QRSER: Qualitative Reasoning for Stream Ecosystem Restoration and Recovery Report from the First Workshop 6-8 March 2003 in Jena, Germany

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Abstract

This report presents our initiative to start a pan-European collaboration to build qualitative reasoning models for stream ecosystem restoration and recovery. The first QRSER workshop was held in March 2003 in Jena, Germany, with 17 participants from Europe, Brazil and the USA. The program of the workshop was well balanced between theory and practice sessions. After an introduction to QR in general and to each participant's research, focused lectures about QR in ecology were given. Participants had the opportunity to work out assignments and to practice building QR models. A discussion about the future development of the QRSER initiative (see www.qrser.de), possible projects, proposals, and meetings created a successful end to the first QRSER workshop.

Introduction

Running water bodies constitute a major component of the landscape and are one of the most important limnological habitats with unique structure and function. They have, however, suffered decades of degradation from agricultural and industrial pollution and from weir or dam construction, channelisation, and dredging. This damage has reduced their ability to provide economically important ecosystem services including drinking water, irrigation, hydropower, commerce, recreation and fisheries.

Decision makers in restoration and recovery need predictions to plan their activities. Quantitative ecosystem models may provide such predictions, but they are not only difficult to parameterise, but also difficult to explain to non-experts. Stream ecosystems are especially difficult to model because of our generally poor understanding of ecosystem structure and functioning.

QR is an innovative technique that captures the fundamental aspects of a system, while suppressing much of the irrelevant detail. This approach makes expert knowledge available to non-experts for direct use in applied contexts. It will help reconcile the conflicting interests of water users and facilitate forecasting, management, and restoration of running waters throughout Europe.

Objectives

The QRSER workshop was held to bring together European stream ecologists and QR experts and to teach QR modelling techniques for ecological research. Consequently, the target audience of this workshop were experienced stream ecologists from Europe who work in the area of regeneration, restoration, recovery, or improvement of degraded aquatic ecosystems. Ideally, they should work in a long-term research project and have already collected data and knowledge about the functioning of the investigated ecosystem.

Participants were invited to learn about the application of QR techniques to model ecological systems, share their own ideas about using QR models to investigate stream restoration and recovery, and practice thinking about representing familiar concepts in the intuitive, though unfamiliar, QR framework. Participants also practiced building QR models with example data for simplified systems. Another important goal of the workshop was to develop ideas for a

proposal for the 6th framework programme of the European Union on collaborative research on QR modelling of stream ecosystems and to use QR to improve restoration and recovery in a variety of stream ecosystems.

The venue

Fifteen kilometres north of Jena, Germany, high above the valley of the river Saale, the three *Dornburger Schlösser* build a unique ensemble from different epochs and styles coming from the Middle Ages, Rococo, and Renaissance periods. They are connected together by vineyard terraces and romantic, rose-covered arcades. The workshop was held in the Renaissance Chateau, built ca. 1540. Goethe lived here in 1828 and so the building is named today "*Goetheschloss*", and represents one of the prettiest commemorative sites for this great poet.

The program

The program of the first QRSER workshop was divided into three parts. On the first day, a general introduction to QR was given. Participant had the chance to give a short introduction into their research projects and the area where they would like to build models with QR. It became clear that the focus of work encompassed diverse areas including water quality aspects, structure and size of communities, habitat quality, and integrated catchment management.

During the second day of the workshop, an introduction about QR in ecology and practical assignments were given, followed by a more in-depth tutorial and more sophisticated assignment. A PC computer with the GARP software (including HOMER and VISIGARP) was available for every participant so that they could work on the assignments for a defined time on their own and the solution was presented to everybody at the end. This approach allowed each participant had the chance to learn more about the general background of QR in ecology and to practice building a QR model with GARP.

The third part of the workshop was a discussion about a proposal and the future development of the QRSER initiative. Participants discussed the idea, objectives and work plan of a project to be submitted to the European Commission 6th framework programme. All participants of the workshop supported the idea of a specific targeted research project (STREP) proposal. A time schedule was developed for future collaboration and development of the QRSER initiative (see www.qrser.de). A second workshop at the end of 2003 and a third meeting in spring 2004 during an international conference was planned. The idea is to enable all participants to build QR models on their own and to present these models during an international meeting. Papers of this meeting will be reviewed and published in an edited book about qualitative reasoning in stream ecosystem restoration and recovery.

Overall, the program of the first QRSER workshop was well balanced between theory and practical classes to introduce a new and innovative technique to a group of stream ecologists from all over Europe. The program was flexible enough to accommodate the needs of the participants and left enough time for discussing and future planning. The organisers are very happy with the results of the first workshop and look forward to future developments.

Questionnaire to the participants

After the first QRSER workshop, 12 participants presented their comments about different aspects of the modelling effort by answering a questionnaire. Topics assessed were their individual knowledge and their opinions about the workshop contents, structure, and the

model-building process. The overall evaluation of the QRSER structure and methodology was very good: "Friendly, relaxed atmosphere, good location, diverse array of participants willing to share ideas," "Group not too large", "Everyone had [the] opportunity to discuss, and over-domination of a few was kept minimal". The balance between theory and practice and the amount of material presented was considered about right, considering time available.

However, building QR models was not considered to be an easy task, even though most of the participants had 'some' previous experience modelling, and three of them were experts. Difficulties were found in different aspects of the modelling process. A new way of thinking about well known problems was required. For example, for half of those who answered the questionnaire, it was 'medium' or 'difficult' to create causal models of the system at hand, capture notions like direct and indirect influences imposed by processes, and to represent qualitatively objects, quantities and values. Technical aspects also presented some barriers: "difficult to learn the terminology and what [the modelling primitives] do'.

Prof Yordan Uzunov (Bulgaria): It was a perfect idea to hold this workshop introducing an emerging, innovative technique for non-numerical description of ecosystems of running water. The highest value of the workshop was the final commitment of the participants to join their expert knowledge implementing this. At the moment, the most advantageous feature of this approach is the opportunity to create many scenarios for possible developments within a stream ecosystem when introducing an integrated management and ecosystem approach.

Prof. Stefan Schmutz (Austria): State-of-the-art management of riverine ecosystems follows the principle of an integrated approach. Methods for integrating available knowledge into consistent frameworks are still widely lacking. Decision makers strongly need tools to integrate scattered information differing widely in expressiveness and quality. QR represents an adequate tool to handle these problems by developing consistent models for decision making.

Asked about applications of QR to their work, the participants of the first QRSER workshop were enthusiastic: "Opportunities for immediate application in research activities" and "good application in management decision support in data limiting scenarios" were foreseen by the participants. Most of the answers mentioned educational applications of QR models: "very useful for education and describing general ecological behaviour common to all ecosystems". One of the answers may summarize the general feeling: "[it is very useful and] will influence my practical work".

All in all, we conclude that modelling using QR techniques is very much in line with ecological thinking. The participants indicated that they would recommend a QR approach to colleagues because they found it useful for research, management, and education in stream ecosystem recovery.

The QRSER Project for the EU FP6

Under the call FP6-2002-GLOBAL-1 with a deadline in April 2003, the consortium built during the first workshop submitted a proposal with the acronym "QRSER" for a STREP (reference number FP6-505353). The objective of the QRSER proposal is to apply QR to long-term investigations of stream ecosystems. Our consortium of ecologists and information technologists from 14 European countries and Brazil will develop a cost-effective technology to forecast stream parameters.

This is the first initiative to develop QR models of stream ecosystem restoration and recovery. These models will support researchers and managers throughout Europe to understand behaviour of these complex systems. Simultaneously, this project will develop ecological curricula to teach ecological concepts to university students and applied users, to increase

ecological awareness and promote sustainable development. The work plan of this three-year project includes development of advanced software to support our collaborative approach. Ecological partners will develop QR models on specific problems, share them in a library of model fragments, and involve applied users for integrated model building.

The Relevance for Education

QR functions via the rich vocabulary that humans use to describe system behaviour, and thus facilitates causal reasoning. Hence, QR models are ideal for educational applications. Because of the various levels of understanding of learners, one model cannot be used at all levels of instruction. For example, learners who do not already have an advanced understanding of ecological theory cannot be expected to understand a complex community or ecosystem model if it is presented to them as a single entity. Rather, it is helpful to begin with simple, static models (descriptions of model components), and progressively add dynamic components (e.g., interactions between populations), until finally the full ecosystem model can be understood.

An important aspect of the QRSER initiative concerns its educational objectives. The idea is to develop university curricula using QR models to teach basic to advanced ecological concepts. Additionally, we have the goal to develop instructional methods to teach applied users (e.g. managers, decision makers and stakeholders) how to use QR models to understand and manage stream ecosystems to reach the goal of restoration and recovery.

Outlook for the Second QRSER Workshop

The second QRSER workshop is being organised by the Danube Delta National Institute for Research & Development, Tulcea, Romania. It is planned for the end of September 2003 (see www.qrser.de). The target audience are experienced stream ecologists from all over Europe. As a continuation of the first workshop, participants will learn and practise the GARP software to develop QR models. The second meeting aims to present the large range of stream ecosystem descriptions concerning the relationships among biotic and abiotic components. The goal is to enable participants to build QR models themselves.

An important objective is to involve end users. Participants from Water and Environment Protection Ministries, Water Agencies, etc. will learn and understand this new technique to represent knowledge about stream ecosystem behaviour. The goal is to support their decision making process for restoration and recovery. The EU Water Framework Directive and Flora Fauna Habitat Directive will be summarised and presented to the group to emphasise the current regulatory environment encompassing European stream-ecosystem quality.

The deadline for registration is 1 August 2003. For Information and instructions please contact Dr. Eugenia Cioaca from the Danube Delta National Institute for Research & Development (DDI); 165 Babadag Street, Tulcea, Romania (Tel.: +40240524550; E-mail: eugenia958@yahoo.co.uk).

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