proportionalities (P+ and P-), that propagate the effects of processes.
The model has nine entities: Agricultural intensification, Agricultural matrix, Species source, Target patch, *Sclerurus scansor*, *Pyriglena leucoptera*, *Conopophaga lineata, Chiroxiphia caudata*, *Xiphorhynchus fuscus/Lepidocolates squamatus* (these two last entities were considered as one single entity due to their ecological and phylogenetic similarity). Two external agents are modeled: Emigration and Local Extinctions. Entities and agents are associated to quantities. Matrix has *structural permeability*, *light incidence*, *arboreal component*, *heterogeneity between farm-plots*, *arthropod abundance*, *vertical complexity*, *fruit availability*, *pesticide*. Species entities have *sub-population numbers* and *sub-population variation rate*. Species source has *propagules quantity*; Emigration has *migration rate* and Local extinction has *random extinction rate*.
Structural permeability captures the matrix structure in rendering or facilitating the flux of propagules through it, so different species will respond differently to it. For example, *C. caudata*

is a very vagile species, so that propagules from source will always reach the target patch, no matter of the structural permeability value. Differently *S. scansor* was considered here as the lesser vagile species, so that structural permeability has a minimum effect on its ability to disperse and colonization capacity. The other species are considered to have intermediate response (structural permeability threshold equal to medium value).

In the model, *agricultural intensification rate* acts upon agricultural matrix decreasing (I-) *heterogeneity between farm-plots*, *vertical complexity*, *fruit availability* and increasing (I+) *pesticide* use. All these variables affect *agricultural intensification rate* via feed-back loops that stabilize the system. For species that forage in the matrix, such as *P. leucoptera* and *C. caudata*, *arthropod abundance* and *fruit availability* affect positively *sub-population variation rate*, which leads to an increase in the *sub-population number* in the target fragment.

The model assumes that local extinction in the target patch is a random variable that goes from zero to maximum, so that, for less sensitive species (*C. caudata, P. leucoptera, C. lineata),* if *random extinction rate* is greater than medium values, it affects negatively *sub-population variation rate*. For moderate sensitive species (*Xiphorhynchus fuscus/Lepidocolates squamatus*), negative influence of random extinction rate is active if its value is greater or equal to medium. Finally, *S. scansor*, a very sensitivity species, is always negatively affected by random extinction rate, despite of its values. Random extinctions affect all species, suggesting an inter-species dependence dynamics. Fire occurrence, storm, droughts, predator introduction or population increase, parasite outbreaks, epidemics and human pressure would be good examples of these unpredictable events.

Simulations show that agriculture intensification should, from the causal point of view, lead to instability of understory species populations at different scales. Species were affected by low immigration, caused by decline of farmed matrix permeability reducing arrival of new individuals form the source and reducing rescue effect. For species that forage in the farmed matrix (*C. caudata* and *P. leucoptera*), the decrease of arthropod and food abundance caused by pesticide use and simplification (decrease of heterogeneity, vertical complexity and arboreal component), respectively, negatively affected population variation rate and thus, population numbers. Simulation showed cycles that stabilize the systems maintaining populations at different levels. This seems to represent how intensification could lead to instability in the colonization-extinction ratio. Therefore sub-populations could increase, decrease or remain stable in zero, low or high levels. Bird persistence was greater in non-intensified scenarios especially for species that have low dispersal ability. Even for better dispersal species, such as *C. caudata*, decrease on fruit availability due to intensification may cause population decline. Therefore, conservation and implementation of non-intensified agricultural practices such as organic farming and agroforestry may spur forest bird conservation.

Our model reinforces the burgeoning literature that suggests that matrix quality really does matter to population dynamics so that colonization is possible in balancing random local extinction. If agriculture intensification is implemented in the Atlantic Forest, these species shall present a decline locally, regionally and globally (as they are endemic, regional extinction is also global).

The model also explores important theories of animal movement. For instance, photophobia, or a psychological predisposition to avoid open country habitat that may constrain movement trough the opened matrix. In the model this is captured by the assumption that changes in light incidence causes an opposite effect on structural permeability, so that when the former is increasing, permeability is decreasing.

Our model can be used by graduate and undergraduate students to support understanding of some ecological concepts, such as source-sink-dynamics, rescue effect, matrix permeability, random extinction, landscape connectivity. It also could be used by stakeholders and

researchers in order to go further beyond the use of common sense about causal relations involved in ecological systems.

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Qualitative Models of Global Warming Amplifiers[1]

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Session: Qualitative reasoning (Chair: B. Bredeweg (The Netherlands)

Timing: 14 December 2010, *Blancquaert room*, 15h00-15h20 (Code QR 10)

Abstract

We present a set of qualitative models in the field of environmental science, particularly in the domain of global warming. One motivation behind this effort is to enrich the model repository of the DynaLearn interactive learning environment (http://www.DynaLearn.eu). This learning environment gives learners automated feedback based on a comparison of their model to a set of (expert) models stored in a repository [2]. Therefore, a model repository is created that consists of a large set of models. The second motivation follows the interest of ecological experts to create qualitative models of phenomena for which numerical information is sparse or missing [1,5].

Society is concerned about global warming and the impact this is expected to have on people and the ecosystems on which they depend [4,6,7,8]. Factors that can amplify or reduce the effect of the causes of climate change are known as positive and negative feedbacks, respectively. In this contribution we will present qualitative models of key feedback mechanisms in this context. The models are implemented in Garp3 [3] and provide abstract explanations of these phenomena, tailored to secondary and early years of higher education.

Six models are described and discussed. We first model two of the so-called negative feedback factors (snow and ice albedo, and cooling aerosols). Next, two of the positive feedback factors are tackled (water vapour and warming aerosols). We then combine the two mechanisms in a larger model (low and high clouds), proving the possibility of extracting general mechanisms that can be reapplied to other systems sharing similar characteristics.

Two domain experts have evaluated the models. According to their reviews, the main goal of creating a set of simple models that faithfully represent the domain of global warming amplifiers has been accomplished. Moreover, the secondary goal of creating a set of reusable mechanisms has also been achieved. On the critical side the experts commented the choice of quantity spaces, and the names given to type definitions in the model. It appears that most of the evaluators' comments revolve around preferences regarding the level of explicitness.

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Using qualitative reasoning to model life cycle assessment of wind energy

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Session: Qualitative reasoning (Chair: B. Bredeweg (The Netherlands)

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Abstract

Energy is an essential ingredient of socio-economic development. Wind energy is ubiquitous, renewable and can help in reducing the dependency on fossil fuels. Wind is an indirect form of solar energy and is always being replenished by the sun, which causes differential heating of the earth's surface. Wind energy is clean and because it is free provides the ultimate in energy independence. Wind has emerged as a leading source of energy, in part because it is considered to be environmentally sustainable and has a number of advantages over most other energy sources. Wind farms require much shorter planning and construction time than fossil fuel or nuclear power plants. Wind generators are modular (more turbines can be added if demand grows) and have in their life cycle low fuel costs which means lower air emissions. This view point makes some key elements to move forward in this debate: the construction, implantation and operation steps, and how this knowledge could be represented, shared and learned by beneficiaries' communities in education and licensing processes.

This work presents *Wind Power*, a qualitative simulation model representing the commodity chain of wind farm and its energy production in a qualitative view of the Life Cycle Assessment. The model was built with Qualitative Reasoning techniques, which has been successfully used to model ecological systems (see the special issue on Qualitative Reasoning of *Ecological Informatics* Volume 4, Issues 5-6, pages 261-412, November-December 2009), and implemented in the DynaLearn workbench (www.dynalearn.eu), a software which is already in testing and evaluate phases. An important advantage of the Qualitative Reasoning approach for handling conceptual knowledge is the ability to capture information about both systems' structure and behaviour, including the notion of causality. Knowledge is represented by combining a set of model ingredients. Among them, a central ingredient is the *entity*, which is used to represent the physical objects or abstract concepts that define the system. The whole qualitative model is built around entities. Relevant entity properties that may change under the influence of processes are represented as *quantities*. Relations between quantities include causal dependencies of two types: *direct influences* (I+ and I-) and *qualitative proportionalities* (P+ and P-). Direct influences represent *processes* and are the initial cause of change in the system. The effects of processes are propagated via proportionalities to the rest of the system. Combined, these primitives build up causal chains.

The qualitative modeling workbench in DynaLearn consists of six learning spaces (LS) where the user can build models of increasing complexity, spanning from simple concept maps to the full range of functionalities provided by Garp3. Current version of the Wind Power model is implemented in LS1 (concept map), LS2 (basic causal model), LS3 (basic causal model with stategraph), and LS4 (causal differentiation).
The model aims to answer the following questions:
(a) How the conversion of energy from the sun in wind power is performed?
(b) How air movement is produced?
(c) How kinetic energy of the wind is transformed into electric energy in the wind plant?

Initial ideas involving the fundamental mechanisms involved in electricity generation from the air movement are organized (LS1) and further developed in a basic causal model (LS2). At this level, a simulation shows only trends: as only the derivative of the quantities are represented, possible qualitative values are {decreasing, stable, increasing}. The model shows that solar energy is unequally distributed in the atmosphere and creates regions with differences of air pressure. This unbalanced situation generates the air flow that is captured by the wind turbines. Kinetic energy is transformed into mechanical energy and finally in electricity, further used in industrial and domestic activities. In LS3, this model is improved with the representation of possible magnitude values (for example, the amount of *kinetic energy*, *mechanic energy* and *electric energy* can assume the values {zero, low, medium, high}). Simulation shows state transition and the system behaviour is better captured. Both in LS2 and LS3 causal relations are represented as arrows identified by the signs [+] and [–], and these bare dependencies are not enough to resolve ambiguous situations or to express inequality relations. From this point of view, LS4 represents a big leap, as causal relations are differentiated by means of the use of direct influences (to capture processes) and qualitative proportionalities. These two types of causal dependencies allow for representing complex knowledge, for example, knowledge required to calculate the air flow based on the difference of air pressure in two regions, and to introduce in the model feedback mechanisms that may control the system behaviour.
While simulations in LS2 are limited to the calculation of derivative values and in LS3 state graphs are produced (to show state transitions and behaviour paths through sequencial states) because of magnitude values, LS4 allows for initial scenarios describing unbalanced situations that may drive complex system behaviour that eventually ends up in a balanced situation. Such simulations allow the user to inspect the system behavior in various real-world or experimental situations.

The model can effectively be communicated to learners, as shown in previous studies about using qualitative models in science education. The diagrammatic approach, the explicit representation of causality and the possibility of inspecting all the possible behaviors improve learners understanding of the system. Ongoing work involves the development of didactic material to assess the potential of the wind power use, with minor impacts on the environment. Models and additional materials will be used to explore the capabilities of DynaLearn software in educational contexts.

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Bird communities in the transition Amazon – Cerrado, Brazil: a qualitative model to predict the richness of trophic guilds according to the structure of vegetation.

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Session: Qualitative reasoning (Chair: B. Bredeweg (The Netherlands)

Timing: 14 December 2010, *Blancquaert room*, 16h00-16h20 (Code QR 12)

Abstract

Ecotones present an ideal setting for studying mechanisms of community structure that may cause changes to biodiversity patterns and evolutionary processes. For example, aspects of vegetation structure related to the availability of habitat and resources for a given guild may determine the occurrence and abundance of specific bird species. In spite of their importance, the areas of contact between the Amazonian forest and the Cerrado biome in Central Brazil are among the most critically endangered and neglected area of vegetation in the Amazon biome.
Qualitative reasoning models can be of some help to elucidate ecological processes in the transition range, by expressing incomplete knowledge about key factors held responsible for changes in the system and the consequences of their variation in time and space. The qualitative model developed in this study explores the structure of bird community in the transition zone, determining in which region a trophic guild should have greater richness or more abundant populations, depending on the variation in vegetation structure of riparian forest along the transition between the Amazon and Cerrado biomes.
In this model, rainfall starts changes in the system, through a positive influence on water availability in the soil. In the one hand, soil moisture is higher in the Amazon than in the Cerrado, a factor that contributes to changes in the vegetation structure, resulting in a tall forest with closed canopy and homogeneous profile of vegetation, with large amount of biomass in the form of litter accumulated in the soil surface. These conditions affect the richness and abundance of some bird guilds. Among such guilds, the canopy and soil frugivores, canopy generalists, understory insectivores living in dead leaves, terrestrial insectivores and antbirds should be favored by the vegetation structure typical of the Amazon region. The greater abundance of canopy generalist and frugivore birds, acting as seed dispersers, in turn will contribute to the population growth rate of trees, which fruits are part of their diet, creating a major abundance of tree vegetation in the Amazon region via a positive feedback.
On the other hand, the model shows that in the Cerrado, where soil moisture and ground water availability are lower. In this case, the riparian forest profile tends to be lower and heterogeneous with more open canopy, allowing more light to penetrate onto the soil, a condition that favors the growth of an understory vegetation consisting mainly of shrubs. These conditions are more favorable for green foliage understory insectivorous guilds and understory generalists. Generalist species, being seed dispersers will contribute to the population growth rate of shrubs, providing the increase in the abundance of shrubs completing the cycle.

The model follows the ontology provided by the Qualitative Process Theory and was implemented in the learning environment DynaLearn, a workbench for qualitative modeling and simulation, according to the compositional modeling approach, in which different simulation models can be composed by the combination of quasi-independent fragments of models. Intended use of the model is to provide support for undergraduate and secondary school students to understand the complex interactions between biophysical factors among biotic communities in tropical forests. Ongoing work includes an evaluation with experts and preparation of pedagogical materials to be tested with students.

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Qualitative models about metapopulation dynamics.

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Session: Qualitative reasoning (Chair: B. Bredeweg (The Netherlands)

Timing: 14 December 2010, *Blancquaert room*, 16h20-16h40 (Code QR 13)

Abstract

Facing habitat fragmentation, how populations behave? Habitat destruction poses the greatest threat to the long-term survival of species on Earth. Fragmentation means that the remaining habitat for a species is located in smaller and more isolated discrete fragments (patches) of the original area. The consequences of habitat fragmentation on habitat quality may influence population dynamics via effects on effective patch areas and hence on extinction rate, on colonization rate and by creating source-sink dynamics. These are ideas on the realm of metapopulation dynamics.

To assess the consequences of habitat loss and fragmentation is a complex task due to phenomena happening at different scales and to environmental heterogeneity, for which there will never be enough data to support rigorous empirical analyses. A general theoretical framework is needed, based on a clear conceptual understanding of metapopulations' behavior. This is an urgent task due to accelerating changes and modification of natural landscapes imposed by human activities.

Following current theory on education that advocates learning by doing, modelling is considered fundamental to human cognition and scientific inquiry. Qualitative Reasoning captures human interpretation of reality, and provides a conceptual account that explains why a system presents certain behavior. The Qualitative Reasoning vocabulary used in the model (in fact a symbolic logic-based vocabulary) mimics the way humans understand and explain observable behaviors. So learners can formulate their insights on how systems behave in an appropriate qualitative and causal way.

In order to support secondary school and undergraduate students in learning by modeling, a set of qualitative models about metapopulations was developed in the Qualitative Reasoning engine Garp3 (www.Garp3.org) and in the learning spaces with different levels of complexity of the workbench DynaLearn (www.DynaLearn.eu). The models capture and formalize knowledge and the main principles of conservation biology involved in the metapopulation theory for application in educational settings. In fact, we emphasized the importance of conservation biology principles recommended by the Education Committee of the Society for Conservation Biology.

The main goals to be achieved with these metapopulation models are:

a) to address the problem of habitat fragmentation and the effects of conservation biology measures on the metapopulation dynamics;

b) to formalize causal explanations about the source-sink metapopulation approach;

c) to predict differences between the behaviour of populations depending on their size and carrying capacity;
d) to investigate the use of fundamental laws from physics and chemistry, such as diffusion and osmosis, to explain metapopulation behaviour;
These models are related to the simplified view on how the processes of colonization and extinction influence fragments of population in a metapopulation. Some of the simulation scenarios intend to show how is the behavior of the 'suitable patches' and then of the 'fragments of population' from 'metapopulation' face to the changes caused in the landscape due to human population influences.
In one of the models, for instance, landscape modification can be induced by the process of land use by human population, and reduced by environmental restoration process that control and restore the effects of land use. The human population modifies the habitat, and the landscape modification has a negative influence on the suitable patches on the habitat. These suitable patches positively influence the colonization rate and negatively influence the extinction rate of a metapopulation that lives in the fragment.
The main processes influencing the fragments of population (that is, the population that lives in a fragment) are colonization and extinction. Colonization process increases the fragment of population size, while the extinction process reduces it. Simultaneously, the fragment of population size has a negative influence on the colonization rate, establishing a feedback mechanism that acts as a saturation control – colonization is no longer successful after a threshold population size in the fragment.
Another aspect of great importance is the representation of the conservation effort that is the effect of the environmental restoration rate that can diminish the negative aspects of human population impacts on habitat loss and fragmentation.
Qualitative Reasoning modeling has been considered as a tool for integration and exploration of conceptual knowledge in ecological systems and population dynamics (see the special issue on Qualitative Reasoning of *Ecological Informatics* **Volume 4, Issues 5-6, pages 261-412, November-December 2009**) and the work described here confirms such expectations.
This study indicates that Qualitative Reasoning modeling may be a valuable tool for exploring population dynamics and to provide better understanding of complex scenarios dealing with landscape modification, habitat loss and conservation efforts on fragmented areas. This challenge is of great importance, mainly when conservation efforts are needed in a changing planet.

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Abstracts

GIS and remote sensing

(14 December 2010 – GIS)

ISEI 7
7th International Conference on Ecological Informatics
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Use of GIS and RS in the development of a Policy Support System for the Oum Zessar river basin.

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Session: GIS and remote sensing (Chair: G. Foody (UK))

Timing: 14 December 2010, *Gillis Room*, 10h40-11h00 (Code GIS 2)

Abstract

In the past decades a large number of systems to support decision making in regional planning have been developed. Some for a very specific task in a specific region, others as generic tools that can be applied to a wide range of topics at different locations. Since the development process of a decision or policy support system is generally an expensive and time consuming process, reusing a system for a broad range of problems and reapplying it to different regions after its development would give rise to significant efficiency gains.
The MedAction Policy Support System (PSS) has been developed as a generic system for Northern Mediterranean regions to support integrated decision making in the fields of sustainable farming, water resources, land degradation and desertification. It allows the user to explore the impact of a wide range of external factors and policy options on policy-relevant indicators by simulating future developments in the region over a time span of 20 to 30 years. The system comprises of a wide range of spatial dynamic models, such as a weather generator which can operate from historic datasets or IPCC climate scenarios, a hydrology and soil model, a plant growth model, a natural vegetation type model, a land use model, a water management model and a farmer's decisions model, which have been integrated into one system, thus focusing on the linkages and dynamic feedback loops between the different processes modelled. This presentation will discuss to what extent the version of the MedAction system that was originally developed for a European context can be applied to Northern African countries using the watershed of Oum Zessar in Tunisia as a first test case. In the application of the system GIS data plays a crucial role. Given the limited data availability is most Northern African countries, the question arose to what extent use could be made of RS data when required spatially explicit data was not readily available. We found that this data was very useful in setting up the model, but experienced more difficulties in using it as part of the calibration and validation.

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Crossing utopia: estimating species diversity by remote sensing spectral heterogeneity

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Session: GIS and remote sensing (Chair: G. Foody (Nottingham, UK)

Timing: 14 December 2010, *Gillis Room*, 11h30-11h50 (Code GIS 3)

Abstract

The causal relationship between species community diversity and environmental heterogeneity has been a long-lasting interest among ecologists. In fact, environmental heterogeneity is considered to be one of the main factors associated with biodiversity given that areas with higher environmental heterogeneity can host more species due to their higher number of available niches.

In this view, spatial variability extracted from remotely sensed images has been used as a proxy of species diversity, as these data provide an inexpensive means of deriving environmental information for large areas in a consistent and regular manner.

This study aims at: i) summarizing the work done on species diversity study by remote sensing considering different spatial scales and habitat types, ii) proposing new analysis approaches based on different modelling techniques, including e.g. LOESS regression, quantile regression, spectral rarefaction, iii) proposing a theoretical framework for developing robust empirical tests on species diversity forecasting by remote sensing.

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Remote sensing for niche-based epidemiological modeling.

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Session: GIS and remote sensing (Chair: G. Foody (Nottingham, UK)

Timing: 14 December 2010, *Gillis Room*, 11h50-12h10 (Code GIS 4)

Abstract

Bluetongue is a viral disease of ruminants which is transmitted by *Culicoides* midges. Since the late 1990's a series of bluetongue virus (BTV) serotypes have invaded Mediterranean Europe. In Mediterranean Europe bluetongue is mainly spread by *Culicoides imicola* which is also the main tropical vector in Northern Africa. The occurrence of arthropod vectors of disease in general and biting midges in particular is determined by a large number of (a)biotic factors. Amongst others, soil moisture is one of the variables that is considered to be an explanatory factor of the presence or absence of the insect vector. However, until now, epidemiological research focusing on the prediction of the spread of *Culicoides*, only partially integrates knowledge on soil moisture within its spatial models. This knowledge is included in these models through the Normalized Difference Vegetation Index (NDVI), even though the correlation between NDVI and soil moisture was not validated at most sites. This study investigates an alternative method, the so-called triangle method, for soil moisture estimation from optical remote sensing data. The scatter plot formed by pixel data pairs of NDVI and Land Surface Temperature (LST) should theoretically be a triangle, defined by an upper dry edge and a lower wet edge. The soil moisture condition of a pixel may be estimated based on its position in the scatter cloud with respect to the dry and wet edge. However, some severe limitations restrict the method's applicability for niche-based epidemiological modelling, one of these being the assumption of a flat study site. A soil moisture proxy derived from the adjusted triangle method, which includes multi-year averages and terrain-corrected surface temperature, is currently evaluated in spatial epidemiological models for the bluetongue vector.

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Beyond classification? Mapping floristic patterns of ecotones in a heterogeneous landscape.

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Session: GIS and remote sensing (Chair: G. Foody (Nottingham, UK)

Timing: 14 December 2010, *Gillis Room*, 12h10-12h30 (Code GIS 5)

Abstract

Detailed vegetation maps are required for various tasks in conservation planning and management. For such maps, a meaningful generalization of information is inevitable. Frequently, classification is used to generalize the floristic composition of (semi-) natural plant assemblages. The resulting class boundaries are often artificial and do not reflect the fuzzy character of vegetation. Classification may thus be inappropriate for a detailed description of ecotones with gradual changes in the floristic composition (Trodd, 1996). Alternatively, ordination methods can be used to extract major floristic gradients describing the prevailing compositional variation in a floristic data set as metric variables. The generalization abilities of these methods have been used previously to derive gradient maps that show floristic patterns in continuous fields (Schmidtlein & Sassin, 2004; Schmidtlein et al. 2007).
In the present study, gradient mapping was used for the first time in a heterogeneous landscape with intricate and gradually changing floristic composition (the Wahner Heide area near Cologne, Germany). We tested Isometric Feature Mapping (Isomap, Tenebaum et al., 2000), a promising ordination method, for generalization of the highly variable floristic composition. In comparison, established ordination methods (Detrended Correspondence Analysis and Nonmetric Mulidimensional Scaling) were applied and tested for their generalization abilities. The resulting floristic gradients (= ordination axes) were related to imaging-spectroscopy data (HyMap) using Partial Least Squares Regression (PLSR). The regression equations of the Isomap solution were subsequently applied on the image. Isomap was able to preserve 74% of the original floristic variation inherent to the ground truthing data (195 vegetation records) in a three-dimensional solution. This was considerably more than for the established ordination methods. The PLSR models for the floristic gradients extracted with Isomap showed model fits ranging from $R^2 = 0.59$ to $R^2 = 0.73$ in calibration, and from $R^2 = 0.55$ to $R^2 = 0.69$ in tenfold cross-validation. The resulting gradient map provides detailed information on floristic vegetation patterns and can be related to underlying environmental gradients. The combination of Isomap ordination and imaging spectroscopy hence showed promising results for detailed mapping of complex ecosystems.

Abstracts

Data management standards, data redistribution and data applications

(14 December 2010 – DAT)

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Terms and concepts of ecological data management in a marine context.

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Session: Data management standards, data redistribution and data applications (Chairs: F. Hernandez (Belgium) & K. Deneudt (Belgium)

Timing: 14 December 2010, *Oude Infirmerie Room*, 14h00-14h40 (code DAT 1)

Abstract

Over the last decades several networks of data centres (OBIS, IODE, Seadatanet, WOD) have produced publically available databases which are of interest to the ecological research community. Finding and using suitable data from these online databases may seem easy, but selecting and evaluating good quality datasets can quickly become a difficult enterprise. Knowing how data centres operate will help understand the possibilities and limitations of the data they provide.
In this session we will focus on some data management practices that determine the quality and applicability of ecological databases.
We will look behind the scenes at how data centres work, and explain terms and concepts used in data management: data, datasets, metadata, data systems, archives, integrated databases, centralised or distributed architectures, vocabs and standards, quality control and data products. The terms and concepts introduced here will be illustrated by various examples in the presentations of this session.

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Standards in marine biodiversity data: benefits and applications

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Session: Data management standards, data redistribution and data applications (Chairs: F. Hernandez & K. Deneudt (Belgium))

Timing: 14 December 2010, *Oude Infirmerie Room*, 14h40-15h00 (code DAT2)

Abstract

During recent years, marine biodiversity data are moving more and more from isolated and centralized databases towards online data exchange systems. While individual studies are restricted in the amount of data they can generate, massive databases can be created by combining the results from many studies, allowing analyses on a much-enhanced scale. Such databases have never been of greater importance considering the recent observation of major shifts of marine species due to global change. Consequently standards and common vocabularies, enabling the integration of individual datasets, are now more in demand than before. Standard categories and definitions are required both for the metadata that describes datasets ('discovery metadata') and for the data records themselves. Hence, different standards to describe metadata, spatial and temporal descriptions, taxonomy, habitats or ecological information are currently being developed and agreed amongst marine ecologists worldwide. A mature example of this world wide integration of marine biological datasets is the Ocean Biogeographic Information System (OBIS), the data-integration component of the Census of Marine Life (CoML), which assesses and explains the diversity and distribution of marine life through a network of linked databases.

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How the integration of marine ecological data from different sources can create added value to data and science

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Session: Data management standards, data redistribution and data applications (Chairs: F. Hernandez (Belgium) & K. Deneudt (Belgium)

Timing: 14 December 2010, *Oude Infirmerie Room*, 15h00-15h20 (Code DAT 3)

Abstract

Traditionally, marine biological data are collected as part of research projects, often with a rather limited temporal and spatial range. These data prove to be valuable within the scope of the project or research activities, but are only of limited use when one wants to interpret large-scale or even global phenomena. In addition to confined temporal and spatial boundaries, these individual studies are also restricted in the amount of data they can generate. However, by bringing together several of these datasets into one large consolidated database, new analyses on unprecedented spatial and temporal scales can be carried out, thereby yielding new scientific insights. Compiling such an integrated - thematic - database is very advantageous in many aspects. Involved scientists can bring together data varying over space and time and - after integration - they get access to standardized information, as data are adjusted to international or European standards. Additionally, the data are subjected to very thorough quality control actions, in order to fine-tune the data on the level of taxonomy, geography and sample information so sound comparisons become possible. Due to the close collaboration between data managers and the involved scientists, the integrated database can be designed and developed according to the needs and wishes of the researchers, so they don't have to expend any time on technicalities themselves. Even though the advantages outweigh possible disadvantages, it should be realized that compiling such an integrated database is a very time-consuming and difficult task. The integration exercise mainly stands or falls with the willingness of participating scientists and institutes to contribute and share their data. Therefore, a trust relationship between the data manager & owner is essential, as is an unambiguous data policy which clearly states the restrictions and future uses of the contributing data. This approach has been proven to be successful several times already. Within the Marine Biodiversity and Ecosystem Functioning Network of Excellence (MarBEF NoE, 2004-2009) for example, three integrated thematic databases have been developed and have given researchers better insights in the patterns and processes that influence marine biodiversity.

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Estimating missing data in streamflow time series.

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Session: Data management standards, data redistribution and data applications (Chairs: F. Hernandez (Belgium) and K. Deneudt (Belgium)

Timing: 14 December 2010, *Oude Infirmerie Room*, 15h40-16h00 (Code DAT 4)

Abstract

The present study attempts to estimate missing data in river discharge time series. This is a common problem in some Latin-American and other developing countries where low budgets and poor data collection campaign management are the case. The approach uses the Hodrick-Prescott filter in which two variants were tested, assuming heterocedastic behaviour and homocedastic by blocks (depending on the main source of the streamflow: rainfall-driven and baseflow-driven). Daily discharges signals were divided in trend and noise. The former was modeled and extended in the unknown period using Fourier series. On the other hand, noise was considered as a function of the trend and modeled employing the Maximum Likelihood Estimation in order to simulate a most probable pattern during the missing period. Furthermore, the full new signal was reconstructed joining the two-modeled components. This proposed methodology was verified in some river stations in Ecuador across Guayas River Basin (34000 Km^2) which surround the Abras de Mantequilla wetland (Ramsar Site). Further applicabilities of the outcomes would be to identify overbanking periods or complete river boundary conditions towards hydrodynamic, water allocation and climate changes simulations

Key words: streamflow time series, Hodrick-Prescott filter, homocedastic, heterocedastic, trend, noise.

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Validating ecological regions in European seas based on the European Ocean Biogeographic Information System (EurOBIS)

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Session: Data management standards, data redistribution and data applications (Chair: F. Hernandez (Belgium) and K. Deneudt (Belgium)

Timing: 14 December 2010, *Oude Infirmerie Room*, 16h00-16h20 (Code DAT 5)

Abstract

For management implementation purposes the recent European Marine Strategy Framework Directive (MSFD) divides European seas into four regions (Baltic Sea, Northeast Atlantic Ocean, Mediterranean Sea, and Black Sea) and a number of sub-regions for the Northeast Atlantic and the Mediterranean Sea. The delineation of these geographical units largely follows the ICES definition of eco-regions, but a number of boundaries or still under discussion. Combining the available biodiversity data in the European Ocean Biogeographic Information System (EUROBIS, http://www.marbef.org/data/eurobis.php) and the GIS information of the VLIZ Maritime Boundaries Geodatabase (Marbound, http://www.vliz.be/vmdcdata/marbound) a number of data products can be produced that could contribute to these discussions. First a series of GIS maps is created describing the suggested MSFD regions and subregions in terms of species richness, predicted biodiversity, and species composition of benthos, plankton, fish, mammals and seabirds. A considerable effort is made to base analyses on a reliable data selection out of the variety of data sources available in the EUROBIS system. A match of the occurring species names with the World Register of Marine Species (WORMS, http://www.marinespecies.org) accounts for synonymy and other taxonomic issues. In a second step the described eco-regions are validated using GIS layers based on cluster analysis of species composition of 1° latitude-longitude 'c-squares'. The presented data products are generated within the framework of the European Marine Observation and Data Network (EMODNET) and will be made available through to the biological portal of EMODNET (http://bio.emodnet.eu).

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When is a habitat suitability model a reliable model? Randomization techniques in habitat suitability modeling.

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Session: Data management standards, data redistribution and data applications (Chairs: F. Hernandez (Belgium) and K. Deneudt (Belgium)

Timing: 14 December 2010, *Oude Infirmerie Room*, 16h20-16h40 (Code DAT 6)

Abstract

Biodiversity and the conservation of species is a major concern in ecology nowadays.

Species are driven to extinction at a high rate due to the loss of suitable habitats. The natural habitats in the oceans are endangered, especially the sea bottom is under peril due to bottom trawling, aggregate extraction, dredging and dumping. These habitat disturbances may threaten species to disappear. Habitat suitability models can therefore be an important tool in protecting and conserving species. However, it is of major importance that the models are beyond discussion. Thus models need to be tested profoundly before they can be considered for conservation. Several potential pitfalls need to be circumvented during modelling: spatial autocorrelation, preferential sampling and overfitting.

In this study several validation techniques were applied to an extensive dataset of marine nematodes of the Southern Bight of the North Sea. The modelling software is MaxEnt. First, null-models help in identifying models significantly different from random (Raes and ter Steege, 2007). These null models can be considered as 'random species', which can be selected from the complete area or from the actual sampling stations. In this way the influence of preferential sampling can be estimated. Second, this approach is combined with a 5-fold-cross-validation, which deals with overfitting of the model algorithm. And finally, in order to detect the influence of spatial autocorrelation, this method is further improved by selecting datasets which are spatially independent.

Initially, about 85% of the 223 nematode species result in different from random models. However, if preferential sampling is taken into account only 60% of the species seem to be different from random. This number reduces even further when spatial autocorrelation is considered; independent datasets with a minimum distance of 5 or 10 km can be created for respectively 68% and 62% of the 223 species. From these remaining species only 44% result in non-random models.

Therefore, in order to create trustworthy non-random models, preferential sampling and spatial autocorrelation should always be considered.

Reference: Raes, N., ter Steege, H., 2007. A null-model for significance testing of presence-only species distribution models. Ecography 30, 727-736.

Keywords: Nematoda, habitat suitability models, null models, preferential sampling, spatial autocorrelation

Abstracts

Spatio-temporal computation

(14 December 2010 – ST)

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Spatio-temporal ecological models.

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Session: Spatio-temporal computation (Chair: Q. Chen (Beijing, China))

Timing: 14 December 2010, *Gillis Room*, 14h00-14h20 (Code ST 1)

Abstract

An ecological model is a mathematical statement of the rules governing ecosystem changes. Traditional models based on system dynamics approach provide a useful way to represent and comprehend changing behaviors in time, but it does not adequately represent spatial processes. Although Geographic Information System (GIS) and Remote Sensing (RS) are powerful tools for spatial analyses, they maintain an inherently static view of the world and fail to capture dynamics of system. Ecosystem is a system that evolves both with time and space, thus development of spatio-temporal ecological models is necessary. The paper starts from system dynamic models and extends to spatio-temporal models. Finally, it focuses on spatially-explicit and individual based models. Both continuous and discrete formulations in time, space and state variables are addressed as well. Applicability and advantage of different modelling paradigms are discussed.

Keywords: ecological models, spatial-temporal dynamics, continuous formulation, discrete formulation

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Applications of spatial-temporal modelling methods for decision-support in environmental management.

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Session: Spatio-temporal computation (Chair: Q. Chen (China)

Timing: 14 December 2010, *Gillis Room*, 14h40-15h20 (Code ST 2)

Abstract

Spatial-temporal models that model policy-relevant processes, often presented in the form of Decision Support Systems (DSS), are attracting more and more attention in the planning and policy-making community. Despite their potential, few are actually used in practice, for a wide range of reasons.
This presentation will give an overview of a broad spectrum of integrated spatial-temporal models that provide support to strategic decision making in policy organisations. To be able to support planning and policy making, these models need to be able to represent the complex interactions between humans and their environment. Furthermore, the needs of the intended users and beneficiaries of the results present particular challenges in terms of policy-relevant driver selection, the development of integrated scenarios, model transparency and credibility, model selection and integration, and aggregation and visualization of results.
The science and practice of model integration has seen many advances over the last decade, facilitated inter alia by increasing computational capacity in computing hardware and the development of methodological frameworks that provide structure to this process. This presentation will discuss advances and challenges in the state of the art regarding integrating spatially explicit models from different, often disjoint, disciplines. It will pay particular attention to the problems arising from linking models developed on different modeling paradigms and linking models that operate on distinct temporal and spatial resolutions.
The second topic will be the use of such integrated systems in practice, drawing from experience from the field and discussing various use cases carried out with these systems as well as the challenges in getting DSS applied and used over longer periods of time.
Drawing these topics together and looking ahead to future developments, the presentation will conclude with some observations on the role information technology could play in supporting the policy practitioner and overcome current obstacles, to realise their full potential.

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A concept study for modeling a pike (*Esox lucius* L.) population using a cellular automaton

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Session: Spatio-temporal computation (Chair: Q. Chen (Beijing, China)

Timing: 14 December 2010, *Gillis Room*, 15h40-16h00 (Code ST 3)

Abstract

During the last decades the pike (*Esox lucius* L.) population declined substantially in Flemish rivers (Belgium). This relapse results mainly from habitat deterioration and migration barriers, but also from water pollution and sport fishing. To reverse this tendency, river managers need to gain more insight into the spatial and temporal dynamics of pike. Although existing habitat suitability and migration models provide insight into habitat requirements of pike, they fail to provide information about this species' spatio-temporal dynamics because they either keep track of the spatial or temporal component, but never both. This paper presents a first step in the development of a model for simulating the spatio-temporal dynamics of pike that is based upon the cellular automata modeling paradigm. This modeling paradigm is increasingly being used to describe ecological processes. So far, model development and validation are based on expert knowledge on the ecology of pike. Yet, in the near future a combination of this expert knowledge with observed data will allow to apply the model to an existing natural system. This concept study emphasizes the usability of cellular automata to describe the spatio-temporal dynamics of pike, so that space- and time-related management questions may be solved.

Keywords: cellular automaton, fish, pike, habitat suitability, ecological knowledge, spatial explicit model, dynamic model

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Study on the parameter uncertainty of a catchment water quality model through Monte-Carlo fuzzy α-Cut approach.

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Session: Spatio-temporal computation (Chair: Q. Chen (Beijing, China)

Timing: 14 December 2010, *Gillis Room*, 16h00-16h20 (Code ST 4)

Abstract

Uncertainty in model results is crucial to management and decision making. Understanding and quantifying model uncertainties is an interesting and challenging subject. In the application of total maximum daily load (TMDL), estimation on margin of safety is essential, which is basically related to the uncertainty in catchment models. Model uncertainty mainly comes from formulation, parameters and measurements. A number of methods have been developed for uncertainty analyses, including fuzzy α-Cut, Bayesian updating and Latin Hypercube Sampling. This study proposed a method which combines Monte Carlo simulation and fuzzy α-Cut approach. The method was applied to investigate parameter uncertainty in a water quality model for the Cajialu catchment of the Miyun reservoir in Beijing. The modelled variables were discharge (*Q*) and total inorganic nitrogen (*TIN*). The model was calibrated and validated by field observations. Through sensitivity analyses, the upper zone drainage coefficient (*UZK*) was selected for uncertainty analyses. By using fuzzy logic theory, the membership degree of *UZK* was defined. The α-cut method combined with Monte Carlo simulation was used to investigate the relationship between uncertainty interval and safety degree of the model results under different α-cut level. Finally, a joint optimal of safety and uncertainty was found when α cut at 0.45. The developed method is more simple and applicable comparing to the rigorous α-Cut approach requiring all the detailed information, which is rarely available.

Keywords: catchment model; uncertainty interval; safety degree; fuzzy α-Cut; Monte-Carlo

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A discrete, spatially explicit and GIS-coupled model for epidemic spread.

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Session: Spatio-temporal computation (Chair: Q. Chen (Beijing, China)

Timing: 14 December 2010, *Gillis Room*, 16h20-16h40 (Code ST 5)

Abstract

During the last decades an increasing number of dynamic models describing epidemics has been developed, enabling more accurate predictions of the number of casualties and supporting officials in their choice of adequate health measures for fighting disease spread [1]. These models are commonly built upon a set of ordinary differential equations (ODEs). Partial differential equations (PDE) are mostly resorted to if attention should be paid to both the spatial and temporal component of the epidemic spread. However, spatial information is becoming increasingly available and accessible by means of GIS software, it cannot be included straightforwardly in such PDE models due to their inherent continuous nature [2,3]. Nonetheless, the spatial component of an epidemic should not be ignored in a globalized world as is brought to our attention by the recent outbreak of Mexican flu.

As such, we propose a continuous state irregular cellular automaton, called CA-SIR due to its similarity with the well-known PDE-based SIR model, for describing spatio-temporal epidemic spread and taking into account explicit spatial data on the epidemic's virulence. The current model implementation uses land cover data extracted from the European CORINE land cover database for simulating epidemic spread in a region containing Belgium with a spatial extent of approximately 62 000 km^2, and divided into 250 000 irregular cells. The land cover categorical data were used to delimit zones with similar epidemic virulence.

It is shown that the simulated spatio-temporal patterns of epidemic spread complies with the expectations on spatio-temporal disease spread (Figure 1), while the simulated temporal evolution agrees with the patterns obtained by means of classical SIR models. Though, future work should focus on the identifiability of the CA-SIR model parameters from simulated, and in a later phase from observed spatio-temporal spread data.

Abstracts

Role of ecoinformatics in supporting trait-based approaches in biological monitoring and environmental risk assessment

(14 December 2010 – T)

ISEI 7
7th International Conference on Ecological Informatics
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PCTs for Hierarchical Classification of Diatom Images.

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Session: Role of ecoinformatics in supporting trait-based approaches in biological monitoring and environmental risk assessment (Chair: Dr. K. Lock (Belgium))

Timing: 14 December 2010, *Prior room*, 14h00-14h20 (Code T 1)

Abstract

Problem definition

Diatoms are a large and ecologically important group of unicellular or colonial organisms (algae). They are characterized by their highly patterned cell wall composed mainly of hydrated amorphous silica. The cell wall can be divided into two halves. Each half of the cell wall consists of a valve and a number of girdle bands. One half is slightly larger than the other and overlaps it. Together, the halves make a cylinder, with the two valves at the ends. The cross section of the cylinder, and hence the outline of the valve, varies greatly in shape between species and genera. This, together with the pattern of pores and other markings on the valve, provides the information needed for species classification. Figure 1 depicts an example image of a diatom.

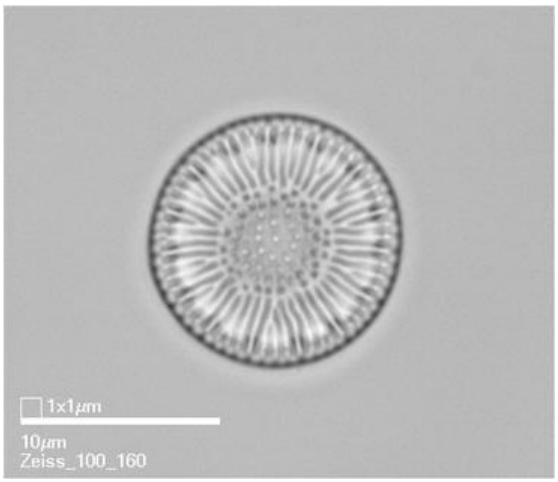

Figure 1. An image of a diatom cell from the species *Cyclotella radiosa*

In the variety of uses of diatoms, such as water quality monitoring, paleoecology and forensics, microscope slides must be first scanned for diatoms and then if diatoms are present they need to be classified. Most classifications are done using classification keys and/or comparing specimens using slides, photographs or drawings of diatoms in books and atlasses. This is not a trivial task taking into consideration that taxonomists estimate that there may be 200000 different diatom species, half of them still undiscovered, and many of these extremely hard to distinguish on the basis of morphology [1]. Furthermore, this is very tedious and repetitive work, thus any degree of automation would be a vast improvement.

Having this in mind, we propose a system for automatic diatom classification. The system contains two parts: image processing (feature extraction from images) and image classification. The image processing part converts an image to a set of numerical features that are extracted directly from the image pixels. The second part, image classification, labels and groups the images. The labels can be organized in a hierarchy and an image can be labeled with more than one label (can belong to more than one group).

Feature extraction from images

The first step in the feature extraction part is the automatic detection of diatoms in the images. After that, the system can extract different features of the diatoms, including various measures of contour, area, shape, intensity, texture etc. Most of the diatoms can be distinguished by evaluating properties of the valve outline hence contour features are of high importance in automatic diatom classification. The contour features measure the symmetry, global and local shape characteristics, as well as geometric properties, such as length and width of the diatoms, which are all easy to interpret by expert taxonomists.

An important characteristic of diatoms is also the ornamentation of the valve face, which is a specific type of texture. Here we use several known feature sets able to measure texture properties: features derived from gray level co-occurrence matrices, Gabor wavelets, scale invariant feature transform (SIFT) and local binary patterns (LBP). The application of these methods to diatom identification is especially useful for the description of morphological properties.

Hierarchical classification

The diatom species are separated/classified in several categories (taxonomic rank). These categories are grouped in a logical system of categories with hierarchical structure based on their characteristics. The most global subdivision is the genus. Within each genus there are many species which can be further divided into subspecies, varieties, forms, morphotypes, etc. Our system for automatic diatom classification exploits the hierarchical structure of this classification scheme by using predictive clustering trees (PCTs) for hierarchical multi-label classification (HMLC) [5], [7].

Hierarchical multi-label classification is a variant of classification were a single example may belong to multiple classes at the same time and these classes are organized in a hierarchy. An example that belongs to some class automatically belongs to all its super-classes, as implied by the hierarchical constraint. While in our case each diatom is only annotated with labels from a single path in the hierarchy, the PCT predictions can predict lables from multiple paths.

We use predictive clustering trees (PCTs) to automatically annotate images with classes from a hierarchy. In the PCTs framework, a decision tree is viewed as a hierarchy of clusters: the top node corresponds to one cluster containing all images, which is recursively partitioned into smaller clusters while moving down the tree [3]. Note that the hierarchical structure of the PCT does not necessary reflect the hierarchical structure of the annotations. The PCTs use

minimization of intra-cluster variance as a heuristic function that directs the construction of the tree: smaller intra-cluster variance results in more correct predictions. PCTs can be used for the following tasks: simultaneous predictions of multiple targets, prediction of time series and hierarchical multi-label classification.

To improve the predictive performance of PCTs, we use ensemble methods [4], [6]. An ensemble classifier is a set of classifiers. Each new example is classified by combining the predictions of each classifier (PCT) from the ensemble. These predictions can be combined by taking the average (for regression tasks) or the majority vote (for classification tasks). In our case, the predictions in a leaf are the class proportions (for each class in the hierarchy) over the examples in the leaf. A class is considered present if its proportion is over a given threshold.

To construct an ensemble of PCTs, we use the random forest approach. A random forest is an ensemble of trees, obtained both by bootstrap sampling, and by randomly changing the feature set during learning. More precisely, at each node in the decision tree, a random subset of the input attributes is taken, and the best feature is selected from this subset (instead of the set of all attributes). We use averaging to combine the predictions of the different trees. As for the base classifiers, a threshold should be specified to make a prediction.

Results and summary

We evaluate the presented techniques for feature extraction from diatom images and hierarchical multi-label classification on the ADIAC Diatom Image Database [2]. The dataset consists of approx 3400 images that are classified using the taxonomic rank mentioned above.

The predictive modeling problem that we consider is to learn PCTs that predict the taxonomy of the image by using the hierarchical structure and the features of the image, extracted as discussed above.

We compare the different feature extraction techniques and suggest the one that is most suitable for automatic classification of diatom images. We also contrast our results with earlier results on this dataset, which used older machine learning technology and special purpose features (contour-based). Previous work also used only a small portion of this dataset, with just a handful of species, and focused on images of high quality

To summarize, we propose a system for automatic diatom classification that consists of two parts: image processing (feature extraction from images) and image classification. The proposed approach can be easily extended with new feature extraction techniques. It can thus be applied to other similar tasks, such as the taxonomic classification of other groups of organisms.

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Relating taxonomy-based traits of macro-invertebrates and sediment pollution by means of statistical analyses.

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Session: Role of ecoinformatics in supporting trait-based approaches in biological monitoring and environmental risk assessment (Chair: Dr. K. Lock (Belgium))

Timing: 14 December 2010, *Prior room*, 14h20-14h40 (Code T 2)

Abstract

1. Introduction

To date, most approaches used in environmental risk assessment (ERA) are based on taxonomy-based descriptions of ecosystems [1]. Due to the widespread occurrence of numerous types of chemicals in the environment and ensuing environmental risks [2] there is a need to establish the mechanistic link between the response of the ecosystem and the characteristics or traits of the organisms. Biodiversity protection and restoration pose a major challenge to ERA, since each species (and individual) responds dissimilarly to a given level of environmental disturbance [2]. Recently it has become clear that conventional taxonomy-based approaches are very diverse and may not provide complete information on the risks of substances to ecosystems. As such, more general ecological and physiological insights are highly needed to support alternative ERA approaches. One of the promising approaches is Trait-based Ecological Risk Assessment (TERA) in which traits are used to examine shifts in the community composition due to pollution stress. These traits can be characteristics of individuals, species/taxa or even ecosystems [3] and influence potential exposure and response to a toxicant and the subsequent recovery from any effects [4].
The main hypothesis of the present research is that the trait composition of macroinvertebrate communities changes in a consistent manner along general environmental disturbance gradients. Here, we analyze the relationship between traits of macroinvertebrates and environmental variables (ecotoxicity test data and biological indices) characterizing river sediments in Flanders (Belgium).

2. Materials and methods

This research is based on data collected by of the Flemish Environmental Agency (VMM) in the context of their TRIAD integrated assessment of river sediments in Flanders (Belgium). A sub-set of data was selected covering field data from the period 2000-2008. This dataset consists of two cycles of four years during which 600 stations were monitored twice (2000-2003 and 2004-2007) and 75 out of the 600 stations were monitored for a third time during 2008. The available environmental variables are a combination of physical, chemical, biological, ecotoxicological and hydromorphological measurements performed on the 1,275 sediment samples. Trait information for the macorinvertebrate taxa was gathered from literature and expert knowledge. In this study, the trait that was studied was the maximum body length (solely considering the aquatic life stages). Statistical analysis was performed to establish and examine the relationship between sediment quality and the body length of the macroinvertebrates in the benthic community. In this context it is expected that a community with mixed sizes (high variance) will shift towards a community composed of smaller organisms (lower variance and smaller average size) when the environmental quality decreases.

The relationship between sediment quality and maximal body length was investigated using two different techniques. The first technique examined changes in body length frequency distributions as a function of sediment properties. The second technique was used to predict the species-abundance distribution as a function of the ecological characteristics and the sediment quality. This technique is called the Zero-Inflated Poisson (ZIP) regression model. In this study, it describes the relationship between body length and metal concentration, however, it can also be applied to other traits in future research. The reliability of both techniques was evaluated by investigating the goodness of fit based on different mathematical criteria.

3. Results

We observed that the frequency distribution of body length and of the abundances decreased as the sediment quality decreased (i.e. Biological Water Quality index change from 1 to 4). The reduction of the variance on the different length classes is also observed (Figure 1). The smallest and the larger body lengths seem to be the most sensitive to disturbance. This pattern is also observed when considering the metal contamination in the sediments. For arsenic, lead, copper and zinc the following organism's sensitivity ranking (high tot low) was noted: smallest organisms > large organisms > median-sized organisms. However, for cadmium, chromium and mercury this ranking pattern could not be confirmed. The monitoring data of the river sediments also showed that the abundances of the different taxonomic groups shifted towards lower values as sediment contamination increased. The number of different taxonomic groups present in the macroinvertebrate community also decreased with increasing pollution. This is the same trend as observed for the frequency distribution of the body length.

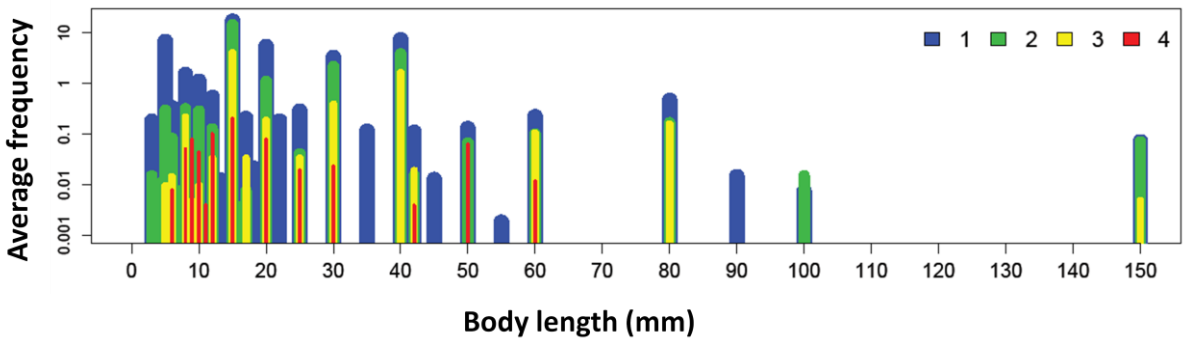

Figure 1: Average length frequency distribution as a function of the BWI (Biological Water Indices) classes used in the Triad method. The four classes represent: 1) good, 2) moderate, 3) bad and 4) very bad quality of the river sediment.

A challenging aspect of this research is the assessment of the reliability of the ZIP regression model. The low reliability of this model can be due to different factors such as the use of non-tested assumptions and the use of arbitrary classes of metal concentrations. One of these factors is that only one ecological trait and one characteristic of the river sediment (univariate approach) is used to study the relationship between the maximum body length and the metal concentration. This indirectly suggests that a change in the ecological trait is only caused by a change in the metal concentration. Another limitation is that the body length of each taxonomic group is a static value. Therefore, the variation in body length that can appear in and between populations is neglected. More aspects such as bioavailability of the metals and ecological interactions need to be included to improve the reliability of this model. However, this new technique has the potential to be used in future research on the relationships between habitat characteristics and ecological traits of organisms.

4. Conclusions

Analysis of monitoring data of the river sediments in Flanders showed that with increasing pollution, the abundances and number of different taxonomic groups decreased. The same trend was seen for the body length of the collected organisms. However, it could not be established which body length is the most sensitive to a certain metal concentration. Results of arsenic, copper, lead and zinc suggest that the smallest taxa are the most sensitive. However, for cadmium, mercury and nickel the results were unclear. To determine this degree of metal pollution based on ecological traits, traits other than body length should be taken into account. This type of research can be helpful to discover the critical traits that help the survival of these intolerant taxa.

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Application of the Fourth-Corner method to test biological trait-environment hypotheses.

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Session: Role of ecoinformatics in supporting trait-based approaches in biological monitoring and environmental risk assessment (Chair: Dr. K. Lock (Belgium))

Timing: 14 December 2010, *Prior room*, 14h40-15h00 (Code T 3)

Abstract

In recent years, a functional approach to ecosystem analysis based on multiple biological traits of species has provided new insights into the study of aquatic assemblages and their adaptation to environmental constraints. However, certain problems arise in studying relationships among trait affinity, taxa abundance and environmental constraints; in particular, how to relate these three aspects simultaneously and how to test the significance of their relationships, a difficulty known as the "fourth-corner problem". In 2008 Dray and Legendre provided an improved statistical method to address this issue, namely the fourth-corner statistic. This improved procedure offers the opportunity to work with species abundance or presence/absence, and several testing procedures for confirming or rejecting hypotheses positing trait-environment relationships. In this study, we test the ability of the fourth-corner statistic to test hypothesized trait-environment relationships in a river-floodplain ecosystem. Predictions on the effect of flooding and confinement on aquatic communities were made under the River Habitat Templet, a basic theoretical framework in river ecology. Using the implementation of the fourth-corner statistics in R 2.5.1, we found that flooding-related variables, mainly pH and turbidity, were related to traits that confer an ability of the organism to resist flooding (e.g., small body-shape, protection of eggs) or recuperate faster after flooding (e.g., short life-span, asexual reproduction). In contrast, confinement-related variables, mainly temperature and organic matter, enhanced traits that allow organisms to interact and compete with other organisms (e.g., large size, sexual reproduction) and to efficiently use habitat and resources (e.g., diverse locomotion and feeding strategies). These results are in agreement with predictions made under the River Habitat Templet and demonstrate the ability of the fourth-corner method to test hypothesis that posit trait-environment relationships. Criticisms on this improved solution to the four-corner problem will be finally discussed.

Abstracts

Applications of ecological informatics in environmental impact assessment

(15 December 2010 – AS)

ISEI 7
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Computational bioindication of wetland habitat conditions by assemblages of benthic diatoms and macroinvertebrates

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Session: Applications of ecological informatics in environmental impact assessment (Chairs: T.-S. Chon (Korea) and F. Recknagel (Australia)

Timing: 15 December 2010, *Oude Infirmerie Room*, 10h00-10h20 (Code AS 1)

Abstract

Predictive models have been developed for electrical conductivity, pH, turbidity as well as concentrations of phosphate, nitrate and silica in floodplain wetlands along the River Murray in South Australia. A cross-sectional database for water quality and abundances of benthic diatoms and macroinvertebrates of 47 wetlands was used to synthesise the models by means of hybrid evolutionary algorithms HEA.
The models require abundances of selected diatoms and macroinvertebrates as inputs. They achieve good forecasting accuracies of $0.7 < r^2 < 0.9$ and can be implemented as bioindication tools.

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Aquatic macroinvertebrates as bioindicators for the assessment of the quality of the Guayas River Basin (Ecuador).

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Session: Applications of ecological informatics in environmental impact assessment (Chairs: T.-S. Chon (Korea) and F. Recknagel (Australia)

Timing: 15 December 2010, *Oude Infirmerie Room*, 10h20-10h40 (Code AS 2)

Abstract

Aquatic macroinvertebrates communities were sampled in the middle catchment of the Guayas River Basin. Samples were collected in 12 sites: 3 sites in the wetland "*Abras de Mantequilla*" (RAMSAR site) and 9 in its influence area (mainly 3rd stream order rivers) during the dry season (August, 2009). The main land use in the area is the agriculture and two hydroelectrical projects are located upstream the study area. Physico-chemical parameters were measured in situ and ex-situ.

A total of 3490 specimens, belonging to 54 families and 11 orders were collected in the 12 sites. The class Insecta dominated the macroinvertebrate community; being Ephemeroptera and Diptera the most abundant orders with 28% and 26% respectively. Single metrics, such as abundance, richness, diversity, evenness, Biological Monitoring Working Party-Colombia/adaptation (BMWP/Col) and Average Score per Taxon (ASPT) were calculated. The sites were grouped in four water quality classes (WQC) according to the results of the BMWP/Col: good (I), acceptable (II), doubtful (III) and critical (IV).

One-way ANOVA was used to test significant difference among BMWP/Col WQC with physico-chemical parameters. Of all results, nitrogen-related parameters were significant ($p<0.05$), showing that Nitrogen components could be used as a good discriminator parameter that can help to distinguish the different BMWP/Col WQC. Spearman rank correlation was applied to explore relationships between physico-chemical and biotic (single metrics) parameters; correlation values greater than 0.7 were selected.

A Non-metric Multidimensional Scaling method (NMS) was applied to analyze the macroinvertebrate community composition, and to visualize their similarities considering the taxa composition. The method was based on the Bray-Curtis dissimilarity matrices computed from log (x+1)-transformed taxa abundances. From the results, a clear cluster can be seen grouping the sites that belong to the BMWP/Col WQC I and IV, and showing dissimilarity between both

classes. In contrast, sites belonging to WQC II and III were more spread and did not present a defined pattern.

To analyze seasonal variations in the wetland area, a T-test was applied. For this analysis, physico-chemical parameters and macroinvertebrate data from the dry season (August, 2009) were compared with data from the wet season (February 2009). In general, the majority of the parameters did not show a significant difference ($p > 0.05$) between the two seasons, with the exception of nitrites, conductivity and Odonata (%relative abundance).

Key words: Bioindicators, aquatic macroinvertebrates, wetland, tropical rivers, metrics, statistical analysis, BMWP/Colombia, water quality classes.

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Integrated and model-based ecological assessment of the Cauca river (Colombia)

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Session: Applications of ecological informatics in environmental impact assessment (Chairs: T.-S. Chon (Korea) and F. Recknagel (Australia))

Timing: 15 December 2010, *Oude Infirmerie Room*, 10h40-11h00 (Code AS 3)

Abstract

The Cauca river is one of most severe cases of pollution for domestic and industrial wastewater discharges in Colombia. The rapid urbanization and major economic development in the Cauca river´s geographical valley has led to dramatic degradation of the environment and increased health risks due to inefficient processing of the increased pollutant load effluents and solid wastes. For this reason, the main objective of this research was to contribute to the integrated water quality management of the Cauca river in Colombia, developing a mathematical model to investigate the ecological quality of this river under actual conditions as well as after different restoration actions. The approach followed was to build habitat suitability models (statistical models) that allow predicting the presence and the abundance of macroinvertebrates in this river under different conditions. An integration of these ecological models with the hydrodynamic and physical-chemical water quality model MIKE11 was performed. The integrated ecological model allows to model and assess the ecological impact of wastewater discharges into the Cauca river and calculate the needed reductions in discharges of organic matter to meet biological quality criteria in this river.

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The devil is in the details: overcoming the challenge of implementing consistent ecosystem indicators for cross-scale ecosystem understanding.

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Session: Applications of ecological informatics in environmental impact assessment (Chairs: T.-S. Chon (Korea) and F. Recknagel (Australia)

Timing: 15 December 2010, *Oude Infirmerie Room*, 11h30-11h50 (Code AS 4)

Abstract

Addressing environmental challenges requires understanding and monitoring of ecosystem responses to direct and indirect human impacts from local to global scales. Because it is generally not possible to sample at a sufficiently high density across a large spatial extent with a single data program, achieving a cross-scale understanding of ecosystem responses to global change requires the collection and synthesis of data from a number of sources, including broad-scale monitoring efforts, sensor arrays, networks of long-term research sites, and locally-collected datasets. Previous studies have highlighted the importance of data accessibility, metadata and data ontologies, database structures, and scientific workflows for discovering and integrating data. However, two critical aspects of data semantics (consistency in definitions of basic ecosystem indicators observational units, compatibility of methods of measurement) can greatly affect the ability to combine datasets measuring the same attribute. Consistency and compatibility among datasets can be achieved if there is general agreement and coordination on how observational units are defined and measured. While the need for standard indicators and methods is broadly agreed upon, the coordination and implementation of such standards has proved challenging. We review different approaches to achieving consistency and compatibility in ecological data along a continuum of observer control, from completely dispersed, independent data collection without standard protocols across sites (e.g., U.S. Long Term Ecological Research sites) to a mix of independent and standardized data collections (e.g., EcoTrends Project) and then completely centralized data collection and storage according to formal protocols (e.g., U.S. Natural Resource Inventory, National Climate Data Center). In the context of a national, multi-scale monitoring effort being developed for the U.S. Bureau of Land Management, we then consider external factors that have necessitated adoption of standard indicators and methods and the impact these are having on the degree to which datasets can be integrated to answer questions across a range of spatial scales. Finally, we provide recommendations for implementing minimum standard indicators and methods for ecological data collection that can be supplemented for local needs. Improving data consistency and compatibility through standard indicators and methods will support a broad-scale framework for synthesis of ecological information that is necessary to link different sources of data across scales to address pressing environmental challenges at scales at which they are occurring.

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Computational bioindication of wetland habitat conditions by assemblages of benthic diatoms and macroinvertebrates

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Session: Applications of ecological informatics in environmental impact assessment (Chairs: T.-S. Chon (Korea) and F. Recknagel (Australia)

Timing: 15 December 2010, *Oude Infirmerie Room*, 11h50-12h10 (Code AS 5)

Abstract

Predictive models have been developed for electrical conductivity, pH, turbidity as well as concentrations of phosphate, nitrate and silica in floodplain wetlands along the River Murray in South Australia. A cross-sectional database for water quality and abundances of benthic diatoms and macroinvertebrates of 47 wetlands was used to synthesise the models by means of hybrid evolutionary algorithms HEA.

The models require abundances of selected diatoms and macroinvertebrates as inputs. They achieve good forecasting accuracies of $0.7 < r2 < 0.9$ and can be implemented as bioindication tools.

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Integrated urban water system modeling of the Drava river (Varazdin, Croatia) for cost-efficient wastewater treatment selection to meet the requirements of the European Water Framework Directive

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Session: Applications of ecological informatics in environmental impact assessment (Chairs: T.-S. Chon (Korea) and F. Recknagel (Australia)

Timing: 15 December 2010, *Oude Infirmerie Room*, 12h10-12h30 (Code AS 6)

Abstract

This study used the integration of wastewater treatment, river water quality and ecological assessment models to study the effect of improving wastewater treatments systems and their ecological results for the receiving river. For the ecological modeling, the approach followed was to build statistical models called Generalized Linear Models (GLMs) (parametrical method, that provides users with a conventional mathematical function), which are mathematical extensions of linear models for non-linearity and non-constant variance structures in the data. GLMs are better suited for analyzing ecological relationships, which can be poorly represented by classical Gaussian distributions. Two types of Logistic regression models were built, one for predicting the biological quality related to abiotic river conditions considering the MMIF index, and other for predicting the presence or absence of macroinvertebrates and to establish the relation between river conditions and particular indicator taxa. The ecological models developed were satisfactory, and showed a good predictive performance and good discrimination capacity.

In order to have an integrated ecological modelling for decision support in the Drava river management, the ecological models where integrated to the hydrodynamic and physical-chemical water quality model – WEST. Using this integrated ecological model seven scenarios were run and evaluated (Figures 6). These scenarios were: 1) no discharge of WWTP effluent; 2) improvement of WWTP treatment with N and P removal; 3) current situation and; 4) discharge of untreated WWTP influent. Using the integrated ecological model for the Drava river, seven scenarios were run and evaluated. These scenarios were: 1) upstream treatment and improvement of WWTP treatment with N and P removal; 2) upstream treatment and current situation; 3) upstream treatment and no discharge of WWTP effluent; 4) no discharge of WWTP effluent; 5) improvement of WWTP treatment with N and P removal; 6) current situation and; 7) discharge of untreated WWTP influent (no treatment). This kind of integrated approach is useful to get insight in aquatic ecosystems, for finding what is necessary to improve in the integrated river water management and policy development. This integrated model allows investigating the

ecological quality of the Drava river under actual conditions as well as after different restoration actions.

The scenario assessment showed that it is necessary an integrated approach for the water management at the Drava river, which considers an improvement of the WWT system with N and P removal, the treatment of the scattered waste water discharges into the small channel, which are located upstream the WWTP and an increase in the amount of water released by the dams. An optimization of these ecological models by including additional data and hydraulic variables, would make possible to estimate the needed reductions in wastewater discharges of organic matter and the amount of water necessary to be released by the dams, in order to meet biological quality criteria in this river.

Abstracts

Ecoinformatics to support studies on evolution and climate (change)

(15 December 2010 – CL)

ISEI 7
7th International Conference on Ecological Informatics
13 – 16 December 2010

Ghent University
Ghent, Belgium

Does genetic adaptation to chemical pollution prepare natural populations of daphnia for climate warming?

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Session: Ecoinformatics to support studies on evolution and climate (change) (Chairs: K. De Schamphelaere (Belgium)

Timing: 15 December 2010, *Gillis Room*, 10h00-10h20 (Code CL 1)

Abstract

Natural populations can only persist if they can deal sufficiently with chemical and non-chemical stressors in their habitat. We investigated if *Daphnia pulex* from the Sudbury region (ON, Canada) that have genetically adapted to Cd stress, would show a lower or a higher tolerance to climate change compared to non-Cd-adapted *D. pulex*. The climate change stressor considered was the presence of toxic cyanobacteria in the diet, since cyanobacterial blooms are predicted to increase in incidence and intensity under climate change. We performed a full three-factorial study with D. pulex clone (Cd-adapted vs. non-adapted), Cd (control and 500 ng/L) and cyanobacterial (control food vs. 50% *Microcystis aurigunosa* in food) as the factors. A 21-day life table experiment showed that reproduction was not significantly affected by either Cd, *Microcystis* or combined exposure in the Cd-adapted clone, thus demonstrating cross-tolerance. On the other hand, the non-Cd-adapted clone exhibited a pronounced reproductive inhibition following Cd (by 58%), Microcystis (by 59%) and combined exposure (by 82%). The inhibition under the combined exposure was in agreement with the expectation from the independent action model of mixture toxicity, suggesting no interactive effect of the two stressors. Metallothionein (Mtn-1) expression across the 8 treatments showed different patterns than fitness, suggesting that Mtn-1 is not the only gene involved in stress response, adaptation and cross-tolerance to Cd and *Microcystis*. Further, we performed a genome-wide expression analysis using a an ultradense (12 x 135k probes per slide) microarray platform (Roche/NimbleGen), holding triplicate probes of every gene (approximately 30,000 genes in total) of the recently sequenced and annotated *D. pulex* genome. While only a limited number of genes was differentialy regulated by Cd exposure in both clones, 5761 genes were differentially regulated by *Microcystis* exposure, 4250 of which were uniquely regulated in the non-Cd adapted clone. The data further suggest that genes in energy metabolism and detoxification pathways may be involved in tolerance to *Microcystis* exposure. Our work sheds light on how populations might deal with and evolve under long-term combined chemical and climate change stress. This research benefits from, and contributes to the Daphnia Genomic Consortium.

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Individual Based Model Applied to Macro-invertebrate Communities in Response to Climate Change.

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Session: Ecoinformatics to support studies on evolution and climate (change) (Chair: Prof. K. De Schamphelaere (Belgium)

Timing: 15 December 2010, *Gillis Room*, 10h20-10h40 (Code CL 2)

Abstract

Recently global climate change has been the key issue in ecological sciences. Monitoring and management of ecological responses are urgent in keeping ecosystems sustainable and survivable. Climate change would cause changes in community dynamics, and especially macro-invertebrates would be sensitive to temperature, since macro-invertebrates are poikilothermic. To elucidate community responses to temperature change in macro-invertebrate communities, the Individual Based Model (IBM) developed to include life events such as birth, death, activity, competitions development and tolerance. Tolerance ranges in temperature species distribution were accordingly illustrated in response to the long-term temperature change. Population and community dynamics were further presented by illustrating population changes and species abundance distribution in response to temperature increase. The species abundance distribution revealed the impact of temperature change through variation in community types. The individual-population relationships were further discussed in revealing ecological processes in response to environmental disturbances.

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Application of Self-Organizing Maps to Grass Community Patterns in Response to Temperature Change.

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Session: Ecoinformatics to support studies on evolution and climate (change) (Chair: Prof. K. De Schamphelaere (Belgium)

Timing: 15 December 2010, *Gillis Room*, 10h40-11h00 (Code CL 3)

Abstract

Climate change has been an important issue regarding sustainability of ecosystems in global and local scales recently. Especially, tolerance changes are a primary factor in determining community responses to temperature increase. Adaptability to temperature and other related environmental factors (e.g., soil moisture) would determine species abundances patterns in spatial and temporal domains of grass communities. Self-Organizing Maps (SOMs) were applied to information extraction of plant distribution data. Biomass, tolerance range, and other ecological and geographical information are used as variables for the network. Subsequently climate data based on Intergovernmental Panel on Climate Change (IPCC) reports were provided as environmental conditions. Along with changes in temperature, species compositions and abundance patterns were correspondingly variable in different regions. Temperature increase was likely to be the key factor in controlling species composition such as C3 and C4 plants. The relationships between grass community and the effects of climate changes in spatial domains were further discussed to provide information on monitoring and management of grass community dynamics.

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Abstracts

Education and training in ecological informatics

(15 December 2010 – ET)

ISEI 7
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Ghent, Belgium

Progressive Knowledge Representations for Learning Conceptual Knowledge of System Behaviour[2]

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Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands))

Timing: 15 December 2010, *Persconferentie Room*, 10h20-10h40 (Code ET 2)

Abstract

The work presented here is part of the DynaLearn project (http://www.DynaLearn.eu), which builds an Interactive Learning Environment to support a constructive approach to having learners develop a qualitative understanding of how systems behave.

There is ample research that points out the importance of learners constructing conceptual interpretations of system's behaviour (e.g. [3,5,7,10,11]). There is a need for software that 'goes beyond data handling' and supports learners in actively dealing with the theoretical concepts involved. This can be achieved by having learners create models and perform concept prediction and explanation [6,8,10]. However, such techniques are sparsely available or too complex to use, and therefore seldom part of prescribed learning activities [9].

This paper presents knowledge representations for articulating conceptual knowledge. Particularly, it discusses the idea of a set of representations, which act as sequence of progressive scaffolds to support learners in developing their conceptual knowledge. The representations are referred to as Learning Spaces (LSs) and based on Qualitative Reasoning (QR) technology (cf. [1,4]). A qualitative model provides formal means to externalize thought. It captures the explanation the creator of the models believes to be true of how and why a system behaves. The approach is domain independent.

In DynaLearn we utilize the full expressiveness and potential of the QR formalism based on Garp3 [2]. This allows us to divide the qualitative system dynamics phenomena over a range of LSs of increasing complexity, implementing a progression where at 'the next level' learners are confronted with additional and alternative expressive power for representing and reasoning about the behaviour of systems, and hence facilitating the construction of a better understanding of the phenomena involved. As such, six LSs have been designed and implemented, and will be discussed in the full paper: (1) Concept map, (2) Basic Causal Model, (3) Basic Causal Model with State-grap, (4) Causal Differentiation, (5) Conditional Knowledge, and (6) Generic and Reusable Knowledge.

Two aspects guided the design of the LSs: the logic of the representation and the ability for a representation to capture relevant system behaviour (for the latter, see the goals mentioned

[2] This work is co-funded by the EC in FP7, Project no. 231526, http://www.DynaLearn.eu.

below in the sections describing each LS). LS1 is the smallest subset of ingredients that constitute a meaningful subset from the representation used by this engine. Effectively this subset of modelling ingredients allows the construction of concept maps, consisting of nodes connected by arcs. Defining a higher LS is done by augmenting the current space with the smallest subset of possible modelling ingredients while ensuring that the next level is self-contained. Self-contained implies that the representational primitives available within a LS form a logical subset of all the primitives available. Hence, they allow for automated reasoning on behalf of the underlying software. It also implies that from a Qualitative System Dynamics perspective, learners are able to create meaningful representations of the phenomena they perceive when observing the behaviour of a real-world system.

In the DynaLearn software, learners construct knowledge by manipulating icons, and their inter-relationships, using a diagrammatic representation. The diagrams represent models that can be simulated confronting learners with the logical consequences of the knowledge they represented.

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Design Decisions for Virtual Characters in the DynaLearn Interactive Learning Environment.

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Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands)

Timing: 15 December 2010, *Persconferentie Room*, 10h40-11h00 (Code ET 3)

Abstract

In this contribution we report on how we designed, created and evaluated a cast of virtual characters for the interactive learning environment "DynaLearn". Our goal was to create characters that enable learners to interact with the different parts of the software in an easy, intuitive, unobtrusive as well as motivating and engaging way. Furthermore, ecological topics like cause-effect relations in ecosystems covered by the software's learning contents were meant to be picked up by the character design for consistency and completeness. The outcome of our design phase in this context is a set of cartoonish humanized hamsters. By choosing animals in general, we connect the virtual characters and ecological topics so learners can interact with natural life forms on screen. When using the software features of teachable agents and adoptable pets, this reflection of the human-environmental interaction becomes even stronger. Hamsters do not only pick up the idea of virtual pets literally, but knowing about the danger of extinction of some hamster genera brings up the issue of humans' environmental responsibility again.

We decided to mix up the animal appearance with anthropomorphic characteristics, human behavior patterns and the ability to speak for smoothing their integration into the educational environment, to match their functional tasks in the learning process and to support the impression of intelligent characters. Consequently, the graphical style resulted in a non-realistic cartoon design which gives us the possibility to exaggerate animations and expressions without appearing implausible or absurd. These emphasized expressions in turn ease the graphical transmission of comprehensible educational and technical software feedback compared to realistic human animation which might be more discreet and therefore less intuitively understandable.

The DynaLearn workbench provides different use cases and events like help and feedback functionality whose content is communicated by the virtual characters. To avoid overloading a single character with different purposes and taking the risk of confusing the learner, a group of hamsters was built and the functional load dived among them. Different personalities and roles ease the identification of meaning for the learner and increase the dramaturgical aspects of the on-screen society which decreases monotony. By staging the group of virtual characters in the

form of a school yard scenario we approach the learner's real situation. This setup requires personalities of various characteristics, levels of competence, models of activity and social roles. The learner interacts with experienced adult hamsters that offer supporting help and feedback as well as student hamsters that can be trained, fed with knowledge and sent to challenges.

Creating graphical character designs that transmit different personality roles requires careful design decisions so that the characteristics of each character is reflected clearly in the visual form. Separate color sets and props (such as glasses) used in the character design were applied to categorize and group characters by their roles in the software as well as in the virtual community of hamsters. Each character's style of motion and the used gesture space were furthermore adapted according to the personality and characteristics to be expressed.

We conducted two studies among members of the target group in order to evaluate the design of our characters. The first study aimed solely on the graphical design of the characters and whether it subtly communicated the intended roles and personalities. The second study's goal was to evaluate the effect of the characters' functional and dialog behavior in the context of the software environment. It turned out that the intended suggestion of functionality, roles and graphical design matched the perception of the studies' participants very well.

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DynaLearn in school: introduction to qualitative reasoning modeling for secondary school teachers

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Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands)

Timing: 15 December 2010, *Persconferentie Room*, 11h30-11h50 (Code ET 4)

Abstract

Learning by modeling has been seen as an advanced way to develop scientific inquiry capabilities and related reasoning skills. This is the main focus of DynaLearn (DL), an EU funded project aiming at the development of a modeling workbench that integrates three cutting the edge technologies: qualitative reasoning, virtual pedagogical agents and ontology mapping (www.dynalearn.eu). The software offers six modeling environments (Learning Spaces, LS), described as follows: Concept Map (LS1), Basic causal model (LS2), Causal model with state graph (LS3), Causal differentiation (LS4), Conditional knowledge (LS5), and Reusable knowledge (LS6).

Teachers are key partners in the learning by modeling enterprise, as they are the ones to offer the student curriculum opportunities for the development of models and to explore in all the possible ways the development of cognitive competences and abilities related to the model building process.

This paper describes the experience of 21 teachers of different disciplines (Biology, Chemistry, Physics, Mathematics, Portuguese, Philosophy, etc.) being introduced to DL and to modeling, in a 15h course held at a public secondary school in Sobradinho, a small town 35 km far from Brasília, Federal District, Brazil.

The main goals of the course were to present conceptual modeling using DynaLearn software and to investigate the teachers' opinion about the software. The methodology included an introductory lecture; after that, focus was given to modeling with DL, mainly in an evolving model-mode (the user develops a model guided by the researcher), or in a build-model mode (the user has full access to software and may create a model starting from the scratch. The collaborative modeling-mode will be used in all classes, with teachers working in pairs.

The teachers were involved in a broad set of modeling activities, exploring the lake as an ecosystem, conservation of natural resources, and other issues. Initially, the teachers were introduced to the concept map (LS1), both to inspect a map and to create their own representations at this level. Next, the teachers were exposed to LS2 by recreating models implemented by the researchers, changing models already done by the researchers, and by creating new models by starting from scratch, after consulting specific written texts. Some topics

(e.g. biomagnification) were further explored in LS3 and in LS4 (e.g. polluting and cleaning the lake). At the end of the activity, 8 teachers completed two questionnaires developed for collect their impressions on motivation and attitudes, and on the modeling activities, and wrote texts about how they foresee the use of conceptual modeling in the short term.
The answers to the questionnaires and texts were very positive and full of interesting ideas for further development of the software. Challenging is to create didactic materials that capture heuristic knowledge that may support learners and teachers while transforming vague ideas or fragmented knowledge into formal representations that may be used to simulate the system behaviour and to predict the future of the system under specific initial conditions.

This work is co-funded by the EC within FP7, Project no. 231526. For further information, visit http://www.DynaLearn.eu

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Issues and opportunities for learning by conceptual modelling: a pilot case study of the new DynaLearn integrated learning environment

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Timing: 15 December 2010, *Persconferentie Room*, 11h50-12h10 (Code ET 5)

Abstract

Learning by modelling, where students develop their understanding of concepts by building or exploring models, has been promoted as an important educational activity because it not only enables students to enhance their understanding of a topic but also to develop core skills and competences that are essential within scientific disciplines. One such modelling approach that could be applied in an educational setting is qualitative conceptual modelling, a computer-based Artificial Intelligence approach. This approach enables modellers to build mechanistic models and develop reasoning about systems behaviour without the need for numerical or empirical models. The EU-funded FP7 project DynaLearn is developing a learning environment and curricula that both furthers the technological capabilities of conceptual qualitative modelling and explores the requirements and opportunities for learning by modelling within the domain of environmental sciences. Within the DynaLearn system a number of learning spaces are available for students to develop models and model expressions at different levels of complexity using different modelling primitives. The software enables students to build models ranging from traditional concept maps, through formalised representations of systems structures and basic notions of causal relations, to qualitative models that utilise hierarchies of re-usable knowledge fragments.

This paper presents the results of small pilot case-study to test the prototype DynaLearn environment, to explore the potential for conceptual modelling activities to be used in a classroom setting and to evaluate the response of students. A small group of volunteer undergraduate students with no previous experience of qualitative modelling undertook a series of four modelling workshops exploring the capabilities of three of the learning spaces within the DynaLearn software. Three of the workshops were based around modelling tasks addressing concepts related to climate change scenarios, whilst the remaining workshop acted as an introductory session to qualitative modelling. Within each session the students were asked to undertake a modelling task and then to use those models to help with a written exercise that required them to describe the system being modelled and reason about the potential system behaviour under different scenarios. The four sessions consisted of:

1. Students creating concept maps from stimulus material (short texts and diagrams) to help them answer a given problem related to climate change.

2. Students being introduced to qualitative reasoning modelling and building models in DynaLearn, using photosynthesis as a topic.
3. Students translating a concept map on climate change into a basic causal model in learning space 2 of DynaLearn.
4. Students developing a causal differentiation model (learning space 4) from a given basic causal model (expanding causal relations between quantities from simple positive and negative relations to the formalised representations of direct influences and proportionalities).

The work undertaken by students and their experiences were recorded using four instruments. Firstly, the students' models were analysed as the output of their modelling activity, secondly at the end of each session on climate change the students were given the same written assignment requiring them to describe the system they had modelled and to reason about and explain potential behaviours under different scenarios. The written assignment was the same in each session and the answers were analysed to determine whether the different modelling activities affected their understanding, their descriptions or their reasoning ability. At the end of the series of workshops students were asked to complete a questionnaire concerning their experience and to submit a short diary detailing their experiences given a series of open questions as prompts.

The experiences of the volunteer students and the patterns observed in their modelling and written output highlighted a number of issues related to the requirements of learning by qualitative conceptual modelling. The two main issues that were observed related to the students' ability to extract and collate the important information from the stimulus materials sufficient to address the given problem and their ability to then translate that knowledge into the formalised reasoning "language" of qualitative reasoning in DynaLearn. These issue present great opportunities for DynaLearn to address through enhanced technology and development of suitable curricula and modelling activities. Whilst the first issue is not solely an issue related to learning by modelling it is an essential competency for modelling and thus an aspect that learning by modelling should address. The DynaLearn software is addressing this aspect by developing technologies allowing students to freely build models whilst receiving feedback and guidance based on comparison of their models with a teacher's model stored in an online repository. The second issue related to learning the new "language" of modelling highlights the need for modelling curricula and activities to be developed that ideally enable students to simultaneously learn domain knowledge at the same time as developing modelling and reasoning competencies. These modelling skills and competencies can then be transferred to other modelling modes and activities to learn other domain knowledge.

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Learning by modeling: an attractive approach to learning environmental systems knowledge for secondary school students

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Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands)

Timing: 15 December 2010, *Persconferentie Room*, 12h10-12h30 (Code ET 6)

Abstract

Current trends in science education point out to the importance of knowledge construction by students through an active interaction with the learning environment. Modeling activities will become part of science education, and will contribute to the learners' scientific reasoning. While involved in modeling tasks, learners acquire an understanding of the concepts at hand by exploring, building, using and testing computer models. Qualitative conceptual modeling has a great potential to support the learning by modeling approach as it provides a compact set of modeling elements, a formal language based on explicit representation of causality combined with mathematical foundations and the possibility of expressing heterogeneous, incomplete or uncertain knowledge and still run simulations to express the dynamics of (physical, biological, social etc.) systems without using numerical data.

The work described in this paper aims to present the results of an evaluation study of DynaLearn, a learning environment that combines qualitative reasoning, virtual pedagogical agents and semantic ontology (www.dynalearn.eu). This software is intended to be used primarily by secondary school and undergraduate students in a learning by modeling context, exploring a curriculum on environmental science, and, for the present study, principles of conservation biology.

The evaluation work was conducted in a public secondary school where 21 second year students, 15 to 17 years old, participate in a workshop on conducted by the authors of this paper. The workshop lasted 18 hours during which expositive dialogued lectures, discussion about relevant topics based on selected texts, and modeling activities were performed. The software DynaLearn (DL) was used as a learning workbench for the students to model knowledge about dynamic systems and, this way, to understand concepts and principles of conservation biology and their implications. DL presents a graphical interface where it is possible to access six different modeling environments, called Learning Spaces (LS), varying the quantity and types of model ingredients available for modeling activities. The most basic Learning Space

(LS1) allows for building conceptual maps and the most complete or complex Learning Space (LS6), to build generic and reusable models. During the workshop the students were asked to inspect, create and simulate qualitative models about fragmentation and devastation of the Cerrado biome due to agricultural expansion in LS1 (concept map) and LS2 (basic causal model); deforestation in LS3 (basic causal model with state graph); and main factors of biodiversity loss in Learning Space 4 (Causal differentiation model). To evaluate their experience with DL and modeling and reasoning about the issues explored in the workshop, two questionnaires were applied after the modeling activities and answered by 11 students.

The students were able to build models about the subjects discussed in class. Initially they expressed their understanding of the system in concept maps (LS1), including much more details than they did in LS2 and LS3. In doing so, they were developing the capacity of focusing on relevant aspects of the system to model. It was observed also that the students were able to correctly express causal relations between the objects and the variables in LS2 and LS3 and to correctly identify positive and negative influences.

Overall the students reported that the modeling activity was a motivating task, and agreed with the idea that modeling is an interesting approach both for teaching and learning. For some students, conceptual modeling is a totally new approach. Moreover, it was appointed by the students that this type of activity encourages a new way of thinking about the behavior of the ecological and environmental systems: “the software is really impressive, I could see problems our society is facing in a different way”.

Students reported no major difficulties in the tasks of identifying and extracting key information from relevant texts of reference used for the model development. Also, in general they agreed that, having built models, it was easier for them to express the same concepts in written texts.

The students did not indicate great difficulty in understanding and in describing the structure and behavior of the system when transposing knowledge expressed in concept maps into basic causal models. We notice, however, greater difficulty in understanding of the differences between direct influences and qualitative proportionalities, causal dependencies that respectively represent processes, the initial cause of changes in the system, and the modeling element used to propagate the effects of processes.

Asked about the course and the experience of using the software, the students considered very interesting the learning activities and showed a favourable opinion towards DL. One of the students said “I liked everything a lot, DynaLearn is a new way of learning; it was a little complicated in the beginning, but as time pass by our understanding is improved by the practice”.

After exploring problems related to biodiversity conservation in DL, students said they understand these topics much better, demonstrating greater interest on the potential of DL in the learning process: “I found this new software very interesting, because I think it would help very much learning in classroom; it is something different, and as a general rule, different things call our attention”.

Students agreed that modeling with the DL software opened up new ways of thinking about the natural systems. This argument can be found in statements like “What I found more interesting is that, after we establish some relations, it ‘thinks’ for us!” Another student “liked that it is possible

to better organize the knowledge and run simulations starting from some influences and quantities".

Thus, it seems that the software has promoted stronger ties between students and the subject matter, which facilitated and motivated them to participate in the activities proposed by the researchers, thereby learning the objects of knowledge, and hopefully developing scientific reasoning skills about the behavior of dynamic systems.

These results support the idea that learning by modeling may change the way students interact with their environment, possibly applying knowledge acquired at school and assuming a pro-active attitude towards their reality. As mentioned by one student: "Now all the polemic issues I see on the news, I feel like doing a model, even if mentally, pointing out which are the entities, quantities, causal relations… Anyway, it was very helpful!"

This work is co-funded by the EC within FP7, Project no. 231526. For further information, visit http://www.DynaLearn.eu

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7th International Conference on Ecological Informatics
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Ghent University
Ghent, Belgium

A new curriculum for teaching conceptual systems understanding of river catchments.

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Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands)

Timing: 15 December 2010, *Persconferentie Room*, 14h00-14h20 (Code ET 7)

Abstract

Humans have changed riverine landscapes all over the world in a way that their natural ecological functions are critically impaired. Integrated river basin management is therefore one of the biggest challenges of the 21st century (UNESCO IHE). Achieving the Millennium Development goals and the goals of the EU Water Framework Directive of coupling human welfare with healthy riverine environments is only possible when the co-dependence of people and of ecosystems are acknowledged and physical, chemical, biological, social, economic and political issues are adequately considered.

To achieve understanding of the highly complex interactions between humans and the biophysical properties of catchments, particularly under the current global change scenarios, an ecosystem approach has to be taken. Interlinked models at different scales tackling across a wide variety of scientific disciplines including human behaviour and social sciences are needed. Furthermore, education represents a crucial part in integrated management and sustainable development. But environmental education in secondary schools in Europe increasingly fails to attract students, as environmental issues are perceived as too complex. Within the DynaLearn (DL) project (http://www.dynalearn.eu), an interactive, hierarchically structured learning environment able to capture and simulate causal relationships across disciplines and scales is being developed. The DL software is based on qualitative reasoning, a research area within artificial intelligence (AI), and as such it provides means to integrate knowledge of different grain and extent without using numerical information.

Six Learning Spaces (LS) including concept maps, generic causal reasoning, qualitative system dynamics simulations based on rates, state variables, assumptions and agents allow for a cross disciplinary exploration of practically every topic at different levels of complexity. Another important feature of the software is the potential to simulate non-linear dynamics and emergent properties of systems. Accompanying the DL software a new curriculum based on a constructivist and hierarchical ecosystem approach including thermodynamics and archetypical system patterns is being developed.

The basic structure of the new curriculum and selected models integrating biological and physical processes in river catchments will be presented.

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Semantic enrichment of models in DynaLearn learning environment.

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Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. correa (Brazil) and B. Bredeweg (The Netherlands)

Timing: 15 December 2010, *Persconferentie Room*, 14h20-14h40 (Code ET 8)

Abstract

In this work we present our contribution to the DynaLearn learning environment. DynaLearn is an interactive modeling tool for education based on the "learning by modeling" approach. DynaLearn allows students to build Qualitative Reasoning (QR) models to formally represent a domain of their interest. This process helps the students to get a better understanding of the domain and to predict the behavior of the modeled system in view of the possible changes.
Even though the isolated creation of models has significant benefits for the students, those benefits can be increased by a collaborative modeling approach. In this case, students have access to an increasing number of resources, which are the QR models created by experts or other students. This gives them the opportunity of reusing knowledge from those models to improve their modeling experience. In addition, the models built by experts can be used as reference to evaluate the students' models and generate valuable feedback to help them in the process.

In this context, we apply semantic techniques to facilitate the modeling process by exploiting the available models in order to identify the knowledge pieces that might be relevant to a specific student. These techniques allow the automatic generation of semantic feedback and recommendation, thus semantically enriching the models.

By means of techniques of ontology matching, we can automatically detect the semantic differences among the models. The types of differences we can point out to the students include differences in the used terminology, like the chosen names of the terms, terms that should be present in the student model or terms that should not be. Inconsistencies in the hierarchy of terms can also be detected. Finally, we can exploit the particular semantic of the QR vocabulary to perform more QR-specific comparisons between models. In fact, we can identify differences in the model structures that can modify the final behavior of the model. The final set of differences found during this process is used to generate feedback to the students. In DynaLearn, this feedback is provided by virtual characters in form of suggestions given along a dialogue with the student.

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Development of ecological assessment models for the European Water Framework Directive: key issues for trainers in datadriven modeling approaches

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Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands))

Timing: 15 December 2010, *Persconferentie Room*, 14h40-15h00 (Code ET 9)

Abstract

One of the objectives of the course 'Ecotechnology' (taught at the Faculty of Bioscience Engineering, Ghent University) is to instruct students on making datadriven models. The tutors make use of a realistic case study during which students build their own predictive water quality models. The case can be summarized as: 'The European Water Framework Directive (WFD) (EU, 2000) requires the European member states to achieve a good ecological and chemical surface water quality by the year 2015. In order to achieve a good water quality, the European member states should take measures. The impact of these measures on the water quality is not straightforward, because aquatic systems are exposed to various external pressures (especially effluents from population, industry and agriculture). River managers lack predictive tools to help them decide how they can most effectively allocate the limited resources for ecological restoration. The possible ecological impact of measures can be predicted using numerical models relating the biological status with physical-chemical variables. Please make this kind of models in the Flemish context.'

In order to solve the task, students have two main subgoals. First, they have to create ecological models that relate physical-chemical properties of the rivers and lakes with the corresponding biological statuses. In order to find these relations, they should make use of datadriven techniques such as classification and regression trees and artificial neural networks. The resulting models are typically composed of multiple knowledge rules, which are in a second step applied on a new dataset, containing simulated physical-chemical properties of the Flemish rivers for the years 2015 and 2027 and for different measures river managers can take. So, the application of the knowledge rules (=relation physical-chemical properties with the biological statuses) on the second dataset results in predictions of the biological statuses for the years 2015 and 2027 and for the different measures. Finally, based on the predicted biological statuses, students can decide which measures are best implemented in the short run.

After a short introduction to the Waikato Environment for Knowledge Analysis (WEKA; Witten & Frank, 2005 version 3.6.1) students are divided into small groups and start building their own models guided by a manual. There is no single solution as both parts of the exercise make use of realistic field data. So, students have to decide themselves whether they have generated a

reliable model. They should evaluate their models based on mathematical criteria, ecological insight and user convenience (clarity, simplicity and applicability of the knowledge rules).
During the evaluation of the reports it became clear that all groups evaluated their models based on the mathematical criteria which is the most easy part. Some groups had difficulties to interpret the derived knowledge rules from an ecological point of view. Only one group executed the sensitivity analysis correctly, whereas several groups used models which were relatively complex.

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Habitat suitability modeling for Master of Science students: case of pike modeling in Flanders

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Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands))

Timing: 15 December 2010, *Persconferentie Room*, 15h00-15h20 (Code ET 10)

Abstract

The aim of this practical exercise was to apply the data driven (static) modelling techniques to 'real' ecosystems and in the practical context of water management, and in this case the threatened fish species pike was chosen as study object. The exercise aimed to make students familiar with the 'ecological engineering' course content both from a theoretical as practical perspective, and apply state-of-the-art methods with real data from contemporary river monitoring campaigns of the Flemish Environment Agency.

In the provided PhD work of Zarkami (2009), Pike was studied based on habitat suitability modeling and 4 model development techniques were used. The aim each of the groups of students was to optimize one of these four techniques, and place the results in a practical context (data collection, model development, river management). The students present the work to fellow students, in which the explanation of the modelling technique was a key part.

The report had to consist of the following components:
- Ecological description of pike (focus on relevance for the model exercise)
- Description of the modeling technique, and what are the options/limitations in WEKA. Compare with other modeling software if you think this is relevant (e.g. Matlab, R)
- Model goals and purposes (these have to be used as criteria for variable selection and for the evaluation of the models), and related model development approach
- Description and analysis of data (based on your own folds, reshuffles, …)
- Selection of the variables and instances (preprocessing) and determination of the optimal number of folds in case you use cross-validation
- Development of a (set of) model(s) based on classification trees, neural networks, ...
- Evaluate the theoretical performance, ecological relevance and practical use of the models
- Potential future research/improvements and practical applications (general description or a practical simulation example)

This presentation will provide a set of conclusions related to this experience on practical implementation of habitat suitability modeling for Master students. Based on this, a set of pitfalls and ways to improve this type of teaching are provided.

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Learning By Qualitative Modeling: Undergraduate Students' Conceptual Understanding of Ecological Systems

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Tel Aviv University

Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. correa (Brazil) and B. Bredeweg (The Netherlands)

Timing: 15 December 2010, *Persconferentie Room*, 15h40-16h00 (Code ET 11)

Abstract

Understanding the structural and behavioral aspects of complex systems has become a challenging intellectual endeavor for scientists and science students as well. Since the development of systemic approaches in the early years of the previous century, the shift in perspective enables scientists to study phenomena and processes in the world focusing on aspects, interrelationships and processes that were overlooked by traditional Science. From the educational perspective, the "acculturation" of these novel approaches, methods and tools into educational practice is not trivial. At the conceptual level, the systems approach as well as specific concepts embedded in it (e.g., emergence, self-organization, non-linearity, feedback) represent a serious learning challenge for many students. Portions of this knowledge appear to them epistemologically counterintuitive, and/or incongruent with the approaches, assumptions and practices characterizing the way they learn Science with the curricula prevalent in educational systems. At the methodological level the new approaches demand learning the languages, tools and methods required to model and explore systemic phenomena. "Learning-by-modeling" (LbM) represents by itself a challenging endeavor. The study reported in this paper aimed to examine undergraduate students' learning of ecological systems concepts by constructing models of these systems using **qualitative modeling** (QM) software . The study's main research questions focused on whether students' involvement in QM of ecological systems supported their: (1) understanding of ecological concepts; (2) adoption of a system thinking mode for understanding the complexity and dynamics of ecological systems; (3) learning of modeling capabilities; (4) motivation to learn Science in the QM approach.

Participants were 10 undergraduate students attending a Marine Biology course in Tel-Aviv University, who chose voluntarily to participate in the modeling workshop taught in addition to the regular classes. The workshop lasted 7 weeks with a two-hours class once a week, totaling 14 hours plus additional homework time. The software used was Garp3 (predecessor of DynaLearn) in a sequence partially corresponding (however not identical) with DynaLearn's Learning Spaces. In the meetings they were introduced to: (1) the qualitative modeling approach - its logic and terminology as embedded in the software; (2) the use of concept maps for analyzing the components in a system and the interconnections among them; (3) ways to address processes occurring within the system (such as predation or competition) or caused by

external agents (such as over-fishing or pollution); (4) ways to express quantities in a model: assigning qualitative values and defining quantity spaces; (5) ways to determine assumptions and conditions under which the system works, looking at their consequences on its dynamics; and (6) ways for tailoring together existing model fragments into more complex representations of a marine environment. Each meeting comprised two parts: an explanation and demonstration part conducted by the lecturer, and a 'hands-on' part where students carried out a model building task along the lines of the one in the demonstration. The trigger for the modeling tasks were scientific papers assigned to the students - they were asked to read the papers, understand the phenomenon described, analyze the components, relationship and process described in the paper, represent them in a concept map and gradually build qualitative models that fully represent the dynamics of the relevant ecological system.

Data were collected by means of six instruments: (1) a Concept Mapping Task serving as pre-test before using the QM software; (2) Worksheets focusing on different aspects of the modeling process administered during the learning process; (3) Observations conducted during the learning process; (4) Students' models at the end of the learning process; (5) Attitudes and motivation questionnaire; (6) Interviews with the students. Data were analyzed using mainly qualitative methods, however some aspects of the learning process could be quantitatively summarized. At the end of the learning all students presented orally their modeling work and by means of a computer presentation.

Brief account of the study's results:

On students' learning:

The modeling activity contributed to the cognitive transition towards a systemic view of the phenomena under study. This perception evolved through active involvement in manipulating and constructing representations (scenarios, models, conditions to be explored).

Transitions observed through the modeling process:

- Structure of the ecological models [from extensive/redundant to parsimonious structural configurations]
- Types of processes included in the ecological models [from simple linear relationships to differentiated causality and reciprocal relationships, towards understanding of ecological equilibrium].
- Increasing activation of inquiry skills along the modeling tasks [questioning, hypothesizing, predicting, generating new knowledge].

High order cognitive insights observed through the learning process:

- While modeling, the necessity to define (and reduce) models' ingredients supported students' understanding of the constraints/possibilities of the models built vis-à-vis the real phenomena being modeled.
- Students perceived that the value of the models, besides their intrinsic value as object for learning, have added value as paradigmatic examples -- they are potentially applicable for inquiry on other complex systems.
- Using updated scientific papers enabled students to not only reproduce and represent the information provided, but also to explore other directions of inquiry and create new knowledge. In this sense, the modeling activity using the software fits the constructivist approach toward learning.

Students' Perception of the contribution of LbM:

- Students perceived as main gain an enhancement of their conceptual understanding of the ecosystem and their understanding of its complexity.

- In second place they reported on an increase in motivation for model building as learning experience.

On usability of the modeling software from the learners perspective:

- Students reported on the need to understand "the logics of the software" (i.e., the modeling "language" and the underlying calculus), in order "to trust" its outputs.

They looked for ways to solve conflicts between expected outcomes (based either on intuition, previous knowledge or scientific definitions) and actual outcomes, or to work around situations perceived by them as "not allowed" by the software.

ISEI 7 7th International Conference on Ecological Informatics 13 – 16 December 2010 Ghent University Ghent, Belgium	**First evaluations of the effect of the DynaLearn software on conceptual systems understanding of river catchments.** Zitek A.[1], Poppe, M.[1], Stelzhammer, M.[1], Bredeweg, B.[2], Muhar S.[1] [1]University of Natural Resources and Life Sciences, Vienna, Austria [2]University of Amsterdam, Informatics Institute, Amsterdam, Netherlands,

Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands)

Timing: 15 December 2010, *Persconferentie Room*, 16h00-16h20 (Code ET 12)

Abstract

Environmental education in secondary schools in Europe increasingly fails to attract students, as environmental issues are perceived as too complex. Within the DynaLearn (DL) project, therefore an engaging, interactive, hierarchically structured learning environment able to capture and simulate causal relationships across disciplines and scales without the necessity of using numbers is being developed. The DL software provides means to integrate knowledge of different grain and extent without using numbers and is based on qualitative reasoning, a method that has been developed within artificial intelligence (AI). The software offers six Learning Spaces (LS) including concept maps (LS 1), basic causal models (LS 2), basic causal models with state graph (LS 3), differentiated causal models with rates and state variables (LS 4), differentiated causal models with the potential to define assumptions (LS 5) and finally generic reusable causal models based on a compositional modelling approach (LS 6). These LSs allow for a cross disciplinary exploration of practically every topic at different levels of complexity.

First evaluations of a prototype of the DL software were carried out in Austria at a secondary technical high school and at the University of Natural Resources and Life Sciences (BOKU), Vienna. An important target of this pilot evaluations was to get feedback on usability and problems learners encounter with the software, supporting the development of 'Basic help', 'Diagnostic feedback', 'Recommendations', 'bug repair', etc.

Videotaping was used to document the modelling activity and upcoming questions. Furthermore motivation questionnaires were used to get an impression, what the students liked and what they disliked and to collect further ideas to make the software more usable. Additionally domain specific pre- and post-tests were used to study the changes in student `s conceptual understanding after some learning activities with DL. A final exam at BOKU showed how students performed with regard to other content delivered in a more traditional way (held as frontal power point lectures). Atlas.ti software was used to annotate the pre- and post-tests following the grounded theory approach. Causal knowledge networks were developed and results were discussed along the prior hypotheses. Transcripts of the videos supporting software development were made using Transana 2.42 software.

At the secondary technical high school two students (one male and one female) were selected to participate the evaluation lasting for three days (09:00-13:30) with a final official presentation of their work at day four. The topic explored was the relationship between increased wind energy production and hydropower production and related environmental consequences. At each day a different learning space was introduced (LS 1, LS 2 and LS 4). The hypothesis for the pre- and post-test was, that there would be a significant increase in domain specific concepts identified, a significant increase in causal relations between concepts and an increase in graphical and abstract means to express relationships.

At the BOKU University 29 students (17 male, 12 female, 22-39 years old) participated the evaluation lasting for one afternoon (12:00-17:00). Models dealing with drivers and effects of river channelization on abiotic and biotic features of riverine landscapes were developed at three learning spaces (LS 1, LS 2 and LS 4). During pre- and post-test students were asked to describe with paper and pencil what could be seen at a series of four pictures showing the degradation and restoration of riverine landscape. The hypothesis was that the descriptions will be more abstract and causal in the post-test with an increased use of verbal and graphical causal relations. Because of the high level of the students` prior knowledge, an absolute increase in new concepts identified was not expected.

In general, the first evaluation results yielded very positive feedback of students with regard to the way learning content is delivered using the DL software, highlighting causal relationships and allowing for the creation of scenarios. Furthermore using the DL software as means for learning was experienced as very interesting and it was rated as very highly useful to be used in other disciplines. LS 1 (concept map) was recognized as an important pilot step for structuring the topic under exploration. In LS 2 especially the students at the secondary high school developed very personal viewpoints of the system under study. This was recognized as a very engaging feature helping to integrate prior knowledge into new content. LS 4 (detailed causal model) was liked most at the secondary technical high school due to its potential for a more realistic representation of real world systems, whereas LS 2 was most liked at the university, which can be explained by the limited time available to explore this LS.

In both situations, the use of DL software yielded significant effects on learning and causal understanding. More specifically, DL activities at the university level contributed to a significant decrease in words used for describing a phenomenon, and a significant increase in the level of abstraction of knowledge with an increase of using graphical causal relations. As expected, the number of identified concepts was not increasing, but slightly decreasing, which could be interpreted as the development of a focus towards the topic that has been explored.

At the secondary high school, based on a lower level of prior content related knowledge, the number of words used to describe a phenomenon, and the number of related concepts identified significantly increased from pre- to post-tests. Furthermore the use of verbal causal expressions increased significantly; graphical ways to express causal relations were only used sporadically.

Summarizing, different effects of DL activities were found during different evaluation situations. leading to the following hypotheses: If factual knowledge *increases***,** words and concepts might *increase* (new factual learning), if focus *increases,* numbers of words and concepts are expected to *decrease* and if causal and structural understanding *increase* the use of causal notations *(*graphical and verbal) might *increase* (structural and causal learning). Further evaluations will prove the consistency of these findings.

The first pilot evaluations helped to identify the potential for improving the usability of the software and the potential of the presented learning by modelling approach to contribute to a better environmental education.

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A survey on education and training in ecological informatics

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Session: Education and training in ecological informatics (Chairs: Prof. P. Salles (Brazil), P. Correa (Brazil) and B. Bredeweg (The Netherlands)

Timing: 15 December 2010, *Persconferentie Room*, 16h20-16h40 (Code ET 13)

Abstract

Modeling and the use of models are becoming ubiquitous, and have been recognized as valuable activities for the development of cognitive and reasoning skills. We are interested in learning what the ecological informatics community is doing now to prepare the next generation of modelers, researchers and model users.
This paper presents the results of a survey conducted to find out how ecological informatics is being taught by the current generation. Information about modeling courses for pre-university, undergraduate and graduate students and the public, including the objectives of the courses, learners profile, content topics, the use of software, textbooks and other didactic materials, evaluation activities is discussed.
Most intriguing for us is the vision of the future: how does the ecological informatics community see the future of modeling? Is it feasible to have young students learning by modeling and using models as early as in the fundamental school? We also want to know if the community would support the creation of a network of modelers to support education and training in ecological informatics.
The results will be discussed at ISEI7.

Paulo Salles and Bert Bredeweg are grateful to the DynaLearn, project co-funded by the EC within FP7, contract no. 231526. For further information, visit www.DynaLearn

Abstracts

Integrated ecological modelling for decision support in water management

(15 December 2010 – DSS)

ISEI 7
7th International Conference on Ecological Informatics
13 – 16 December 2010
Ghent University
Ghent, Belgium

Future ecoinformatics and hydroinformatics tools for integrated water management at catchment scale

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Session: Integrated ecological modelling for decision support in water management (Chairs: A. Van Griensven (The Netherlands), H. Duel (The Netherlands) and P. Goethals (Belgium)

Timing: 15 December 2010, *Gillis Room*, 11h30-12h10 (Code DSS 1)

Abstract

The new holistic and participatory policies for water management (eg Water Framework Directive in Europe or TMDL in USA) have posed new challenges to ecoinformaics and hydroinformatics tools. A simple emission based approach is replaced by an 'immission' based approach whereby the pollution is regulated according to the accumulated ecological effect in the receiving water. For this, all pollution sources, coming from urban, agricultural or groundwater systems have to be linked to the receiving systems whereas the biological and human aspects have to be accounted for in the decision making process. We are currently moving from single PC-based water quality models towards community models that are remotely linked through the internet. The tools are typically not owned by a single team or institute and models are regularly updated by new data, new software versions, stakeholder inputs etc. Such a process is supported by new technologies on linking models (eg OpenMI standards), web-services approaches, remote sensing data sources and grid computing.

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WFD Explorer: information system to design effective restoration programmes in the context of WFD implementation'.

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Session: Integrated ecological modeling for decision support in water management (Chairs: A. Van Griensven (The Netherlands), H. Duel (The Netherlands) and P. Goethals (Belgium)

Timing: 15 December 2010, *Gillis Room*, 12h10-12h30 (code DSS 2)

Abstract

Ecologically sound water bodies, that is what the Water Framework Directive calls for. Evaluation of the ecological status of water bodies, however, is no easy task. Assessment of the effectiveness of measures to improve the ecological quality is even more complex. Nevertheless, water managers need such information to make well-informed decisions on what measures to implement. To support water managers in this task an easy to use tool is being developed with which various strategies to improve ecological quality can be analyzed.

The WFD-Explorer is a tool in which information about the hydro morphology and the chemical situation is combined. To derive the chemical status of a water body a substance balance is implemented to convert loads to concentrations. For the regional water systems, the ecological status of a water body is derived by a regression tree based on a large dataset for all water bodies in the Netherlands. For the larger water systems like rivers, another method, based on ecotopes, is being developed.

An essential characteristic of the WFD-Explorer is its swift response to user interaction. After selection of a measure it is shown on the fly how much this measure contributes to the realization of the water quality and ecological objectives. Thanks to this set-up, the WFD-Explorer offers to water managers and stakeholders the opportunity to learn about the relationships between the objectives pursued, the measures that might be taken and the impacts of such measures, including costs. In this way, the WFD-Explorer supports the water manager with the selection of the most cost-effective measures to achieve the water quality and ecological "good status".

The WFD-Explorer is currently under reconstruction and is being developed by a consortium of research institutes and water management authorities in the Netherlands lead by Deltares. The release of the new WFD-Explorer is planned in the end of 2011.

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Toolbox for assessing ecological response to changes in hydromorphology and water quality

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Session: Integrated ecological modelling for decision support in water management
(Chairs: A. van Griensven (The Netherlands), H. Duel (The Netherlands) and P. Goethals (Belgium))

Timing: 15 December 2010, *Gillis Room*, 14h00-14h20 (Code DSS 3)

Abstract

Currently, the Water Framework Directive Explorer (WFD-explorer) is being developed by Deltares, PBL (Netherlands Environmental Assessment Agency) and Alterra. Predicting ecological effects of WFD measures is one of the main goals of the instrument. We make a distinction between ecology on small regional scale and larger State-water scale. On the regional scale we use a statistical approach to define the relation between on the one hand hydro-morphology and water quality parameters and on the other hand the ecological score. This score is expressed as an ecological quality ratio determined by the WFD biological quality elements metric.

For State-waters another method is currently being developed. This is due to the fact that these waters have a different hydro-morphology and scale and there is too little data available to use a statistical approach. We are developing a new method that is based on ecotopes as calculation units. An advantage of using ecotopes is that all State-waters in the Netherlands have been mapped in a GIS using the ecotope system.

We consider ecotopes as a set of abiotic variables and landcover which together determine the occurrence of biota. Regular monitoring data and specific project monitoring data is used to connect species to ecotopes. When the ecotope composition changes by landscape measures, species composition also changes. The new species composition is calculated through an area weighted approach and changes in species and species abundances are then reflected in the ecological quality ratio.

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Modelling diatom species co-occurrence to assess the importance of biotic relationships, neutral dispersion and meta-community processes in river communities.

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Session: Integrated ecological modeling for decision support in water management (Chairs: A. Van Griensven (The Netherlands), H. Duel (The Netherlands) and P. Goethals (Belgium)

Timing: 15 December 2010, *Gillis Room*, 14h20-14h40 (Code DSS 4)

Abstract

Biomonitoring often consists in a simplified model in which we only consider direct relations between species and environmental parameters. Neither the role of neutral dispersion, nor interspecific relationships are taken into account. However these processes are known to shape diatom community structure by influencing co-occurrences between species. Such processes are usually studied through null-models. Most of these models use random patterns, without considering environmental variations.
Here we used a dataset of 115 diatom samples from French-wide river survey programs. We modeled the presence-absence of each diatom species individually as a function of environmental variables. To this end Random Forest, linear regression and logistic regression were used to predict probabilities of presence of each species. The resulting models were used to construct an environmentally constrained null hypothesis by sampling presences from these probabilities. Then we obtained 1000 presence matrices. Both "Checkerboard Unit" and "matrix temperature" indices were calculated on each matrix in order to describe the co-occurrence patterns.
Comparing co-occurrence patterns between null-models and real data, we found significant associations between species. Such patterns could be explained by biotic relationships and neutral dispersion. It also shows that diatom communities are structured as meta-communities, even in rivers.

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Integrated modelling of ecological state and biodiversity in lakes in response to eutrophication and climate change.

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Session: Integrated ecological modelling for decision support in water management

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Abstract

It is an important question to lake modellers worldwide to forecast the combined effects of different anthropogenic pressures (like eutrophication, climate, hydrology, fisheries) and management on lake ecosystems: water quality, ecological functioning and biodiversity, including possible shifts, and accounting for differences among lake types. It is a challenge to cover those aspects in a model (or combination of models) in an integrative way. *PCLake* is an example of a dynamic model integrating some of these aspects for shallow lakes. The model combines the nutrient cycling in a lake with a simplified food web. The model can simulate the switch between the turbid, phytoplankton-dominated state and the clear, macrophyte-dominated state of shallow lakes, and the critical P loading levels for this switch, dependent on lake type. These results are also made available in a metamodel. The critical loading levels are expected to decrease due to climate change, making lake restoration more difficult. The perspectives for upscaling this methodology are discussed, as well as coupling with empirical biodiversity relations such as a biodiversity intactness index used in the *GLOBIO* model.

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Performance Analysis of Machine Learning Algorithms in Biodiversity Modeling

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Session: Integrated ecological modeling for decision support in water management (Chairs: A. Van Griensven (The Netherlands), H. Duel (The Netherlands) and P. Goethals (Belgium)

Timing: 15 December 2010, *Gillis Room*, 15h00-15h20 (Code DSS 6)

Abstract

Human and financial resources applied to environmental conservation are scarce, considering the current demand. Strategic decisions are fundamental for optimizing the application of these resources. In this context, tools of biodiversity modeling can support the decision making process, for example, tools for modeling of species geographic distribution can assist in the identification of areas with high risk of biodiversity loss, directing the resources for these regions and its threatened species. Currently, tools for modeling of species geographic distribution, use algorithms to estimate the occurrence probability of a given species in a geographic region. The generated models represent a potential distribution of the species and are based on its fundamental niche. The modeling algorithms create potential distribution models from georeferenced data of the species occurrence, also known as primary data, and important environmental variables for this species, also known as environmental layers. The modeling algorithms account for classification tasks or clustering assignments in the potential distribution models generation. In complex models, the training stage of these algorithms has a high computational cost, involving a great data volume. Issues related to performance of modeling algorithms are not well defined yet, neither concerning the computational view point nor the generated distribution models quality. There are several challenges in the use of tools for biodiversity modeling, such as: (1) the choice of the more suitable modeling algorithm to the studied problem as well as to the available data set; and (2) the choice of the algorithm parameters initial values. The first challenge is mainly related to the variety of modeling algorithms available, making the choice of the most suitable method for the application difficult. An example is the openModeller, a biodiversity modeling tool which provides several algorithms. The second one is mainly related to the machine learning algorithms. Such algorithms are considered robust, producing more accurate results for biodiversity modeling. On the other hand, the parameters adjustment of these algorithms is generally a complex task. The aim is to analyze the performance of machine learning algorithms in modeling geographic distribution of different species in different biome. The algorithms studied are the GARP (Genetic Algorithm for

Rule-set Production), Artificial Neural Networks and SVM (Support Vector Machine). The experiments take into account the selection of workloads, the use of a data resampling method and a comparison process among the algorithms. The workloads are organized in occurrence data of different species, including plants and insects, and different sets of environmental variables. The method used for data resampling is a variation of the r-fold cross-validation method, commonly used in machine learning. The results of this work can contribute to the modeling process of geographic distribution of species, mainly to the choice of the most suitable algorithm to the problem and with the correct definition of the initial algorithm parameters. Besides that, the process of performance analysis applied herein can be used in the validation of new algorithms. The more suitable to the problem the algorithm chosen is and the more correct its initial parameters are, the more accurate the species distribution models generated will be.

Keywords: *Biodiversity Modeling, Performance Analysis, Machine Learning.*

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Integrating hydrodynamic, physical-chemical and ecological models for decision support in water management of the Cuenca river in Ecuador

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Session: Integrated ecological modeling for decision support in water management (Chairs: A. Van Griensven (The Netherlands), H. Duel (The Netherlands) and P. Goethals (Belgium)

Timing: 15 December 2010, *Gillis Room*, 15h40-16h00 (Code DSS 7)

Abstract:

One of the worldwide problems that affect the quality of water resources, has been their use such as receiving aquatic ecosystems of controlled or uncontrolled discharges of wastes from agricultural, urban or industrial activities. These discharges can potentially affect human health and aquatic life, limit water uses, affect riverine ecology and cause loss of amenity. In this context, models can show the limitations of the self-cleaning capacity of water resources. Indeed, water quality modelling is an effective tool to investigate the ecological situation of surface water resources. Nevertheless, until now ecological models have rarely been used to support river management and water policy.

The application of ecological modelling approaches that integrate hydrodynamic, physical-chemical, and biological components in sub-models for predicting macroinvertebrates in rivers, is rather limited and hardly described in literature. This research deals with an integrated framework that was implemented in an andean mountain river (2.550 m.a.s.l.), in Ecuador, for the determination of water quality requirements. The framework is flexible enough to be used with different approaches to analysing ecosystem responses, ranging from hydraulic habitat assessments to ecological impact of waste water discharges. In this research an integration of habitat suitability models with the hydrodynamic and physical-chemical water quality model QUAL2Kw was performed. The modelling technique Generalized Linear Models (GLM) was used in this research to build ecological models that allow predicting the occurrence (by logistic regression) of macroinvertebrates (Plecoptera, Trichoptera y Basommatophora) and to predict the value of the Biotic Integrity Index using aquatic invertebrates - IBIAP (by quasi-Poisson regression) in this river under different conditions.

The rapid urbanization and major economic development in the Cuenca river´s geographical valley in Ecuador, has led to a degradation of the environment and increased health risks due to the increased pollutant load effluents and solid wastes. The main source of water pollution in the study zone is related with the discharge of domestic wastewaters. The city of Cuenca is the third largest city in Ecuador by population, with around 500.000 inhabitants (year 2010) and the main urbanization center in the study area. This city has a wastewater treatment system in functioning since the year 1999, based on 2 parallel systems of aerated, facultative and maturation lagoons, which discharge around 10 tons of organic matter load per day in terms of BOD_5 to the Cuenca river. However, in the study zone, there is still part of the sewer system which is connected directly to the Cuenca river or to its tributary rivers without any kind of treatment. These discharges of treated and untreated wastewater are producing an increasing deterioration of the water quality of the Cuenca river. This pollution problem is critical after the river crosses the city of Cuenca, especially during dry season (low flows), when pollution can reach values of 10 mg/l of BDO_5, concentrations of Dissolved Oxygen (DO) around 6.9 mg/l, values of Faecal and Total Coliforms in the order of $1.4x10^5$ NMP/100ml in this river.

The integrated ecological model proposed in this research is a powerful operational tool, which allows to model and to assess the ecological impact of wastewater discharges into the Cuenca river and can help to calculate the needed reductions in wastewater discharges of organic matter to meet biological quality criteria in this river. Additionally, this ecological model is interesting to see what would be the impact of collecting all the wastewater generated in the city and improving the wastewater treatment system.

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MDL-based Clustering for Modeling of Species Geographic Distribution

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Session: Integrated ecological modeling for decision support in water management (Chairs: A. Van Griensven (The Netherlands), H. Duel (The Netherlands) and P. Goethals (Belgium)

Timing: 15 December 2010, *Gillis Room*, 16h00-16h20 (Code DSS 8)

Abstract

Modeling of species geographic distribution is a technique that has been used in many tasks related to biodiversity conservation. The modeling tools produce niche-based models, that is, models that represent environmental conditions for the species survival for a long period of time. These models are generated from occurrence data, which are georeferenced points (latitude and longitude) where the species were observed, and environmental data, such as temperature and precipitation, known as environmental layer or environmental variable. The environmental data are also georeferenced sites and must belong to same study region as the occurrence data.

One of the main challenges in modeling of species geographic distribution is the use of a data set with presence-only records for generating the model. Species absence records are rarely available in databases because they are very difficult to obtain since factors such as seasonality can interfere with the observations. There are some Artificial Intelligence techniques that have been studied to model species geographic distribution with presence-only records. Clustering is a concept of machine learning that can help to solve this issue. The clustering goal is to group similar data so that they are partitioned into an unknown number of clusters. The Minimum Description Length (MDL) principle was already successfully used for the clustering problem and it has some interesting properties that could be useful in modeling. However, the MDL-based clustering was never employed to model species geographic distribution.

The central idea of the MDL principle is to compress together data that present some regularity. Thus, MDL-based clustering method groups similar data that can be compressed according to some regularity, optimizing the total code length over all the data. The most interesting property of the MDL principle is its capacity of automatically avoiding overfitting when learning the parameters of a model, which is a classical machine learning problem. When overfitting happens, the model is a very good description of the examples used to create it but it is a poor representation of external examples. Thus, a method that avoids overfitting is essential for applications which make predictions from its generated models. It is important to point out that niche-based models are projected in a geographic area of interest, producing a potential distribution map that can be used to study previous, current or future scenarios, depending on the environmental data.

Another important characteristic of the MDL principle is that it does not need negative examples in the model selection, that is, the non-existence of absence points does not affect the method. Some Artificial Intelligence methods use pseudo-absence points, which are random sites presented to the algorithm as if they were absence points recorded in a given region. However, as they are false absence records, it introduces error in the generated models since a point can be used as absence when in the truth the environmental conditions are suitable for the species at that point. Therefore, the non-needing of absence points can be considered an advantage of the MDL principle under other Artificial Intelligence techniques.

The aim is to present how MDL-based clustering is used to model species geographic distribution. The main contributions are the use of a strategy (MDL) that automatically avoids overfitting and a new approach to treat presence-only data. The first contribution is crucial for applications which use the generated models to make predictions and the second one is very important to any application with presence-only data set, as previously emphasized.

In a preliminary study, the MDL principle with irregular histograms was introduced in the modeling process of species geographic distribution. In this case, the purpose was to define the best set of environmental data for the *Xylopia aromatica* species. It was used as a pre-analysis step, that is, before the model construction; an importance measure for each environmental layer was calculated based on the MDL principle. This pre-analysis step can be useful for improving the performance of the algorithm in the model generation. Although the MDL principle had been successfully applied to ranking the environmental layers, it is necessary to study a method to identify the best number of layers to generate a model.

Keywords: *Minimum Description Length Principle, Clustering, Modeling of Geographic Distribution of Species.*

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Early warning system for harmful algal blooms

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Session: Integrated ecological modelling for decision support in water management (Chairs: A. Van Griensven (The Netherlands), H. Duel (The Netherlands) and P. Goethals (Belgium)

Timing: 15 December 2010, *Gillis Room*, 16h20-16h40 (code DSS 9)

Abstract

Cyanobacterial surface scums (blue-green algae) represent a major problem in many lakes in the Netherlands and globally, often leading to the closure of recreational swimming beaches due to elevated concentrations of cyanotoxins which may impact human health. Surface scum formation and dispersal processes are strongly coupled to meteorological conditions and scums are highly dynamic and not easily captured by routine water quality monitoring programs. The ability to automatically forecast the presence and location of a surface scum several days in advance would allow water managers to make better decisions aimed at mitigating scum transport into recreational zones, and to inform recreational users about potential health risks in the days to come.

In this study EWACS (Early Warning Against sCumsS), a stand-alone, early warning system for forecasting cyanobacterial surface scums in both small and large lake systems was developed. The complete model instrumentation is based on a combination of fuzzy logic and deterministic (hydrodynamic-water quality) modeling to determine scum appearance, disappearance and dispersal pathways based on forecasted meteorological conditions. The model was tested operationally in four lakes in The Netherlands (Delftse Hout, Gooimeer-Eemmeer, Sloterplas and Westeinderplassen) over the 2009 summer period with water managers receiving daily model output bulletins of forecasted cyanobacteria densities and scum location up to several days in advance. Model performance was scored against field validation data collected from the same lakes where available. Initial model results are promising but more comprehensive and qualitative field validation data is required to better test and calibrate model performance as well as refine processes for scum appearance and disappearance.

Abstracts

Quantifying trophic flows in ecosystems: modelling approaches and applications

(15 December 2010 – TM)

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Using EcoTroph (ET) to diagnose fishing impacts in marine ecosystems: application to the Southern Benguela.

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Session: Quantifying trophic flows in ecosystems: modeling approaches and applications (Chairs: F. De Laender (Belgium) and D. Van Oevelen (The Netherlands)

Timing: 15 December 2010, *Oude Infirmerie Room*, 14h40-15h00 (Code TM 2)

Abstract

EcoTroph (ET) is a trophic-level based model, recently added as a plug-in to Ecopath withEcosim software, and built on the idea that aquatic ecosystems can be simply represented by their biomass distribution across trophic levels. Such distribution is called the biomass trophic spectrum and can be modelled using equations that describe the ecosystem functioning as a flow of biomass surging up the food web, because of predation and ontogenetic processes. In this presentation we show that ET is able to produce useful diagnoses of the ecosystem impact of fishing, using the Southern Benguela ecosystem as a case study. First, an ET model has been set up, based on the 1990-97 Ecopath model of the Southern Benguela upwelling ecosystem, and provides a very synthetic overview of the fishing strategy at the ecosystem level for this period. The fishing strategy is represented by means of the trophic spectrum of fishing mortality, used as an indicator of targeted fishing, and the trophic spectrum of fishing loss rate, used as an indicator of the fishing impact per trophic level. Then, we simulated changes in fishing mortality, using multipliers applied to all trophic levels and ranging from 0 (no fishing) to 5. Simulations show that the ecosystem can be divided into two groups: small pelagic species that are not very sensitive to fishing and predatory fish species that are much more sensitive to fishing. As a result, increasing fishing pressure leads to a decline in mean trophic level for both the total catch and also a decrease in the ecosystem biomass. Fishing decreases accessible biomass, while it increases the biomass of species that are not accessible to fisheries. In terms of catch, simulations show that high trophic level species are far more heavily targeted by fishing than small pelagic species. This is coherent with other results estimating that the predator catch is at its MSY (maximum sustainable yield). As global indicators of the ecosystem fishing impact, trophic spectra are also calculated for two reference values of the fishing effort multiplier, EMSY and E0.1. These spectra depict the Southern Benguela ecosystem as being moderately exploited.

Finally, we present a recent addition to the ET model allowing simulations of changes in the ecosystem fishing pattern. Two scenarios have been simulated: a doubling in the fishing mortality of the three main small pelagic species and a doubling in the fishing mortality of hakes.

The model suggests that increasing the fishing mortality on small pelagics may strongly decrease catch of their predators. Besides, this increase markedly decreases accessible biomass at all trophic levels in the ecosystem. This gives prominence to the fact that fishing small pelagic species may be more harmful for the ecosystem than commonly thought.

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Ecosystem Models for fisheries management: What is the best model for Vietnam's fisheries management?

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Session: Quantifying trophic flows in ecosystems: modelling approaches and applications (Chairs: F. De Laender (Belgium) and D. Van Oevelen (The Netherlands)

Timing: 15 December 2010, *Oude Infirmerie Room*, 15h00-15h20 (Code TM 3)

Abstract

It is gradually being realized that the impacts of fishing on marine ecosystems can be large, dramatic and difficult to reverse. For example, there is often by-catch of non-targeted species, physical damage to habitats, food-chain effects and others. Therefore, there has been a growing recognition of the value of f ecosystem approaches to fisheries (EAF[1]) assessment and management. To implement such approaches, ecological models which can provide important scientific tools for fisheries management need to be proposed to estimate interactions between species and fisheries in ecosystem-based marine fisheries management.
This paper reviews several different ecosystem models that have been used for EAF and evaluates their level of complexity, data requirements, assumptions and crucial parameters. Moreover, advantages, disadvantages and limitations are also discussed on addressing questions relating on EAF. These characteristics are compared with criteria for management purposes in order to compare and select the best ecosystem model for fisheries management in Vietnam. The review currently concludes that Ecopath with Ecosim (EwE) model can be the best selection for fisheries management and assessment considering on EAF in Vietnam. There are several reasons why this is the case: (1) the complexity of marine ecosystems of Vietnam is the best justification to use the EwE model since the approach allows for wide exploration of many multispecies and ecosystem issues in fisheries; (2) considering multi-species models to make management policies in the situation of multi-species and complex ecosystem in order to improve current single-species approach and (3) in term of data requirements and model suitability for data poor situations, the EwE approach is less data intensive than other ecosystem models and input data, usually not available directly, may be available from local and regional studies., The approach is thus appropriate for fisheries monitoring and management activities in Vietnam where fisheries data are usually limited due to lack of financial and human resources.

[1] EAF is generally defined as an extending existing management focus (e.g., fisheries) to include additional considerations consistent with ecosystem management characteristics.

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Analysis of the role of macroinvertebrates in degradation and nutrient removal processes in constructed wetlands for wastewater treatment'

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Session: Quantifying trophic flows in ecosystems: modelling approaches and applications (Chairs: F. De Laender (Belgium) and D. Van Oevelen (The Netherlands)

Timing: 15 December 2010, *Oude Infirmerie Room*, 15h40-16h00 (Code TM 4)

Abstract

Constructed wetlands have already a long tradition to be used for wastewater treatment. The role of biofilms on plants and substrate has been analysed for many years, however the impact of the larger biota, like macroinvertebrates and fish, on the treatment proces in these systems was so far hardly investigated. This research aims to analyse the role of macroinvertebrates on the energy removal in constructed reed bed systems. In particular the traits of the animals is looked at in function of the type of energy (wastewater and sunlight) that is entering the system.

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Modelling trophic flows in ecosystems to assess the efficiency of Marine Protected Area (MPA): a case study on the coast of Senegal

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Session: Quantifying trophic flows in ecosystems: modeling approaches and applications (Chairs: F. De Laender (Belgium) and D. Van Oevelen (The Netherlands)

Timing: 15 December 2010, *Oude Infirmerie Room*, 16h00-16h20 (Code TM 5)

Abstract

In the face of the global overexploitation of marine resources and the fast degradation of ecosystems integrity, the implementation of an Ecosystem Approach to Fisheries (EAF) is worldwide recognized as an urgent need. In this context, developing Marine Protected Areas (MPA) is now viewed as an efficient way to preserve biodiversity and to protect specific habitats. However, the ability of MPAs to reduce the fishing impact on the targeted resources and on the entire trophic network is still poorly known. In the present study, using the *Bolong de Bamboung* (Senegal) as a case in point, we show that modelling trophic flows in an ecosystem is a useful approach to assess the efficiency of MPAs.
The *Bolong de Bamboung* is a small tributary (4.5 km^2) of the *Sine-Saloum* estuary, monitored since 2003 and where fishing has been prohibited since 2004. Available data thus refers to a reverse form of Before After Control Impact (BACI). First, a reference Ecopath mass-balanced model was built for year 2003, synthesizing data available on the trophic network. Then 2003-2008 time series of abundance per Ecopath group were estimated from data of scientific surveys using a delta approach. A 2008 Ecopath model was derived from the reference one, accordingly to changes observed in the abundance of the various groups. Additionally, starting with the 2003 Ecopath model, we used EcoTroph (a new plug-in of the EwE software) to simulate the closure of the fishery. Results were compared to the 2008 model, in order to determine if changes that have occurred may result from the MPA effect. Finally, an Ecopath model was built for the *Sangako*, a similar to the *Bolong de Bamboung* but still heavily fished area.
Results are little sensitive to the model parameters used as input and clearly demonstrate the MPA effect. In this specific ecosystem, the closure of the fishery increased the biomass of predator species by around 30 %, while the biomass of prey fish is decreasing, at least partially due to a top-down control effect. Globally, the MPA effect is limited, probably due to the small fishing effort occurring in the *Bolong de Bamboung* in 2003 (the area where MPA was implemented was still of little interest for fishermen). Comparison with *Sangako*, where very small biomass are observed for all groups, suggests that MPA has a strong effect as refuge for coastal species and that this refuge effect was already in place in 2003 in the Bolong de Bamboung. We conclude that trophic models are efficient tools to assess MPAs effects on marine ecosystems.

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Dynamics of microbial interspecies competition in nitrifying reactors

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Session: Quantifying trophic flows in ecosystems: modeling approaches and applications (Chairs: F. De Laender (Belgium) and D. Van Oevelen (The Netherlands))

Timing: 15 December 2010, *Oude Infirmerie Room*, 16h20-16h40 (Code TM 6)

Abstract

Key biological processes such as nitrification do not result from the work of a single bacterial species but are performed by a wide variety of bacteria. However, this microbial diversity is usually not tracked during reactor operation and mostly neglected in present mathematical models, which distinguish at the most between ammonium oxidizers and nitrite oxidizers, assuming the same properties for all bacteria of each group. Nevertheless, experimental evidence is available that different process conditions may favour the selection of different types of bacteria. This contribution deals with observed differences between two nitrifying inverse turbulent bed reactors (ITBRs) with different solid hold-ups. Additional experimental data reveal a microbial population shift upon changing the operating conditions in one of these reactors. The reactor behaviour is described with a basic two-step nitrification model, which includes the competition between two different types of ammonium oxidizers, besides nitrite oxidizers. Considering the oxygen concentration as the key variable governing the population shift, the influence of microbial growth parameters on the competition dynamics is assessed.

Abstracts

Ecological informatics to study the distribution, impact and control options of invasive species

(16 December 2010 – IS)

ISEI 7
7th International Conference on Ecological Informatics
13 – 16 December 2010
Ghent University
Ghent, Belgium

The need for modelling to predict the distribution and impact of invasive species: which species where?

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Session: Ecological informatics to study the distribution, impact and control options of invasive species (Chairs: S. Worner (New Zealand), P. Boets (Belgium) and P. Goethals (Belgium)

Timing: 16 December 2010, *Oude Infirmerie Room*, 10h00-10h40 (Code IS 1)

Abstract

If allowed to cross regional borders, invasive species pose one of the greatest threats to global biodiversity, environment, economic activity and human and animal health. As such, both productive and indigenous ecosystems are at risk. Global travel, tourism and trade are increasing the flow of people and products at an alarming rate. Climate is changing, converting areas previously inhospitable to some species to those more amenable and vice versa. The growing emphasis on reduction of fossil fuel use and increasing interest in growing biofuels means some crops are being grown where they never have before. Additionally, food is increasingly being moved around the world in response to local disasters. The potential for serious and damaging pests and diseases to accompany these products is rising. Often the focus is on a few headline-grabbing species but in reality, many thousands of organisms capable of causing immeasurable damage, threaten every country. As well, there are often costly cascading effects of alien incursions that are not immediately apparent. Clearly, prevention is much better than cure, and internationally there is focus on research and biosecurity agencies to provide the science, regulations and strategies for efficient prevention.

Despite that invasive species have been studied for many decades little progress has been made in the attempt to identify new threats before they arrive in a country. When there are many thousands of well recognised invasive species that could cross any border, it is difficult to know where to start. If a species happens to get across, is it likely to establish a viable population? The usual approach to assessing such threats is usually reactive. For example, agencies are put on alert when an insect species cause problems in other countries. Biosecurity agencies also take notice of species that are frequently intercepted at the border , and assess new imported products to determine the risk that they may harbour potentially damaging invasive species. The last thing any agency in charge of biosecurity for any country wants, is to be taken by surprise by a new incursion. One of the best ways to prevent that is to recognise potential threats well before they breach the border. Recent research shows that modelling is an important part of the risk analysis process.

For example, Self Organising maps (SOMs) can be used to cluster species assemblages of a large number of global geographic regions as well as a large number of invasive species. Such regional invasive species profiles can give very useful information. The analysis can show the regions in the world with pest profiles most similar to a target site. Such regions may be a

high risk source of invasive species. The weights derived from a SOM analysis can also indicate which species are most likely to establish in a region.

If an invasive species establishes successfully, it is important to predict where it is likely to spread. Predicting future establishment and spread is integral to invasive species risk analysis. Increasingly, different classes of models are used to integrate the high dimensional array of climate and biotic information required to gain greater predictive precision. Machine learning, comprising well known artificial neural network algorithms, as well as a wide range of emergent statistical modelling and computational techniques, is quickly becoming an essential part of such risk analysis. Such models are used for risk assessments and bioclimatic mapping when detailed data of the relationship between a species and its environment, are lacking. While the models allow large scale empirical comparisons to predict species potential establishment based on climate and other variables, it is becoming more important to identify suitable habitat at high resolution. While suitable habitat can often be identified using environmental information and GIS technology, more detailed models to assess the eco-climatic suitability of new sites are required. If a map of spatially explicit habitat suitability is available then the dynamic dispersal of the species can be modelled across the landscape subject to a range of scenarios including climate change. Not only do such models allow more precise and dynamic estimates of impact, they can be used to run virtual experiments that are impossible to carry out in reality. For example, one of the most difficult things to determine when a new invasive species is detected in a new area, is how long it has been there. Has it come from a local established population or escaped from some recently imported commodity? Has it been established for a long time at such low abundance that it could not be detected? How much effort is needed, or samples sizes required, to detect a species that is in very low abundance? Which sampling method should be used to delimit its spread? Models can be used to simulate and optimise search, surveillance and monitoring programmes for species in a complex environment. They are also needed to determine the cost benefits of containment or eradication. Models also help answer which containment or eradication strategy is best? For example, is it better to eradicate over large contiguous areas or over a large number of smaller foci throughout the species current distribution. Clearly, there are a range of models that are used to both predict and mitigate the impact of invasive species in new areas but clearly, there are still a number of issues that must be highlighted and resolved. We still need to improve our models, and establish good practice and sensible modelling protocols.

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Modelling approaches to analyse and predict invasive species behaviour in aquatic ecosystems

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Session: Ecological informatics to study the distribution, impact and control options of invasive species (Chairs: S. Worner (New Zealand), P. Boets (Belgium) and P. Goethals (Belgium)

Timing: 16 December 2010, *Oude Infirmerie Room*, 10h40-11h00 (Code IS 2)

Abstract

During recent years, the risk of successful invasions is increasing due to deterioration of habitat and shipping. Additionally, existing migration barriers are in many cases mitigated within the context of river restoration and natural recolonization goals. This underpins the need to gain insight into the risk of invasions as a means of identifying key invasive species and the most vulnerable types of ecosystems, as well as defining potential ecosystem protection measures.

In general, it is difficult or impossible to exactly predict the migration routes and impacts of invasive species, due to the many factors that affect the colonisation process. However, ecological modelling can provide insight into the most crucial factors that stimulate or restrict migration. Such migration models may serve to support managers in taking relevant measures to reduce the risks of invasions. Moreover, impact models can be used to determine the potential ecological shifts in the case of successful invasions. In combination with the migration models, ecological impact models may allow managers to develop a set of priority control measures for river systems to avoid drastic ecological impacts by particularly invasive species. For this, existing and new ecological modelling approaches will be necessary, enabling the description of species behaviour on the basis of individuals, populations, communities and whole ecosystems.

This review brings together the mainly theoretical knowledge on the distribution processes and potential ecological impacts of invasive macroinvertebrates in rivers and discusses how these concepts can be applied for decision support in water management. The use of ecological models is proposed as a framework to integrate and apply ecological insights in this context.

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A comparative study on the genetic diversity of an invasive plant, *Lonicera japonica* in its native and introduced ranges

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Session: Ecological informatics to study the distribution, impact and control options of invasive species (Chairs: S. Worner (New Zealand), P. Boets (Belgium) and P. Goethals (Belgium)

Timing: 16 December 2010, *Oude Infirmerie Room*, 11h30-11h50 (Code IS 3)

Abstract

It is critical to understand the role of species genetic diversity in the process of plant invasion. In this study, inter-simple sequence repeat (ISSR) polymorphism markers were used to determine and compare genetic diversity of Japanese honeysuckle (*Lonicera japonica*) in both native and introduced ranges. By studying plant samples collected from 7 populations with a total of 37 individuals at the molecular level, our results indicate significant genetic variability within and among Japanese honeysuckle populations from both ranges. Genetic diversity of the native population is higher than all populations from the introduced ranges. A lower level of genetic diversity found in populations sampled from the introduced range suggests that lost genetic diversity may largely be due to founder effects and bottleneck events that occurred during the invasion process. These losses however, might not preclude the rapid adaptive evolution of life history traits that enhance invasion. Our study also indicates that even with reduced genetic variation in the introduced range, a substantial level of genetic diversity exists in the invading populations. Therefore, it is very likely that a certain level of genetic variability is required to permit an adaptive response of the introduced species to the new selective pressure after introduction. We consider that genetic diversity could be a prerequisite of invasion success for some invaders such as Japanese honeysuckle.

Keywords: plant invasion, genetic diversity, rapid adaptive evolution, genetic constrains, Japanese honeysuckle (*Lonicera japonica*), native and introduced ranges

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Predicting presence, species richness and abundance of alien macrocrustaceans in surface waters in Flanders (Belgium) using decision trees

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Session: Ecological informatics to study the distribution, impact and control options of invasive species (Chairs: S. Worner (New Zealand), P. Boets (Belgium) and P. Goethals (Belgium)

Timing: 16 December 2010, *Oude Infirmerie Room*, 11h50-12h10 (Code IS 4)

Abstract

The introduction and spread of invasive species is a worldwide phenomenon causing global ecologic and economic damage. Among the invaders, alien macrocrustaceans are known to be very successful and to colonise new habitats rapidly. A combination of several factors such as shipping, interconnection of waterways, prevailing physical-chemical and habitat conditions as well as species characteristics determine the success of these alien species. Data about different fresh and brackish waters gathered by the Flemish Environment Agency (VMM) were used to build data-driven models predicting the presence/absence, the abundance and the species richness of alien macro-Crustacea in surface waters in Flanders. Different techniques such as regression and classification trees in combination with several optimisation methods were used to construct the models. The analysis pointed out that conductivity and shipping in combination with the chemical water quality were the major factors determining the presence or absence of alien macrocrustaceans. Alien macrocrustaceans were present under brackish waters conditions or in fresh waters with intensive ship traffic and low levels of organic pollution. The alien species richness increased with improving water quality and when there was a lot of ship traffic. Especially in brackish waters, alien macrocrustaceans reached high abundances. In fresh water the abundance of alien species was positively influenced by low levels of nutrients. Brackish water conditions in combination with high levels of ship traffic seemed to be very favourable for alien macrocrustaceans to establish and to reproduce. Stronger regulations regarding ballast water control and the trade in alien species, especially in estuarine regions, can help to prevent further introductions.

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Application of Bioclimatic Models coupled with Network Analysis for risk assessment of aquatic invasive species

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Session: Ecological informatics to study the distribution, impact and control options of invasive species (Chairs: S. Worner (New Zealand), P. Boets (Belgium) and P. Goethals (Belgium)

Timing: 16 December 2010, *Oude Infirmerie Room*, 14h00-14h20 (Code IS 5)

Abstract

Bioclimatic models predict the area suitable for a species from the bioclimatic conditions at which it is normally found and have been successfully applied to predict invasive species spread. The main advantages of bioclimatic models rely on the availability of data (both on species presences and bioclimatic conditions) and modelling software (e.g., openModeller, Desktop GARP, Maxent) free on internet. Bioclimatic models provide comprehensive maps on the areas at most risk of invasion and constitute an interesting tool for environmental managers to improve prevention and early detection of invasive species. However, the dispersal of aquatic species is highly limited by aquatic connectivity that is difficult to include in the models, thereby hampering the use of bioclimatic models. Network analysis is a spatial analyst tool commonly used to model the dispersal of pollutants in river networks that have the potential to overcome this limitation. In this study we combine bioclimatic modelling with network analysis to assess the potential spread of invasive species. As a case study we use *Dikerogammarus villosus*, a Ponto-Caspian shrimp that has been recently detected in Great Britain. First bioclimatic models (openModeller implementation of Support Vector Machines) are used to identify areas most climatically suitable for *D. Villosus* in GB. For calibration, a comprehensive dataset on the species occurrence in Europe and 20 environmental variables (19 bioclimatic and altitude extracted from WorldClim) are used. As a result, the area showing >90% climate suitability coincided with the catchment where *D. Villosus* was first detected, the Grafham reservoir in the Great Ouse River. After that we applied Network Analysis in ArcGIS 9.3 to the Great Ouse catchment to analyze the potential spread of *D. Villosus* from the source point. This tool allowed us to predict the maximum spread of the species in the catchment at different time periods, thereby helping to prevent its arrival at the most vulnerable areas. Potential and limitations of this combined approach to invasive species modelling will be further discussed.

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The ability to predict species presence is made conspicuous by the quality of absence: therein lies a dilemma.

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Session: Ecological informatics to study the distribution, impact and control options of invasive species (Chairs: S. Worner (New Zealand), P. Boets (Belgium) and P. Goethals (Belgium)

Timing: 16 December 2010, *Oude Infirmerie Room*, 14h20-14h40 (Code IS 6)

Abstract

Currently, there is wide range of species distribution models that can be used to infer habitat suitability from species presence data. For the more correlative approaches both presence and absence records are required. However there are several problems that recent studies have attempted to address. The first is that true absences are almost never recorded, and if they are, it is difficult to confirm that they are real. It may be that the search was not able to detect the species, or the species is able to survive in a target location but cannot reach there. Second, species distribution databases are commonly extremely unbalanced with many potential absence records compared with presence records. That imbalance can result in poor model predictive performance when presented with new data. A common solution is to select a random subset of the absence data (called pseudo-absences), or to use either “background data” or implied absences. In several recent studies, profile methods have been used to select representative pseudo-absence data. In this study, we develop another procedure for choosing representative absence data that is capable of handling high dimension data and complex nonlinear relationships based on one class support vector machines (OCSVMs). The method enabled us to explore the performance of nine SDMs over 21potential invasive species in response to changing quality of pseudo-absences. We selected pseudo-absences that were most environmentally distant from the presence locations. Then we progressively “contaminated” that data by including locations closer to the environmental conditions that characterize the presence locations. We found that the predictive performance of all models, as measured by cross-validation and nine performance measures, barely changed as the data were manipulated. But, despite good model performance, we found that the resulting projected distributions of the species likely to present a dilemma for both species distribution modelers and decision makers.

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Habitat analysis of invasive crustaceans based on datadriven approaches applied on recently and long-term colonized habitats

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Session: Ecological informatics to study the distribution, impact and control options of invasive species (Chairs: S. Worner (New Zealand), P. Boets (Belgium) and P. Goethals (Belgium)

Timing: 16 December 2010, *Oude Infirmerie Room*, 14h40-15h00 (Code IS 7)

Abstract

This modeling study compares habitat suitability models developed based on data gathered in recently invaded rivers and channels in Flanders, with similar models developed on long-term colonized systems in Croatia. In this manner, the effect of ecosystem stabilization and equilibrium is studied as well as –more technical- to what extend datadriven habitat suitability models can reflect this. This type of studies are interesting to see to what extend models can be extrapolated, and in particular, to what extend can the behavior of invaders be predicted in potentially colonized systems.

Abstracts

Ecological engineering

(16 December 2010 – EE)

ISEI 7
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Towards a sustainable management of pond diversity at the landscape level

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Session: Ecological Engineering (Chair: G. Everaert (Belgium))

Timing: 16 December 2010, *Oude Infirmerie Room*, 15h40-16h00 (Code EE 1)

Abstract

Water is needed in all aspects of life (article 18.2 of Agenda 21). The biota of freshwater habitats constitutes a large component of overall biodiversity. Recent research (Williams et al. 2004, Biggs et al. 2005) has pointed out that ponds, despite their small size, contribute significantly to the aquatic biodiversity at the regional scale. In comparison to lakes, rivers, streams and ditches, ponds were found to harbour relatively high local species richness (alpha diversity) when sampling is standardized for area. Furthermore, and even more importantly, ponds harbour a significant proportion of the total species richness of plants and macro-invertebrates that are present at larger spatial scales. In the U.K., ponds harbour about 60% of all rare freshwater species. As a result of the high diversity among ponds (beta diversity), these habitats contribute disproportional to regional total species richness (gamma diversity). Among-habitat ecological differences, isolation and chance effects leading to different alternative ecological states, are considered to be key factors promoting the high beta-diversity of pond ecosystems (Scheffer et al. 2005).
The ecological quality of individual ponds seems to be mainly determined by the influence of local land use, because they generally have a small catchment's area (Declerck et al., 2006; Davies et al., 2008). This implies that adverse land use effects can be mitigated relatively easily by local management. Because of these characteristics, ponds and pools emerge as systems that may allow preservation of a substantial portion of the aquatic diversity in a cost-efficient way.
The project PONDSCAPE conducts research on patterns of biodiversity and ecosystem functions in ponds at multiple spatial scales, and relates these to important factors and processes, such as succession, land use, pollution, pond creation and pond management. The results of these biological investigations will, for the first time, quantify levels of scaling that are relevant to biodiversity. As such, the translation of these results into management strategies is clear.
At the same time, PONDSCAPE will assess the history of the economic and social relevance of ponds for different sectors (agriculture, nature conservation) over the past century and will assess present day perception of these stakeholders with regard to risks and benefits of pond use. Ponds are situated on land owned or managed by these stakeholders and management strategies can only be sustainable if acceptable to these stakeholders.
Based on these research avenues, PONDSCAPE will provide scientifically underpinned recommendations for a sustainable management approach (Göteborg strategy) that will

reconcile desires to protect and increase biodiversity levels at various spatial scales (CBD, RAMSAR convention on wetlands, EU Water Framework Directive) with the need to sustain economic activities and ensure economic growth (Lisbon strategy with renewed impetus from the European Council meeting in Brussels 2005). The ultimate aim of PONDSCAPE is to contribute to a sustainable management regime of such water bodies that is acceptable to all stakeholders.

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Development of datadriven models to analyze relations between ecologically sound bank quality and biological communities

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Session: Ecological Engineering (Chair: G. Everaert (Belgium))

Timing: 16 December 2010, *Oude Infirmerie Room*, 16h00-16h20 (Code EE 2)

Abstract

The European Water Framework Directive (WFD) requires the European member states to achieve a good ecological status of the freshwater aquatic systems by the year 2015. In order to achieve this target, member states should take measures, which has resulted in an increased interest in reconstruction of banks. The basic idea is that by improving or restoring the physical habitat, the natural dynamic of the entire system improves. Although ecologically sound banks are already constructed along several rivers, canals and lakes throughout Europe, it is not yet quantified whether these investments contribute to achieve the targets set by the WFD. Currenly, river managers lack essential knowledge about the design and management of ecologically sound banks in the context of the WFD.
The ecological implications of various design and management options of ecologically sound banks are highlighted in this project. The effects of design and management decisions were summarized and some guidelines were developed.

The Dutch water boards have been gathering water quality and biological data for several years in thousands of sites throughout the country. Additionally, based on a questionnaire the design and management properties were requested per bank. These data have been used to develop predictive models relating the design and management properties of environmental sound (nature friendly) banks with their corresponding ecological status.
The datadriven models (classification trees) were built through applying the Waikato Environment for Knowledge Analysis (WEKA; Witten & Frank, 2005 version 3.6.1) and

several optimisations were made by altering the dataset (variable and record selections). Classification trees offer an advantage over traditional techniques, because they introduce less prior assumptions about the relationships between the variables and have an inherent ability to discover patterns in the data that are not possible to detect using conventional models. Classification trees derive knowledge rules from the data that subsequently can be used to quantify the impact of the various design and management options. Models were evaluated based on mathematical criteria, ecological insight and user convenience (clarity, simplicity and applicability).

Models were made with satisfactory reliabilities. The first analyses have shown that design parameters such as the surrounding land use, frequency of the management, water-level management, substrate type and the type of bank (floatland, marsh, ect.) have a direct effect on the ecology of macroinvertebrates, macrophytes and fishes. The chemical water quality was less important compared to the design and management parameters. Although there were only a limited number of case of river banks having a good or high ecological status, the models based on a stratified dataset have succeeded to predict all quality statuses ranging from bad to high. Our analyses are a first step to provide a framework for river managers that may help them to construct the most optimal ecologically sound bank given a local situation.

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Hybrid ecosystem simulation system for model structure and parameter optimisation of lakes.

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Session: Ecological Engineering (Chairs: G. Everaert (Belgium))

Timing: 16 December 2010, *Oude Infirmerie Room*, 16h20-16h40 (Code EE 3)

Abstract

The lake simulation library SALMO-OO has been used as core for a hybrid simulation system that firstly step-wise improves the model validity for a specific lake and secondly provides decision support for eutrophication control of the lake. In order to improve the model validity simulation system automatically assembles the optimum structure of process models from the library for a specific lake. The library provides 5 alternative process models for algal growth and grazing as well as zooplankton growth and mortality, and the simulation system identifies their best combination. The simulation system also conducts sensitivity analysis to identify key parameters that undergo multi-objective parameter optimisation. The multi-objective parameter optimisation utilises the open source library SWARM.
After successful model validation scenario analysis assist in identifying sustainable management concepts including external nutrient control, biomanipulation and artificial mixing.
The paper demonstrates the functionality of the simulation system for a case study lake.

Poster abstracts

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Predicting changes in ecosystem services with Bayesian Belief Networks

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Code PO 1

Abstract

Bayesian belief networks (BBN) allow to predict how ecosystems react on changes in biotic and abiotic conditions based on a combination of empirical data and, in its absence, expert knowledge. In contrast to hydrological models, they are able to incorporate hydrological as well as biogeochemical and ecological processes. The models can be used to quantify and map historic gains and losses of ecosystem services allowing to improve sustainable use of ecosystem services in the future. The models are also valuable tools to assess effects of climate change, management decisions, ecological succession etc. on ecosystem service delivery in the future.

The BBN are constructed based on visualization of ecosystem components, interactions and processes in conceptual models. To preserve transparency, only the most crucial variables and processes with high impact on ecosystem service delivery will be included. The complexity of the models can increase from one model per ecosystem service to an integrated model combining all important ecosystem services within a study area.

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Application of the Fourth-Corner method to test biological trait-environment hypotheses

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Code PO 2

Abstract

In recent years, a functional approach to ecosystem analysis based on multiple biological traits of species has provided new insights into the study of aquatic assemblages and their adaptation to environmental constraints. However, certain problems arise in studying relationships among trait affinity, taxa abundance and environmental constraints; in particular, how to relate these three aspects simultaneously and how to test the significance of their relationships, a difficulty known as the “fourth-corner problem”. In 2008 Dray and Legendre provided an improved statistical method to address this issue, namely the fourth-corner statistic. This improved procedure offers the opportunity to work with species abundance or presence/absence, and several testing procedures for confirming or rejecting hypotheses positing trait-environment relationships. In this study, we test the ability of the fourth-corner statistic to test hypothesized trait-environment relationships in a river-floodplain ecosystem. Predictions on the effect of flooding and confinement on aquatic communities were made under the River Habitat Templet, a basic theoretical framework in river ecology. Using the implementation of the fourth-corner statistics in R 2.5.1, we found that flooding-related variables, mainly pH and turbidity, were related to traits that confer an ability of the organism to resist flooding (e.g., small body-shape, protection of eggs) or recuperate faster after flooding (e.g., short life-span, asexual reproduction). In contrast, confinement-related variables, mainly temperature and organic matter, enhanced traits that allow organisms to interact and compete with other organisms (e.g., large size, sexual reproduction) and to efficiently use habitat and resources (e.g., diverse locomotion and feeding strategies). These results are in agreement with predictions made under the River Habitat Templet and demonstrate the ability of the fourth-corner method to test hypothesis that posit trait-environment relationships. Criticisms on this improved solution to the four-corner problem will be finally discussed.

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EDUCATION ABOUT THE EU WATER FRAMEWORK DIRECTIVE USING QUALITIVE MODELS

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Code PO 3

Abstract

The main objective of the European Water Framework Directive 2000/60/EC (WFD) is the protection, restoration and improvement of the ecological state of water bodies. The general environmental objective of the WFD is achieving good ecological status of all natural water bodies and good ecological potential of artificial or modified water bodies through development and implementation of River Basin Management Plans by the year 2015. These plans provide solutions for a set of problems related with water quantity and quality, and in general – with the ecological status. One of these problems is increasing water use, which leads to a decline of the river runoff, habitats and species diversity. Solving this problem is important not only to meet the people water needs, but also to support the various services provided by riverine ecosystems to the humans. However, for many students and stakeholders this is difficult to understand. Therefore, conceptual knowledge of system's behaviour is crucial for society to understand and successfully interact with its environment.

Educators experience educating students and stakeholders about the effects of ratifying and implementing legislation on the natural world as a difficult task. Particularly for environmental science students, who are taught to view the world as natural processes, law does not fit their learned perspective. Furthermore, teaching about the processes occurring in the natural world is already challenging without the added complexity of legislation. An added complication is that the environmental science and law disciplines are not well integrated. We argue that qualitative conceptual models can contribute to the education about legislation and environmental science due to their unique features. Conceptual models primary purpose is to capture a person's understanding about the natural world and allow it to be communicated. As such, conceptual models are useful to use in educational settings. Such models encompass both the structure of the system and behavior of the system, and these features are neatly separated within the models. Conceptually relevant values of quantities are explicitly modeled in favor numerical details that do not contribute to understanding. The explicit causal relationships between the

quantities not only allows learners to understand the underlying processes of the system, but also allows running simulations that predict the effects of implementing certain kinds of legislation. Furthermore, the representation allows environmental science and law to be integrated in a single representation, which allows showing a holistic view of water quality. This is a fundamental approach proposed by the WFD.

This paper presents qualitative models that capture both the effects of water use on aquatic species and their habitats, and the role that legislative regulation (such as the WFD) has on both water use and river runoff. Such legislative actions can lead to an improvement of the ecological state of water bodies. The models show that increasing governmental pressure and decreasing economical pressure (both in the form of legislation) can be a good solution to the problem of water use.

The models shown in this paper have been implemented using software developed in the DynaLearn EC project. Models have been developed in different Learning Spaces (LSs), allowing each of them to emphasize specific details of the system behavior. The objectives of the models are to demonstrate the main effects of an increase of governmental pressure (by means of water legislation and standards) and protection actions on water quality. The models give answer of the following questions: (1) How do the protection actions and their consequences affect the water bodies? (2) What happens if the governmental pressure increases? (3) What happens if economic pressure increases? The answers of these questions should give students and stakeholders a better understanding about the interaction between law and water management.

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The Multimetric Macroinvertebrate Index Flanders (MMIF): a new method for evaluating rivers and lakes compliant to the WFD

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Code PO 4

Abstract

The EU-WFD requires that member states assess all their surface waters based on a number of biological elements, including macroinvertebrates. The assessment methods used must meet a number of requirements. Throughout the years, the Belgian Biotic Index has proven to be a reliable and robust method providing a good indication of general degradation of river water and habitat quality. Since the Belgian Biotic Index does not meet all the requirements of the WFD, a new index, the Multimetric Macroinvertebrate Index Flanders (MMIF) for assessing rivers and lakes was proposed. This poster provides an overview of this method.

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Linking PEGASE with classification tree models predicting the ecological status in the watercourses of the river Nete (Flanders, Belgium)

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Code PO 5

Abstract

Water quality models are regarded as tools with a high potential to facilitate the implementation of the Water Framework Directive (WFD) since they can offer information on the present, as well as the future state of a water body. In this way they allow the assessment of different management options and have the potential to support decision-making for river restoration and conservation management. From a technical perspective, there are two modelling approaches: one can decide to construct a new model for each application or to utilise existing models where possible (Lam et al., 2004). The first approach has the benefit of control in the model design and linkage, but requires longer development time, while the second approach saves on development time but requires additional work to link up existing models. It seems that when suitable models are available this second approach is the best option.

In the present study the water quality model PEGASE is linked with classification tree models for the prediction of the biotic integrity, expressed by the Belgian Biotic Index (BBI) and the Multimetric Macroinvertebrate Index Flanders (MMIF). This study is performed in the watercourses of the river Nete (Flanders, BELGIUM).

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The Water Framework Directive Explorer for decision support in integrated water management

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Code PO 6

Abstract

The Water Framework Directive Explorer (WFD) is developed by a consortium of research institutes and water management authorities. The main objective of the WFD Explorer is to support water managers with the development of river basin management plans in the context of the implementation of the WFD (Van Der Most et al., 2006). This software platform allows an ecological status analysis of water bodies in a catchment according to the WFD. Moreover the models embedded in the platform can calculate the ecological effects of different river restoration scenarios. The challenge for the development of the WFD-Explorer was to account for the 'simplicity' and transparency required in the policy process while at the same time acknowledging the complexity and fuzziness of ecological processes. This pilot study on this Belgian catchment is part of a validation study, aiming to assess the generality of the software system and optimisation for use in an international context.