

## **Okinawa Artificial Reef, Pompano Beach, Florida, USA.**

Source: Journal of Coastal Research, 37(1)

Published By: Coastal Education and Research Foundation

URL: <https://doi.org/10.2112/0749-0208-37.1.i>

---

BioOne Complete ([complete.BioOne.org](https://complete.BioOne.org)) is a full-text database of 200 subscribed and open-access titles in the biological, ecological, and environmental sciences published by nonprofit societies, associations, museums, institutions, and presses.

Your use of this PDF, the BioOne Complete website, and all posted and associated content indicates your acceptance of BioOne's Terms of Use, available at [www.bioone.org/terms-of-use](https://www.bioone.org/terms-of-use).

Usage of BioOne Complete content is strictly limited to personal, educational, and non - commercial use. Commercial inquiries or rights and permissions requests should be directed to the individual publisher as copyright holder.

---

BioOne sees sustainable scholarly publishing as an inherently collaborative enterprise connecting authors, nonprofit publishers, academic institutions, research libraries, and research funders in the common goal of maximizing access to critical research.

Journal of

# Coastal Research

VOL. 37, NO. 1 • CERF • January 2021



*Official Publisher*

*An International Forum for the Littoral Sciences*  
**Christopher Makowski, Ph.D.**  
Editor-in-Chief



*Year of Service*



# JOURNAL OF COASTAL RESEARCH

An International Forum for the Littoral Sciences

CHEF-HERAUSGEBER

313 S. Braeside Court  
Asheville, NC  
28803, U.S.A.

## EDITOR-IN-CHIEF EMERITUS

Charles W. Finkl  
Coastal Education and Research  
Foundation, Inc. (CERF)  
313 S. Braeside Court  
Asheville, NC 28803, U.S.A.  
cfinkl@cerf-jcr.com

EDITOR-IN-CHIEF

**Christopher Makowski, Ph.D.**

Coastal Education and Research Foundation, Inc. (CERF)

Editorial Offices:  
7570 NW 47th Avenue  
Coconut Creek, FL  
33073, U.S.A.

RÉDACTEUR-EN-CHEF

(Business Office, Coconut Creek)  
Website: [www.CERF-JCR.org](http://www.CERF-JCR.org)  
E-mail: [cmakowski@cerf-jcr.com](mailto:cmakowski@cerf-jcr.com)

## EDITORIAL ASSISTANT

Barbara Russell  
Coastal Education and Research  
Foundation, Inc. (CERF)  
7570 NW 47th Avenue  
Coconut Creek, FL 33073, U.S.A.  
barbara@cerf-jcr.com

## BOOK REVIEW EDITOR

Luciana S. Esteves  
Faculty of Science and Technology  
Bournemouth University  
Dorset, England, U.K.  
lesteves@bournemouth.ac.uk

## WEB DESIGN & DEVELOPMENT

Jon Finkl  
Media Mine  
17600 River Ford Drive  
Davidson, NC 28036, U.S.A.  
jon@mediamine.net

## MITHERAUSGEBER

**Edward J. Anthony**  
*Coastal Geomorphology*  
Dunkerque, France  
**Patrick Barnard**  
*Coastal Geomorphology*  
Santa Cruz, California  
**Natalia Bugajny**  
*Coastal Geomorphology*  
Szczecin, Poland  
**M. Paula Bunicentro**  
*Coastal Geomorphology*  
Buenos Aires, Argentina  
**David M. Bush**  
*Coastal Geology & Hazards*  
Carrollton, Georgia  
**Ilya V. Buynevich**  
*Coastal Geology*  
Philadelphia, Pennsylvania  
**Javier A. Carrió**  
*Sediment Processes*  
Valencia, Spain  
**Insik Chun**  
*Coastal Engineering*  
Seoul, Republic of Korea  
**Vanda Claudino-Sales**  
*Coastal Dynamics, Dunes*  
Ceard, Brazil  
**Mark Crowell**  
*Coastal Zone Management*  
McLean, Virginia  
**Omar Defeo**  
*Sandy Beach Ecology*  
Montevideo, Uruguay  
**Joseph F. Donoghue**  
*Coastal Morphology & Hazards*  
Orlando, Florida  
**Jean Ellis**  
*Aeolian Sediment Transport*  
Columbia, South Carolina  
**Hany Elwany**  
*Coastal Engineering,*  
*Oceanography*  
La Jolla, California  
**Luciana Esteves**  
*Coastal Flooding & Erosion*  
Bournemouth, England, UK  
**Niki Evelpidou**  
*Sea-Level Change,*  
*Palaeogeography*  
Athens, Greece  
**Oscar Manuel Ferreira**  
*Storm Impacts*  
Faro, Portugal

**Duncan M. FitzGerald**  
*Sediment Transport*  
Boston, Massachusetts  
**Kazimierz K. Furmańczyk**  
*Marine Cartography*  
Szczecin, Poland  
**Allen Gontz**  
*Geophysics, Stratigraphy*  
San Diego, California  
**Gary B. Griggs**  
*Coastal Engineering & Hazards*  
Santa Cruz, California  
**Pramod Hanamgond**  
*Coastal Geomorphology*  
Belgaum, India  
**Hans Hanson**  
*Coastal Protection*  
Lund, Sweden  
**Simon Haslett**  
*Paleoceanography*  
Swansea, Wales, UK  
**Michael Hilton**  
*Dune Geomorphology & Ecology*  
Dunedin, New Zealand  
**James R. Houston**  
*Sea-Level Change*  
Vicksburg, Mississippi  
**Wenrui Huang**  
*Coastal Hydrodynamics*  
Tallahassee, Florida  
**Federico I. Isla**  
*Sea-Level Change*  
Mar Del Plata, Argentina  
**Nancy L. Jackson**  
*Coastal Geomorphology*  
Newark, New Jersey  
**Markes E. Johnson**  
*Paleoshores, Coastal Sand Dunes*  
Williamstown, Massachusetts  
**Timothy Kana**  
*Coastal Science & Engineering*  
Columbia, South Carolina  
**Dieter H. Kelletat**  
*Coastal Geomorphology*  
Essen / Cologne, Germany  
**Joseph T. Kelley**  
*Sea-Level Change*  
Orono, Maine  
**Björn Kjerfve**  
*Physical Oceanography, Wetlands*  
College Station, Texas  
**Nobuhisa Kobayashi**  
*Coastal Engineering*  
Newark, Delaware

## ASSOCIATE EDITORS

**Vladimir N. Kosmynin**  
*Coral Reefs, Coastal Ecology*  
Tallahassee, Florida  
**Michael J. Lacey**  
*Coastal Landforms & Processes*  
West Branch, Iowa  
**Stephen P. Leatherman**  
*Barrier Islands, Beach Erosion*  
Miami, Florida  
**Jay Jooyong Lee**  
*Rip Currents, Coastal Hazards*  
Busan, Republic of Korea  
**Charles Lemckert**  
*Environmental Fluid Dynamics*  
Bruce, ACT, Australia  
**Hak Soo Lim**  
*Hydrodynamics, Coastal*  
*Engineering*  
Busan, Republic of Korea  
**Ioannis Liritzis**  
*Geophysical Proxy Data,*  
*Archaeometry*  
Rhodes, Greece  
**J. Paul Liu**  
*Sea-Level Change, Deltas*  
Raleigh, North Carolina  
**Michel M. de Mahiques**  
*Sediment Processes*  
São Paulo, Brazil  
**Gonzalo C. Malvárez**  
*Beach Morphodynamics*  
Seville, Spain  
**Nobuo Mimura**  
*Environmental Engineering*  
Ibaraki, Japan  
**Norberto C. Nadal-Caraballo**  
*Coastal Hazards*  
Vicksburg, Mississippi  
**Fatima Navas**  
*Coastal Morphodynamics*  
Seville, Spain  
**Robert Nicholls**  
*Global Climate Change*  
Southampton, England, UK  
**Julian Orford**  
*Gravel Beaches, Storm Events*  
Belfast, Northern Ireland, UK  
**Phil D. Osborne**  
*Sediment Dynamics*  
Vancouver, BC, Canada  
**Hugh Parker**  
*Airborne Lidar Bathymetry*  
Adelaide, SA, Australia  
**Charitha B. Pattiaratchi**  
*Physical Oceanography*  
Crawley, WA, Australia  
**Carlos Pereira da Silva**  
*Coastal Zone Management*  
Lisbon, Portugal  
**Michael Phillips**  
*Coastal Geomorphology*  
Doha, Qatar  
**Orrin H. Pilkey, Jr.**  
*Coastal Geology*  
Durham, North Carolina  
**Nobert P. Psuty**  
*Coastal Geomorphology*  
New Brunswick, New Jersey  
**Elijah W. Ramsey, III**  
*Coastal Image Processing*  
Lafayette, Louisiana  
**Tiffany Roberts Briggs**  
*Coastal Geomorphology*  
Boca Raton, Florida  
**Kirt Rusenko**  
*Sea Turtles, Dune Restoration*  
Boca Raton, Florida  
**Daniele Scarponi**  
*Marine Paleocology*  
Bologna, Italy  
**Anja Scheffers**  
*Coastal Hazards,*  
*Palaeoclimatology*  
Lismore, NSW, Australia  
**Vic Semeniuk**  
*Mangroves*  
Perth, WA, Australia  
**Douglas J. Sherman**  
*Coastal & Aeolian Geomorphology*  
Tuscaloosa, Alabama  
**Andrew D. Short**  
*Coastal Geomorphology*  
Sydney, NSW, Australia  
**Pravi Shrestha**  
*Coastal Engineering*  
Irvine, California  
**Tom Spencer**  
*Biogeomorphology*  
Cambridge, England, UK  
**Marcel J.F. Stive**  
*Coastal Hydrodynamics*  
Delft, The Netherlands  
**Vallam Sundar**  
*Coastal Engineering*  
Chennai, India

## COMITÉ DE REDACTION

**Ana Teodoro**  
*Remote Sensing*  
Porto, Portugal  
**E. Robert Thielert**  
*Marine Geology*  
Woods Hole, Massachusetts  
**Hannes Tönisson**  
*Coastal Evolution*  
Tallinn, Estonia  
**Arthur C. Trembanis**  
*Coastal Morphodynamics*  
Newark, Delaware  
**Frank van der Meulen**  
*Coastal Zone Management*  
Delft, The Netherlands  
**Ana Vila Concejó**  
*Coastal Morphodynamics*  
Sydney, NSW, Australia  
**Ian J. Walker**  
*Coastal Dunes & Sediments*  
Santa Barbara, California  
**Ping Wang**  
*Beach Morphodynamics*  
Tampa, Florida  
**Phil J. Watson**  
*Sea-Level Change*  
Gosford, NSW, Australia  
**Harry F. Williams**  
*Paleotempestology*  
Denton, Texas  
**Colin D. Woodroffe**  
*Coastal Geomorphology*  
Wollongong, NSW, Australia  
**Zhaoqing Yang**  
*Hydrodynamic Modeling*  
Seattle, Washington  
**Robert S. Young**  
*Coastal Processes*  
Cullowhee, North Carolina  
**Guoliang Yu**  
*Sediment Transport*  
Shanghai, China  
**Saiyu Yuan**  
*Water Flow, Sediment Transport*  
Nanjing, China



THE JOURNAL OF COASTAL RESEARCH (JCR) (ISSN 0749-0208) IS PUBLISHED BIMONTHLY FOR \$115.00 FOR INDIVIDUAL US CERF MEMBERS, \$125.00 FOR INDIVIDUAL INTERNATIONAL CERF MEMBERS, \$519.00 FOR US INSTITUTIONS, AND \$541.00 FOR INTERNATIONAL INSTITUTIONS BY THE COASTAL EDUCATION AND RESEARCH FOUNDATION, INC. (CERF), 7570 NW 47TH AVENUE, COCONUT CREEK, FL 33073-2723. PERIODICALS POSTAGE PAID AT FORT LAUDERDALE, FL AND ADDITIONAL MAILING OFFICES. **POSTMASTER:** SEND ADDRESS CHANGES TO JOURNAL OF COASTAL RESEARCH, ALLEN PRESS ASSOCIATION MANAGEMENT, P.O. BOX 1897, LAWRENCE, KS 66044-3018.

© 2021 Coastal Education and Research Foundation, Inc. [CERF].

© This paper meets the requirements of ANSI/NISO Z39.48-1992 (Permanence of Paper).



# JOURNAL OF COASTAL RESEARCH

An International Forum for the Littoral Sciences

Supporting Scientific Institutions



- Consorzio Nazionale Interuniversitario per le Scienze del Mare (Co.N.I.S.Ma.) [Rome, Italy; [www.conisma.it/](http://www.conisma.it/)]
- Delft University of Technology [Department of Hydraulic Engineering, Delft, The Netherlands; <http://www.citg.tudelft.nl/over-faculteit/afdelingen/hydraulic-engineering/>]
- Duke University [Earth and Ocean Sciences Division, Durham, North Carolina, U.S.A.; <https://nicholas.duke.edu/marinelab>]
- Griffith University [Center for Infrastructure Engineering and Management, Southport, Queensland, Australia; <https://www.griffith.edu.au/>]
- Ibaraki University [Center for Water Environmental Studies, Mito, Japan; <http://www.cwes.ibaraki.ac.jp/>]
- International Geographical Union (IGU) [Commission on Coastal System (CCS); <http://www.igu-ccs.org/>]
- Royal Belgian Institute of Natural Sciences [Management Unit of the North Sea Mathematical Models (MUMM), Brussels, Belgium; <http://www.mumm.ac.be/EN/index.php>]
- Rutgers University [Institute of Marine and Coastal Sciences (IMCS), New Brunswick, New Jersey, U.S.A.; <http://marine.rutgers.edu/main/>]
- Universidad de la República [Marine Science Unit, Montevideo, Uruguay; <http://www.imber.info/Science/National-Network/URUGUAY>]
- Universidade Nova de Lisboa [e-Geo Center for Geographical and Regional Planning Studies, Lisbon, Portugal; <http://e-geo.fcsh.unl.pt/>]
- University of California, Santa Cruz [Institute of Marine Sciences, Santa Cruz, California, U.S.A.; <http://ims.ucsc.edu/>]
- University of Delaware [School of Marine Science and Policy, Newark, Delaware, U.S.A.; <http://www.ocean.udel.edu>]
- University of Maine [Climate Change Institute, Orono, Maine, U.S.A.; <http://climatechange.umaine.edu/>]
- University of Sydney [Coastal Studies Unit, Sydney, New South Wales, Australia; <http://sydney.edu.au/>]
- University of Szczecin [Institute of Marine and Coastal Science, Szczecin, Poland; <http://www.wnoz.zti.km.szczecin.pl/en/1/inom/structure/>]
- University of Ulster [Environmental Sciences Research Institute, Coleraine, Northern Ireland; <http://www.ulster.ac.uk/es/research/>]
- University of Wales, Trinity Saint David [Swansea Metropolitan University, Mount Pleasant, Swansea, South Wales, U.K.; <http://www.uwtsd.ac.uk/>]
- U.S. Army Corps of Engineers [Coastal and Hydraulics Laboratory (CHL), Vicksburg, Mississippi, U.S.A.; <http://chl.erdc.usace.army.mil/>]
- U.S. Geological Survey [National Wetlands Research Center, Lafayette, Louisiana, U.S.A.; <http://www.nwrc.usgs.gov/>]

## Aims and Scope of the *Journal of Coastal Research* (JCR)

*Journal of Coastal Research* (JCR), an International Forum for the Littoral Sciences, is dedicated to all aspects of coastal research. These include geology, biology, geomorphology (physical geography), climate, littoral oceanography, hydrography, coastal hydraulics, environmental (resource) management, engineering, and remote sensing. Although each field functions effectively within its own purview, the cross-disciplinary nature of coastal studies requires familiarity with other fields as well. Hence, the scope of topics is necessarily broad in order to address the complexity of coastal biophysical and socio-economic interactions. Because of the wide range of interrelated topics, the journal invites original contributions and manuscripts dealing with theory, methodology, techniques, and field or applied topic studies on interdisciplinary coastal issues.

The journal encourages the dissemination of knowledge and understanding of the coastal zone by promoting cooperation and communication between specialists in different disciplines. Natural scientists, for example, are encouraged to collaborate with professionals in other fields to prepare contributions relating to the coastal zone that foster increased appreciation of coastal environments and processes. By means of this journal, with its scholarly and professional papers, systematic review articles, book and symposia reviews, communications and news, and special topical issues, an international forum for the development of integrated coastal research is provided.

## Advertising, Editorial, and Subscription Information

**Advertising and Editorial Office:** All advertising and editorial correspondence should be sent to Dr. Chris Makowski, Editor-in-Chief, *Journal of Coastal Research*, 7570 NW 47th Avenue, Coconut Creek, FL 33073, U.S.A. PHONE: (+1) 954-899-8416. E-MAIL: [cmakowski@cerf-jcr.com](mailto:cmakowski@cerf-jcr.com) WEBSITE: [www.cerf-jcr.org](http://www.cerf-jcr.org)

**Subscription Information:** The *Journal of Coastal Research* is a bimonthly publication. Calendar-year (2021) print and online subscription prices for the JCR are: \$115.00 for US CERF members / \$125.00 for International CERF members (\$95.00 for online only), and \$519.00 for US institutions / \$541.00 for International institutions (\$437.00 for online only). Additional surface charges may apply to subscribers located outside of the USA. For additional membership and subscription forms and information, please go to [www.cerf-jcr.org](http://www.cerf-jcr.org). To obtain a membership or subscription form by mail, please send request to *Journal of Coastal Research*, P.O. Box 7065, Lawrence, KS 66044. Back Issues and Special Issues of the JCR, when available, can be directly requested at: [cerf.jcr@gmail.com](mailto:cerf.jcr@gmail.com).

**Abstracting Information:** The *Journal of Coastal Research* (JCR) is currently surveyed in: *Web of Science* (WoS) *Core Collection* / *Web of Knowledge* (Clarivate Analytics); *Science Citation Index Expanded*; *SCOPUS* (Elsevier); *BioOne Complete*; *JSTOR*; *EBSCO*; *ProQuest*; *Charlesworth*; *BIOSIS Previews*; *Zoological Record*; *Biological Abstract*; *H.W. Wilson Company*; *Thomson Reuters (ISI)*; *Cabells Scholarly Analytics*; *Essential Science Indicators*; *Chemical Abstracts Service (CAS)*; *Gale Group* (Gale / Cengage Learning); *Copyright Clearance Center, Inc. (CCC)*; *Current Contents - Physical, Chemical & Earth Sciences*; and *Current Contents - Agriculture, Biology & Environmental Sciences*.





www.JCRonline.org

## COVER PHOTOGRAPH



www.cerf-jcr.org



**Okinawa Artificial Reef, Pompano Beach, Florida, USA.** Originally named LT 1970, the Okinawa was manufactured as a U.S. Army tugboat in October of 1953. It has a length of 32.6 m, with an 8.1 m beam across, and was renamed the Okinawa after the Battle of Okinawa in World War II. The Okinawa wreck was sunk on Aug 9, 2017, and became the 18<sup>th</sup> artificial reef (wreck) in Shipwreck Park offshore of Pompano Beach, Florida, USA. Even though it is a 390-ton displacement vessel, the Okinawa was spun 180 degrees on the ocean floor by hurricanes in 2017 and carried over 100 meters away from its original location. The storms also caused the wreck to list heavily to the starboard side. Luckily, most of the structural integrity of the shipwreck was maintained.

As seen in the photograph, an entire underwater community has developed upon the outside hull of the wreck. This includes species of encrusting corals, sponges, tunicates, hydroids, bryozoans, zoanthids, and macroalgae. Schooling fish (such as white and blue striped grunts, *Haemulon plumieri* and *H. sciurus*) use the artificial reef as a refuge area, while rogue predatory fish (such as the great barracuda, *Sphyraena barracuda*) use the wreck as a hunting ground. Overall, this is a balanced, vibrant coral reef community that has taken just over three years to be established. This example of nature's resiliency reminds us what is possible when adverse anthropogenic pressures are removed. (Photograph taken November 2020 by Chris Makowski, Coastal Education and Research Foundation (CERF-JCR), Coconut Creek, Florida, U.S.A.)



# COASTAL EDUCATION AND RESEARCH FOUNDATION (CERF)

7570 NW 47th Avenue  
Coconut Creek, FL 33073, U.S.A.

## Officers of the Foundation

Founded in 1983 by: Charles W. Finkl, Sr. (Deceased),  
Charles W. Finkl, Jr., Rhodes W. Fairbridge (Deceased),  
and Maurice L. Schwartz (Deceased)

### President &

#### Executive Director:

Charles W. Finkl

### Secretary:

Heather M. Vollmer

### Senior Vice President &

#### Assistant Director:

Christopher Makowski

### Executive Assistant:

Barbara Russell

## CERF-JCR Regional Vice Presidents

### North America

Gary B. Griggs  
James R. Houston  
Timothy W. Kana  
Norberto C. Nadal-Caraballo

### Western Europe

Luciana S. Esteves  
Carlos Pereira da Silva  
Marcel J.F. Stive

### Eastern Europe

Niki Evelpidou  
Kazimierz K. Furmanczyk

### Oceania

Charles Lemckert  
Anja Scheffers  
Vic Semeniuk  
Andrew D. Short

### Southeast Asia

Hak Soo Lim  
Nobuo Mimura

### South America

Vanda Claudino-Sales  
Omar Defeo

### Middle East and N. Africa

Michael Phillips

## Board of Directors (Trustees)

Vanda Claudino-Sales	Stephen P. Leatherman	Vic Semeniuk
Charles W. Finkl	Charles Lemckert	Douglas J. Sherman
Duncan M. FitzGerald	Gonzalo C. Malvárez	Andrew D. Short
Gary B. Griggs	Christopher Makowski	Daniel J. Stanley
James R. Houston	Carlos Pereira da Silva	Marcel J.F. Stive
Robert Huff	Michael Phillips	Phil J. Watson
Timothy W. Kana	Norbert P. Psuty	
Joseph T. Kelley	Elijah W. Ramsey, III	

### Lifetime Members

Camilo M. Botero	Victor V. Klemas	Nelson G. Rangel-
David M. Bush	Tetsuya Kusuda	Buitrago
Frédéric Bouchette	Stephen P. Leatherman	Yoshiki Saito
Yong-Sik Cho	Charles Lemckert	Anja Scheffers
Insik Chun	J. Paul Liu	Andrew D. Short
Nicholas K. Coch	Gonzalo C. Malvárez	Rodolfo Silva
Hany Elwany	Ashish J. Mehta	Jean-Daniel Stanley
Kazimierz K.	Norberto C. Nadal-	Marcel J.F. Stive
Furmanczyk	Caraballo	Charles Thibault
Allen Gontz	Fatima Navas	Frank van der Meulen
Gary B. Griggs	Philip D. Osborne	Erik van Wellen
Carl H. Hobbs, III	Michael Phillips	Ya Ping Wang
James R. Houston	Orrin H. Pilkey, Jr.	Allan T. Williams
Paul S. Kench	Norbert P. Psuty	Robert S. Young
Björn Kjerfve		Wei Zhang

### Patron Members

Lindino Benedet	John W. Jensen
Georges Chapalain	Timothy W. Kana

## CERF-JCR Society Information

The Coastal Education and Research Foundation (CERF) is a non-profit research society dedicated to the advancement of the coastal sciences and serves as the official publisher of the international *Journal of Coastal Research* (JCR). CERF-JCR is devoted to the multi-disciplinary study of complex problems related to the coastal zone. Our purpose is to help in the translation and interpretation of coastal issues for the public and to assist professional and academic research programs by supporting and encouraging field and laboratory studies on a local, national, and global basis. Through printed scientific publications, current online content, and renowned international symposiums, CERF-JCR brings accurate information to both the public and researchers alike on all aspects of coastal issues in an effort to maintain and improve the quality of shoreline resources.

The *Journal of Coastal Research* (JCR) is one of the leading international journals for coastal studies and processes, and is published bi-monthly by the Coastal Education and Research Foundation (CERF). By covering the entire field of coastal research, the JCR encompasses all subjects relevant to natural and engineered environments (*i.e.* freshwater, brackish, or marine) and the protection/management of their resources in the vicinity of coastlines around the world. Even though the journal broadly focuses on immediate shoreline zones, the JCR also embraces those coastal environments that either reach some indefinite distance inland or that extend seaward beyond the outer margins of the sublittoral (neritic) zone. We encourage you to visit [www.cerf-jcr.org](http://www.cerf-jcr.org) for more information and invite you all to be a part of our CERF-JCR coastal research society.



## CERF-JCR MEMBERSHIP

Society members are those individuals that support the aims of CERF and the JCR. More information is available at: [www.cerf-jcr.org](http://www.cerf-jcr.org). CERF-JCR Memberships are available in different categories with certain privileges and can be viewed at: <https://cerf.allenpress.com/cerf/MEMBERSHIP.aspx>

Subscription information is available upon request by writing to: [cerf.jcr@gmail.com](mailto:cerf.jcr@gmail.com). The CERF-JCR subscriptions office is located at: Allen Press, Inc., P.O. Box 1897, Lawrence, KS 66044, U.S.A.

### Editor-in-Chief

Christopher Makowski, Ph.D.

Dr. Christopher Makowski is the Senior Vice President and Co-Executive Director of the Coastal Education and Research Foundation (CERF), the official publisher of the international *Journal of Coastal Research* (JCR). He received B.Sc. (Marine Biology), M.Sc. (Marine Ecosystem Diversity), and Ph.D. (Coastal Geoscience and Remote Sensing of Biogeomorphological Resources) degrees from Florida Atlantic University of Boca Raton, Florida, USA, and has worked for over 25 years in the coastal research community, holding titles of Assistant Director (Coastal Planning & Engineering's Marine Science and Biological Research Department), Principal Marine Scientist (Collier County, Florida, USA), and Senior Advisor (International Coastal Symposium [ICS]). Dr. Makowski has published numerous peer reviewed papers, authored multiple chapters, and co-edited various volumes in Springer's Coastal Research Library (CRL) Series and Encyclopedia of Earth Sciences Series (EESS). In addition to these accomplishments, he is professionally recognized by the American Academy of Underwater Sciences (AAUS) and is certified as a Master Scuba Diver Trainer through the Professional Association of Diving Instructors (PADI), having logged over 2,000 underwater dives on six different continents. Other professional registrations, certifications, and accreditations include: Coastal Education and Research Foundation (CERF) Board of Directors (Trustees), BioOne Board of Directors, International Society for Reef Studies (ISRS) Member, Florida Association of Environmental Professionals (FAEP) Chapter Member, American Academy of Underwater Sciences (AAUS) Registered Diving Safety Officer, American Association for the Advancement of Science (AAAS) Member, National Marine Fisheries Service (NMFS) Certified Marine Mammal and Protected Species Observer, Professional Association of Diving Instructors (PADI) Open Water Scuba Diver Instructor, PADI Enriched Air Nitrox Specialty Instructor, Emergency First Responder (CPR/FirstAid/AED) Instructor, PADI Specialty Underwater Photographer Instructor, and Divers Alert Network (DAN) Sustaining Member.

For more information, please visit Dr. Makowski's home page at: [www.cerf-jcr.org](http://www.cerf-jcr.org)

## International Coastal Symposium (ICS) Official Meeting of CERF-JCR

The International Coastal Symposium (ICS) was originally set up by Per Bruun (deceased) and Charles W. Finkl as the official meeting of the Coastal Education and Research Foundation (CERF) and the *Journal of Coastal Research* (JCR), with one of the first meetings being held in Hilton Head, South Carolina, in 1993. After the repeated success of these meetings, CERF-JCR moved the ICS to an international platform by holding these conferences in conjunction with local sponsors in the United States, Australia, Brazil, Iceland, New Zealand, Northern Ireland, Poland, Portugal, and South Korea. The ICS brings together delegates from all over the world to collaborate and discuss the most current coastal research studies and projects. During the ICS 2014, which was held in Durban, South Africa, a grand celebration took place to mark the 30th Anniversary of CERF and the JCR. For more information, please visit [www.cerf-jcr.org](http://www.cerf-jcr.org).

# Journal of Coastal Research (JCR)

VOL. 37, NO. 1 (pages 1–226)

January 2021

ISSN 0749-0208

## CONTENTS

### RESEARCH ARTICLES

Alongshore Classification and Super Domain Delineation of Coastal Belts Based on Interpretation of Biophysical Catenary Sequences Observed from Satellite Images.....	Charles W. Finkl and Christopher Makowski	1
Evaluating the Impacts of Dam Construction and Longshore Transport upon Modern Sedimentation within the Rio Grande Delta (Texas, U.S.A.).....	Samantha Moore, Elizabeth A. Heise, Marty Grove, Anthony Reisinger, and Jude A. Benavides	26
Hydrogeophysical Characterization of the Coastal Aquifer System in the Northeast Gulf of Aqaba (Saudi Arabia): An Investigation in the Context of Groundwater Resources Management .....	Mahmoud M. El Waheidi, Habes Ghrefat, Saleh Qaysi, Awni T. Batayneh, Giorgio Russo, Chokri Jallouli, Omar Badhris, Tariq Maeshi, Eslam A. Elawadhi, and Ibrahim Bahkali	41
Emission of Greenhouse Gases (CH <sub>4</sub> and CO <sub>2</sub> ) into the Atmosphere from Restored Mangrove Soil in South China .....	Yaowen Xu, Baowen Liao, Zhongmao Jiang, Kun Xin, Yanmei Xiong, and Wei Guan	52
Elephant Tracks: A Biogenic Cause of Potholes in Pleistocene South African Coastal Rocks.....	Charles W. Helm, Hayley C. Cawthra, Jan C. De Vynck, Mark Dixon, and Willo Stear	59
Effects of Thinning on Aboveground Net Primary Productivity in Overcrowded Mangrove <i>Kandelia obovate</i> Stands.....	Mouctar Kamara and Md Kamruzzaman	75
Large Eddy Simulation of Bubbles on the Ocean Surface under High-Speed Winds.....	Zhanhong Wan, Shizhu Luo, Saihua Huang, Zhilin Sun, Zhongshui Zou, and Xiuyang Lu	82
Numerical Study of Longshore Variation in Beach Morphodynamics along Eastern Lake Erie Shoreline due to Seiche .....	Erdinc Sogut and Ali Farhadzadeh	92
Morphological Evolution of the Lingding Channel in the Pearl River Estuary over the Last Decades.....	Zhiyuan Han, Hualiang Xie, Huaiyuan Li, Wendan Li, Xianhua Wen, and Mingxiao Xie	104
Do Diploid and Haploid Solitary Cells of <i>Phaeocystis globosa</i> Support the Same Copepod Grazing, Survival, Egg Production, and Hatching Success? .....	Jie Li, Jiachang Lu, Jiale Wang, Yinghui Wang, Junxiang Lai, and Kefu Yu	113
Magnetic Properties of Late Cenozoic Sediments in the Subei Basin: Implications for the Yangtze River Run-through Time .....	Qiang Shu, Zhijun Zhao, Yifei Zhao, Ye Chen, and Maoheng Zhang	122
Large Eddy Simulation of Wake Formation around a Free Surface–Piercing Circular Cylinder .....	Hang Guo, Fahim Bahrian, Weipeng Zhang, Cong Sun, and Jian Hu	132
Induction of Cytochrome P4501 Genes by Various Inducers in Rainbow Trout ( <i>Oncorhynchus mykiss</i> ) .....	Kai Gao, Jing Tian, Yalin Wu, Pengyu Mei, Zhen Zhang, Maria E. Jönsson, and Ingvar Brandt	143
Nonlinear Behavior of Marine Soil on the Dynamic Stability of Upper Wharf Structures: A Numerical Simulation Approach .....	Caihua Shen, Jin Qian, Xiaofeng Chen, Fei Xie, and Jun Zhu	149
Habitat Use by Fish across Tidal Cycles in a Tropical Estuarine Mangrove Ecosystem (Dongzhaigang Bay, Hainan, China).....	Yamian Zhang, Suzhen Yan, Wenqing Wang, and Mao Wang	156
Morphodynamic Responses to the Hong Kong–Zhuhai–Macao Bridge in the Pearl River Estuary, China .....	Mengguo Li, Wendan Li, Mingxiao Xie, and Ting Xu	168
Laboratory Flume Experiments on Cohesive Sediment Erosion by Oscillating Wall Jet.....	Chuanming Dong, Peng Zhao, Guoliang Yu, and Minxi Zhang	179
Dynamic Response of Heavy-Haul Railway Tunnels in Fully Weathered Coastal Red Sandstone Strata with Base Rock Reinforcement: A Numerical Study.....	Haiyan Xu, Changjian Chen, Zimeng Shao, Zhijie Wang, Libin Cai, Zhen Li, and Cheng Xu	191
Specialization and Diversification of the Marine Industry and Marine Economic Growth: An Example from Chinese Coastal Areas .....	Malin Song, Qianying Wang, Shuhong Wang, and Li Zhou	203

### TECHNICAL COMMUNICATIONS

Quantifying Changes in Surface Elevation in Conjunction with Growth Characteristics of Incipient and Fore-dune Vegetation .....	Marita T. McGuirk, David M. Kennedy, Teresa Konlechner, and Andre Chiaradia	216
---	---	-----

### BOOK REVIEWS

<i>Sediment Transport and Morphodynamics Modelling for Coasts and Shallow Environments</i> by V. Magar.....	Emilia Guisado-Pintado	225
---	------------------------	-----

### IN MEMORIAM

Prof. Dr. Niklas Mörner (1938–2020) .....	Alberto Boretti	226
---	-----------------	-----



[www.cerf-jcr.org](http://www.cerf-jcr.org)

*An International Forum for the Littoral Sciences*  
Christopher Makowski, Ph.D.  
Editor-in-Chief



[www.JCRonline.org](http://www.JCRonline.org)