

# Coastal Environments

Problems and Perspectives

*Editors*

**K.S. Jayappa**

**A.C. Narayana**

**J.K. International**

**Coastal Environments**  
**Problems and Perspectives**

# Coastal Environments

## Problems and Perspectives

*Editors*

**K.S. Jayappa**

*Department of Marine Geology  
Mangalore University  
Mangalore*

**A.C. Narayana**

*Centre for Earth and Space Sciences  
University of Hyderabad  
Hyderabad*



**I.K. International Publishing House Pvt. Ltd.**

---

NEW DELHI • BANGALORE

*Published by*

I.K. International Publishing House Pvt. Ltd.  
S-25, Green Park Extension, Uphaar Cinema Market  
New Delhi - 110 016 (India)  
E-mail : ik\_in@vsnl.net

ISBN: 978-81-80026-28-2

10 9 8 7 6 5 4 3 2 1

© 2009 I.K. International Publishing House Pvt. Ltd.

All rights reserved. No part of this publication may be reproduced, stored in a retrieval system, or transmitted in any form or any means: electronic, mechanical, photocopying, recording, or otherwise, without the prior written permission from the publisher.

Published by Krishan Makhijani for I.K. International Publishing House Pvt. Ltd.,  
S-25, Green Park Extension, Uphaar Cinema Market, New Delhi - 110 016  
and Printed by Rekha Printers Pvt. Ltd., Okhla Industrial Area, Phase II,  
New Delhi - 110 020.

## Foreword

---

Globally, a large percentage of population lives within a few kilometers of the coastline. This increases the significance of understanding the coastal environment and necessitates measures to stop degradation of the same. It was observed during the assessment of the damage caused by the unprecedented tsunami generated by the 26<sup>th</sup> December 2004  $M_w$  9.3 earthquake, that the coastal areas with healthy mangrove growth were much less affected. The much talked impending climate change and sealevel rise, coastal inundation, erosion, and random construction of seawalls with huge costs for prevention of coastal erosion, add to the importance of the 'Coastal Environment' topic.

The present volume includes interesting papers on several important topics such as mineral resources; fishery and bio resources; evolution of coastal landforms; shoreline changes; sediment dynamics and transport; coastal erosion and measures to prevent it; role of seawalls in coastal protection; and application of remote sensing and GIS in Coastal Zone Management.

All involved with coastal zone studies, its management and protection will find this volume useful.

I congratulate Prof. A.C. Narayana and Dr. K.S. Jayappa for their sincere effort in bringing out this timely publication.

**Harsh K. Gupta**

## Preface

---

There is an increasing public and academic interest in coastal environments and related problems because of natural disasters, sea level rise, marine ecosystem and mineral resources on one side, and industrial growth, population settlements etc. on the other side. Coastal environments display the impact of natural forces and processes on man and also the impact of man on the coastal environment. The exploitation of natural mineral resources, navigation and recreation activities are an integral part of the problems and perspectives of coastal environments.

The main purpose of this volume is to highlight various processes, particularly sediment transport processes, coastal erosion and management, landform evolution and resources of the coastal region. The case studies are presented under each section. The availability of comprehensive basic scientific data is vital for effective coastal zone management. There are sixteen papers together on coastal resources, coastal landforms, coastal erosion, sediment transport and dredging and all these add the scientific information for coastal zone management. The last section of the volume comprises the papers on application of remote sensing in environmental studies and two assorted papers on surface run-off and flora of Gondwanaland. The causes for coastal erosion, the present scenario of erosion along Kerala and Karnataka coasts and the mitigation procedures have been explained in this book. The utility of seawalls and other protection structures in arresting coastal erosion has been discussed and debated in detail.

The book is illustrated with line drawings and photographs wherever necessary. Each paper ends with definite conclusions and suggestions. The contributors for this volume are highly qualified and drawn from universities, academic and other research institutes and industry. We hope that this book will provide the useful information for students and researchers, and readers will enjoy the approach and style of this book.

**K. S. Jayappa**  
**A. C. Narayana**

## Acknowledgements

---

We place on record our sincere thanks to the referees – K.R. Subrahmanya, K.P. Thrivikramji, R. Tatavarti, J. Dattatri, K.R. Chandrashekar, Kusuma Nilakantan, K. Seshadri, N. Laxman, D. Mitra – for critically going through the manuscripts and for valuable suggestions, which helped to improve the quality of the papers.

Council of Scientific and Industrial Research, Indian Space Research Organization, and Mangalore University are gratefully acknowledged for the financial support for the seminar. Department of Ocean Development has extended partial financial support for publication of this volume.

KSJ thanks Professors B. Hanumaiah and K.M. Kaveriappa, former and present Vice-Chancellors of Mangalore University, and K.R. Subrahmanya, former Chairman of the Department, for their encouragement and support. KSJ is also thankful to H. Gangadhar Bhat and G.T. Vijay Kumar for their help. Sincere thanks are also due to Avinash Kumar and Deepika for the assistance in processing this book.

**K. S. Jayappa**

**A. C. Narayana**

## Contents

---

<i>Foreword</i>	v
<i>Preface</i>	vi
<i>Acknowledgements</i>	ix
<b>1. Coastal Environments: Problems and Perspectives</b> K.S. JAYAPPA and A.C. NARAYANA	<b>1</b>
<b>SECTION 1 – COASTAL RESOURCES</b>	
<b>2. Mineral Resources of Coastal Tracts of India</b> A.C. NARAYANA and K.S. JAYAPPA	<b>9</b>
<b>3. Coastal and Marine Fisheries Resources of Kerala — Conservation and Sustainable Development</b> B. MADHUSODANA KURUP	<b>19</b>
<b>4. Coastal Fishery Resources of India with Special Reference to Karnataka — Management Implications</b> S.M. SHIVAPRAKASH	<b>39</b>
<b>5. Bioresources of Coastal Sand Dunes – Are They Neglected?</b> K.R. SRIDHAR	<b>53</b>
<b>SECTION 2 – COASTAL LANDFORMS</b>	
<b>6. Evolution of Coastal Landforms Southern Karnataka: A Remote Sensing Approach</b> K.S. JAYAPPA, G.T. VIJAYA KUMAR and AVINASH KUMAR	<b>79</b>
<b>7. Long-term Morphological Changes of Shoreline and Estuaries along the Northern Kerala Coast — Remote Sensing and GIS Based Study</b> P.V. VIJAYAN, H. GANGADHARA BHAT and M.S. VINAYA	<b>96</b>

xii *Contents*

<b>8.</b>	<b>Coastal Landform Changes in and Around Cochin and Their Implications in Coastal Zone Management</b>	<b>108</b>
	C.P. PRIJU and A.C. NARAYANA	
<b>9.</b>	<b>Delineation of Submerged Paleo-shorelines and Paleo-channels along the Southern Karnataka Coast using Remote Sensing</b>	<b>118</b>
	M.S. VINAYA, H. GANGADHARA BHAT and K.S. JAYAPPA	
<b>10.</b>	<b>Preparation of Land Use/Land Cover Map as an Input to Universal Soil Loss Equation through Remote Sensing and GIS</b>	<b>127</b>
	G.S. DWARAKISH and K. ASHA JYOTHI	
<b>SECTION 3 – SEDIMENT TRANSPORT AND MAINTENANCE DREDGING</b>		
<b>11.</b>	<b>Alongshore Sediment Transport and Maintenance Dredging Practices in Major Ports of India</b>	<b>139</b>
	M.M. KAMATH	
<b>12.</b>	<b>Effect of Hydro-meteorological Conditions on Sediment Transport – A Case Study in Hugli Estuary using Radiotracers</b>	<b>159</b>
	NOBLE JACOB, U. SARAVANA KUMAR, U.P. KULKARNI, G.N. MENDHEKAR, S.V. NAVADA and K. CHAKRABORTY	
<b>13.</b>	<b>Application of Remote Sensing and Mike-21 for Sediment Dynamics off Mangalore Coast</b>	<b>167</b>
	G.S. DWARAKISH and K. SANKAR BABU	
<b>SECTION 4 – COASTAL EROSION AND MANAGEMENT</b>		
<b>14.</b>	<b>Coastal Erosion and Management</b>	<b>183</b>
	K.S. JAYAPPA and A.C. NARAYANA	
<b>15.</b>	<b>Breakwaters – An Innovative Hard Option for Coastal Erosion Mitigation Measures</b>	<b>199</b>
	KIRAN G. SHIRLAL, SUBBA RAO and B. RADHESHYAM	
<b>16.</b>	<b>Miramar (Goa) Beach Management Project: An Oceanographic Evaluation</b>	<b>212</b>
	ANTONIO MASCARENHAS and BABAN INGOLE	
<b>17.</b>	<b>Failure Analysis of Seawalls along Karnataka Coast and Recent Trends in Coastal Protection</b>	<b>226</b>
	SUBBA RAO, B. RADHESHYAM, K. SUBRAHMANYA, V.R. CHANDRAMOHAN, D.H. RAJU, U. SHETTY and K.S. JAYAPPA	

**SECTION 5 – APPLICATION OF RS & GIS AND FLORA IN  
ENVIRONMENTAL GEOSCIENCES STUDIES**

<b>18.</b>	<b>Remote Sensing in Geological and Environmental Studies</b>	<b>237</b>
	K. GANESHA RAJ	
<b>19.</b>	<b>Modelling Spatio-temporal Distributions of Surface Runoff in Undulating Terrain Using Remote Sensing and GIS</b>	<b>255</b>
	N.S. ANANDA RAO, K.H.V. DURGA RAO and H. GANGADHARA BHAT	
<b>20.</b>	<b>Status of Coastal Gondwana — A Floristic Perspective</b>	<b>264</b>
	A. RAJANIKANTH	
	<i>Index</i>	<b>277</b>

## Contributors

---

**Mr. Ananda Rao N.S.**

Dept of Civil Engineering  
Manipal Institute of Technology, Manipal  
E-mail: rao\_nsar@yahoo.com

**Dr. Antonio Mascarenhas**

National Institute of Oceanography  
Dona Paula - 403 004, Goa  
E-mail: antmas1954@yahoo.co.in

**Ms. Asha Jyothi K.**

Dept of Applied Mechanics and Hydraulics,  
National Institute of Technology, Karnataka,  
Surathkal, Srinivasnagar - 575 025

**Mr. Avinash Kumar**

Dept of Marine Geology  
Mangalore University,  
Mangalagangothri - 574 199

**Dr. Baban Ingole**

National Institute of Oceanography  
Dona Paula - 403 004, Goa

**Dr. Chakraborty, K.**

Hydraulic Study Department  
Kolkata Port Trust, Kolkata

**Mr. Chandramohan, V.R.**

Dept of Applied Mechanics and Hydraulics,  
National Institute of Technology, Karnataka,  
Surathkal, Srinivasnagar - 575 025

**Dr. Durga Rao, K.H.V.**

Indian Institute of Remote Sensing  
Dehradun - 248 001

**Dr. Dwarakish G.S.**

Dept of Applied Mechanics and Hydraulics,  
National Institute of Technology, Karnataka,  
Surathkal, Srinivasnagar - 575 025  
E-mail: dwaraki\_gs@yahoo.com

**Dr. Ganesha Raj K.**

Indian Space Research Organisation  
Antariksh Bhavan, New BEL Road  
Bangalore - 560 094  
Email: ganeshraj@rediffmail.com

**Dr. Gangadhara Bhat H.**

Dept of Marine Geology  
Mangalore University,  
Mangalagangothri - 574 199  
Email: gangadharab@yahoo.com

**Dr. Jayappa K.S.**

Dept of Marine Geology  
Mangalore University,  
Mangalagangothri - 574 199  
E-mail: ksjayappa@yahoo.com

**Mr. Kamath M.M.**

Shree Matha, Mizar Ramakrishna Pai  
Compound, Mannagudda,  
Mangalore - 575 003  
E-mail: mmkamath40@yahoo.com

**Dr. Kiran G. Shirlal**

Dept of Applied Mechanics and Hydraulics,  
National Institute of Technology,  
Karnataka, Surathkal,  
Srinivasnagar - 575 025  
E-mail: kshirlal@yahoo.co.in

**Mr. Kulkarni U.P.**

Isotope Applications Division  
Bhabha Atomic Research Centre  
Trombay, Mumbai - 400 085

**Prof. Madhusodana Kurup B.**

Cochin University of Science &  
Technology, School of Industrial Fisheries,  
Cochin - 682 016  
Email: bmkurup@rediffmail.com

*xvi Contributors*

**Mr. Mendhekar G.N.**

Isotope Applications Division  
Bhabha Atomic Research Centre  
Trombay, Mumbai - 400 085

**Prof. Narayana A.C.**

Dept of Marine Geology and Geophysics,  
Cochin University of Science and  
Technology, Lakeside Campus,  
Cochin -682 016  
E-mail: acnarayana@cusat.ac.in

**Dr. Navada S.V.**

Isotope Applications Division  
Bhabha Atomic Research Centre  
Trombay, Mumbai - 400 085

**Mr. Noble Jacob**

Isotope Applications Division  
Bhabha Atomic Research Centre  
Trombay, Mumbai - 400 085  
Email: noblej@magnum.barc.ernet.in

**Dr. Priju C.P.**

Dept of Marine Geology and Geophysics,  
Cochin University of Science and  
Technology, Lakeside Campus,  
Cochin - 682 016

**Mr. Radheshyam B.**

Dept of Applied Mechanics and Hydraulics,  
National Institute of Technology, Karnataka,  
Surathkal, Srinivasnagar - 575 025

**Dr. Rajanikanth A.**

Birbal Sahni Institute of Palaeobotany  
53 University Road,  
Lucknow 226007, UP  
Email: arajanikanth@hotmail.com

**Mr. Raju D.H.**

Dept of Applied Mechanics and Hydraulics,  
National Institute of Technology, Karnataka,  
Surathkal, Srinivasnagar - 575 025

**Mr. Sankar Babu K.**

Dept of Ocean Engineering  
Indian Institute of Technology Madras  
Chennai - 600 025

**Dr. Saravana Kumar U.**

Isotope Applications Division  
Bhabha Atomic Research Centre  
Trombay, Mumbai - 400 085

**Prof. Shivaprakash S.M.**

Dept of Fisheries Resources &  
Management, College of Fisheries,  
Karnataka Veterinary Animal and  
Fisheries Sciences University,  
Mangalore - 575 002  
E-mail: smsprakash@yahoo.com

**Prof. Sridhar K.R.**

Dept of Biosciences  
Mangalore University,  
Mangalagangotri - 574 199  
E-mail: sirikr@yahoo.com

**Dr. Subba Rao**

Dept of Applied Mechanics and Hydraulics,  
National Institute of Technology,  
Karnataka, Surathkal,  
Srinivasnagar - 575 025  
E-mail: sura@nitk.ac.in

**Mr. Subrahmanya, K.**

Dept of Applied Mechanics and Hydraulics,  
National Institute of Technology, Karnataka,  
Surathkal, Srinivasnagar - 575 025

**Mr. Umashankar Shetty**

Dept of Applied Mechanics and Hydraulics,  
National Institute of Technology, Karnataka,  
Surathkal, Srinivasnagar - 575 025

**Dr. Vijaya Kumar G.T.**

Dept of Marine Geology  
Mangalore University, Mangalagangotri -  
574 199

**Dr. Vijayan P.V.**

Dept of Geology, Government College  
Kasaragod, Kerala

**Mr. Vinaya M.S.**

Dept of Marine Geology, Mangalore  
University, Mangalagangotri - 574 199  
Email: msvinaya@gmail.com

# 1

## **Coastal Environments: Problems and Perspectives**

**K.S. JAYAPPA and A.C. NARAYANA**

---

The coastal zone delimits an area from 200 m below the water level that is the continental shelf and up to 200 m above the water level on the landward side. The coastal ocean accounts for about 30% of the oceans' primary production, for about 75-90% of the global sink of suspended river load and associated pollutants and for about 80% of the global organic matter burial (LOICZ, 1999). The coastal zone is an important ecosystem with high productivity, dense population, exploitation of renewable and non-renewable resources, development of industries and spurts in recreational activities. Nearly 60% of the world population is concentrated in a stretch less than 60 km from the shoreline and most of the world's largest cities are located in the coastal zone. This area produces food and livelihood for a large percentage of the world's population and thus it is exposed to severe pollution and environmental degradation. About 95% of the world's marine fish-catch is from coastal zones. The coastal zone supports rich biodiversity and offers an intermediary biotope between marine and freshwater environments. The economic significance of coastal environment is mainly seen in relation to fishing, tourism, ports, oil and gas extraction, mining of minerals and corals and industrial development. In addition to these, forestry yields from mangroves make an important contribution to the economy of many countries. Several of the earth's most productive ecosystems are found in coastal zones. Thus, coastal zone is the focus of expansion and diversification of economic activity.

The coastal ocean is critically important for global biogeochemical fluxes. Knowledge of nearshore processes is useful for implementation of plans pertaining to coastal structures, fishing, navigation, safety of life and materials on shores, transport and dispersal of pollutants, microclimate moderation etc. Considering the diversity of uses and the length of Indian coastline, an understanding of the coastal processes is critical for coastal zone management. Further, coastal zone is enriched with mineral deposits, hence protection of shore and coastal resources are often key issues.

A principal concern of coastal zone management is to ensure rational development of the area and judicious use of its resources. Thus, an environmentally effective coastal zone management depends upon the procurement of accurate and comprehensive basic scientific data on the aeral

## 2 Coastal Environments: Problems and Perspectives

extent of coastal landforms, their changes and present status (Stow and Estes, 1983), land use / cover pattern, availability of resources etc. Remote sensing technique, in conjunction with conventional methods, is an ideal tool for monitoring the fragile coastal environment in a speedy and cost-effective way and helps in effective management and sustainable development of the coastal zone.

Taking into consideration, the major problems of Indian coasts and the developments of Remote Sensing & GIS techniques in the field of Earth Sciences, a two-day National seminar on 'Coastal Dynamics and Role of Geoinformation with Special Reference to Indian Peninsula' was organised in July 2003. Some of the papers presented in the seminar and a few invited contributions are included in this edited book. The papers deal with five major themes – (i) Coastal Resources, (ii) Coastal Landforms, (iii) Sediment Transport and Maintenance Dredging Practices in Major Ports, (iv) Coastal Erosion and Management, and (v) Application of RS & GIS and Flora in Environmental Geosciences Studies.

The first section **Coastal Resources** deals with both living and non-living. There are four papers pertaining to this section. In the first paper - **Mineral Resources of Coastal Tracts of India** - Narayana and Jayappa have presented the processes and accumulation of placer mineral and lime shell deposits in the present day coastal and offshore regions. The paper throws light on the formation and available reserves of the deposits along the coastal zone in the country and impacts of mining as well as measures for containment of its impacts on ecology and environment. The second paper pertaining to **Coastal and Marine Fisheries Resources of Kerala** authored by Madhusodana Kurup. This paper explains the status, sustainability issues, conservation efforts, discards and biodiversity loss from trawling and other various challenges on marine and brackish water fishery resources. The third paper is on **Coastal Fishery Resources of India with Special Reference to Karnataka and Management Implications** by Shivaprakash. He has discussed the trends in marine fish production, problems being faced by the fisheries sector and management issues of the fishing industry. **Ecological and Economic Importance of Coastal Sand Dunes** by Sridhar is the fourth paper. The importance of sand dunes as biomes of marine ecosystem and their role in coastal protection are discussed in this paper. Further, he examines their susceptibility for continuous alteration of topography and physicochemical features. Plant species and stress-tolerant microbes adapted to dunes have applications in agriculture (as green manure) and forestry. Some of them have medicinal and edible properties. Human interference such as agriculture, waste disposal, seawall construction and road traffic accelerates destruction of dune ecosystem and hence he opines that systematic attempts and stringent measures have to be enforced to conserve this ecosystem.

The second section is devoted to **Coastal Landforms**. Coastal landforms are mainly classified into depositional landforms and erosional landforms. The depositional landforms are beaches, spits, bars, barrier islands, beach ridges and swales, sand dunes, tidal flats/mudflats, and floodplains. The erosional landforms are beach cliffs, sea caves, stacks, islands, lagoon etc. The coastal landforms are also classified into marine and estuarine geomorphic landforms. The main marine geomorphic landforms are sand bars, barrier beaches and spits, paleo-beach ridges, marshy and swampy zones. Estuarine geomorphic landforms include shoals, tidal flats, tidal creeks, ebb and flood channels, holms or kudrus.

There are five papers dealing with coastal landforms. They are: **Evolution of Coastal Landforms along Southern Karnataka**. Based on Survey of India topomaps, satellite images and field data, Jayappa et al. have delineated and tried to quantify the significant morphological changes that have taken place during the period 1910 to 2005. Vijayan et al. in their study on **Long-Term Morphological Changes of Shoreline and Estuaries along Northern Kerala Coast** using remote sensing and GIS techniques have brought out major changes that have taken place both near the estuarine mouths and along the shoreline due to natural and anthropogenic activities for the period 1910-2000. **Coastal Landform Changes in and around Cochin and their Implication in Coastal Zone Management** are investigated by Priju and Narayana by employing topomaps, geocoded satellite images and field checks. They have quantified the changes that have taken place in flood plain area, backwater system and other coastal landforms. They ascribe landform changes to the increase in urbanization and high population density. The alarming rate of change in the land use / cover patterns needs an effective coastal zone management programme as they point out. In the fourth paper, Vinaya et al. have discussed on **Delineation of Paleo-Shorelines and Paleo-Channels along the Southern Karnataka Coast** using image enhancement techniques. This particular study has showed that the surficial expressions of under water features and their enhancement have greater advantage in exposing the information hidden in satellite data. Based on land use / land cover map, Dwarakish and Asha Jyothi discussed **Universal Soil Loss Equation through Remote Sensing and GIS**. Catchments of two streams - Baidur hole and Yedamavina hole - in Udupi district of Karnataka State have been chosen by the authors to understand the severity of the soil erosion problem in the watershed region. They demonstrate that USLE takes into account the factors such as rainfall, soil, erodability, slope, land use / land cover for estimating the soil erosion.

Third section deals with **Sediment Transport and Maintenance Dredging of Ports**. Knowledge of alongshore sediment transport rate and direction would be useful for selecting suitable sites for harbours/ports and coastal engineering projects like construction of groynes, breakwaters, jetties etc. Under this section, three papers dealing with sediment transport are included. The first paper - **Alongshore Sediment Transport and Maintenance Dredging**

#### 4 *Coastal Environments: Problems and Perspectives*

**Practices in Major Ports of India** - by Kamath is devoted to quantitative estimation of gross and net littoral drift along the west and east coasts of India, problems associated with beach nourishment and siltation in the open sea channels. Cost effective of maintenance dredging of the major ports of India is also discussed in this paper. The second paper by Noble Jacob and others deals with a case study pertaining to the **Effect of Hydro-Meteorological Conditions on Sediment Transport in the Hugli Estuary, Sagar Island, West Bengal**. They have inferred that the river discharges and storm induced turbulence play a dominant role in sediment transport dynamics of Hugli estuary. Dwarakish and Sankar Babu have explained how seasonal variation of sediment transport can be determined by using in-situ and remote sensing data and modeling techniques with the help of MIKE – 21 software. They have taken Mangalore coast as an example where a good correlation is found between suspended sediment concentration estimate derived from ocean colour monitor data and field measurements during pre- and post-monsoon seasons.

Fourth section of this volume is devoted to **Coastal Erosion and Its Management**. Coastal erosion, construction of coastal engineering structures, reclamation of fragile zones, encroachment of newly accreted beaches and recently evolved spits, and those areas protected with seawalls by the coastal communities for their settlement are the main issues of coastal zone in India. Reclamation of fragile areas adds to the problem of coastal erosion and management. In addition to this, indiscriminate deforestation in the catchments area has caused silting up of riverbeds, making the adjacent areas flood prone. The problems associated with erosion include loss of valuable beaches, agricultural lands and palm trees, damage to houses and infrastructure, hindrance to fishing activities and hardship for the people living in the coastal areas. In order to understand the causes of such problems and come out with suitable remedial measures, four papers have been included in this section. Jayappa and Narayana, in the paper titled **Coastal Erosion and Management** have explained the present scenario of coastal erosion and various causes responsible for erosion. They also discussed various management issues and mitigation aspects. Kiran Shirlal and others brought out a brief discussion on the **Evolution of Breakwaters and New Innovations in the Breakwater Design. Management Aspects of Beaches** by Antonio Mascarenhas and Baban Ingole deals with facilities for beach users, ecological significance of sand dunes, and oceanographic perspective and a cross-sectoral approach for management solutions. Subba Rao et al. have explained on **Failure Analysis of Seawalls along Karnataka Coast and Recent Trends in Coastal Protection**.

The fifth section deals with **Application of RS & GIS and Flora in Environmental Geosciences Studies**. Remote Sensing data products play a significant role in the effective utilization of GIS technology. GIS is becoming an important tool for data base management, to store, retrieve, manipulate and analyse spatial and non-spatial data. Three papers dealing with above theme are included under this section. Ganesh Raj in his paper **Remote Sensing in**

**Geological and Environmental Studies** has explained the applications of remote sensing in geology and environment. In the second paper, Ananda Rao et al. have discussed about a model pertaining to **Spatio-Temporal Distributions of Surface Runoff in Undulating Terrain Using Remote Sensing and GIS Techniques**. In the third paper, Annam Raju Rajanikanth has dealt with the **Status of Coastal Gondwana Flora with Special Reference to East Coast of India**.

## **REFERENCES**

LOICZ, 1999. <http://www.nioz.nl/logiz/>.

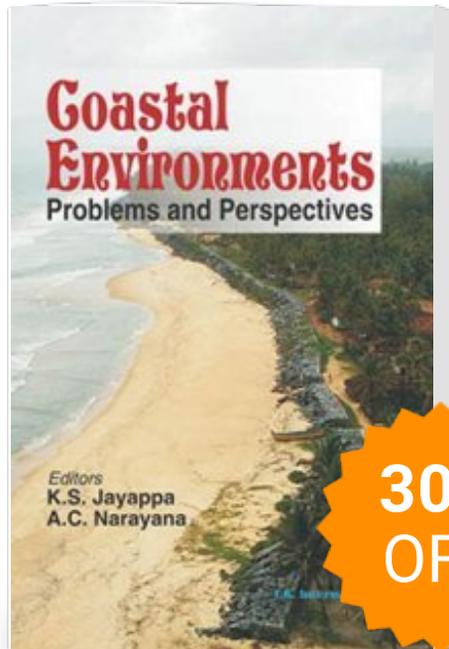
Stow, D. and Estes, J. 1983. Status of remote sensing for coastal zone management. *In*: O.T. Magoon, (Ed.), Proc. 3<sup>rd</sup> Symp. on coastal and ocean management (New York, American Society of Civil Engineers), 565-574.



**Section – 1**  
**COASTAL RESOURCES**



# Coastal Environments Problems And Perspectives



Publisher : IK International

ISBN : 9789380026282

Author : K.S. Jayappa &  
A.C. Narayana

Type the URL : <http://www.kopykitab.com/product/5645>



Get this eBook