

JOURNAL OF COASTAL RESEARCH

An International Forum for the Littoral Sciences

EDITOR-IN-CHIEF

Charles W. Finkl, Jr.

Coastal Education and Research Foundation, Inc. /CERF/
4310 NE 25th Avenue
Fort Lauderdale, FL 33308, USA

CONSULTING EDITOR

Rhodes W. Fairbridge
Goddard Institute for Space Studies
New York, NY 10027, USA

BOOK REVIEW EDITOR

R.W.G. Carter
University of Ulster
Northern Ireland BT52 1SA, UK

ASSOCIATE EDITORS

BIOLOGICAL SCIENCES

Clinton J. Dawes
University of South Florida
Tampa, Florida

OCEANOGRAPHY

David Huntley
Plymouth Polytechnic
Plymouth, England

ENGINEERING & TECHNOLOGY

Per Bruun
International Marine Science
Hilton Head, South Carolina

COASTAL GEOLOGY

Joseph T. Kelley
University of Maine
Orono, Maine

POLICY & MANAGEMENT

James R. Broadus
Woods Hole Oceanographic Institute
Woods Hole, Massachusetts

GEOMORPHOLOGY

Orson van de Plassche
Free University of Amsterdam
Amsterdam, The Netherlands

MARINE GEOLOGY

Terry R. Healy
University of Waikato
Hamilton, New Zealand

EDITORIAL BOARD

Cecile Baeteman
Brussels, Belgium

Eric C. F. Bird
Parkville, Victoria, Australia

Charles Birkeland
Mangilao, Guam

Charles Bretschneider
Honolulu, Hawaii

Donald R. Coates
Binghamton, New York

F. Vasco Costa
Lisbon, Portugal

Anthony J. Davy
Norwich, England

Elliot W. Dawson
Wellington, New Zealand

Richard V. Dingle
Cape Town, South Africa

Robert Dolan
Charlottesville, Virginia

Keith R. Dyer
Plymouth, England

Lionel N. Eleuterius
Ocean Springs, Mississippi

Shoji Fujii
Toyama City, Japan

D.F. Geritsen
Honolulu, Hawaii

Edgardo D. Gomez
Quezon City, Philippines

André Guilcher
Brest, France

Ali Günbak
Ankara, Turkey

David Hopley
Townsville, Qlds., Australia

O.G. Houmb
Trondheim, Norway

Paul Kaplin
Moscow, USSR

Dieter Kelletat
Essen, W. Germany

Vic Klemas
Newark, Delaware

N. Kobayashi
Newark, Delaware

Nicholas C. Kraus
Vicksburg, Mississippi

Néstor W. Lanfredi
La Plata, Argentina

Pierre Lasserre
Paris, France

Miguel A. Losada
Santander, Spain

E. van der Maarel
Uppsala, Sweden

M. Anwar Maun
London, Ontario, Canada

B. Mazurkiewicz
Gdansk, Poland

C. Peter McRoy
Fairbanks, Alaska

Ashish J. Mehta
Gainesville, Florida

M.R. Nayak
Dona Paula, India

P. Nielsen
Hornsby, NSW, Australia

Roland P. Paskoff
Le Chesnay, France

Orrin H. Pilkey, Jr.
Durham, N. Carolina

Paolo A. Pirazzoli
Paris, France

Norbert P. Psuty
New Brunswick, New Jersey

Ren Meie
Nanjing, China

Michael R. Rampino
New York, New York

William Sackinger
Fairbanks, Alaska

Bernard Salvat
Paris, France

Toru Sawaragi
Osaka, Japan

Carlos Schubert
Caracas, Venezuela

Maurice L. Schwartz
Bellingham, Washington

Andrew D. Short
Sydney, NSW, Australia

H.B. Sørensen
Lemvig, Denmark

Bernard A. Thomassin
Marseille, France

Michael J. Tooley
Durham, England

P. Tryde
Lyngby, Denmark

J. van de Kreeke
Coconut Grove, Florida

José F. Araya
Santiago, Chile

Herman Th. Verstappen
Enschede, The Netherlands

Ian Watson
Boca Raton, Florida

Niels West
Kingston, Rhode Island

Xu Jizu
Tianjin, China

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 authorization is extended to libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service, provided that the base fee of \$ US 1.00 per copy of the article plus \$ US 0.10 per page is paid directly to the Copyright Clearance Center, 27 Congress Street, Salem, MA 01970. For those organizations that have been granted a License with the Copyright Clearance Center, a separate system of payments has been arranged. Please contact the Copyright Clearance Center to determine whether the License fee arrangement covers your organization. This consent does not extend to other kinds of copying, such as copying for general distributions, for creating new collective works, or for resale. Fees for past articles are the same as those shown for current articles. The Item Fee-Code for users of the Transactional Reporting Service is 0749-0208/1989 \$1.00 + 0.10.

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. No part of this publication may be reproduced, stored in a retrieval system or transmitted in any form or by any means, electronic, electrostatic, magnetic tape, mechanical, photocopying, recording or otherwise, without permission in writing from the copyright holder.

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 1991 are \$125.00 for institutions, \$58 for individuals and \$43 for students. Members of The Coastal Education & Research Foundation (CERF) receive the journal for \$48. All subscribers outside the USA please add \$10 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 must be received within 90 days of publication for domestic subscribers and within 120 days for those outside the USA.

© 1990, the Coastal Education & Research Foundation /CERF/. Printed by Allen Press, Inc., Lawrence, Kansas, USA.

Journal of Coastal Research

An International Forum for the Littoral Sciences

Supporting 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, Jr., Editor-in-Chief, 4310 NE 25th Avenue, Fort Lauderdale, Florida 33308 USA. Telephone: (305) 565-1051, (305) 564-5653. FAX (305) 565-1051. All certified or registered mail should be sent to: Dr. Charles W. Finkl, Jr., Editor-in-Chief, P.O. Box 8068, Charlottesville, VA 22906 USA.

Published Quarterly in January, March, June, and September. *Annual Subscription Rate (1991):* \$ US43.00 (Student), \$ US58.00 (Personal), \$ US125.00 (Institution). Subscribers outside of the USA please add \$ US10.00 for surface postage or \$ US45.00 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*; *Current Awareness in Biological Sciences*; *Current Contents/Agriculture*; *Biology & Environmental Sciences*; *Ecology Abstracts*; *FLUIDEX (British Hydromechanics Research Association)*; *GeoAbstracts*; *GeoScience Contents*; *Institute of Scientific Information (USSR)*; *Marine Science Contents Tables*; *Oceanic Abstracts*; *Oceanographic Literature Review*; *Physics Abstracts*; and *Pollution Abstracts*.



London Bridge (a double arch structure near Port Campbell, Victoria, Australia) as it was in March 1977 (upper photo). The inner arch collapsed into the sea at 7:45pm on 15 January 1990 (lower photo), just after two people had walked across it to the outer arch. They were rescued by police helicopter three hours later. Although small pieces of rock had fallen from the inner arch from time to time, the collapse was sudden and unexpected. (Courtesy of Eric C.F. Bird).

JOURNAL OF COASTAL RESEARCH

An International Forum for the Littoral Sciences

INSTRUCTIONS TO AUTHORS

SCOPE OF THE JOURNAL

The *Journal of Coastal Research*, covering the entire field of coastal research, encompasses all subjects relevant to natural and man-made environments (freshwater or marine) and the protection/management of their resources in the vicinity of coastlines of the world. The journal broadly focuses on shorelines but embraces coastal environments that reach to some indefinite distance inland and that extend seaward beyond the outer margins of the sublittoral (neritic) zone.

EDITORIAL POLICY

The journal is published quarterly in English by the Coastal Education and Research Foundation [CERF]. The following main departments are included in most issues: Professional Papers, Technical Communications, Meeting Reports, News and Announcements, Coastal Calendar, Letters to the Editor, Coastal Photographs, Book Reviews, and Books Received. Manuscripts received are normally reviewed by at least two referees. An author citation index and geographic and subject indices are bound in the first fascicle of a volume. The Editor-in-Chief is responsible for the published material.

Before submitting a manuscript, the following rules should be read carefully. Contributions that differ from the specifications will be returned for correction before review. Revised manuscripts are assumed to be in final form when received at the editorial office. The papers must have been carefully prepared to avoid charges for corrections in proof (other than those caused by the printers).

Professional Papers: Original contributions dealing with all aspects of coastal and environmental problems are of prime interest to the journal. Manuscripts dealing with theory, methodology, applied topics, and case studies are also appropriate for publication. Periodic reviews of history, state-of-the-art summaries, and progress on specific topics or problems are also welcome.

Technical Communications: Brief reports and notes dealing with a new or improved technique, procedure, or methodology are treated similarly to professional papers. These short reports may contain line drawings, photographs, and references.

News and Announcements: Announcements, discussions, and progress reports of supporting organizations (INQUA, IGCP, ITC, IABO, IFAQ, TCS) and other associations with coastal themes and interests will highlight this section. Brief descriptions of representative professional activities and news items of international, national or regional interest are also relevant here.

Letters to the Editor: Critical observations (pro and contra) and clarifying discussions of articles appearing in the journal will be published as soon as possible along with the author's reply. Brief and pertinent responses are encouraged. Editorials providing informative commentaries on any aspect of coastal research are also welcome.

Literature Reviews, Abstracts: Topical reviews in specialized subjects should feature classical interpretations of contentious issues as well as modern developments. Selected book reviews, shorter listings of books received, and current titles in coastal research, management, and engineering will be included.

Coastal Photographs: Black and white photographs of general interest will be published as a single page entry with an appropriate caption (it is helpful to include location and date). Refer to previous issues for photo proportions and submit proofs to the Editor-in-Chief.

FOUND MARKING

Manuscript Requirements: Manuscripts must be original and not currently being considered for publication elsewhere.

Manuscripts in general should be organized in the following order:

(a) Title; (b) names and affiliations of authors; (c) abstract; (d) index words; (e) introduction; (f) methods, techniques, materials, study area; (g) results; (h) discussion; (i) conclusions; (j) acknowledgements; (k) references; (l) tables; and (m) figure captions.

For general guides to manuscript lay-out and style, contributors are referred to: *A Manual of Style* (1982), The University of Chicago Press; *Suggestions to Authors of the Reports of the United States Geological Survey* (1958), U.S. Government Printing Office, Washington, DC; *Geowriting—A Guide to Writing, Editing, and Printing in Earth Science* (1973), American Geological Institute, Washington, DC.

Manuscripts must be typewritten on one side of white bond paper and double spaced, including abstracts and references, on unbound pages of uniform size not more than 30 cm in length. Number all pages through the reference section beginning with the abstract.

In the text, first-order headings are in capitals and centered; second-order headings are upper and lower case, flush left; third-order heads are italic upper and lower case indented as a paragraph and running into copy.

Manuscripts should be prepared using a popular typestyle such as Courier, Prestige, Letter Gothic, Bookface, or OCR-B. Over- or under-size typestyles, fancy typewriter fonts, lazer jet, or dot-matrix printers are unsuitable. Only *letter-quality copy* is acceptable. **Do not** use oversize letters, boldface, or fancy fonts for headings (follow instructions in preceding paragraphs). Use continuous underlining to indicate italic type (for book or journal titles, foreign words and phrases, etc.). Symbolization used in mathematical formulae must be accompanied by marginal notes that identify the foreign characters for the typesetter. All marginal notes *must* be made using a red felt-tipped pen.

Title Page: The first page should contain a concise title, the name(s) of the author(s), then the complete postal address(es). Footnotes for new affiliation(s), contribution numbers from institutions, and financial support may be added to this page only.

Abstract: A concise abstract, no more than 250 words, should be on the second page. The content should summarize the work and indicate important research findings or results. For those able to do so, a short summary in French, German, Spanish and/or other language utilizing the Latin alphabet would be appreciated. Technical communications may be published without an abstract.

Index Words: Provide additional words not found in the title. These key words are useful to indexers who prepare lists for computer searches by subject.

Table: These are to be included in the main body of the manuscript when printed but should be submitted separately, each to a page after the references. They should be numbered consecutively, appropriately based, and kept as simple and short as possible. Longer appendices are exceptionally allowed.

Illustrations: Photographs and line drawings are to be numbered in Arabic numerals in a single sequence as "Figure 1," "Figure 2," etc., and so referred to in the text. Each must be clearly captioned and acknowledged when necessary. Legends of figures must be typed on a separate page. The size of a figure, its lettering and lines, must be carefully considered for reduction because figures will be reduced as much as possible to one column (70 mm, 2.75 inches) or two columns (148 mm, 5.75 inches). The length of a column is 205 mm (8 inches). Larger illustrations may be rotated sideways and printed as a turnpage to take advantage of maximum page size. The minimum size of a reduced letter should be about 2 mm high. For a figure that is

to be reduced to 1/4 of its size (1/2 length of size), lines of 0.5 to 0.8 mm and 16 to 18 point bold are recommended. A lettering device should be used—do not submit figures labeled on a typewriter.

Each figure must be clearly captioned and acknowledged when necessary. The figure captions should be typed consecutively on a separate sheet at the end of the paper. The International System of Units (SI) or modern metric units should be used. Equivalents, if necessary, may be included in parenthesis immediately following the acceptable units.

Magnifications should be given as bar lines in the photograph and defined in the caption or legend. Maps and planimetric drawings should also contain scales in bar lines as well as a north sign.

Scientific Names: Identifiers of plant and animal genera, subgenera, species and lower taxa need to be underlined for italic, specific and lower epithets being written with a lower case initial letter. Nomenclature should follow the appropriate international code. Geological, ecological and other scientific terms should follow standard usage or be defined the first time they are employed in the paper.

Titles: The titles of all papers should be as short as possible, *inter alia* for use as running heads. Those of professional reports will be balanced by titles and author's names on the tops of pages.

Literature References: Citations are generally treated according to the "Harvard System." In the body of the text they are cited by naming the author in upper-case letters (or authors connected by "and" if two, or with *et al.* replacing all names after the first if more than three) and indicating the year of publication. Enclose the cite in parentheses if referring to indirectly, or enclose the year of publication in parentheses if referring to directly, e.g., "(JONES, 1980)", "(SMITH *et al.*, 1986)"; "according to JONES (1980)", "from data prepared by SMITH *et al.* (1986)". Papers cited should be grouped together in a list headed "Literature Cited", alphabetically arranged by first authors' surnames (again, the names should be in upper-case letters) but unnumbered, at the end of the body of the paper. There all authors' names and initials are required followed by the date of publication and the full title of the paper. Then follows the full title of the periodical, underlined for italic, then the volume number in Arabic numerals, and finally the page spread. For books, the title is given underlined for italic, and then the bare name of the publisher preceded by the place of publication. The list of references to journal articles and books, as found in the *Journal*, should be in the following format:

FLEMMING, N.C., 1968. Submerged shorelines. *In*: Fairbridge, R.W. (ed.), *The Encyclopedia of Geomorphology*. New York: Reinhold, 1097-1098.

McFADGEN, B.G. and YALDWYN, J.C., 1984. Holocene sand dunes on Enderby Island, Auckland Islands. *New Zealand Journal of Geology and Geophysics*, 27(1), 27-33.

HOPLEY, D., 1982. *The Geomorphology of the Great Barrier Reef: Quaternary Development of Coral Reefs*. New York: Wiley-Interscience, 453p.

PETUCH, E.J. and SARGENT, D.M., 1986. *Atlas of the Living Olive Shells of the World*. Charlottesville, VA: Coastal Education and Research Foundation, 253p.

Proofs: Page proofs will be sent to the author or designed correspondee of each professional paper (but not conference reports, news, or letters). Proofs should be carefully checked for printing errors. Only necessary corrections can be made in page proof due to increasing costs of altering set pages. Changes other than printing errors will be charged at cost. The publisher reserves the rights to "pass for press" when authors' corrections are not returned in time. Authors receiving proofs should check with their co-authors concerning corrections.

Reprints: A form for ordering reprints is provided with the proofs. Reprints will be sent to the author (or first named if more than one) of each signed paper, unless otherwise advised. Offprints may be ordered with covers if desired, as indicated on the form.

SUBSCRIBER INFORMATION

The *Journal of coastal Research* is published quarterly. A volume (4 issues) consists of approximately 800 printed pages. Special issues are published on an irregular basis and are available separately from ordinary subscriptions as standing orders or single copies.

Subscription Prices: The annual (calendar year basis) subscription price (4 issues for 1991) is \$43 for students, \$58 for personal subscriptions, and \$125.00 for institutions (incl. libraries). Add \$10.00 for surface postage outside the United States. Airmail delivery rates are as follows: \$38.00 to Europe and South America; \$45 to Africa, Australia, and the Far East. Back issues are available on request by volume or single issue. The journal may be ordered directly from the Editorial Office or from booksellers.

COPYRIGHT

Upon acceptance of the manuscript, the publishers acquire the copyright for publication as well as the sole right for reproduction, *in toto* or *pro parte*, distribution, or translation. Reprinting and commercial reproduction of articles and illustrations requires the written consent of the publishers. Authorization to photocopy single items for internal use is extended to libraries and other users registered with the Copyright Clearance Center (CCC) Transactional Reporting Service in Salem, Massachusetts.

EDITORIAL OFFICE

All correspondence, payments and manuscripts (original and two copies) should be addressed to:

Journal of Coastal Research
4310 NE 25th Avenue
Fort Lauderdale, FL 33308 USA

Telephone/FAX (305) 565-1051