
Estuaries of the World

Series editor

Jean-Paul Ducrotoy

For further volumes:
<http://www.springer.com/series/11705>



Mudflats in the Banc d'Arguin National Park, functional delta derived from a fossil estuary, Mauritania—
Credit: JF Hellio et N Van Ingen/FIBA Special thanks to Mathieu Ducrocq, regional coordinator PACO/
Programme Marin et Côtier (MACO)/Union Internationale pour la Conservation de la Nature (UICN)—
Dakar—Sénégal, for providing this picture

Salif Diop • Jean-Paul Barusseau
Cyr Descamps
Editors

The Land/Ocean Interactions in the Coastal Zone of West and Central Africa



UNEP

 Springer

Editors
Salif Diop
Cheikh Anta Diop University
Dakar
Senegal

Cyr Descamps
University of Perpignan
Perpignan
France

Jean-Paul Barusseau
University of Perpignan
Perpignan
France

ISSN 2214-1553 ISSN 2214-1561 (electronic)
ISBN 978-3-319-06387-4 ISBN 978-3-319-06388-1 (eBook)
DOI 10.1007/978-3-319-06388-1

Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014940389

© Springer International Publishing Switzerland 2014

This work is subject to copyright. All rights are reserved by the Publisher, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilms or in any other physical way, and transmission or information storage and retrieval, electronic adaptation, computer software, or by similar or dissimilar methodology now known or hereafter developed. Exempted from this legal reservation are brief excerpts in connection with reviews or scholarly analysis or material supplied specifically for the purpose of being entered and executed on a computer system, for exclusive use by the purchaser of the work. Duplication of this publication or parts thereof is permitted only under the provisions of the Copyright Law of the Publisher's location, in its current version, and permission for use must always be obtained from Springer. Permissions for use may be obtained through RightsLink at the Copyright Clearance Center. Violations are liable to prosecution under the respective Copyright Law.

The use of general descriptive names, registered names, trademarks, service marks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

While the advice and information in this book are believed to be true and accurate at the date of publication, neither the authors nor the editors nor the publisher can accept any legal responsibility for any errors or omissions that may be made. The publisher makes no warranty, express or implied, with respect to the material contained herein.

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Mandela

This book is dedicated to Nelson Rolihlahla Mandela “Madiba” (1918–2013), The First post-apartheid President of South Africa. As Calestous Juma, Professor at Harvard University; USA, used to say: “Mandela will be remembered as one of the greatest leaders of all time. One of the best ways to live up to his loftiest aspirations for Africa are to give future generations science and technology education that gives them the skills to expand their economic opportunity”

Mandela’s direct involvement in science may be seen as linked to his firm belief about the power of education in building democracy and development. He said, “Education is the most powerful weapon which you can use to change the world”. Motivated by this concern, Mandela lent his name to the creation of a new generation of African Institutes of Science and Technology, seen as the beginning of a new generation of African research universities. Two have already been established, in Tanzania and Nigeria

To quote Dr. Ismail Serageldin, Director of the Bibliotheca Alexandrina in Egypt “Nelson Mandela was undoubtedly one of those immortal leaders. He now belongs to history, but we are fortunate to have lived in his time and to have been witness to his magic allure, his saintly demeanor, his twinkling mischievous eyes, his humor and his wisdom. We have witnessed his mind and his heart at work, and admired his unique combination of political genius and human warmth, his vision of the Rainbow Nation and how to make it a reality”

May Madiba rest in Peace, and may his legacy live forever

Foreword

The coastline of western and central Africa is made up of diverse marine and coastal ecosystems, such as estuaries, mangrove swamps and forests and offshore cold water springs. Although the focus of this publication is on the estuaries, as part of the “Estuaries of the World” series, its scope goes well beyond this particular coastal feature. Indeed, the estuary can only be considered as part of the life cycle of the entire river and the marine area it feeds into: an area particularly subject to human and natural pressures. Land degradation upstream, sea level rise downstream, salinization and drought, overexploitation of fisheries and mangroves, are all issues whose impact is felt at the river’s mouth.

The vital role these estuaries play in the ecosystem of the region has been recognised in the creation of a number of protected areas, natural parks and reserves. Specific habitats such as mangroves, sea grass beds and sand banks provide refuge to many endangered species, and cover the flight path of most of the migratory birds of West and Central Africa.

The main estuaries and deltas of this region provide a variety of goods and services to its coastal population. The most important of them are related to critical fish habitat, wood and charcoal from mangroves, as well as space for agriculture, aquaculture, urban development, tourism and transport.

Mangroves, in particular, play a significant role in terms of flood control, groundwater replenishment, coastline stabilisation and protection against storms. They also retain sediments and nutrients, purify water and provide critical carbon storage. Such hydrological and ecological functions explain the focus on serving mangrove ecosystems and the nearby communities, which draw significant income from fishing, rice production, tourism, salt extraction and other activities such as harvesting honey and medicinal plants.

However, in recent decades, population growth, environmental degradation and climate change have led to an erosion of the biodiversity in these ecosystems. Resources, as a result, are becoming scarce, and the pressure upon local communities is increasing.

There is a need to focus and to prioritise research and data to help manage and protect sustainable estuaries in the region, for the benefit of future generations. A number of international and regional programmes have been undertaken to address the critical issues and to find appropriate solutions. Among the principal programmes involved are the UNEP Regional Seas and the Intergovernmental Oceanographic Commissions, and other IGO and NGO programmes.

There is still much to be done to achieve the goal of restoring and protecting the resource-rich estuarine and other coastal water ecosystems in West and Central Africa. This new publication constitutes a first step towards that goal, bringing together new and updated information, including maps, models, new data and knowledge on recent changes and evolution, and their implications in the management of coastal waters in the region.

The close cooperation between Prof. Salif Diop, Prof. Jean-Paul Barousseau, Prof. Cyr Descamps and Prof. Jean-Paul Ducrotoy has been the driving force behind this publication. The Editors of this book would like to thank all the authors who contributed their time, resources and expertise.

It is my firm belief that this book will provide important and up-to-date information essential for the public at large but more specifically for scientists, researchers, managers, decision makers all working together in order to safeguard, protect and sustainably manage estuaries, deltas and lagoons, and the coastal and ocean waters of Western and Central Africa.

Achim Steiner

Preface

Why are West African estuaries so important in land/sea interactions?

One of the major challenges that humans face today is the management of estuaries so that future generations can also enjoy the remarkable visual, cultural and food products that they provide. The book series “Estuaries of the World” (EOTW) by Springer uses a multidisciplinary approach in presenting the science of estuaries. Such an approach presupposes that all users of the environment can share views and are able to communicate effectively on the basis of robust science.

Estuaries are vulnerable because they are exposed to multiple human activities such as fish and shrimp farming, industrial and domestic pollution, dredging, land reclamation and agriculture in the watershed. The threat to coastal ecosystems posed by human activities is well recognised and documented, yet the mitigation of human impact remains a major challenge due to a lack of understanding of the scale and rate of observed changes. Mangroves, for instance, are subject to clear-cutting and overlogging and such disturbances increase the variability of natural systems. The variability of natural systems is difficult to include in any political agenda due to the certainty of information required for decision making. It is possible, however, to better understand how humans change the way in which ecosystems function using a combination of different approaches aimed at combining functional ecology studies and a pressure/risk assessment approach (both on ecological and socio-economic aspects). In this way, it is possible to integrate the novel and interdisciplinary scientific evidence of multiple research disciplines. Such a dynamic interplay between theory and empirical study forms the basis for the transdisciplinary approach of the EOTW series.

With this perspective in mind, it is important to assess the capacity of ecosystems in fulfilling their role within the biosphere. Integration can be seen as one of the tools or methodologies for realising this goal by encompassing all aspects of an issue through a collaborative approach between natural sciences and economic, socio-cultural, legal and institutional disciplines. Integrated Coastal Zone Management (ICZM) is still a relatively new and evolving concept and there is no consensus regarding issues such as the fundamental nature and structure of the coastal zone, the most appropriate timescales for the application of ICZM policies, or the key criteria for defining sustainability in coastal zone development. Integration needs to be established between disciplines, sectors and in governance across the land–water interface. Through improving the scientific understanding of the performance of coastal ecosystems in terms of fluxes of energy and matter in relation to human impacts, ICZM should be able to predict the effects of measures taken and find responses to the fast evolving demands from society. The EOTW series offers a framework for facilitating such integration.

The notion of ecosystem services is useful in that it provides insight into the resilience of ecosystems and how changes affect them. The reduction in marine biodiversity and productivity is multifactorial, especially in coastal waters. Direct habitat destruction through the erection of engineering and drainage works, which disturb the physical integrity of coastal and marine systems is the most drastic, as the habitat itself is changed

to a point where the ecosystem loses its identity and assumes a different function. Poor fisheries management, including the uncontrolled exploitation of corals and molluscs and the by-catch of large numbers of non-target species in fisheries, is another pertinent example of detrimental marine resource exploitation. An integrated approach to coastal zone management of fisheries is predicted to prevent impoverished functioning of such ecosystems. The consequence of unchecked exploitation is that the productivity of fisheries and important ecosystems, such as mangroves and coral reefs, reduces which in turn causes suffering for the affected local communities.

In general, estuaries and salt marshes, mangrove forests and sea grass beds near cities and towns are severely degraded worldwide with many species now threatened to become extinct in the near future. Found in tropical and subtropical regions, mangroves are especially vulnerable. These salt-tolerant forested wetlands at the sea–land interface form the link between the terrestrial landscapes and the marine environment. Rapid changes in anthropogenic activities in coastal zones impact on the structure of organism populations, which will in turn affect the geochemical cycles of the ecosystem, to a point where such cycles might become dysfunctional. Changes in coastal ecosystems can lead to an imbalance in fluxes of energy and minerals at the interface between land and sea. These localised changes have the propensity to reach a global level. The dynamics of such systems are complex and conservation should address all aspects of this complexity and not solely focus on fixing the coastline to its physical limits, or preventing erosion and sea level rise. Because coastal systems are alive, they are able to cope with a multitude of changes. The critical determinant of an ecosystem's capacity to cope with change, however, is the rate of change, and it is the rapidity of change inflicted by humans to natural systems, which makes the anthropocene unique.

This volume in the EOTW series offers case studies in West and Central Africa and demonstrates that mangrove ecosystems are extremely valuable in mitigating effects from deleterious human activities, providing ecosystem services like carbon sequestration, protection from storms, floods and erosion, processing of waste and nutrient pollution, aquaculture and agriculture support and a refuge for aquatic and terrestrial species.

In order to discriminate between global and local influences, it is essential to acquire an in-depth knowledge of natural processes, as well as understand relevant institutional, cultural, economic, social and political frameworks based on a robust scientific approach. Suitable studies have been developed and used to analyse causal linkages within West African coastal ecosystems, forecasting the effects of acute or chronic interference on resource use, and to address wider, management-related issues such as the restoration of damaged habitats and the potential for aquaculture. The context of natural resource management in West Africa is complex. If the elements of ecosystems are interconnected and interdependent, those of regional environmental systems are even more so. Thus, the work as presented in this volume of the EOTW series contributes to improve the understanding of the dynamics and functioning of coastal ecosystems and habitats, including mangrove forests that constitute the most apparent features along western and central African coasts. Considering the highly threatened nature of marine and coastal ecosystems in this part of Africa and bearing in mind that the major drivers of change, degradation and loss of marine and coastal ecosystems and services are mainly anthropogenic, the question will be what types of options exist to respond to such challenges? By all means, addressing uncertainties and elaborating trade-offs could provide useful mechanisms for operational responses and this should be undertaken through established ecosystem-based approaches and improving the capacity of scientists to predict the consequences of the change of drivers in marine and coastal ecosystems. In this regard, long-term ecological processes and further research are needed in a number of areas in order to improve sustainable management policies of coastal and marine ecosystems of West and Central Africa.

The complex problems caused by human–environment interactions occur within the intricate structure of ecosystems, which are in a natural state of constant flux and change. This book explores the complex problems caused by human–environment interactions within the naturally and artificially fluctuating and changing coastal ecosystems of West and Central Africa. The authors have shared their knowledge and experience on ecological, social and cultural aspects simultaneously. This interdisciplinary approach makes the discovery of this fascinating region even more enriching.

Dakar, Senegal
Hull, UK

Salif Diop
Jean-Paul Ducrotoy

Acknowledgments

The authors would like to thank those experts involved in numerous marine and coastal programmes from various parts of the world and who have peer reviewed this overall publication, namely: François Blasco, Joan Fabres, Hartwig Kremer, Jacqueline Alder, Koranteng Kwame, Lorna Inniss, Marc Steyaert, Alan Simcock, Eric Wolanski, Beatrice Padovani Ferreira, Rice Jake, Johnson U. Kitheka, Enrique marschoff, Peyman Eghtesadi Araghi, Luiz Drude de Lacerda, Kalifa Goïta and Peter Scheren.

A special note of thanks should be dedicated to M. Ibrahim Thiaw, Deputy-Executive Director of the United Nations Environment Programme for his constant support during the preparation of this book, to Peter Saunders from UK who has proceeded for the English pre-editing of all articles prior to sending them to peer reviewers and to Walter Rast, Professor Emeritus and Director, Texas State University, USA for his extensive peer review of important chapters of the book. I would like to thank as well M. Taibou Ba, from the “Centre de Suivi Ecologique—Dakar—Senegal”, for redesigning some of the maps contained in this publication, Joana Akrofi and Matthew Billot, from Scientific Assessment Branch, Saly Sambou and Birane Cisse, students at Doctoral Level in University Cheikh Anta Diop/CAD of Dakar—Senegal and Awa Niang, Senior Lecturer at the same University CAD/Dakar. Finally, the authors would also like to thank UNEP and especially colleagues from the Division of Early Warning Assessment (DEWA) and the Division of Environmental Policy and Implementation (DEPI) for their contribution during the preparation process of this volume dedicated to the African continent.

Contents

The Western and Central Africa Land–Sea Interface: A Vulnerable, Threatened, and Important Coastal Zone Within a Changing Environment. . . .	1
S. Diop, J. Fabres, R. Pravettoni, J.-P. Barusseau, C. Descamps, and J.-P. Ducrotoy	
West African Coastal Area: Challenges and Outlook	9
Jean-Jacques Goussard and Mathieu Ducrocq	
Morphological and Hydrodynamic Changes in the Lower Estuary of the Senegal River: Effects on the Environment of the Breach of the ‘Langue De Barbarie’ Sand Spit in 2003	23
Awa Niang and Alioune Kane	
Management of a Tropical River: Impacts on the Resilience of the Senegal River Estuary	41
Coura Kane, Alioune Kane, and Joël Humbert	
Combined Uses of Supervised Classification and Normalized Difference Vegetation Index Techniques to Monitor Land Degradation in the Saloum Saline Estuary System	49
Ndeye Maguette Dieng, Joel Dinis, Serigne Faye, Marçia Gonçalves, and Mário Caetano	
Studies and Transactions on Pollution Assessment of the Lagos Lagoon System, Nigeria.	65
Babajide Alo, Kehinde Olayinka, Aderonke Oyeyiola, Temilola Oluseyi, Rose Alani, and Akeem Abayomi	
Estuarine and Ocean Circulation Dynamics in the Niger Delta, Nigeria: Implications for Oil Spill and Pollution Management	77
Larry Awosika and Regina Folorunsho	
Morphological Characteristics of the Bonny and Cross River (Calabar) Estuaries in Nigeria: Implications for Navigation and Environmental Hazards	87
Regina Folorunsho and Larry Awosika	
Status of Large Marine Flagship Faunal Diversity Within Cameroon Estuaries of Central African Coast	97
Isidore Ayissi, Gordon N. Ajonina, and Hyacinthe Angoni	

Morphology Analysis of Niger Delta Shoreline and Estuaries for Ecotourism Potential in Nigeria	109
O. Adeaga	
Importance of Mangrove Litter Production in the Protection of Atlantic Coastal Forest of Cameroon and Ghana.	123
Sylvie Carole Ondo Ntyam, A. Kojo Armah, Gordon N. Ajonina, Wiafe George, J. K. Adomako, Nyarko Elvis, and Benjamin O. Obiang	
Carbon Budget as a Tool for Assessing Mangrove Forests Degradation in the Western, Coastal Wetlands Complex (Ramsar Site 1017) of Southern Benin, West Africa	139
Gordon N. Ajonina, Expedit Evariste Ago, Gautier Amoussou, Eugene Diyouke Mibog, Is Deen Akambi, and Eunice Dossa	
Mangrove Conditions as Indicator for Potential Payment for Ecosystem Services in Some Estuaries of Western Region of Ghana, West Africa	151
Gordon N. Ajonina, Tundi Agardy, Winnie Lau, Kofi Agbogah, and Balertey Gormey	
Plantation Agriculture as a Driver of Deforestation and Degradation of Central African Coastal Estuarine Forest Landscape of South-Western Cameroon	167
Patience U. Ajonina, Francis A. Adesina, and Oluwagbenga O. I. Orimoogunje	
Assessment of Mangrove Carbon Stocks in Cameroon, Gabon, the Republic of Congo (RoC) and the Democratic Republic of Congo (DRC) Including their Potential for Reducing Emissions from Deforestation and Forest Degradation (REDD+).	177
Gordon N. Ajonina, James Kairo, Gabriel Grimsditch, Thomas Sembres, George Chuyong, and Eugene Diyouke	
Governing Through Networks: Working Toward a Sustainable Management of West Africa's Coastal Mangrove Ecosystems	191
Dominique Duval-Diop, Ahmed Senhoury, and Pierre Campredon	
The Importance of Scientific Knowledge as Support to Protection, Conservation and Management of West and Central African Estuaries.	207
S. Diop, J.-P. Barusseau, and C. Descamps	
Index	209

Contributors

Akeem Abayomi Analytical and Environmental Research Group, Department of Chemistry, University of Lagos, Lagos, Nigeria

O. Adeaga Department of Geography, University of Lagos, Lagos, Nigeria

Francis A. Adesina Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria

J. K. Adomako Department of Botany, University of Ghana, Legon, Ghana

Tundi Agardy The Marine Ecosystem Service (MARES) Programme, Washington, DC, USA

Kofi Agbogah Coastal Resources Center, Takoradi, Ghana

Expedit Evariste Ago Unit of Biosystem Physics, University of Liege Gembloux Agro-Bio Tech (GxABT), Gembloux, Belgium

Gordon N. Ajonina CWCS Coastal Forests and Mangrove Programme, Mouanko, Littoral Region, Cameroon; Institute of Fisheries and Aquatic Sciences, University of Douala (Yabassi), Douala, Cameroon

Patience U. Ajonina Department of Geography, University of Buea, Buea, Cameroon

Is Deen Akambi Benin Ecotourism Concern (Eco-Benin), Zogbadjè, Rue début Clôture IITA, Jéricho, Benin

Rose Alani Analytical and Environmental Research Group, Department of Chemistry, University of Lagos, Lagos, Nigeria

Babajide Alo Analytical and Environmental Research Group, Department of Chemistry, University of Lagos, Lagos, Nigeria

Gautier Amoussou Benin Ecotourism Concern (Eco-Benin), Zogbadjè, Rue début Clôture IITA, Jéricho, Benin

Hyacinthe Angoni Faculty of Science, Department of Plant Biology, University of Yaounde I, Yaounde, Cameroon

Larry Awosika Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos, Nigeria

Isidore Ayissi Cameroon Marine Biology Association (CMBA), Ayos, Cameroon; Specialized Research Center for Marine Ecosystems (CERECOMA), Institute of Agricultural Research for Development, Kribi, Cameroon; Institute of Fisheries and Aquatic Sciences, University of Douala, Yabassi, Cameroon

J.-P. Barusseau CEFREM, Université de Perpignan, Perpignan, France

Mário Caetano Higher Institute of Statistics and Information Management, New University of Lisbon, Lisbon, Portugal

Pierre Campredon International Union for Conservation of Nature (IUCN), Bissau, Republic of Guinea-Bissau

George Chuyong University of Buea, Buea, Cameroon

C. Descamps Maître de Conférences Emeritus, Institut Fondamental d'Afrique Noire—Cheikh Anta Diop, Dakar, Senegal

Ndeye Maguette Dieng Geology Department, Faculty of Sciences and Techniques University Cheikh Anta Diop, Dakar, Senegal

Joel Dinis Higher Institute of Statistics and Information Management, New University of Lisbon, Lisbon, Portugal

S. Diop Université Cheikh Anta Diop de Dakar, Dakar-Fann, Senegal

Eunice Dossa Benin Ecotourism Concern (Eco-Benin), Zogbadjè, Rue début Clôture IITA, Jéricho, Benin

Mathieu Ducrocq Coastal Ecosystems Group of the Commission on Ecosystem Management, IUCN, Gland, Switzerland

Dominique Duval-Diop West African Regional Network of Marine Protected Areas (RAMPAO), Dakar, Senegal

Nyarko Elvis Department of Marine and Fisheries Sciences, University of Ghana, Legon, Ghana

J. Fabres GRID-Arendal, Arendal, Norway

Serigne Faye Geology Department, Faculty of Sciences and Techniques University Cheikh Anta Diop, Dakar, Senegal

Regina Folorunsho Nigerian Institute for Oceanography and Marine Research, Victoria Island, Lagos, Nigeria

Wiafe George Department of Marine and Fisheries Sciences, University of Ghana, Legon, Ghana

Marçia Gonçalves Remote Sensing Unit of the Portuguese Geographic Institute, Lisbon, Portugal

Balertey Gormey Coastal Resources Center, Takoradi, Ghana

Jean-Jacques Goussard Coastal Ecosystems Group of the Commission on Ecosystem Management, IUCN, Gland, Switzerland

Gabriel Grimsditch UNEP, Nairobi, Kenya

Joël Humbert Laboratoire Image, Ville, Environnement—UMR 7362, CNRS, Université de Strasbourg, Strasbourg cedex, France

James Kairo Kenya Marine and Fisheries Research Institute, Mombasa, Kenya

Alioune Kane Ecole Doctorale «Eau, Qualité et Usages de l'Eau» (EDEQUE), Université Cheikh Anta Diop de Dakar, Dakar, Sénégal; Laboratoire LINUS «Littoraux: Interface Natures-Sociétés», Unité Mixte Internationale (Joint International Unit) 236 Résiliences, Institut de Recherche pour le Développement (Research Institute for Development) Campus International de Dakar-Hann, Dakar, Sénégal

A. Kojo Armah Department of Marine and Fisheries Sciences, University of Ghana, Legon, Ghana

Winnie Lau The Marine Ecosystem Service (MARES) Programme, Washington, DC, USA

Eugene Diyouke Mibog CWCS Coastal Forests and Mangrove Programme, Mouanko, Cameroon

Awa Niang Ecole Doctorale «Eau, Qualité et Usages de l'Eau» (EDEQUE), Université Cheikh Anta Diop de Dakar, Dakar, Senegal; Laboratoire LINUS «Littoraux: Interface Natures-Sociétés», Unité Mixte Internationale (Joint International Unit) 236 Résiliences, Institut de Recherche pour le Développement (Research Institute for Development) Campus International de Dakar-Hann, Dakar, Senegal

Sylvie Carole Ondo Ntyam Department of Marine and Fisheries Sciences, University of Ghana, Legon, Ghana; Centre for Coastal and Marine Research (CERECOMA/IRAD), Kribi, Cameroon

Benjamin O. Obiang CEPFILD Circle of Forest Promotion and Local Initiatives Development, Kribi, Cameroon

Kehinde Olayinka Analytical and Environmental Research Group, Department of Chemistry, University of Lagos, Lagos, Nigeria

Temilola Oluseyi Analytical and Environmental Research Group, Department of Chemistry, University of Lagos, Lagos, Nigeria

Oluwagbenga O. I. Orimoogunje Department of Geography, Obafemi Awolowo University, Ile-Ife, Nigeria

Aderonke Oyeyiola Analytical and Environmental Research Group, Department of Chemistry, University of Lagos, Lagos, Nigeria

R. Pravettoni GRID-Arendal, Arendal, Norway

Thomas Sembres UNEP, Nairobi, Kenya

Ahmed Senhoury Mobilization and Coordination Unit Regional Partnership for the Conservation of the West African Coastal and Marine Zone (PRCM), Nouakchott, Mauritania

About the Editors



Prof. S. Diop, who is a water expert with a number of referred related publications and broad experience in various aspects of scientific assessment of freshwater, coastal and marine resources as well as in areas related to the management and sustainable development of the environment. So far, he has pursued the coordination of important international programmes on freshwater, marine and coastal processes including scientific assessment of marine and coastal waters, assessment of groundwater resources in Africa and in other regions of the world, evaluation processes and scientific assessment of the world oceans and coasts; geosphere–biosphere interactions; processes on integrated management of marine areas and coastal interfaces land/sea/water and atmosphere, assessment of water resources as a key factor for sustainable development, the development of modules for the evaluation of freshwater resources, wetlands, marine waters and coastal areas, including the relations and impacts of climate change.

Prof. Salif Diop, Professor of University, UCAD
Member National Academy of Sciences and Techniques of Senegal (ANSTS) and African Academy of Sciences (AAS)
The World Academy of Sciences for the Advancement of Sciences in Developing Countries (TWAS)



Dr. Jean-Paul Barusseau, is attached to the centre of education, training and research on marine environments (CEFREM). He is a geologist sedimentologist, specialised in studies of the coastal zone. His interest is directed towards the history of these environments during the Late Quaternary, especially the second half of the Holocene, and their dynamic evolution in the Recent with a particular interest in the issue of erosion of sandy coasts. His work has been conducted in France (Bay of Biscay, Gulf of Lions) and Africa, particularly in Senegal and Mauritania. In Senegal, his work has concerned the Petite Côte, the post-dam evolution of Senegal River Valley and the Saloum river delta; in 2007–2009, he participated in the revision of the geological map, such as 1/200000 sheets of the river valley and 1/50000 sheets of the Petite Côte (PASMI program). In Mauritania, he participated in the study of the Banc d'Arguin area in order to present a land–

sea continuum of the coastal sedimentary unit evolution, from the coastal plain to the marine basin during the Late Holocene (PACOBAs program). His work provided 156 publications. He was the director of 12 Ph.D. theses.

Prof. Emeritus Jean-Paul Barusseau
CEFREM—University Via Domitia—Perpignan
(France)



Prof. Cyr Descamps, lecturer in retirement, is attached to the France Centre for Historical Research on Mediterranean Societies (CRHiSM) at the University of Perpignan Via Domitia, and Senegal to the Fundamental Institute of Africa South of Sahara (IFAN) Ch. A. Diop University of Dakar. He participated in a series of pre-historical investigations in West African coastal regions including in estuaries, deltas and coastal lagoons, especially in the Senegal–Mauritania sub-region. One of his other focuses is the historical and pre-historical underwater investigations Prof. Descamps has undertaken in the Mediterranean. Prof. Descamps's key interests are people living in estuarine and deltaic areas who collect shellfish with significant accumulations on sandy

shores, muddy and rocky. Ethno-archaeological approach and consideration of environmental parameters has allowed him to better understand the dynamics of these stands. He also participated in multidisciplinary work on changes of such historical and pre-historical sites at different timescales, bathymetry and coastal shorelines in tropical regions.

Prof. Cyr Descamps Centre for Historical Research on Mediterranean Societies (CRHiSM)—University Via Domitia—Perpignan (France) and Fundamental Institute of Africa South of Sahara (IFAN) Ch. A. Diop University of Dakar—Senegal.