Ecological Modelling 319 (2016) 3–8

Contents lists available at ScienceDirect

Ecological Modelling

journal homepage: www.elsevier.com/locate/ecolmodel

Editorial

1. How did it start?

My first encounter with ecological modeling was at the Water Research Conference in Jerusalem in 1971. Neal Armstrong (not the first man on the moon, but a professor at The University of Texas, Austin) spoke at the conference about a new powerful tool, ecological modeling, that could be used to develop an environmental management strategy, based on both the problem and the complex properties of ecosystems. I was immediately fascinated by this new, holistic, surveying tool. I have always been attracted to informative surveys and here was a tool that allowed me to obtain a better understanding of a complex problem (such as pollution problems) in a complex system (an ecosystem). Ecological models were known and developed before 1971. Already in the 1920s, we had the Lotka–Volterra prey–predator model and the Streeter-Phelps river models, but the idea to solve more complex environmental management problems and to capture the many features of ecosystems – to see the forest through the trees as we say – started around 1970. The computer technology was at that time – 45 years ago – sufficiently advanced to solve numerically, even very complex mathematical problems, which was needed for the development of ecological models.

Following my return from the water research conference, I applied for a scholarship to visit the United States universities that had started development of these new model types that required use of computers due to the complex mathematics. This was in contrast to the Lotka–Volterra and the Streeter-Phelps models that were solved analytically. I received the scholarship and visited several universities in the US in 1972, including Athens, Georgia, where E.P. Odum and B.C. Patten had residence and Gainesville, Florida, where H.T. Odum was the leading scientist and, of course, also Austin, where my friend from Jerusalem, Neal Armstrong, was developing lake models, which I meanwhile had started to develop for Danish lakes. I learned a lot about how to go modeling during the two-month study tour, but I learned also that outside the enthusiastic relatively few groups of ecological modelers, nobody believed that it was possible to develop ecological models – nature was too complex. All the researchers dealing with ecological modeling complained that it was not possible to have their ecological modeling papers published. I asked all the modelers: but why don't you launch a new journal called *Ecological Modelling* which could publish your modeling papers? All the American modelers were positive to the idea, but they encouraged me to start the journal in Europe, as they claimed that Europe was sometimes more susceptible to new ideas than the US. I started the journal naively by myself, invited an editorial board, and found a good printing house. However, the rumor that I was on my way to start a new journal reached Elsevier. In the beginning of 1974, I was contacted by Elsevier with an offer: Elsevier would take care of the administration, the distribution and the printing and so on, while I should be the Editor-in-Chief. This was obviously a much better solution to have a global publishing firm as Elsevier behind the management and publication of *Ecological Modelling* and I could concentrate my effort on the scientific quality of the journal and not worry about the administration and distribution and so on. The result was that the first issue of *Ecological Modelling* was published January 1975.

2. The development of the journal 1975–2015

Since 1975, the journal has grown enormously – both quantitatively and qualitatively. Statistical results of the journal show that the number of pages per year today is 16 times the number of pages published per year during the first five years of *Ecological Modelling* – from 1975 to 1979 (Table 1). Additionally, the journal is covering all corners of ecological modeling and systems ecology. The statistics show furthermore, that we have papers based on more model types today than 40 years ago – new model types that have emerged to solve problems that the ecological modelers have developed in their effort to consider many complex ecological questions. Moreover, the wide spectrum of papers in this special issue published to celebrate the 40th anniversary of the journal demonstrates the development of the journal (see the last section of this editorial).

The reason for this enormous development of the field of ecological modeling is, to a high extent, due to the fast development of computer technology. When we conveniently develop our model today on our PCs, we rarely appreciate how much easier it is today to develop a model than it was 40 years ago. At that time, the models were developed on mainframe computers using punch cards.

Ecological Modelling has only had two editors in chief during these 40 years as I served from 1975–2009 as Editor-in-Chief while Brian Fath is now – since 2009 – the captain on the ship. I am grateful that Brian is doing an excellent job to nurse the journal and navigate the ship properly in the new sea of *Ecological Modelling* and Systems Ecology. I am of course following the journal and have observed how the journal is still growing – maybe the last five years more qualitatively than quantitatively. More and more papers are submitted to the journal which implies that the rejection rate with the same number of published papers per year inevitably must increase. Furthermore, more and more

http://dx.doi.org/10.1016/j.ecolmodel.2015.10.021
0304-3800/

Table 1
Ecological Modelling, statistics.

	Number of papers 2012–2014	Number of papers 1975–1979
Total	833	123
Pages	9690	2323
Pages, format 1975–1979	22,287	2323
Pages/paper format 1975–1979	26.8	18.9
Pages/year format 1975–1979	7429	465
Ratio pages/year	16	1

Table 2
Ecological Modelling types, statistics.

Model type	Number of papers 2012–2014	Number of papers 1975–1979
Biogeochemical Models	309	62
Population dynamic Models	176	13
Spatial Distribution Models	110	4
Structural Dynamic Models	40	4
Steady State Models	2	0
Ecotoxicological Models	16	8
Individual Based Models	31	0
ANN and SOM	5	0
Stochastic Models	3	0
Models using Artificial Intelligence	12	0
Fuzzy Models	6	0
Modelling Theory	58	15
Systems Ecology	62	14
Socio-economic-ecological Models	3	3

papers covering new challenging ideas and all corners of ecological modeling and systems ecology are published in the journal. In this context, it is obvious to ask the question. What is next? How will ecological modeling and systems ecology develop during the coming five or ten years? We try, with the selection of papers included in this issue, to give at least a partial answer and it is furthermore discussed in the last section of the editorial.

During the 1970s and 1980s, *Ecological Modelling* published papers focusing on ecological engineering and ecological economics, often but not always by application of ecological models. The original title of the journal had even the full name *Ecological Modeling, Systems Ecology and Ecological Engineering*. In 1986, a new journal started covering ecological economics, with the same name. And, in 1992, a journal with the name *Ecological Engineering* was started while "ecological engineering" was simultaneously deleted from the subtitle of *Ecological Modelling* (but the systems ecology subtitle remains) During the 1990s, papers about the use and development of ecological indicators were published in *Ecological Modelling*, but in year 2000 a journal started with the title *Ecological Indicators*. In 2006, the journal *Ecological Informatics* started whereas such papers on that topic were prior from 1996 to 2006 accepted in *Ecological Modelling*. This means that these ecological sub-disciplines, ecological economics, ecological engineering, ecological indicators, and ecological informatics together with ecological modeling have grown much more than a factor 16, probably a factor about thirty between 1975 and 2015. Furthermore, it is clear that *Ecological Modelling* has been a catalyst for the development of other ecological sub-disciplines than modeling. It has expanded the field of ecology and systems ecology and the application of ecology in environmental science and management.

It is possible to divide the models published in *Ecological Modelling* into model types or modeling approaches; see also Jørgensen (2008) and Jørgensen and Fath (2011). Models developed either for (1) environmental management or (2) basic ecology. We are, however, often in practice of using two or more model types to be able to cope with the complexity of the problem. In spite of this complexity, it would be interesting to make statistics of the use of various model types when the journal started 40 years ago until today, to see how the field of ecological modeling has developed. By using a statistic based on eleven types (defined in Jørgensen, 2008 and the types are generally known by ecological modelers), we should be able to see the qualitative and quantitative development in the application of models. If two model types are used in a published model paper, the two types are both counted as 0.5 paper, and if three model types are used the three types are indicated as 0.33 paper and so on. To make the statistics more informative, the number of papers of the chosen eleven types in *Ecological Modelling* the first five years (1975–1979) and the last three years (2012–2014) has been supplemented by the number of theoretical papers covering modeling theory and systems ecology. The results of the statistic examination are summarized in Table 2.

The development of the journal *Ecological Modelling* reflects the development of the field ecological modeling, as it publishes 40–50% of all ecological modeling papers published in international peer-reviewed scientific journals. First of all, the field has grown enormously as we today publish 16 times as many pages per year. The number of pages has been calculated as pages using the format 1975–1979. The number of words per page is about 2.3 times as much today as in the years 1975–1979. The number of papers published per year has increased by a factor 12. The papers are therefore about 33% longer today, which is probably due to an increased complexity of the published models. It is also characteristic for the development that 6 model types that today cover 7% of the papers were not published in 1975–1979. The field of ecological modeling has therefore increased not only in the number of publications but also in the number of model types applied for model development. Spatial models and IBMs have increased in number more than the number of papers in general, indicating that these model types are clearly more significant than in the 1970s. Biogeochemical models have only increased a factor about 6, but this type is still the most applied model type in ecological modeling. The theoretical papers – modeling theory and systems ecology – have increased less than the number of model papers. It is understandable as these theoretical questions: "How to develop a good model?" and "How does an ecosystem function?" were core problems in the 1970s. Still, significantly more papers are published today to cover these two important theoretical fields.

During the forty years all types of ecosystems have been modeled – and in this issue we have the opportunity to publish a model even of an Antarctic ecosystem. For many ecosystems many different models have been developed, taking into considerations the problems and the available data and regional and climatic conditions. We have today many models of lakes, wetlands, estuaries, coastal lagoons, fjords, bays, grasslands, forest, agricultural systems, tundra, floodplains, bogs and urban ecosystems. Lately, papers with models of Arctic ecosystems and now also Antarctic ecosystems have been published. *Ecological Modelling* has furthermore published papers focusing on a wide spectrum of environmental problems: oxygen depletion, eutrophication, toxic substance contamination, distribution of toxic substances, sustainable fishery, aquaculture management, sustainable agriculture, sustainable forestry, water quality in general, global warming, the impact of climate changes on ecosystems, landscape management, erection of artificial wetlands, soil quality and properties, immigration of exotic species. On the more theoretical front, papers focusing on all the steps of model development and almost all issues of systems ecology have been published: the selection of model complexity, the role of biodiversity, carrying capacity and ecological niches, the resistance, stability, buffer capacity and resilience of ecosystems, network theory, hierarchy theory, thermodynamics of ecosystems and the importance of many ecological processes for