# Chapter 5 Modelling Phosphorus Dynamics In The Soil Plant

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## CARMELO MAHONEY

*Dynamic Modeling of Environmental Systems* Oxford University Press
African papyrus (Cyperus papyrus L.) wetlands provide water, food and materials to millions of people, and perform important landscape functions such as water and nutrient storage, habitat provision for fish, birds and other wildlife. They are also an integral part of the culture of African wetland communities. With an increasing demand for food, papyrus wetlands are at risk of conversion to agriculture and losing these ecosystem services. Combining increased agricultural production with wetland conservation is urgently needed. The research presented in this book consisted of two parts. First, field experiments investigated nitrogen and phosphorus retention, showing that papyrus grows faster with disturbance from human activities or flooding, but produces less biomass and stores less nutrients. Then, a dynamic simulation model (Papyrus Simulator) based on the hydrological and ecological wetland processes showed that assimilation, mortality, decay, re-translocation, nutrient inflow and soil porosity were the most influential factors. The model demonstrated that controlled harvesting can increase nutrient retention by up to 40%, but overharvesting leads to the release of nutrients. These findings can help determining optimum harvesting strategies for constructed and natural wetlands, and contribute to the quantification of ecosystem services and an evidence-based adaptive management approach for African wetland landscapes.
Modeling Biological Phosphorus Removal in Activated Sludge Systems Springer Science & Business Media
Phosphorus (P) is a finite resource which is essential for life. It is a limiting nutrient in many ecosystems but also a pollutant which can affect biodiversity in terrestrial ecosystems and change the ecology of water bodies. This book collects the latest information on biological processes in soil P cycling, which to date have remained much less understood than physico-chemical processes. The methods section presents spectroscopic techniques and the characterization of microbial P forms, as well as the use of tracers, molecular approaches and modeling of soil-plant systems. The section on processes deals with mycorrhizal symbioses, microbial P solubilization, soil macrofauna, phosphatase enzymes and rhizosphere processes. On the system level, P cycling is examined for grasslands, arctic and alpine soils, forest plantations, tropical forests, and dryland regions. Further, P management with respect to animal production and cropping, and the interactions between global change and P cycling, are treated.
**SOIL MICROBIOLOGY A MODEL OF DECOMPOSITION & NUTR CYCLING** Springer
Despite advances in modeling, such as graphical user interfaces, the use of GIS layers, and databases for developing input files, the approaches to modeling phosphorus (P) have not changed since their initial development in the 1980s. Current understanding of P processes has evolved and this new information needs to be incorporated into the current
**Current Developments in Biotechnology and Bioengineering** Cambridge University Press
The thoroughly updated new edition of Gordon Bonan's comprehensive textbook on terrestrial ecosystems and climate change, for advanced students and researchers.
**Environmental Applications of Digital Terrain Modeling** Springer Science & Business Media
Ocean Biogeochemical Dynamics provides a broad theoretical framework upon which graduate students and upper-level undergraduates can formulate an understanding of the processes that control the mean concentration and distribution of biologically utilized elements and compounds in the ocean. Though it is written as a textbook, it will also be of interest to more advanced scientists as a wide-ranging synthesis of our present understanding of ocean biogeochemical processes. The first two chapters of the book provide an introductory overview of biogeochemical and physical oceanography. The next four chapters concentrate on processes at the air-sea interface, the production of organic matter in the upper ocean, the remineralization of organic matter in the water column, and the processing of organic matter in the sediments. The focus of these chapters is on analyzing the cycles of organic carbon, oxygen, and nutrients. The next three chapters round out the authors' coverage of ocean biogeochemical cycles with discussions of silica, dissolved inorganic carbon and alkalinity, and CaCO3. The final chapter discusses applications of ocean biogeochemistry to our understanding of the role of the ocean carbon cycle in interannual to decadal variability, paleoclimatology, and the anthropogenic carbon budget. The problem sets included at the end of each chapter encourage students to ask critical questions in this exciting new field. While much of the approach is mathematical, the math is at a level that should be accessible to students with a year or two of college level mathematics and/or physics.
Development and Verification of a Simulation Model on Phosphorus Dynamics in Soil and Uptake by Plant Roots Springer Nature
Photobioreactors: Design and Applications provides a comprehensive overview of photobioreactor design, types and applications. It also introduces key principles that enable chemical and environmental engineers to engage in analysis, optimization and design with consistent control over

biological and chemical transformations. The use of computational modeling of processes, control systems and CFD is in great demand. This book covers these aspects of chemical and bioprocesses. Focuses on design, types, modeling and simulation of photobioreactors and applications in biohydrogen and microalgae production Includes up-to-date reviews of photobioreactors Discusses biopolymers, diatoms, cyanobacteria and pigments production using different types of photobioreactors

*Phosphorus Dynamics in Castle Lake, California* Bentham Science Publishers

Learn to create and use simulation models—the most reliable and cost-effective tools for predicting real-world results! The Handbook of Processes and Modeling in the Soil-Plant System is the first book to present a holistic view of the processes within the soil-plant-atmosphere continuum. Unlike other publications, which tend to be more specialized, this book covers nearly all of the processes in the soil-plant system, including the fundamental processes of soil formation, degradation, and the dynamics of water and matter. It also illustrates how simulation modeling can be used to understand and forecast multiple interactions among various processes and predict their environmental impact. This unique volume assembles information that until now was scattered among journals, bulletins, reports, and symposia proceedings to present models that simulate almost all of the processes occurring in the soil-plant system and explores the results that these models are capable of producing. With chapters authored by experts with years of research and teaching experience, the Handbook of Processes and Modeling in the Soil-Plant System examines: physical, chemical, and biological soil processes the soil formation and weathering process and its modeling the impact of radioactive fallout on the soil-plant system soil degradation processes and ways to control them water and matter dynamics in the soil-plant system growth and development of crops at various levels of production the potentials and limitations of using simulation models Students, educators, and professionals alike will find the Handbook of Processes and Modeling in the Soil-Plant System an invaluable reference on the soil-plant-atmosphere system and an ideal tool to help develop an effective decision support system.

**Modelling Long-term Phosphorus Dynamics in Swiss Agricultural Soils Using EPIC** CRC Press

Lakes are ecologically, economically, and culturally significant resources that are, at the same time, very fragile and sensitive to human disturbances. During the last decades, intensified urbanization and discharge of nutrients lead to the increase of lake eutrophication in many regions of the world. Moreover, biogeochemical cycles within the lakes are changing due to climate warming, which increases water temperature and affects physical and hydrological lake regimes. In this thesis, I investigate a vast scope of the natural and anthropogenic processes affecting the biogeochemical cycles in lakes at different scales. In particular, I examine the cascading effect of the climate, regional weather, human interventions, and microbial control on phosphorus dynamics in lakes. In Chapter 2, I demonstrate that on the lake scale, phosphorus cycle is driven by internal loading and iron recycling, while it is vulnerable to the reduction of ice cover. To achieve that, I expand the existing MyLake model by incorporating a sediment diagenesis module. Moreover, I develop the continuous reaction network that couples biogeochemical reactions taking place both in water column and sediment. In the modeling scenarios, I assess the importance of the sediment processes and the effects of the climatic and anthro- pogenic drivers on water quality in Lake Vansjø, Norway. I also highlight the importance of phosphorus accumulation within the lake that controls timing and magnitude of bio- geochemical lake responses to external forcing. This includes projected changes in the air temperature, absence of ice cover, and potential management practices. In Chapter 3, I contribute to the long-standing understanding that on the scales of microbial systems, the respiration reactions exert substantial control on biogeochemi- cal cycles by regulating the availability of the electron donors and acceptors, secondary minerals, adsorption sites, and alkalinity. Moreover, I develop a new conceptual model to simulate the preferential catabolic reaction pathways based on power produced in reactions. In contrast to common kinetic rate expressions, I demonstrate that new ther- modynamically based formulations can be applied to describe the microbial respiration of arbitrary large reaction networks. New approach substantially improves the robustness, transferability, and allows the generalization of the model-derived parameters. In Chapter 4, I show that on the regional scale, weather defines hydrodynamic flush rates and water circulation patterns, which, in turn, control the phosphorus transport in Lake Erie, Canada. Specifically, precipitation controls the release of phosphorus from the watershed in the spring, while wind governs the water circulation and transport of the phosphorus released from sediment in the central basin during summer. I also illustrate that climate and weather in the upper Laurentian Great Lakes regulate changes in the water level of Lake Erie. Overall, this thesis improves the fundamental understanding of the phosphorus cycle in lakes, which is being controlled by numerous biogeochemical and physical processes at various scales. In particular, I show that the climate has a cascading effect on the phosphorus cycle in lakes. First, climate controls regional precipitation, wind, and air temperature, which in turn control phosphorus supply from the watershed and basin- wide phosphorus transport. Second, being vulnerable to climate warming, the duration of ice cover impacts the phosphorus cycle through changes in light attenuation, water temperature, mixing regimes, and water column ventilation. Lastly, local environmental perturbations (e.g., pH, temperature, or redox state) define thermodynamic properties of the sediment, which control microbial metabolism and, therefore, the internal phosphorus loading. Finally, this thesis provides new open-source tools for reactive transport simula- tions in lakes as well as in saturated media. In addition to the coupled lake-sediment model developed in Chapter 3, I develop a computer program PorousMediaLab, which performs biogeochemical simulations in water-saturated media and described In Chapter 5. PorousMediaLab is the core component of the numerical investigations presented in the thesis. For example, PorousMediaLab is applied in Chapter 2 to design and test the initial reaction network, calculate fluxes at the sediment-water interface, and estimate re- action timescales. In Chapter 3, PorousMediaLab is used to simulate the reaction rates of batch and one-dimensional sediment column using a novel approach based on the thermo-dynamic switch function. In Chapter 4, PorousMediaLab is used to build a mass balance model and to improve the current understanding of the inter-basin exchange. Both tools are open-source, and they are available online.

**Electroless Copper and Nickel-Phosphorus Plating** WIT Press

Environmental Zeolites and Aqueous Media: Examples of practical solutions brings to light the characteristic features of ion exchange and adsorption onto natural zeolite for environmental

cleanup processes, particularly for water purification, zeolite`s present, past and future. This ebook emphasizes on the recent development in the synthesis and manufacturing of the advanced cost-effective organic and inorganic zeolite-based adsorbents. The scope of this ebook covers a range of topics including natural zeolite, general aspects of adsorption, physical characterization of fundamental ion exc.

Modeling Phosphorus Dynamics in Soils Elsevier

The primary reference for the modeling of hydrodynamics and water quality in rivers, lake, estuaries, coastal waters, and wetlands This comprehensive text perfectly illustrates the principles, basic processes, mathematical descriptions, case studies, and practical applications associated with surface waters. It focuses on solving practical problems in rivers, lakes, estuaries, coastal waters, and wetlands. Most of the theories and technical approaches presented within have been implemented in mathematical models and applied to solve practical problems. Throughout the book, case studies are presented to demonstrate how the basic theories and technical approaches are implemented into models, and how these models are applied to solve practical environmental/water resources problems. This new edition of Hydrodynamics and Water Quality: Modeling Rivers, Lakes, and Estuaries has been updated with more than 40% new information. It features several new chapters, including one devoted to shallow water processes in wetlands as well as another focused on extreme value theory and environmental risk analysis. It is also supplemented with a new website that provides files needed for sample applications, such as source codes, executable codes, input files, output files, model manuals, reports, technical notes, and utility programs. This new edition of the book: Includes more than 120 new/updated figures and 450 references Covers state-of-the-art hydrodynamics, sediment transport, toxics fate and transport, and water quality in surface waters Provides essential and updated information on mathematical models Focuses on how to solve practical problems in surface waters—presenting basic theories and technical approaches so that mathematical models can be understood and applied to simulate processes in surface waters Hailed as “a great addition to any university library” by the Journal of the American Water Resources Association (July 2009), Hydrodynamics and Water Quality, Second Edition is an essential reference for practicing engineers, scientists, and water resource managers worldwide.

Ocean Biogeochemical Dynamics CRC Press

A primer on modeling concepts and applications that is specifically geared toward the environmental field. Sections on modeling terminology, the uses of models, the model-building process, and the interpretation of output provide the foundation for detailed applications. After an introduction to the basics of dynamic modeling, the book leads students through an analysis of several environmental problems, including surface-water pollution, matter-cycling disruptions, and global warming. The scientific and technical context is provided for each problem, and the methods for analyzing and designing appropriate modeling approaches is provided. While the mathematical content does not exceed the level of a first-semester calculus course, the book gives students all of the background, examples, and practice exercises needed both to use and understand environmental modeling. It is suitable for upper-level undergraduate and beginning-graduate level environmental professionals seeking an introduction to modeling in their field.

**Handbook of Processes and Modeling in the Soil-Plant System** Princeton University Press

A First Course in Systems Biology is an introduction for advanced undergraduate and graduate students to the growing field of systems biology. Its main focus is the development of computational models and their applications to diverse biological systems. The book begins with the fundamentals of modeling, then reviews features of the molecular inventories that bring biological systems to life and discusses case studies that represent some of the frontiers in systems biology and synthetic biology. In this way, it provides the reader with a comprehensive background and access to methods for executing standard systems biology tasks, understanding the modern literature, and launching into specialized courses or projects that address biological questions using theoretical and computational means. New topics in this edition include: default modules for model design, limit cycles and chaos, parameter estimation in Excel, model representations of gene regulation through transcription factors, derivation of the Michaelis-Menten rate law from the original conceptual model, different types of inhibition, hysteresis, a model of differentiation, system adaptation to persistent signals, nonlinear nullclines, PBPK models, and elementary modes. The format is a combination of instructional text and references to primary literature, complemented by sets of small-scale exercises that enable hands-on experience, and large-scale, often open-ended questions for further reflection.

Hydrodynamics and Water Quality CRC Press

Unlike electroplating, electroless plating allows uniform deposits of coating materials over all surfaces, regardless of size, shape and electrical conductivity. Electroless copper and nickel-phosphorus deposits provide protective and functional coatings in industries as diverse as electronics, automotive, aerospace and chemical engineering. This book discusses the latest research in electroless depositions.After an introductory chapter, part one focuses on electroless copper depositions reviewing such areas as surface morphology and residual stress, modelling surface structure, adhesion strength of electroless copper deposit, electrical resistivity and applications of electroless copper deposits. Part two goes on to look at electroless nickel-phosphorus depositions with chapters on the crystallisation of nickel-phosphorus deposits, modelling the thermodynamics and kinetics of crystallisation of nickel-phosphorus deposits, artificial neural network (ANN) modelling of crystallisation temperatures, hardness evolution of nickel-phosphorus deposits and applications of electroless nickel-phosphorus plating.Written by leading experts in the field Electroless copper and nickel-phosphorus plating: Processing, characterisation and modelling is an invaluable guide for researchers studying electroless deposits or materials science as well as for those working in the chemical, oil and gas, automotive, electronics and aerospace industries. Written by leading experts in the field, this important book reviews the deposition process and the key properties of electroless copper and nickel-phosphorus deposits as well as their practical applications Chapters review areas such as surface morphology and residual stress, modelling surface structure, crystallisation of nickel-phosphorus deposits and hardness evolution An invaluable guide for researchers studying electroless deposits or materials science as well as for those working in the chemical, oil and gas, automotive, electronics and aerospace industries

*A First Course in Systems Biology* ScholarlyEditions

Covers the fundamentals and the latest advances in computerized automation and process control, control algorithms, and specific applications essential food manufacturing processes and unit

operations. This text highlights the use of efficient process control to convert from batch to continuous operation and enhance plant sanitation. It compares both established and innovative control schemes.

Handbook of Biological Wastewater Treatment Springer Science & Business Media

A perspective of modeling. A review of models in soil microbiology. Mathematical development. A decomposition and nutrient cycling model. Mathematical basis of the spatial approximation. The decomposers. The general microbe population. The nitrifiers. Symbols. Parameters. The carbon cycle. Disintegration of dead plant and animal matter. Free polysaccharide in soil. Bound polysaccharide. Simple sugar in soil solution. The phosphorus cycle. Free organic phosphorus in soil. Bound phosphorus. Mineral phosphorus. Soil solution phosphorus. The potassium cycle. Potassium leached from live cells. Potassium leached or dissolved from dead cells. Nonexchangeable potassium. Exchangeable potassium. Soluble mineral potassium. Atmospheric input and groundwater loss. Soil solution potassium. The nitrogen-aromatic cycle. Free organic nitrogen in soil. Bound organic nitrogen. Condensable aromatics. Soil solution NH+4. Soil solution NO-2 and NO-3. Cell chemistry. Plants. Microbes. Temperature and moisture dependence of processes. Organic and inorganic reactions. The role of plants in decomposition and nutrient cycling. Model development. Comparison of model with experiment. Comparison of model with theories of plant growth. Simplified version of the plant model. The steady state. Phosphorus. Potassium. Nitrogen. The dynamic state. Overall pattern of decomposition and microbe growth. The influence of substrate carbon and nitrogen content on mineralization and immobilization. Microbe growth limited by nitrogen. Wastage of substrate. The rate-limiting step of nitrogen mineralization. The priming effect of soil amendments on rate of mineralization. Accumulation of organic matter in soils. Effect on microbes of oscillating low soil temperatures. Effect on microbes of soil moist-dry cycles. Microbe and plant competition for nutrients. Strategy of optimum crop fertilization. A look ahead. Mathematical and numerical techniques. The runge-kutta method. Solution of coupled nonlinear algebraic equations.

Ecological Modelling CRC Press

The scope of this comprehensive new edition of Handbook of Biological Wastewater Treatment ranges from the design of the activated sludge system, final settlers, auxiliary units (sludge thickeners and digesters) to pre-treatment units such as primary settlers and UASB reactors. The core of the book deals with the optimized design of biological and chemical nutrient removal. The book presents the state-of-the-art theory concerning the various aspects of the activated sludge system and develops procedures for optimized cost-based design and operation. It offers a truly integrated cost-based design method that can be easily implemented in spreadsheets and adapted to the particular needs of the user. Handbook of Biological Wastewater Treatment: Second Edition incorporates valuable new material that improves the instructive qualities of the first edition. The book has a new structure that makes the material more readily understandable and the numerous additional examples clarify the text. On the website www.wastewaterhandbook.com three free excel design spreadsheets for different configurations (secondary treatment with and without primary settling and nitrogen removal) can be downloaded to get the reader started with their own design projects. New sections have been added throughout: to explain the difference between true and apparent yield while the section on the F/M ratio, and especially the reasons not to use it, has been expanded; to demonstrate the effect of the oxygen recycle to the anoxic zones on both the denitrification capacity and the concept of available nitrate is explained in more detail. the latest developments on the causes and solution to sludge bulking and scum formation to show the rapid developments of innovative nitrogen removal and sludge separation problems the anaerobic pre-treatment section is completely rewritten based on the experiences obtained from an extensive review of large full-scale UASB based sewage treatment plants a new section on industrial anaerobic wastewater treatment three new appendices have been added. These deal with the calibration of the denitrification model, empirical design guidelines for final settler design (STORA/STOWA and ATV) and with the potential for development of denitrification in the final settler. A new chapter on moving bed biofilm reactors Handbook of Biological Wastewater Treatment: Second Edition is written for post graduate students and engineers in consulting firms and environmental protection agencies. It is an invaluable resource for everybody working in the field of wastewater treatment. Lecturer support material is available when adopted for university courses. This includes course material for the first 7 modules in the form of PDF printouts and an exercise file with questions and answers and a symbol list. Authors: Prof. dr. ir. A.C. van Haandel, Federal University of Campina Grande - Brazil and Ir. J.G.M. van der Lubbe, Biothane Systems International - Veolia, The Netherlands

*Modeling Biological Systems:* John Wiley & Sons

Achieving food security and economic developmental objectives in the face of climate change and rapid population growth requires systems modelling approaches, for example in the design of sustainable agriculture farming systems. Such approaches increase our understanding of system responses to different soil and climatic conditions, and provide insights into the effects of various variable climate change scenarios, providing valuable information for decision-makers. Further, in the agricultural sector, systems modelling can help optimise crop management and adaptation measures to boost productivity under variable climatic conditions. Presenting key outcomes from crop models used in agricultural systems this book is a valuable resource for professionals interested in using modelling approaches to manage the growth and improve the quality of various crops.

*Report - Hydrodynamics Laboratory, Massachusetts Institute of Technology* Garland Science

Issues in Global Environment—Freshwater and Marine Environments: 2012 Edition is a ScholarlyEditions™ eBook that delivers timely, authoritative, and comprehensive information about Freshwater Research. The editors have built Issues in Global Environment—Freshwater and Marine Environments: 2012 Edition on the vast information databases of ScholarlyNews.™ You can expect the information about Freshwater Research in this eBook to be deeper than what you can access anywhere else, as well as consistently reliable, authoritative, informed, and relevant. The content of Issues in Global Environment—Freshwater and Marine Environments: 2012 Edition has been produced by the world’s leading scientists, engineers, analysts, research institutions, and companies. All of the content is from peer-reviewed sources, and all of it is written, assembled, and edited by the editors at ScholarlyEditions™ and available exclusively from us. You now have a source you can cite with authority, confidence, and credibility. More information is available at

http://www.ScholarlyEditions.com/.
*A model of the phosphorus dynamics of Calluna heathland* John Wiley & Sons
Opening with a survey of contemporary global ecodynamics, including its basic components, this book goes on to discuss greenhouse effect problems in the context of global carbon cycle dynamics. The coverage includes land ecosystem changes, air-sea exchange models, high-latitude environmental dynamics, and a discussion of basic aspects of global environmental modelling and relevant monitoring systems. The volume concludes by examining society systems with emphasis on the problems of sustainable development.
**Systems Modeling** Springer Science & Business Media
Addressing the basic concepts of ecological modelling, Jorgensen provides the user with a tool which can assist in the understanding of what various model types/network calculations can do, as well as outlining when to use which type as a tool to solve a specific problem.