Coastal Research Library

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Series Editor
Charles W. Finkl
Department of Geosciences
Florida Atlantic University
Boca Raton, FL, USA

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Charles W. Finkl • Christopher Makowski
Editors

Coastal Wetlands: Alteration and Remediation

Springer

Editors
Charles W. Finkl
Coastal Education and Research Foundation (CERF)
Fletcher, NC, USA

Department of Geosciences
Florida Atlantic University
Boca Raton, FL, USA

Christopher Makowski
Coastal Education and Research Foundation (CERF)
Coconut Creek, FL, USA

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Preface

This volume of *Coastal Research Library* (*CRL*) deals with the general topic of coastal wetlands but specifically from within the purview of impacts that are deleterious to wetlands and kinds of restorative efforts that are deployed in attempts to correct wrongs resulting from human action. To this end, the volume is divided into three main parts: Part I, Impacts of Urbanization, Agricultural Occupation, Pollution, Climate Change, and Coastal Marine Influences; Part II, Impacts of Coastal Engineering and Environmental Degradation; and Part III, Restoration Techniques, Ecological Aesthetics, and Ecosystem Conservation (Sustainability and Biodiversity). These general subject area parts are in turn subdivided into chapters that are exemplars of degradation impacts or vignettes illustrating various approaches to restoration, either conceptually or in principle, and examples of new methodologies.

The geographical scope of this volume ranges from tropical to high-latitude coastal zones with various types of wetlands such as mangroves and salt marsh. A wide range of ecological considerations focuses on fisheries, intertidal benthic fauna, macrobenthic communities, and wildlife management. This selection of wide-ranging topics provides insight into the interconnectedness of various aspects of coastal wetlands. Provided here is a plethora of examples of successes and failures in attempts to correct the errors of human action when it comes to dealing with coastal wetlands. Sadly, many coastal wetlands around the world have been subjected to unwanted or unintended adverse impacts associated with urbanization, industrialization, and commercialization. With half of the world's coastal wetlands destroyed by such activities, it is imperative to absorb what is reported here in the following chapters that outline potential remediation efforts to save, conserve, or protect what is left of these valuable coastal ecosystems that are almost continually under threat from development.

Part I contains eight chapters that are examples of coastal wetlands adjacent to or overtaken by urbanization and agricultural occupation, which in turn result in degradation or destruction of coastal ecosystems. This dismal situation is further exacerbated by pollution, usually associated with urban development and/or agriculture, that compromises the integrity and in some cases the very survival of the

remaining wetlands. Chapter 1 (“The Florida Everglades: An Overview of Alteration and Restoration”), by Charles W. Finkl and Christopher Makowski, discusses how urbanization, agriculture, and flood control destroyed about half of the Florida Everglades (a wetland of international importance [Ramsar Convention] and an international biosphere reserve [UNESCO]) and indicates failures of the world’s most expensive reclamation effort that amounts to more than US$ 8 billion. Chapter 2 (“Recent Agricultural Occupation and Environmental Regeneration of Salt Marshes in Northern Spain”), by Ane García-Artola, Alejandro Cearreta, and María Jesús Irabien, deals with the reclamation of more than 50% of the original salt marshes that were degraded since the seventeenth century. This chapter illustrates how global temperate coastal wetlands with abundant sediment supply can be regarded as a soft adaptation measure that militates against consequences of climate change in the coastal zone. Chapter 3 (“Impact of Urbanization on the Evolution of Mangrove Ecosystem of the Wouri River Estuary [Douala, Cameroon]”), by Ndongo Din, Vanessa Maxemilie Ngo-Massou, Guillaume Léopold Essomè-Koum, Eugene Ndema-Nsombo, Ernest Kottè-Mapoko, and Laurant Nyamsi-Moussian, illustrates the deleterious effects of the urban environment on mangrove depletion around cities due to wood harvesting, sand extraction, and petroleum exploitation, in addition to coastal erosion and climate change. Unfortunately, the prognosis for a change in perception of mangrove degradation in this region is poor due to the absence of implementation of specific regulations to protect the mangrove forests. Chapter 4 (“Impacts of Coastal Land Use Changes on Mangrove Wetlands at Sungai Mangsalut Basin in Brunei Darussalam”), by Shafi Noor Islam and Umar Abdul Aziz Bin Yahya, continues in a similar vein by showing how increasing population pressure and economic development are detrimental to mangroves and salt marshes. Similar to the Everglades, there is the specter of conversion of water bodies and loss of open space where clearing of coastal mangroves and salt marshes result in a wide range of environmental issues and risks, not the least of which is severe pollution. This situation happens because the local authorities are unable to cope with the rapidly changing situations, internal resource constraints, and management limitations. Chapter 5 (“Land Use and Occupation of Coastal Tropical Wetlands: Whale Coast, Bahia, Brazil”), by Sirius O. Souza, Cláudia C. Vale, and Regina C. Oliveira, reports similar impacts in Brazil where coastal tropical wetlands are often compromised by the gradual expansion of population and economic cycles. Better planning proposals for land use and occupation are suggested for implementation. Chapter 6 (“Degraded Coastal Wetlands Ecosystems in the Ganges-Brahmaputra Rivers Delta Region of Bangladesh”), by Shafi Noor Islam, Sandra Reinstädtler, and Albrecht Gnauck, is perhaps the premier example in the world of population pressure on coastal wetland resources where 36.8 million people are living in the coastal region delta and who are dependent on coastal water resources. Unwanted impacts on the delta, tidal flats, mangrove forests, marches, lagoons, estuaries and other natural resources are elucidated in the light of ecosystem development and management strategies that are supposed to ensure communities with livelihood and sustainable development. Chapter 7 (“Handling High Soil Trace Elements Pollution: Case Study of the Odiel and Tinto Rivers and Accompanying Salt Marshes [Southwest

Iberian Peninsula]"), by Sara Muñoz Vallés, Jesús Cambrollé, Jesús M. Castillo, Guillermo Curado, Juan Manuel Mancilla-Leytón, and M. Enrique Figueroa-Clemente, verifies that salt marshes are one of the most prolifically heavy-metal polluted systems in the world. The interesting aspect of this chapter is its explanation of how key native halophytes are able to phytoextract or phytostabilize trace elements leading to the recovery of native prairies of low tidal marshes. Chapter 8 ("El Yali National Reserve: A System of Coastal Wetlands in the Southern Hemisphere Affected by Contemporary Climate Change and Tsunamis"), by Manuel Contreras-López, Julio Salcedo-Castro, Fernanda Cortés-Molina, Pablo Figueroa-Nagel, Hernán Vergara-Cortés, Rodrigo Figueroa-Sterquel, and Cyntia E. Mizobe, like the preceding chapters discusses adverse impact of human activities on coastal wetlands, in this case in central Chile, but additionally brings in the effects of natural disasters such as earthquakes, tsunamis, ocean swells, and ENSO. Field monitoring is also discussed with the objective of eventually implementing ecological restorations.

Part II contains five chapters and deals with direct impacts of coastal engineering and environmental degradation. The chapters here focus on clearly established and obvious links between construction works and degradation of coastal wetlands that are induced by ancillary effects. Chapter 9 ("Physical and Morphological Changes to Wetlands Induced by Coastal Structures"), by Germán Daniel Rivillas-Ospina, Gabriel Ruiz-Martinez, Rodolfo Silva, Edgar Mendoza, Carlos Pacheco, Guillermo Acuña, Juan Rueda, Angélica Felix, Jesús Pérez, and Carlos Pinilla, focuses on procedures that are used to better understand the relationship between modifications of coastal processes and the response of a coastal environment, in the case of civil works in the development of a new port in Barranquilla, Colombia. The interest here is to ascertain what changes in physical conditions will produce negative effects on the stability of natural systems in coastal wetlands. Chapter 10 ("Long Term Impacts of Jetties and Training Walls on Estuarine Hydraulics and Ecologies"), by Alexander F. Nielsen and Angus D. Gordon, probes inlet instabilities caused by the construction of jetties that in turn adversely impact the distribution of seagrass, salt marsh, and mangrove forests on the east coast of Australia. Chapter 11 ("Mangrove Degradation in the Sundarbans"), by Ashis Kr. Paul, Ratnadip Ray, Amrit Kamila, and Subrata Jana, investigates aspects of mangrove degradation in the Sundarbans and identification of contributing factors via extensive fieldwork, geospatial techniques, and factor analysis. This chapter shows hypersalinity, storm effects, fishery development, land erosion, and sediment deposition parameters are mainly responsible for mangrove degradations. Chapter 12 ("Assessment of Anthropogenic Threats to the Biological Resources of Kaliveli Lake, India: A Coastal Wetland"), by Krishnan Silambarasan and Arumugam Sundaramanickam, focuses on various threats to Kaliveli Lake, which is one of the largest wetlands in peninsular India and considered a wetland of international importance by the International Union for Conservation of Nature and Natural Resources (IUCN). Anthropogenic activities such as infringement from agricultural lands, wildlife poaching, loss of surrounding forests, increased salt pan and aquaculture farming, and recreation constitute important threats to the well-being of this wetland. This chapter also explores measures

for conservation and protective management. Chapter 13 ("Egyptian Nile Delta Coastal Lagoons: Alteration and Subsequent Restoration"), by Ayman A. El-Gamal, identifies causes of wetland degradation in the Egyptian Mediterranean coastal region to be pollution, deterioration of water quality, eutrophication, habitat loss, overfishing, siltation, and climate change. Field studies are being conducted in efforts to determine management practices that will improve the resilience of these coastal lagoons.

Part III covers restoration techniques, ecological aesthetics, and ecosystem conservation with particular emphasis on sustainability and biodiversity. Although some of the previous chapters include discussion of remediation, this section highlights restoration efforts that promote sustainability and biodiversity in the broadest sense. This section is thus a logical follow-up to the previous two sections that primarily identified threats or risks to coastal wetlands. Determination or identification of the problem is obviously the first step in remediation; otherwise, it is impossible to remedy causes of unwanted conditions or situations. These chapters are examples of efforts in a diverse range of ecological setups where management strategies are proffered as means of conservation and protection within the realm of restoration and remediation. Chapter 14 ("Coastal Wetland Restoration: Concepts, Methodology, and Application Areas Along the Indian Coast"), by Ramasamy Manivanan, features a new concept that uses natural restoration techniques for coastal wetland restoration using the Chilika wetland ecosystem as a prototype. The idea here is to create conditions under which coastal ecosystem processes can withstand and diminish the impact of stressors. Chapter 15 ("Ecological Aesthetics Perspective for Coastal Wetland Conservation"), by LeeHsueh Lee, posits a new approach to the conservation of coastal wetlands where it is suggested that aesthetic preference provides a critical connection between humans and ecology. Promoted here is the prospect-refuge theory and the preference matrix of the bioevolutionary hypothesis, based on aesthetic experience, that could drive landscape change and pull with it ecological quality. Chapter 16 ("Estuarine Ecoclines and the Associated Fauna: Ecological Information as the Basis for Ecosystem Conservation"), by Mário Barletta, André R.A. Lima, Monica F. Costa, and David V. Dantas, is based on the definition of ecocline as a "gradation from one ecosystem to another where there is no sharp boundary between the two" where there are relatively heterogeneous communities influenced by gradual changes between river-dominated and marshlike waters. This chapter explains how to generate descriptors of reference conditions taking into account how human impacts affect coastal systems while providing steps to guarantee the sustainable use of estuarine resources. Chapter 17 ("Alteration and Remediation of Coastal Wetland Ecosystems in the Danube Delta: A Remote-Sensing Approach"), by Simona Niculescu, Cédric Lardeux, and Jenica Hanganu, demonstrates advantages of using remote sensing techniques to classify coastal wetland vegetation in the Danube Delta (a Biosphere Reservation), which was altered by human intervention in over one quarter of the entire delta surface. The random forest supervised classification algorithm was used to advantage for the Sentinel-1 and Sentinel-2 data collection. Chapter 18 ("Implementation of a Wildlife Management Unit as a Sustainable Support Measure Within the Palo Verde Estuary,

Mexico: An Example of the American Crocodile [*Crocodylus acutus*]"), by Omar Cervantes, Aramis Olivos-Ortiz, Refugio Anguiano-Cuevas, Concepción Contreras, and Juan Carlos Chávez-Comparan, is a species-specific study in the Palo Verde Estuary (a Ramsar site) that recognizes that pollution, fragmentation of ecosystems, and habitat destruction due to human action incite the need for strategic management practices to encourage harvest sustainability. This chapter represents an opportunity to reconcile human activities with the environment based on an analysis made from the perspective of the conceptual Driving Forces-Pressure-State-Impact-Response model. Chapter 19 ("Mangrove Inventory, Monitoring, and Health Assessment"), by Ajai and H.B. Chauhan, identifies threats to mangroves from human activities (reclamation of mangrove areas for human habitation, aquaculture, agriculture, and port and industrial development) and shows how the use of remote sensing data can be used to develop a model for mangrove health assessment. The model developed here is demonstrated through a case study in India. Chapter 20 ("How Can Accurate Landing Stats Help in Designing Better Fisheries and Environmental Management for Western Atlantic Estuaries?"), by Mário Barletta, André R.A. Lima, David V. Dantas, Igor M. Oliveira, Jurandyr Reis Neto, Cezar A.F. Fernandes, Eduardo G.G. Farias, Jorge L.R. Filho, and Monica F. Costa, discusses fishery management in Brazilian estuaries while pointing out the need for better statistics to help avoid the impacts of overfishing. The main thrust of this chapter is the explanation of the need to improve fishery management by compliance of ecological data and biological research, obtaining robust data for landing stats, and establishing a social profile of the fishery community to build better rules of comanagement. Chapter 21 ("Returning the Tide to Dikelands in a Macrotidal and Ice-Influenced Environment: Challenges and Lessons Learned"), by Laura K. Boone, Jeff Ollerhead, Myriam A. Barbeau, Allen D. Beck, Brian G. Sanderson, and Nic R. McLellan, deals with the lessons learned from the design, implementation, and monitoring of salt marsh restoration in the upper Bay of Fundy, Canada. They found that the bioengineering species saltwater cordgrass (*Spartina alterniflora*) performed well and could be used again in similar situations. Chapter 22 ("Macrobenthic Assemblage in the Rupsha-Pasur River System of the Sundarbans Ecosystem (Bangladesh) for the Sustainable Management of Coastal Wetlands"), by Salma Begum, investigates a non-forestry product (benthic invertebrates) of the Sundarbans (the world's largest mangrove forest) and found that the combined effects of environmental and biological parameters influence relative species abundance. Chapter 23 ("Ecological Services of Intertidal Benthic Fauna and the Sustenance of Coastal Wetlands along the Midnapore [East] Coast, West Bengal, India"), the last chapter in the book, by Susanta Kumar Chakraborty, shows the value and functional contribution of benthic biodiversity (macrobenthos and meiobenthos) for the continuation of the Sundarbans mangrove estuarine complex. These bioindicators are indicative of the health of this disturbed coastal environment.

What is presented in this volume is but a snippet of the global situation confronting coastal wetlands today, which entails a universal threat from human action. The chapters illustrate the status of coastal wetlands from the geographical spread ranging from the tropics to high-latitudes via studies in Florida, Spain, Cameroon,

Brunei Darussalam, Brazil, Bangladesh, Chile, Colombia, Australia, India, Egypt, Romania, Mexico, and Canada. These vignettes carry the common theme of coastal wetlands under stresses of variable types ranging dominantly from human action and less so from natural causes related to climate change. With about half of the world's coastal wetlands already destroyed by either urban expansion or the development of industrial and commercial infrastructure, the remainder are seriously threatened by a range of human activities (e.g., wood harvesting and loss of surrounding forests, sand extraction, petroleum exploitation, infringement from agricultural lands, wildlife poaching, increased salt pan and aquaculture farming, fishery development, land erosion, sediment deposition, and recreation) that usually fall under the radar of governing bodies that either turn blind eyes to what is happening or do not have the available resources to control the deterioration of the wetland ecosystems.

The other main theme of the various chapters is that the remaining coastal wetlands worldwide that have or continue to receive protection usually cannot remediate the damage that has already incurred. Although large areas have come under the "protection" of various types of statuses (e.g., Ramsar Convention, International Biosphere Reserve [UNESCO], International Union for Conservation of Nature and Natural Resources [IUCN]), this does not guarantee proper management by local authorities. Although the intent is laudable, the practicalities of the present world situation is that population growth is out of control in many regions that contain coastal wetlands. Human pressure on wetland resources is immense, and constructive efforts to protect, preserve, and conserve coastal wetland ecosystems are currently too weak to achieve goals that will maintain this valuable resource base for posterity. Several chapters point to new research that is being conducted into innovative ways of understanding and comprehending how these ecosystems function so they can be better managed. But the research and implementation of its findings are generally too slow compared to population growth with the result that coastal wetlands remain under threat from a wide range of human activities that eventually harken the death knell. What is required are more stringent protective measures that will secure a sustainable and unfettered future for the world's mangrove forests, fresh- and saltwater marshes, lakes, estuaries, and lagoons. All of the chapters in this book indicate in one way or another the present status and probable conditions of coastal wetlands as we look to the future.

Fletcher, NC, USA — Charles W. Finkl
Coconut Creek, FL, USA — Christopher Makowski

Contents

Contributors

Umar Abdul Aziz Bin Yahya Department of Geography, Development, and Environmental Studies, Faculty of Arts and Social Sciences (FASS), University of Brunei Darussalam (UBD), Gadong, Brunei Darussalam

Guillermo Acuña Departamento de Ingeniería Civil y Ambiental. PIANC-COLOMBIA, Universidad del Norte, Puerto Colombia, Colombia

Ajai ES, CSIR, Space Applications Centre, ISRO, Ahmedabad, India

Refugio Anguiano-Cuevas Centro de Estudios Tecnológicos del Mar, Manzanillo, Colima, Mexico

Myriam A. Barbeau Department of Biology, University of New Brunswick, Fredericton, New Brunswick, Canada

Mário Barletta Laboratório de Ecologia e Gerenciamento de Ecossistemas Costeiros e Estuarinos (LEGECE), Departamento de Oceanografia, Universidade Federal de Pernambuco (UFPE), Recife, Brazil

Allen D. Beck Department of Biology, University of New Brunswick, Fredericton, New Brunswick, Canada

Salma Begum Environmental Science Discipline, Khulna University, Khulna, Bangladesh

Laura K. Boone Department of Biology, University of New Brunswick, Fredericton, New Brunswick, Canada

Jesús Cambrollé Departamento de Biología Vegetal y Ecología, Facultad de Biología, Universidad de Sevilla, Seville, Spain

Jesús M. Castillo Departamento de Biología Vegetal y Ecología, Facultad de Biología, Universidad de Sevilla, Seville, Spain

Alejandro Cearreta Departamento de Estratigrafía y Paleontología, Facultad de Ciencia y Tecnología, Universidad del País Vasco UPV/EHU, Bilbao, Spain

Omar Cervantes Facultad de Ciencias Marinas, Universidad de Colima, Colima, Mexico

Susanta Kumar Chakraborty Department of Zoology, Vidyasagar University, Minapore, West Bengal, India

H.B. Chauhan ES, CSIR, Space Applications Centre, ISRO, Ahmedabad, India

Juan Carlos Chávez-Comparan Facultad de Ciencias Marinas, Universidad de Colima, Colima, Mexico

Concepción Contreras Consultoría ambiental: DAT Derecho, Ambiente y Territorio Consultores, Ciudad de México, Mexico

Manuel Contreras-López Facultad de Ingeniería, Universidad de Playa Ancha, Valparaíso, Chile

Centro de Estudios Avanzados, Universidad de Playa Ancha, Valparaíso, Chile

Fernanda Cortés-Molina Universidad de Playa Ancha, Valparaíso, Chile

Monica F. Costa Laboratório de Ecologia e Gerenciamento de Ecossistemas Costeiros e Estuarinos (LEGECE), Departamento de Oceanografia, Universidade Federal de Pernambuco (UFPE), Recife, Brazil

Guillermo Curado Departamento de Biología Vegetal y Ecología, Facultad de Biología, Universidad de Sevilla, Seville, Spain

David V. Dantas Grupo de Tecnologia e Ciência Pesqueira (TECPESCA), Departamento de Engenharia de Pesca, Centro de Ensino Superior da Região Sul (CERES), Universidade do Estado de Santa Catarina (UDESC), Laguna, Brazil

Ndongo Din Department of Botany, Faculty of Science, The University of Douala, Douala, Cameroon

Ayman A. El-Gamal Coastal Research Institute, National Water Research Center, Alexandria, Egypt

Guillaume Léopold Essomè-Koum Department of Botany, Faculty of Science, The University of Douala, Douala, Cameroon

Eduardo G.G. Farias Grupo de Tecnologia e Ciência Pesqueira (TECPESCA), Departamento de Engenharia de Pesca, Centro de Ensino Superior da Região Sul (CERES), Universidade do Estado de Santa Catarina (UDESC), Laguna, Brazil

Angélica Felix Coordinación de Hidráulica, Instituto de Ingeniería, Universidad Nacional Autónoma de México, Ciudad Universitaria, Mexico

Cezar A.F. Fernandes Laboratório de Bioecologia Pesqueira (Biopesca), Departamento de Ciências do Mar, Universidade Federal do Piauí (UFPI), Parnaíba, Brazil

M. Enrique Figueroa-Clemente Departamento de Biología Vegetal y Ecología, Facultad de Biología, Universidad de Sevilla, Seville, Spain

Pablo Figueroa-Nagel Valparaíso, Chile

Rodrigo Figueroa-Sterquel Instituto de Geografía, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile

Jorge L.R. Filho Grupo de Tecnologia e Ciência Pesqueira (TECPESCA), Departamento de Engenharia de Pesca, Centro de Ensino Superior da Região Sul (CERES), Universidade do Estado de Santa Catarina (UDESC), Laguna, Brazil

Charles W. Finkl Coastal Education and Research Foundation (CERF), Fletcher, NC, USA

Department of Geosciences, Florida Atlantic University, Boca Raton, FL, USA

Ane García-Artola Sea Level Research, Department of Marine and Coastal Science, Rutgers University, New Brunswick, NJ, USA

Sociedad de Ciencias Aranzadi, Donostia-San Sebastián, Spain

Departamento de Estratigrafía y Paleontología, Facultad de Ciencia y Tecnología, Universidad del País Vasco UPV/EHU, Bilbao, Spain

Albrecht Gnauck Department of Ecosystems and Environmental Informatics, Brandenburg University of Technology Cottbus-Senftenberg, Cottbus, Germany

Angus D. Gordon Coastal Zone Management and Planning, North Narrabeen, NSW, Australia

Jenica Hanganu Danube Delta National Institute for Research and Development, Tulcea, Romania

María Jesús Irabien Departamento de Mineralogía y Petrología, Facultad de Ciencia y Tecnología, Universidad del País Vasco UPV/EHU, Bilbao, Spain

Shafi Noor Islam Department of Geography, Development, and Environmental Studies, Faculty of Arts and Social Sciences (FASS), University of Brunei Darussalam (UBD), Gadong, Brunei Darussalam

Subrata Jana Department of Geography and Environment Management, Vidyasagar University, Midnapore, India

Amrit Kamila Department of Remote Sensing and GIS, Vidyasagar University, Midnapore, West Bengal, India

Ernest Kottè-Mapoko Department of Botany, Faculty of Science, The University of Douala, Douala, Cameroon

Cédric Lardeux Office National des Forêts, Paris Cedex 12, France

LeeHsueh Lee Department of Landscape Architecture, Chung Hua University, Taiwan, Republic of China

André R.A. Lima Laboratório de Ecologia e Gerenciamento de Ecossistemas Costeiros e Estuarinos (LEGECE), Departamento de Oceanografia, Universidade Federal de Pernambuco (UFPE), Recife, Brazil

Christopher Makowski Coastal Education and Research Foundation (CERF), Coconut Creek, FL, USA

Juan Manuel Mancilla-Leytón Departamento de Biología Vegetal y Ecología, Facultad de Biología, Universidad de Sevilla, Seville, Spain

Ramasamy Manivanan Mathematical Modeling for Coastal Engineering (MMCE), Central Water and Power Research Station, Khadakwasla, Pune, India

Nic R. McLellan Ducks Unlimited Canada, Amherst, Nova Scotia, Canada

Edgar Mendoza Coordinación de Hidráulica, Instituto de Ingeniería, Universidad Nacional Autónoma de México, Ciudad Universitaria, Mexico

Cyntia E. Mizobe Programa Magister en Oceanografía, Pontificia Universidad Católica de Valparaíso, Valparaíso, Chile

Eugene Ndema-Nsombo Department of Aquatics Ecosystem's Management, Institute of Fisheries and Aquatic Sciences, The University of Douala, Douala, Cameroon

Jurandyr Reis Neto Laboratório de Estudos da Pesca (LABPESCA), Unidade de Ensino Penedo, Campus Arapiraca, Universidade Federal de Alagoas (UFAL), Penedo, Brazil

Vanessa Maxemilie Ngo-Massou Department of Biological Sciences, High Teacher's Training College, The University of Yaounde I, Yaounde, Cameroon

Department of Botany, Faculty of Science, The University of Douala, Douala, Cameroon

Simona Niculescu Laboratoire LETG-Brest, Géomer, Plouzané, France

Alexander F. Nielsen Advisian WorleyParsons, Sydney, NSW, Australia

Laurant Nyamsi-Moussian Department of Botany, Faculty of Science, The University of Douala, Douala, Cameroon

Igor M. Oliveira Laboratório de Estudos da Pesca (LABPESCA), Unidade de Ensino Penedo, Campus Arapiraca, Universidade Federal de Alagoas (UFAL), Penedo, Brazil

Regina C. Oliveira Institute of Geosciences, Universidade Estadual de Campinas, Campinas, Brazil

Aramis Olivos-Ortiz Centro Universitario de Investigaciones Oceanológicas, Universidad de Colima, Manzanillo, Colima, Mexico

Jeff Ollerhead Department of Geography and Environment, Mount Allison University, Sackville, New Brunswick, Canada

Carlos Pacheco Departamento de Ingeniería Civil y Ambiental. PIANC-COLOMBIA, Universidad del Norte, Puerto Colombia, Colombia

Ashis Kr. Paul Department of Geography and Environment Management, Vidyasagar University, Midnapore, India

Jesús Pérez Departamento de Ingeniería Civil, Universidad EAFIT, Medellín, Antioquía, Colombia

Carlos Pinilla Departmento de Física, Universidad del Norte, Puerto Colombia, Colombia

Ratnadip Ray Department of Geography and Environment Management, Vidyasagar University, Midnapore, India

Germán Daniel Rivillas-Ospina Departamento de Ingeniería Civil y Ambiental. PIANC-COLOMBIA, Universidad del Norte, Puerto Colombia, Colombia

Sandra Reinstädtler Department of Environmental Planning, Brandenburg University of Technology Cottbus-Senftenberg, Cottbus, Germany

Juan Rueda Departamento de Ingeniería Civil y Ambiental. PIANC-COLOMBIA, Universidad del Norte, Puerto Colombia, Colombia

Gabriel Ruiz-Martinez Departmento de Recursos del Mar, Centro de Investigación y de Estudios Avanzados del Instituto Politécnico Nacional, Mérida, Yucatán, México

Julio Salcedo-Castro Centro de Estudios Avanzados, Universidad de Playa Ancha, Valparaíso, Chile

Brian G. Sanderson Acadia Centre for Estuarine Research, Acadia University, Wolfville, Nova Scotia, Canada

Krishnan Silambarasan P.G. and Research Department of Zoology, Sir Theagaraya College, Chennai, Tamil Nadu, India

Rodolfo Silva Coordinación de Hidráulica, Instituto de Ingeniería, Universidad Nacional Autónoma de México, Ciudad Universitaria, Mexico

Sirius O. Souza Institute of Geosciences, Universidade Estadual de Campinas, Campinas, Brazil

Arumugam Sundaramanickam CAS in Marine Biology, Faculty of Marine Sciences, Annamalai University, Parangipettai, Tamil Nadu, India

Cláudia C. Vale Department of Geography, Universidade Federal do Espírito Santo, Vitória, Espírito Santo, Brazil

Sara Muñoz Vallés Departamento de Biología Vegetal y Ecología, Facultad de Biología, Universidad de Sevilla, Seville, Spain

Evenor-Tech. Centro de Empresas Pabellón de Italia, Seville, Spain

Hernán Vergara-Cortés Facultad de Ciencias del Mar y de Recursos Naturales, Universidad de Valparaíso, Valparaíso, Chile

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