

JOURNAL OF COASTAL RESEARCH

An International Forum for the Littoral Sciences

CHEF*HERAUSGEBER

EDITOR-IN-CHIEF Charles W. Finkl. Jnr.

EDITEUR-EN-CHEF

Coastal Education and Research Foundation, Inc. [CERF] **Editorial Offices:**

Post Office Box 210187 Royal Palm Beach, FL 33421-0187, USA e-mail: finkl@acc.fau.edu

COMITÉ DE REDACTION

cfinkl@gate.net

BOOK REVIEW EDITOR Gregory W. Stone

Louisiana State University Baton Rouge, LA, U.S.A.

JCR PUBLICATIONS MANAGER Karen Hickey

P.O. Box 1897, Lawrence, KS 66044

Telephone: (913) 843-1235/FAX (913) 843-1274

EDITORIAL ASSISTANT

Carol Best CERF, Inc.

Boca Raton, FL 33431

MITHERAUSGEBER

BIOLOGICAL SCIENCES **David Tomasko**

Venice, Florida OCEANOGRAPHY **Kerry Black**

Melbourne, Australia

ASSOCIATE EDITORS

MANAGEMENT **Niels West** Kingston, Rhode Island COASTAL PROCESSES

Miguel A. Losada

Santander, Spain

M. Anwar Maun

B. Mazurkiewicz

Gdansk, Poland

C. Peter McRoy

Fairbanks, Alaska

Austin, Texas

M.R. Nayak

Robert A. Morton

Dona Paula, India

Robert Nicholls

Brisbane, Qlds., Australia

New Brunswick, New Jersey

Randall W. Parkinson

Middlesex, U.K.

Patrick Nunn

Karl F. Nordstrom

Melbourne, Florida

Roland P. Paskoff

Orrin H. Pilkey, Jr.

Durham, N. Carolina

Paolo A. Pirazzoli

Norbert P. Psuty

New Brunswick, New Jersey

Paris, France

Le Chesnay, France

P. Nielsen

Suva, Fiji

London, Ontario, Canada

Joseph T. Kelley

Rhodes W. Fairbridge New York, New York

REDAKTIONSKOMMITEE

Troels Aagaard Copenhagen, Denmark

José F. Araya Santiago, Chile

Mytheenkhan Baba

Trivandrum, India Cecile Baeteman Brussels, Belgium

Daniel F. Belknap Crono, Maine

Eric C.F. Bird Black Rock, Vic., Australia

Charles Birkeland Mangilao, Guam F. Vasco Costa

Lisbon, Portugal Anthony J. Davy Norwich, England

Clinton J. Dawes Tampa, Florida

Ron DeLaune Baton Rouge, Louisiana

Reinhard Dieckmann Bremerhaven, Germany Richard V. Dingle

Cape Town, South Africa Jean-Claude Dionne

Québec, Canada

Robert Dolan Charlottesville, Virginia

Ken Dunton Port Aransas, Texas Lionel N. Eleuterius Ocean Springs, Mississippi ENGINEERING & TECHNOLOGY

Per Bruun

Hilton Head, South Carolina COASTAL GEOLOGY

Duncan M. FitzGerald

EDITORIAL BOARD

Donald L. Forbes Dartmouth Canada

Shoji Fujii Toyama City, Japan

Cyril Galvin Springfield, Virginia

F. Gerritsen

Edgardo D. Gomez Quezon City, Philippines

Santa Cruz, California

Charlottesville, Virginia

Saskia Jelgersma Bergen, The Netherlands

Paul Kaplin Moscow, Russia **Dieter Kelletat** Essen, Germany

Vic Klemas Newark, Delaware N. Kobayashi

Nicholas C. Kraus

Pierre Lasserre Paris, France S.P. Leatherman

Athens. Greece Jeffrey H. List Woods Hole, Massachusetts

Hilton Head, South Carolina

Gary B. Griggs

Bruce Hayden

David Hopley Townsville, Qlds., Australia

Joseph T. Kelley Orono, Maine

Newark. Delaware

Corpus Christi, Texas

College Park, Maryland

COMMISSION DE PUBLICATION Ioannis Liritzis

Michael R. Rampino New York, New York

MARINE GEOLOGY

Terry R. Healy

Hamilton, New Zealand

CONSULTING EDITOR

William Sackinger Fairbanks, Alaska **Bernard Salvat**

Paris, France Toru Sawaragi

Osaka, Japan Maurice L. Schwartz

Bellingham, Washington Andrew D. Short Sydney, NSW, Australia Gregory W. Stone Baton Rouge, Louisiana

Orson van de Plassche Amsterdam, The Netherlands F. van der Meulen

Amsterdam. The Netherlands Herman Th. Verstappen

Enschede, The Netherlands H.J. Walker

Baton Rouge, Louisiana John T. Wells Chapel Hill, N. Carolina

Eric Wolanski Townsville, Qlds, Australia P.L. Woodworth

Merseyside, England Donald R. Young Richmond, Virginia Robert Young

Burlington, Vermont

COPYRIGHT

Authorization to photocopy items for internal or personal use, or the internal or personal use of specific clients, is granted by the Coastal Education and Research Foundation (CERF). This consent does not extend to other kinds of copying, such as copying for general distributions, for creating new collective works, or for resale. It is a condition of publication that manuscripts submitted to this journal have not been published, nor will they be simultaneously submitted or published elsewhere. By submitting a manuscript, the authors agree that the copyright for their article is transferred to the publisher if the article is accepted for publication. Assignment of copyright is not required, however, from authors who work for organizations which do not permit such assignment. The copyright covers the exclusive rights to reproduce and distribute the article, including reprints, photographic reproductions, microform or any other reproductions of a similar nature, and translations.

The JOURNAL OF COASTAL RESEARCH (ISSN 0749-0208) is published quarterly by the Coastal Education & Research Foundation (CERF), 810 East 10th St., Lawrence, KS 66044, USA. Subscription rates for 1996 are \$US 135.00 for institutions, \$US 65.00 for individuals and \$US 43.00 for students. Members of the Coastal Education and Research Foundation (CERF) receive the journal for \$US 55.00. All subscribers outside the USA please add \$US 10.00 for surface postage. Single back issues and parts are available at current subscription rates. Second class postage paid at Lawrence, KS. POSTMASTER: Send address changes to JOURNAL OF COASTAL RESEARCH, P.O. Box 368, Lawrence, KS 66044.

Claims for Missing Issues: No claims allowed for (1) insufficient notice of address change; (2) issues lost in mail unless claimed within (a) 90 days for USA, or (b) 120 days for other countries, from last day of month of publication; or (3) such reasons as "missing from files.

JOURNAL OF COASTAL RESEARCH

An International Forum for the Littoral Sciences

Who rory FL

Supporting Scientific Organizations

- International Union for Quaternary Research (INQUA): Commission on Quaternary Shorelines, The Holocene Commission, and The Neotectonics Commission.
- International Geological Correlation Program (IGCP) (supported by the International Union of Geological Sciences and UNESCO): Project No. 274 Quaternary Coastal Evolution: Case Studies, Models and Regional Patterns.
- The International Geographical Union (IGU): Commission on the Coastal Environment.
- International Institute for Aerial Survey and Earth Sciences (ITC) [Enschede, The Netherlands].
- International Association for Biological Oceanography (IABO).
- International Association of Meiobenthologists (IAM).
- International Post-Graduate Training Courses on Fundamental and Applied Quaternary Geology (**IFAQ**) [Brussels, Belgium].

Aims and Scope of the Journal

Journal of Coastal Research, 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.

Subscription Information

Editorial, Advertising and Publishing Office: Dr. Charles W. Finkl, Jnr., Editor-in-Chief, P.O. Box 210187, Royal Palm Beach, FL 33421, USA. Telephone and FAX: (954) 565-1051. All certified or registered mail should be sent to Dr. Charles W. Finkl, Jnr., Editor-in-Chief, Journal of Coastal Research, Department of Geology, Florida Atlantic University, Boca Raton, FL 33431 USA.

Advertising and Promotion Office: Ralph DeSoignie, 1041 New Hampshire Street, Lawrence, KS 66044. Telephone: (913) 843-1235. FAX: (913) 843-1274.

Subscriptions Office: Karen Hickey, P.O. Box 1897, Lawrence, KS 66044 USA. Telephone: (913) 843-1235. FAX: (913) 843-1274.

Published Quarterly in January, April, July, and October. *Annual Subscription Rate* (1996): \$US 43.00 (Student), \$US 65.00 (Personal), \$US 135.00 (Institution). Subscribers outside of the USA please add \$US 10.00 for surface postage or \$US 50.00 for airmail postage and handling. Back issues (from Volume 3 onwards) are available at current subscription rates.

THE JOURNAL OF COASTAL RESEARCH is surveyed in Aquatic Sciences and Fisheries Abstracts; Civil Engineering Hydraulics Abstracts; Current Awareness in Biological Sciences; Current Contents/Agriculture; Biology & Environmental Sciences; Ecology Abstracts; FLUIDEX (British Hydromechanics Research Association); Focus on: Global Change; GeoAbstracts (Geographical Abstracts: Physical Geography; Ecological Abstracts; Geological Abstracts; GeoScience Contents; Institute of Scientific Information (USSR); Marine Science Contents Tables; Meteorological and Geoastrophysical Abstracts; Oceanic Abstracts; Oceanographic Literature Review; Physics Abstracts; Pollution Abstracts; Selected Water Resources Abstracts (U.S. Geological Survey); Wetland Values Database (U.S. Fish & Wildlife Service); and SciSearch.

JOURNAL OF COASTAL RESEARCH

SUBSCRIPTION INFORMATION

The JOURNAL OF COASTAL RESEARCH (JCR), official publication of the Coastal Education & Research Foundation (a non-profit corporation), acts as a basic world publication for coastal research. The journal publishes original contributions that deal with theory, methodology, techniques, and field or applied studies on inter-disciplinary topics. All aspects of coastal research are considered in the fields of biology, geology, oceanography, environmental (resource) management, engineering, planning, and remote sensing, among others. JCR is surveyed in: Aquatic Sciences and Fisheries Abstracts; Current Awareness in Biological Sciences; Civil Engineering Hydraulics Abstracts; Current Contents/Agriculture, Biology and Environmental Sciences; Ecology Abstracts; FLUIDEX (British Hydromechanics Research Association); GeoAbstracts; USSR Institute of Scientific Information; FAO Marine Science Contents Tables; Oceanic Abstracts; Oceanographic Literature Review; Physics Abstracts, and Pollution Abstracts.

Published quarterly in about 1200 volume pages. Special issues available separately. ISSN No. 0749-0208.

FOUNDATION MEMBERSHIP BENEFITS

- Our scientific journal
- Participation and sharing with a distinguished international group of scholars and scientists
- Foundation newsletter
- Notices of meetings

- State-of-the-art reviews
- Reports of meetings
- Technical communications
- Book reviews
- News from affiliated societies
- · Coastal calendar of events

Please enroll me as a member in the Coastal Education & Research Foundation [CERF] My payment is enclosed for the category marked below.

1996 Volume 12. Numbers 1- 4 inclusive

olun	ne 12, Numbers 1- 4 inclusive			
	Regular membership and subscription (1 year)	\$55.00/\$65.00 foreign		
	Student* membership and subscription (1 year)	\$43.00/\$53.00 foreign		
*Surface postage is included in the membership and subscription rates.				

PLEASE MAKE CHECK PAYABLE TO: CERF

FOR LIBRARIES, SCHOOLS & ORGANIZATIONS

(Subscriptions when not for personal use)
SUBSCRIPTION (U.S.A.— LIBRARY) \$135.00
SUBSCRIPTION (OTHER COUNTRIES) \$145.00

(ADVANCE PAYMENT IN US DOLLARS REQUIRED)

Checks should be in U.S. funds on U.S. or Canadian bank

NAME OF APPLICANT ADDRESS FOR MAIL			GREE	
City	State or Province	Zip Code	Country	
Position or Title		Phone	-	
*Student Status Certified by				

MAIL TO: 🖾

JOURNAL OF COASTAL RESEARCH P.O. BOX 1897 LAWRENCE, KS 66044, USA