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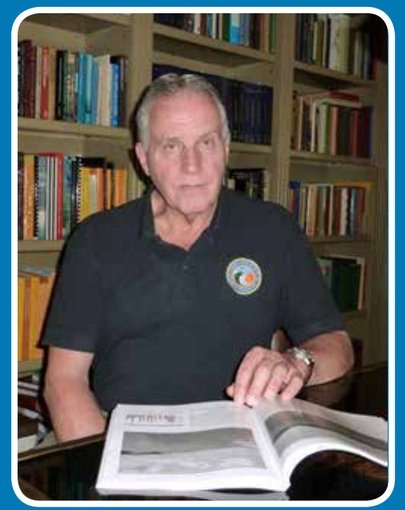

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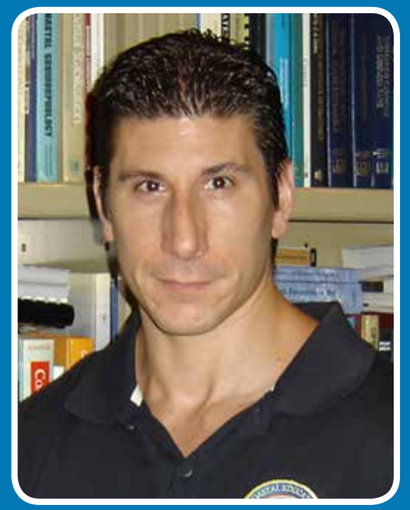

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Coastal Education and Research Foundation *[CERF]* is pleased to announce our newly appointed Regional Vice Presidents (RVP), who throughout the international scientific community continue to provide outstanding representation of our coastal research society. Please join us in honoring the following individuals for their tremendous service and support of CERF and the JCR.

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## CERF-JCR RVP (Southeast Asia)

### Nobuo Mimura, D.Eng.

Nobuo Mimura, D.Eng., is currently serving as the President of Ibaraki University. His academic areas of expertise are global environmental engineering, coastal engineering, and adaptation policy to climate change. Dr. Mimura has also been a member of the advisory committees for Ministry of Foreign Affairs, Ministry of Infrastructure, Land and Transportation, Ministry of the Environment and Ministry of Education, Culture, Sports, and Science and Technology.

## CERF-JCR RVP (North America)

### James R. Houston, Ph.D.

Jim Houston, Ph.D., is Director Emeritus of the U.S. Army Engineer Research and Development Center (ERDC), which includes all the research and development laboratories of the Corps of Engineers. He managed one of the most diverse research organizations in the world – seven laboratories at four geographical sites, with over 2,000 employees and an annual program budget of $1.3 billion. Dr. Houston has published over 130 technical reports and papers and has received several honors and awards including three Presidential Rank Awards and the National Beach Advocacy Award.

### Vic Klemas, Ph.D.

Vic Klemas, Ph.D., is Professor Emeritus in the University of Delaware's College of Earth, Ocean, and Environment. He directed UD's Applied Ocean Science Program from 1981-98, and he has co-directed UD's Center for Remote Sensing for more than 30 years. Dr. Klemas has served on six scientific committees of the National Research Council and received a number of awards, including, in November 2010, the Science Prize of the Republic of Lithuania. The honor recognized his lifetime achievements in applying remote sensing and other advanced techniques to study coastal ecosystems.

### Orrin H. Pilkey, Jr., Ph.D.

Orrin H. Pilkey, Ph.D., is a James B. Duke Professor Emeritus of Geology within the Division of Earth and Ocean Sciences and Director Emeritus of the Program for the Study of Developed Shorelines (PSDS) in the Nicholas School of the Environment and Earth Sciences at Duke University. Since 1965, Dr. Pilkey has been at Duke University with one-year breaks with the Department of Marine Science at the University of Puerto Rico, Mayaquez, and with the U.S. Geological Survey in Woods Hole, Massachusetts. His research career started with the study of shoreline/continental shelf sedimentation, progressed to the deep sea with emphasis on abyssal plain sediments, and back to the nearshore with emphasis on coastal management. Dr. Pilkey has published more than 250 technical publications and has authored, coauthored, or edited 39 books.

## CERF-JCR RVP (South America)

### Vanda Claudino-Sales, Ph.D.

Vanda Claudino-Sales holds a Ph.D. in Geography from the Sorbonne University and a Post-Doctorate in Coastal Geomorphology from the University of South Florida; coming back later to those universities as visiting professor. Now, she is a professor in the Department of Geography at the Federal University of Ceará and part of the Master in Geography program at the State University Valley of Acarau, in Brazil. Her research focuses on areas of geoscience, acting mainly in coastal geomorphology, environmental geomorphology and geoconservation. With her graduating students and her research team, she is currently studying the coastal dynamics and the impacts of development in tropical coasts. She also has an interest in coastal management and participates in environmental social actions in Brazil.

### Omar Defeo, D.Sc.

Omar Defeo, D.Sc., is a professor in the Marine Science Unit at the Universidad de la República in Uruguay. He is also among a select group of ecologists worldwide working on sandy beach ecosystems and how they are threatened by climate change. For the past 15 years, Prof. Defeo has also been involved in artisanal shellfisheries, ecology, and conservation of coastal marine invertebrate biodiversity research in Latin America, primarily in Mexico and Chile.

## CERF-JCR RVP (Eastern Europe)

### Niki Evelpidou, Ph.D.

Dr. Dr. M.Sc. Niki Evelpidou is an Associate Professor at the Faculty of Geology and Geoenvironment, National and Kapodistrian University of Athens. She is a distinguished Doctor in both the Faculty of Geology and Geoenvironment of the University of Athens and the Faculty of Geoarchaeology of the University of Franche Compte (France). Dr. Dr. Evelpidou is actively involved in the research fields of geomorphology, coastal geomorphology, sea level changes, palaeogeography, geology, spatial technologies, study and modelling of natural hazards, while emphasizing on the use of new technologies and innovation. She counts more than 180 scientific publications and 17 books and textbooks, while she has given many lectures in Greece and abroad.

### Kazimierz K. Furmańczyk, D.Sc.

Kaz Furmańczyk, D.Sc., is currently Full Professor at the University of Szczecin and the Head of the Remote Sensing and Marine Cartography Unit at the Institute of Marine and Coastal Sciences. Author and co-author of over 100 scientific publications including books (2) and chapters, journal articles, abstracts, and conference papers. Contributions are mainly in the disciplines of remote sensing, coastal sciences, hydrology, and oceanography. In May 2011, he served as the local Chair and Co-organizer of the 11th International Coastal Symposium (ICS) that took place in Szczecin, Poland.


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## CERF-JCR RVP (Western Europe)

### Luciana S. Esteves, Ph.D.

Luciana Esteves, Ph.D., is a principal academic in the Faculty of Science and Technology and Global Engagement Leader for the Department of Life and Environmental Sciences, Bournemouth University, U.K. The scope of her research includes monitoring and quantifying coastal changes driven by natural and human-induced process and the implications to coastal management. More recently, her work on managed realignment schemes in Europe and practical applications of ecosystem based management in northeast Brazil have led to capacity building workshops for government practitioners and researchers in South Africa and Latin America. She was involved in the organising committee of the International Coastal Symposium 2013 and will co-chair the ICS in 2022. Dr. Esteves actively promotes gender equity in science (she is a founding member of the international network Women in Coastal Geosciences and Engineering) and undergraduate students engagement in research (she chaired the British Conference of Undergraduate Research in 2017 and coordinates the Showcasing Undergraduate Research Excellence conferences at Bournemouth University).

### Carlos Pereira da Silva, Ph.D.

Carlos Pereira da Silva, Ph.D., is the Director of e-GEO within the Research Centre for Geography and Regional Planning at the Universidade Nova de Lisboa, Portugal. Dr. Pereira da Silva's research interests are mainly focused on coastal zone management, with specific emphasis in beach management, public participation studies, and carrying capacity. A long time supporter of CERF and the JCR, in April 2009, he served as the local Chair and Co-organizer of the 10th International Coastal Symposium (ICS) that took place in Lisbon, Portugal.

### Michael Phillips, Ph.D.

Mike R. Phillips (BSc, PGCE, MSc, PhD, MIEnvSc, FRGS) serves as Pro Vice-Chancellor of Research, Innovation, Enterprise, and Commercialization at the University of Wales Trinity Saint David (Swansea Metropolian). Professor Phillips research expertise includes coastal processes, morphological change and adaptation to climate change and sea-level rise. Consultancy includes beach replenishment issues and developing techniques to monitor underwater sediment movement to inform beach management. He is widely published and recently organized a session on Coastal Tourism and Climate Change at UNESCO Headquarters in Paris as part of his role as a member of the Climate Change Working Group of the UNEP Global Forum on Oceans, Coasts, and Islands.

### Marcel J.F. Stive, Ph.D.

Until 2010, Marcel Stive, Ph.D., was Scientific Director of the Water Research Centre Delft, which is now embedded in the Delft Research Initiative Environment. He currently holds the positions of: Chair of Coastal Engineering in the Section of Hydraulic Engineering and Department Head of Hydraulic Engineering at Delft University of Technology. Dr. Stive was recently appointed Knight in the Order of the Dutch Lion in theatre the Rijswijkse Schouwburg in Rijswijk. He was presented with this award for his outstanding record as a top researcher, much consulted expert, distinguished engineer, and inspiring teacher.


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## CERF-JCR RVP (Oceania)

### Charles Lemckert, Ph.D.

Charles Lemckert, Ph.D., is the Head of Discipline at the University of Canberra's School of Built Environment and Design. Professor Lemckert has active research interests in the fields of physical limnology, coastal systems, environmental monitoring techniques, environmental fluid dynamics, coastal zone management, and engineering education. Along with his postgraduate students and research partners, Dr. Lemckert is undertaking research studies on water treatment pond design (for recycling purposes), the dynamics of drinking water reservoirs, the study of whale migration in southeast Queensland waters, and ocean mixing dynamics. In 2007, he served as the local Chair and Co-organizer of the 9th International Coastal Symposium (ICS) along the Gold Coast of Australia.

### Anja Scheffers, D.Sc.

Anja Scheffers, D.Sc., is currently Full Professor at Southern Cross University in Lismore, NSW, Australia. Her main area of study is coastal evolution, including sea-level change and marine physical natural hazards. Her research specializes in using sedimentary signatures to decipher long-term records of environmental change from the natural environment. She is particularly interested in processes that shape and modify coastal landscapes over a variety of length and time scales and the coupling and feedback between such processes, their rates, and their relative roles, especially in the contexts of variation in climatic and tectonic influences and in light of changes due to human impact. Dr. Scheffers is also the recipient of the ARC Future Fellowship Award for "Unraveling Western Australia's Stormy Past - A Precisely-Dated Sediment Record of Cyclones over the past 7000 years" and has been awarded multiple research grants from such prestigious entities as the German Research Council, the German Research Foundation, and the Australian Research Council.

### Vic Semeniuk, Ph.D.

Vic Semeniuk, Ph.D., is a natural history research scientist, specialising in coastal, estuarine and wetland environments, and mangrove and tidal flat environments. He has 45 years experience in scientific research in Australia, Europe, Canada, the USA, Ireland, the United Kingdom, and South Africa. Dr. Semeniuk is currently the Director of the Research & Development Firm, the V & C Semeniuk Research Group, and has over 130 publications in refereed scientific journals. He also has a proactive interest in conservation and coastal management, and has published multiple scientific works directly and indirectly leading to this objective.

### Andrew D. Short, Ph.D.

Andy Short, Ph.D., served as the Director of the Coastal Studies Unit at The University of Sydney and has been the National Coordinator of the Austra-lian Beach Safety and Management Program in cooperation with Surf Life Saving Australia. Dr. Short is mainly interested in the processes and mor-phology of coastal systems. His present research focuses on the beach and barrier systems of Australia, as it relates to the morphodynamics of repre-sentative systems in variable wave and tide environments, and in the nature, hazards, and usage of all Australia beach systems.

# Assessing the Effectiveness of Coastal Foredune Barriers in Reducing Hurricane Washover Sedimentation

# Assessing the Effectiveness of Coastal Foredune Barriers in Reducing Hurricane Washover Sedimentation

**Harry Williams**

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## ABSTRACT

This study tests the effectiveness of physical barriers in blocking or reducing washover sedimentation in coastal marshes. It is widely assumed that natural and artificial physical barriers, such as foredunes and roads, block or reduce storm overwash. However, there appears to be little documented assessment of this effect. This topic has gained significance recently because of concerns over sea-level rise induced by global warming creating a larger potential threat from storm overwash. Nearshore physical barriers act to protect populations and infrastructure farther inland from storm surge, but they may also reduce sediment delivery to coastal marshlands, slowing their vertical accretion and contributing to their submergence by rising sea level. Consequently, there is a critical need for more information on the effect of physical barriers on marsh sedimentation. Washover sediment beds were examined along two transects across marshes in McFaddin National Wildlife Refuge in southeastern Texas, one in the lee of a higher and wider foredune barrier and one where foredunes are lower and narrower. Washover sediment beds deposited by Hurricanes Rita (2005) and Ike (2008) were found on both transects. Comparison of washover sedimentation along the two transects showed an average 40% reduction in sediment volume and an average reduction in inland extent of deposits of 505 m in the lee of the higher and wider barrier. These results show that even relatively subtle increases in barrier dimensions can cause substantial reductions in the magnitude of washover sedimentation in marshes. These findings have implications for paleotempestology studies that use the magnitude of washover sedimentation in the lee of dynamic coastal barriers as geologic proxies of storm intensity. Coastal management agencies contemplating the use of physical barriers to block storm surge should take into consideration the impact of such barriers on the sustainability of coastal marshes faced with rising sea level.

**ADDITIONAL INDEX WORDS:** *Overwash, marsh, LIDAR, global warming, sea-level rise, paleotempestology.*

## INTRODUCTION

Coastal marshes worldwide are threatened by rising sea level, regional subsidence, and natural and anthropogenic barriers to sediment inputs, such as dams and levees. Where marsh aggradation has been unable to keep pace with relative sea-level rise, rates of marsh loss have been dramatic—up to 127 $km^2$ per year in parts of the northern Gulf of Mexico (Blum and Roberts, 2009; Turner, 1997). The loss of coastal marshes may come at a high societal cost, because in addition to providing valuable ecological services, marshes also protect areas farther inland by acting as buffers against storms (Fagherazzi, 2014; Gedan *et al.*, 2011; Jones, Hole, and Zavaleta, 2012; Möller *et al.*, 2014; Shepard, Crain, and Beck, 2011; Temmerman *et al.*, 2013). For marshes to avoid submergence by rising sea level and to continue to protect areas inland by dissipating storm wave energy, coastal management plans should include promotion of vertical accretion of marsh surfaces by organic and inorganic sedimentation.

Inorganic sediment transported into marshes contributes to marsh accretion,

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counteracting the relative elevation loss from sea-level rise and regional subsidence. For example, de Groot, Veeneklaas, and Bakker (2011) found that sand transported into fine-grained marshes bordering the Wadden Sea under stormy conditions accounted for almost 10% of marsh sediment volume. Inputs of inorganic sediment can increase the resilience of salt marshes to sea-level rise by increasing surface elevation and vegetation productivity (Walters and Kirwan, 2016). Results from a coupled model of barrier islands and back-barrier marshes suggest that washover deposition is a significant source of sediment that contributes to long-term back-barrier marsh maintenance and is likely to become increasingly important under conditions of accelerating sea-level rise (Walters *et al.*, 2014)

Williams (2012) found that Hurricane Ike (U.S. landfall 13 September 2008) deposited sediment into marshes along 160 km of coastline in Texas and Louisiana. The storm-surge–derived sediment bed was up to 0.85 m thick and extended up to 3.6 km inland. Other studies have also documented the contribution of tropical cyclones to aggradation of coastal marshes along the northern Gulf of Mexico (Bianchette *et al.*, 2016; Crosby and Reese, 2009; Hodge and Williams, 2016; Liu, 2004; Liu *et al.*, 2014; McKee and Cherry, 2009; Stone *et al.*, 1997; Törnqvist *et al.*, 2006; Turner *et al.*, 2006; Tweel and Turner, 2012, 2014; Williams, 2009, 2010, 2011, 2013; Williams and Denlinger, 2013; Williams and Flanagan, 2009).

Natural and anthropogenic barriers, such as foredunes and roads, can limit storm-surge overwash and inhibit sediment delivery to adjacent marsh surfaces (Bryant and Chabreck, 1998; Day *et al.*, 2000, 2005; Dolan and Lins, 1986; Kennish, 2001; Kirwan and Megonigal, 2013; Turner, 1997; White and Morton, 1997). Rogers *et al.* (2015), for example, found that commercial and residential developments on New Jersey barrier islands reduced volumes of Hurricane Sandy washover sediment by 90% and 40%, respectively, compared to that delivered to natural environments. Furthermore, a model of long-term barrier island evolution suggests that natural barrier islands along this coastline may persist under a range of likely future sea-level rise scenarios, whereas developed barrier islands will have a long-term tendency toward drowning because of reductions in vertical accretion.

Although physical barriers are widely accepted as an important control on the occurrence and magnitude of wash-over sedimentation, there is limited documentation of the effectiveness of barriers in reducing marsh sedimentation (Möller *et al.*, 2014). Given a better understanding of the impact of physical barriers on coastal marsh aggradation, coastal management agencies can design more informed strategies to promote coastal marsh accretion and combat the effects of rising sea level (Temmerman *et al.*, 2013). This study assesses the effectiveness of physical barriers in reducing washover sedimentation, based on a comparison of deposits resulting from Hurricanes Ike and Rita (U.S. landfall 24 September 2005) along two marsh transects, one in the lee of a higher and wider foredune barrier and one where foredunes are lower and narrower.

## Study Area

McFaddin National Wildlife Refuge (MNWR) is a 238 km$^2$ tract of marshes and lakes located in Jefferson County in the far southeastern corner of Texas (Figure 1a). The refuge is remote from significant riverine sediment sources, but storm overwash has been shown to make significant contributions of inorganic sediment to accretion of marshes, extending over 1 km inland (Hodge and Williams, 2016). A wide sandy beach, backed by low discontinuous foredunes, forms the boundary between the refuge and the Gulf of Mexico. Texas State Highway 87 runs along the seaward edge of the refuge, but after repeated washouts caused by hurricanes, the highway was closed in 1990. The majority of marshes on the refuge are classified as estuarine intertidal emergent wetlands that are irregularly flooded (U.S. Fish and Wildlife Service, 2016). These marshes range in elevation from approximately 0 to 1 m above mean sea level (amsl). A narrow strip of palustrine emergent wetlands is located along the seaward edge of the refuge. This area consists primarily of washover fans formed by hurricane overwash. Foredunes are present along much of the seaward boundary of the refuge between the beach and Highway 87. The width and height of the foredunes generally decrease from east to west within the study area. Anthropogenic modifications of the foredunes include the use of fences to promote sedimentation and stabilization of the dunes and the construction and maintenance of wide gaps in the dune field to allow vehicle access to the beach (Figure 1a).

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Hurricane Ike generated an exceptionally high storm tide (storm surge plus tide level) in the study area of 4.31 m relative to the North American Vertical Datum of 1988 (NAVD88) and sustained winds of 65 knots (Hodge and Williams, 2016). Hurricane Ike's high storm surge and strong wind-driven waves caused severe erosion of the beach and foredunes in the study area, resulting in extensive washover sedimentation in marshes landward of Highway 87, including prominent wash-over fans (Figure 1b). Previous studies of Hurricane Ike's washover sedimentation on MNWR include Williams (2010) and Hodge and Williams (2016). Williams (2010) studied Hurricane Ike's washover deposit in a series of spade pits located along a transect across the marsh aligned with the direction of storm-surge sediment transport. This direction was indicated by elongated sand bodies, such as washover fans, leaning of partially buried vegetation, the buildup of sediment on the windward side of obstacles, and ripple marks on the surface of the deposit. The study was conducted in January 2009, about 16 weeks after landfall, when Hurricane Ike's washover deposit was relatively pristine and had undergone little modification, such as bioturbation. The deposit formed a Hodge and Williams (2016), in 2014, obtained a series of cores along the same transect and at the same pit locations as used in the study by Williams (2010). Hurricane Ike's washover deposit was still essentially at the surface of the marsh and easily recognizable. A short depth below the Hurricane Ike deposit, another distinctive sand bed was found and identified as most likely the washover deposit of Hurricane Rita (Figure 2). Identification of the sand bed as Hurricane Rita's washover deposit was based on its stratigraphic position a short depth below Hurricane Ike's deposit, visual evidence of beach erosion and washover deposition on aerial photographs of the study area obtained within days after landfall, reports of relatively thick extensive washover sand beds, attributed to Hurricane Rita, sharply overlying marsh deposits at Texas Point, 18 km to the east of the study area (Crosby and Reese, 2009), and in southwestern Louisiana, 34 km to the east of the study area (Williams, 2011). In addition, Hurricane Rita's storm tide and maximum sustained winds (2.81 m NAVD88 and 61 knots, respectively) were second in magnitude only to Hurricane Ike's in the last 60 years; other recent lower-intensity storms that made landfall near the study area, such as Hurricanes Bonnie (1986) and Humberto (2007), had significantly lower storm tides (,1.65 m NAVD88) and lower maximum sustained winds (<55 knots) and are unlikely to have deposited thick, extensive, sand-rich sediment layers over the marsh surface (Hodge and Williams, 2016).

Interpretation of both sand beds as hurricane washover deposits was supported by their thinning and fining with distance inland, by sharp basal contacts, by analysis of texture and organic content, by the presence of marine microfossils in the sand beds, and by $^{137}$Cs dating of underlying marsh deposits (Williams and Denlinger, 2013). The two washover deposits were found at most of the 13 core sites, extending 1170 m inland from Highway 87 (Figure 1a). Based primarily on texture and microfossil analysis, it is probable that sources of the washover deposits were the foredunes, beach, and shallow offshore zone (Hodge and Williams, 2016).

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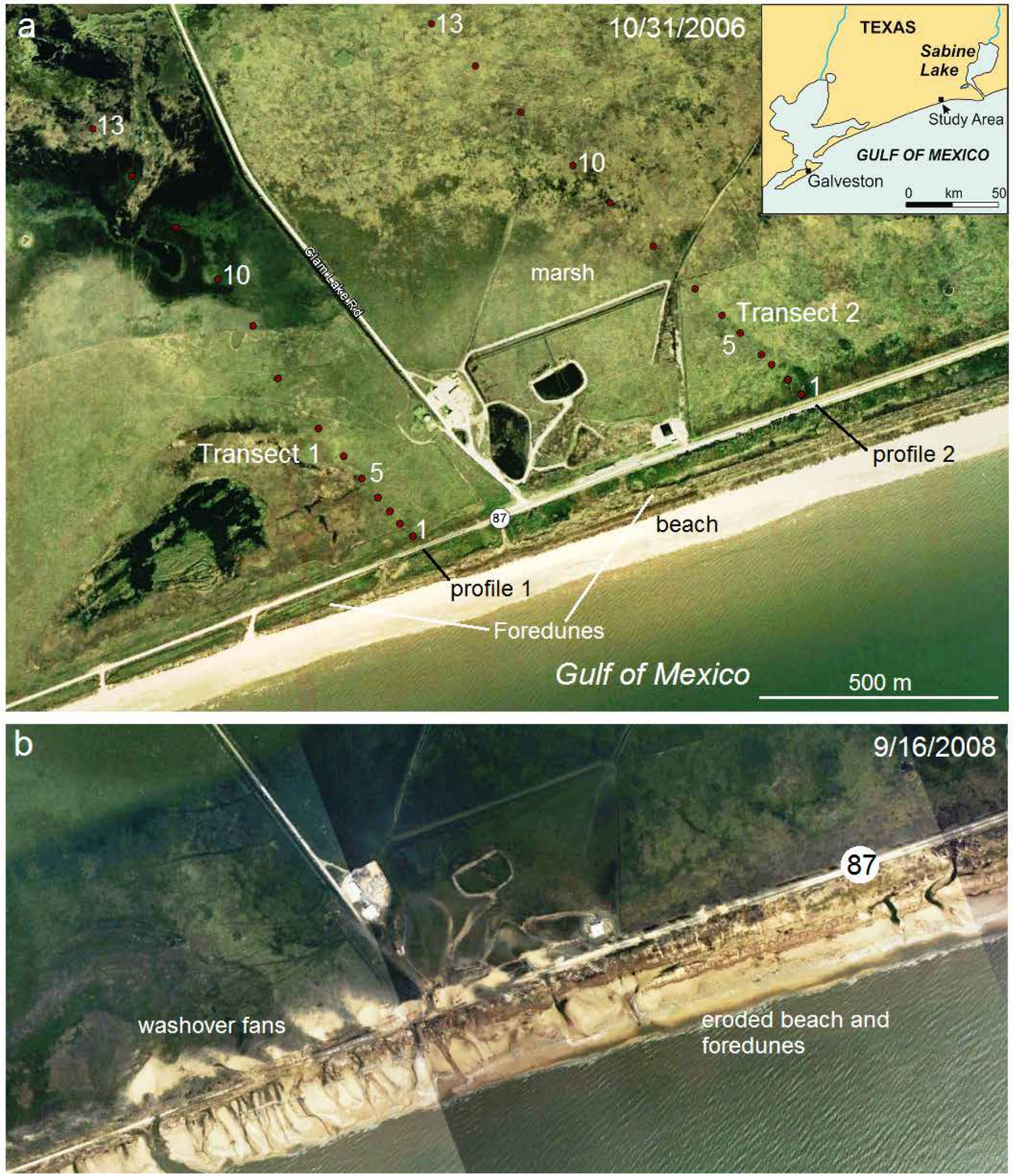


**Figure 1. (a) Study area on the McFaddin National Wildlife Refuge in 2006. Core sites on transects 1 and 2 are numbered consecutively from 1 (nearshore) to 13 (inland). Profiles 1 and 2 show locations of topographic profiles across foredunes derived from LIDAR data. Foredunes, formed between Highway 87 and the beach, become generally narrower and lower from east to west. Inset map shows location of study area in far southeastern Texas. Transects and profiles are aligned with the direction of storm-surge sediment transport. (b) Image acquired a few days after landfall of Hurricane Ike in 2008 showing washover fans and heavily eroded beach and foredunes (Google Earth images).**

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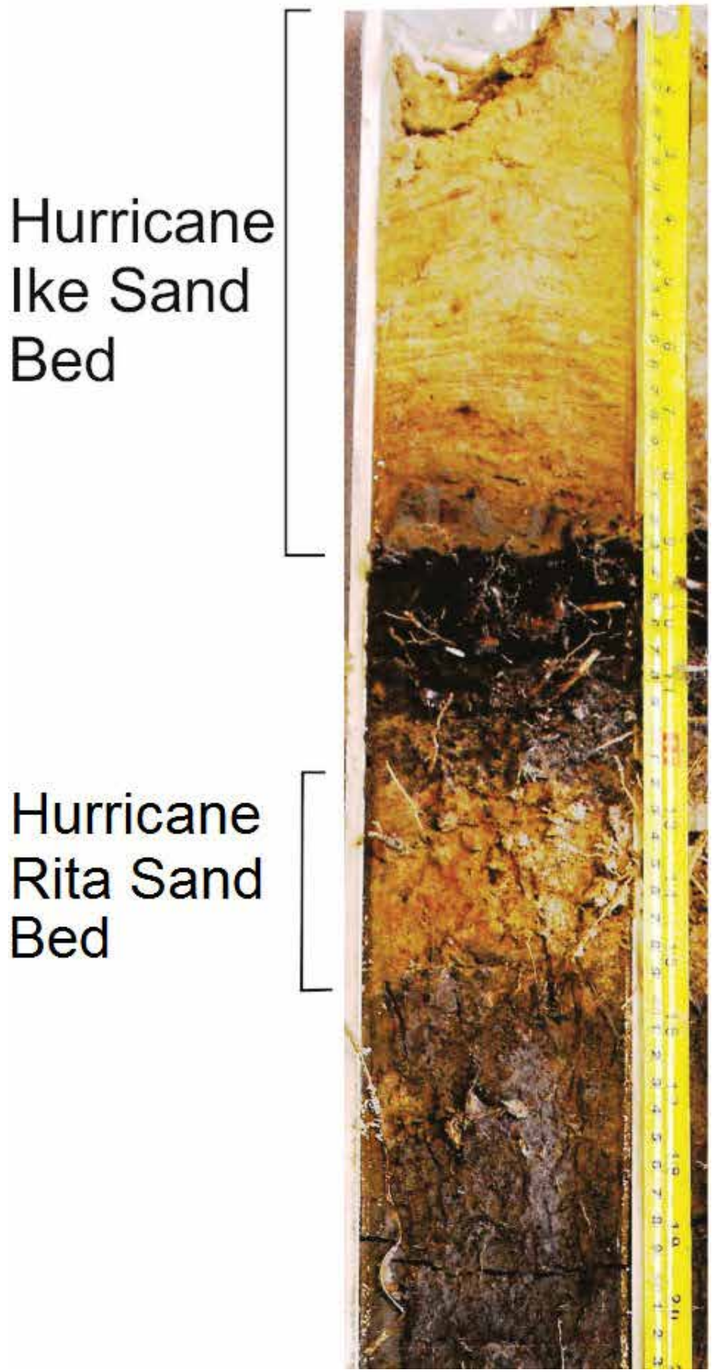


**Figure 2. Washover sediment beds deposited by Hurricanes Ike (2008) and Rita (2005) onto the marsh at McFaddin National Wildlife Refuge. The two sand beds are separated by, and overlie, finer-grained, more organic-rich, marsh deposits. Figure is modified from Hodge and Williams (2016). Location is core site 5 on transect 1.**

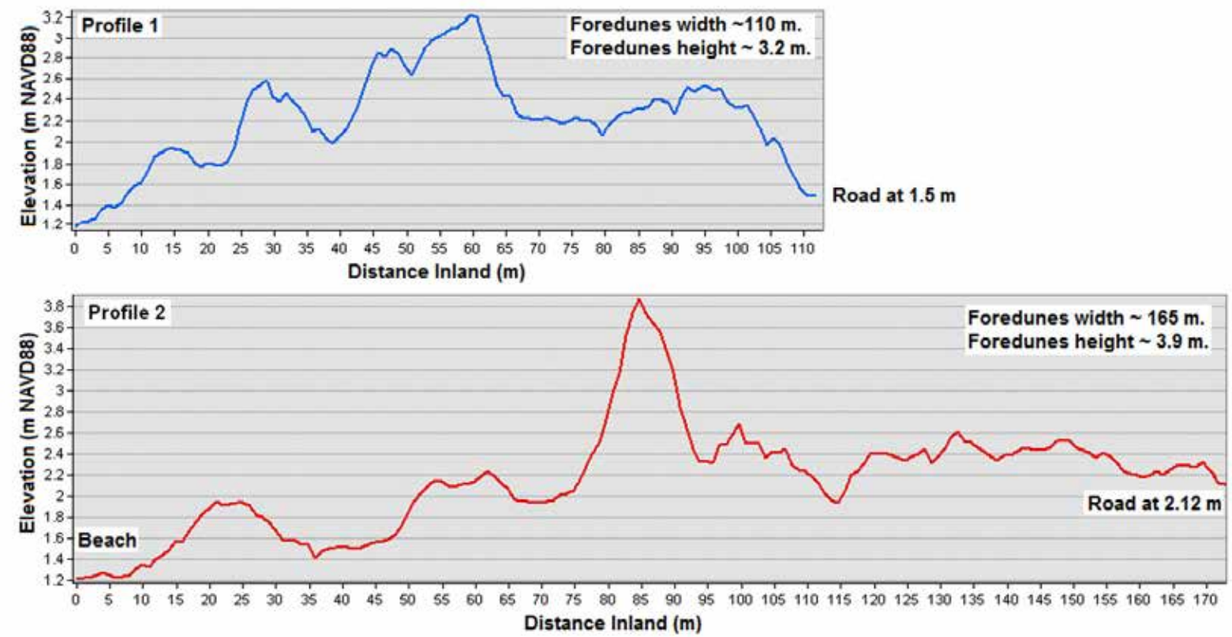


**Figure 3. Topographic profiles across foredunes derived from bare-earth LIDAR data acquired in July 2006. For location of profiles, see Figure 1a.**


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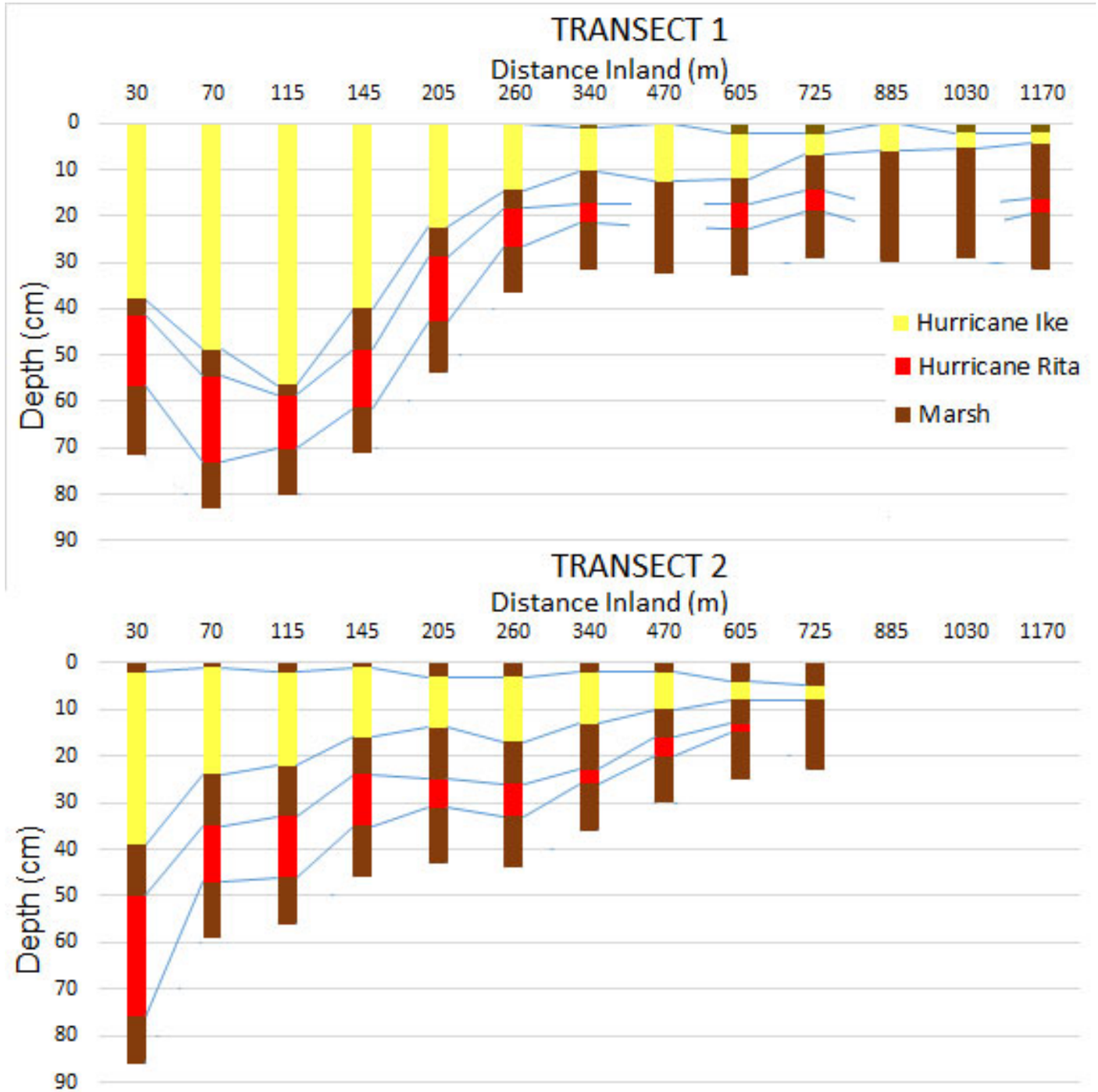


**Figure 4. Thicknesses of Hurricane Ike's and Hurricane Rita's washover deposits along transects 1 and 2. Core sites are not shown at the correct elevation or horizontal spacing. For location of coring transects, see Figure 1a.**

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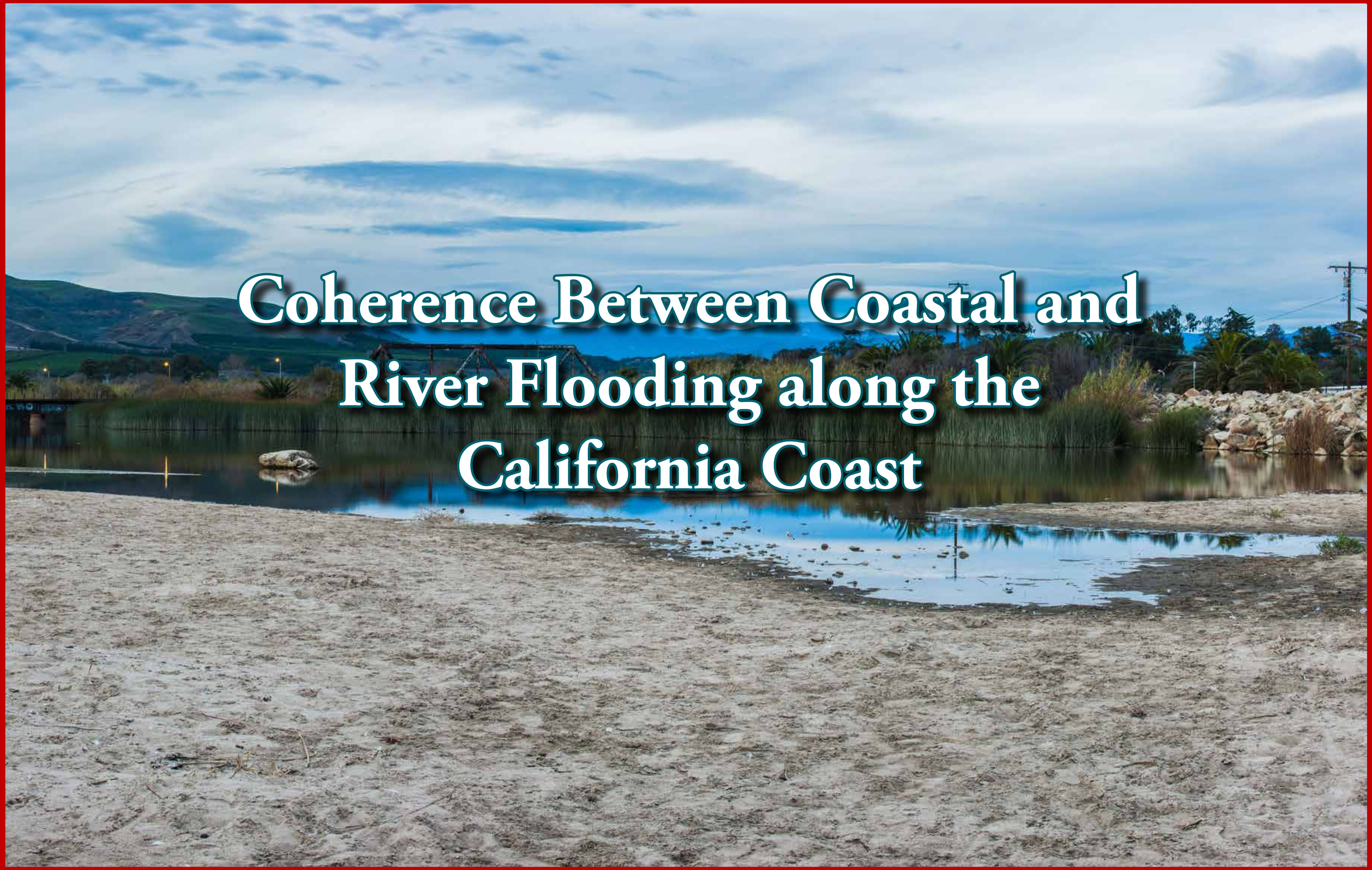
# Coherence Between Coastal and River Flooding along the California Coast



# Coherence Between Coastal and River Flooding along the California Coast

**Kingsley O. Odigie and Jonathan A. Warrick**

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## ABSTRACT

Water levels around river mouths are intrinsically determined by sea level and river discharge. If storm-associated coastal water-level anomalies coincide with extreme river discharge, landscapes near river mouths will be flooded by the hydrodynamic interactions of these two water masses. Unfortunately, the temporal relationships between ocean and river water masses are not well understood. The coherence between extreme river discharge and coastal water levels at six California river mouths across different climatic and geographic regions was examined. Data from river gauges, wave buoys, and tide gauges from 2007 to 2014 were integrated to investigate the relationships between extreme river discharge and coastal water levels near the mouths of the Eel, Russian, San Lorenzo, Ventura, Arroyo Trabuco, and San Diego rivers. Results indicate that mean and extreme coastal water levels during extreme river discharge are significantly higher compared with background conditions. Elevated coastal water levels result from the combination of nontidal residuals (NTRs) and wave setups. Mean and extreme (>99th percentile of observations) NTRs are 3–20 cm and ~30 cm higher during extreme river discharge conditions, respectively. Mean and extreme wave setups are up to 40 cm and ~20–90 cm higher during extreme river discharge than typical conditions, respectively. These water-level anomalies were generally greatest for the northern rivers and least for the southern rivers. Time-series comparisons suggest that increases in NTRs are largely coherent with extreme river discharge, owing to the low atmospheric pressure systems associated with storms. The potential flooding risks of the concurrent timing of these water masses are tempered by the mixed, semidiurnal tides of the region that have amplitudes of 2–2.5 m. In summary, flooding hazard assessments for floodplains near California river mouths for current or future conditions with sea-level rise should include the temporal coherence of fluvial and oceanic water levels.

**ADDITIONAL INDEX WORDS**: *Nontidal residual, wave setup, extreme river discharge.*

## INTRODUCTION

The frequency and intensity of coastal flooding are influenced by global climate variability, weather patterns, sea levels, and the shape of the coastal landscape (Hallegatte *et al.*, 2013; Hinkel *et al.*, 2014; Milly *et al.*, 2002; Sommerfield, Drake, and Wheatcroft, 2002). Flood-related coastal hazards are a concern for low-lying coastal regions, because a large part (greater than 1 billion) of the world's population lives within 100 km of a coastline at densities that are approximately three times the global mean (Dawson *et al.*, 2009; Merkens *et al.*, 2016; Neumann *et al.*, 2015; Wong *et al.*, 2014). In the United States, over 50% of the population lives in coastal counties and 23 of the 25 most densely populated counties in the nation are coastal (Arkema *et al.*, 2013; Scavia *et al.*, 2002). The human and financial cost of flood-related damage can be enormous (Hallegatte *et al.*, 2013; Heberger *et al.*, 2009; Kates *et al.*, 2006). These flooding risks are expected to increase globally with climate change and associated sea-level rise (*e.g.*, Hallegatte *et al.*, 2013; Little *et al.*,

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2015).

Ocean waves and storm surges are important drivers of coastal flooding and morphological change, and as such they can pose hazards to coastal communities and infrastructure (Mawdsley and Haigh, 2016; Serafin and Ruggiero, 2014). Waves increase the mean water level and lead to discrete water-level maxima at the foreshore, referred to as wave setup and run-up, respectively (Stockdon *et al.*, 2006). Energetic waves can produce run-up levels that are several meters higher than offshore water levels depending on the wave conditions and the shape and slope of the beach (*e.g.*, Guza and Feddersen, 2012; Stockdon *et al.*, 2006). Significant changes in wave heights, especially the extremes, have been reported and projected (*e.g.*, Erikson *et al.*, 2015; Young, Zieger, and Babanin, 2011) along the North American West Coast. These changes could have a greater impact than sea-level rise on coastal flooding and erosion in the U.S. Pacific Northwest (*e.g.*, Ruggiero, 2013). In addition, flooding could be exacerbated by storm surge, which refers to a storm-induced elevated water level along the coast due to the low atmospheric pressure and onshore-directed winds associated with storm conditions (Kang, Ma, and Liu, 2016; Wahl *et al.*, 2015). Therefore, improved understanding of the relationships among these water-level extremes (storm surges, waves, and extreme river discharge) will assist in the adaptation and possible mitigation of coastal flooding (Heberger *et al.*, 2009).

The flooding of landscapes adjacent to river mouths is more complex than that along open coastal settings owing to the influence of both oceanic and fluvial processes (Wahl *et al.*, 2015). Water-level fluctuations in and near river mouths are caused by combinations of ocean water levels, wave setup, river stage and discharge, and the hydraulic conditions of these coastal river mouths (Guza and Feddersen, 2012; Ruggiero *et al.*, 2001; Stockdon *et al.*, 2006). The near-simultaneous arrival of large waves, storm surge, and high river discharge can magnify flooding adjacent to river mouths along coasts such as in California (Figure 1; Cayan *et al.*, 2008; Guillén *et al.*, 2006). In addition, seasonal elevation of water levels resulting from semiregular climate events (*e.g.*, due to steric effects and coastally trapped waves, including during El Niño along the Pacific Coast) could add up to ~30 cm to coastal water level (Enfield and Allen, 1980). Unfortunately, information on the spatial and temporal relationships among extreme river discharge, storm surge, and wave setup is limited, so the potential effects of these combined processes on coastal flooding is unknown.

The objective of this study is to investigate the temporal and spatial relationships between river and coastal flooding across a range of geographic and climatic zones of coastal California (Figure 2). California has an extensive coastline of more than 3200 km that includes rocky shorelines, beaches, embayments, and wetlands. Additionally, over 80% of the state's population lives in coastal counties, which highlights the threat that coastal flooding poses to infrastructure, coastal habitats, and human lives in low-lying regions (Arkema *et al.*, 2013; Crossett *et al.*, 2004; Heberger *et al.*, 2009; National Research Council, 2012; U.S. Census Bureau).

A primary goal of this work was to assess the temporal coherence of extreme river discharge conditions and elevated coastal water levels (*e.g.*, nontidal residuals [NTRs] and waves) across a range of sites. Previous analyses suggest that storm conditions that deliver fine-grained sediment to the California coast and transport this sediment on the continental shelf are generally coherent in time owing to the large frontal storms originating over the North Pacific Ocean that generate rainfall and waves (Figure 1a; Kniskern *et al.*, 2011). This paper seeks to extend this understanding of storm coherence to the topic of coastal flooding. These analyses are based on a synthesis of available ocean and river monitoring data for the California study area.

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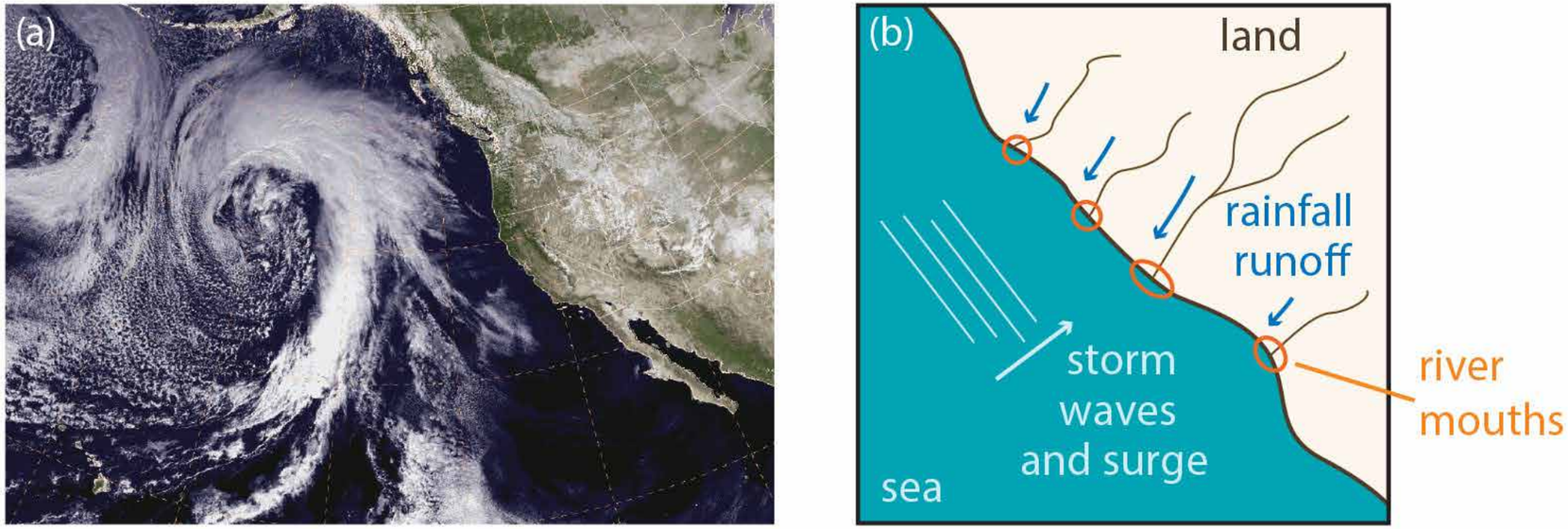


**Figure 1. Conceptual framework for the coherence between coastal and extreme river discharge. (a) A typical winter storm in the North Pacific Ocean that will deliver precipitation, storm waves, and surge to the West Coast of North America as it travels eastward. (b) The effects of these storms converge at river mouths where coastal flooding from storm waves and surge meet river floods from rainfall runoff. Satellite imagery from NOAA GOES Geocolor obtained 22 February 2016 at 2100 UTC.**

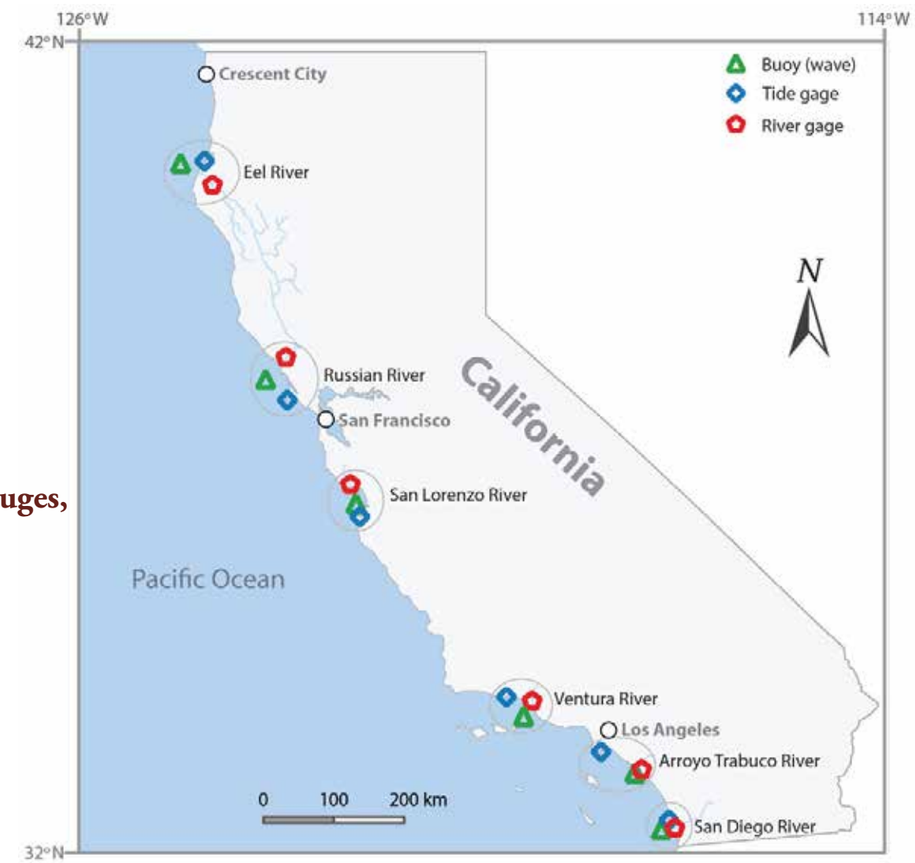


**Figure 2. Map of California showing river gauges, buoys, and tide gauges at the study sites.**


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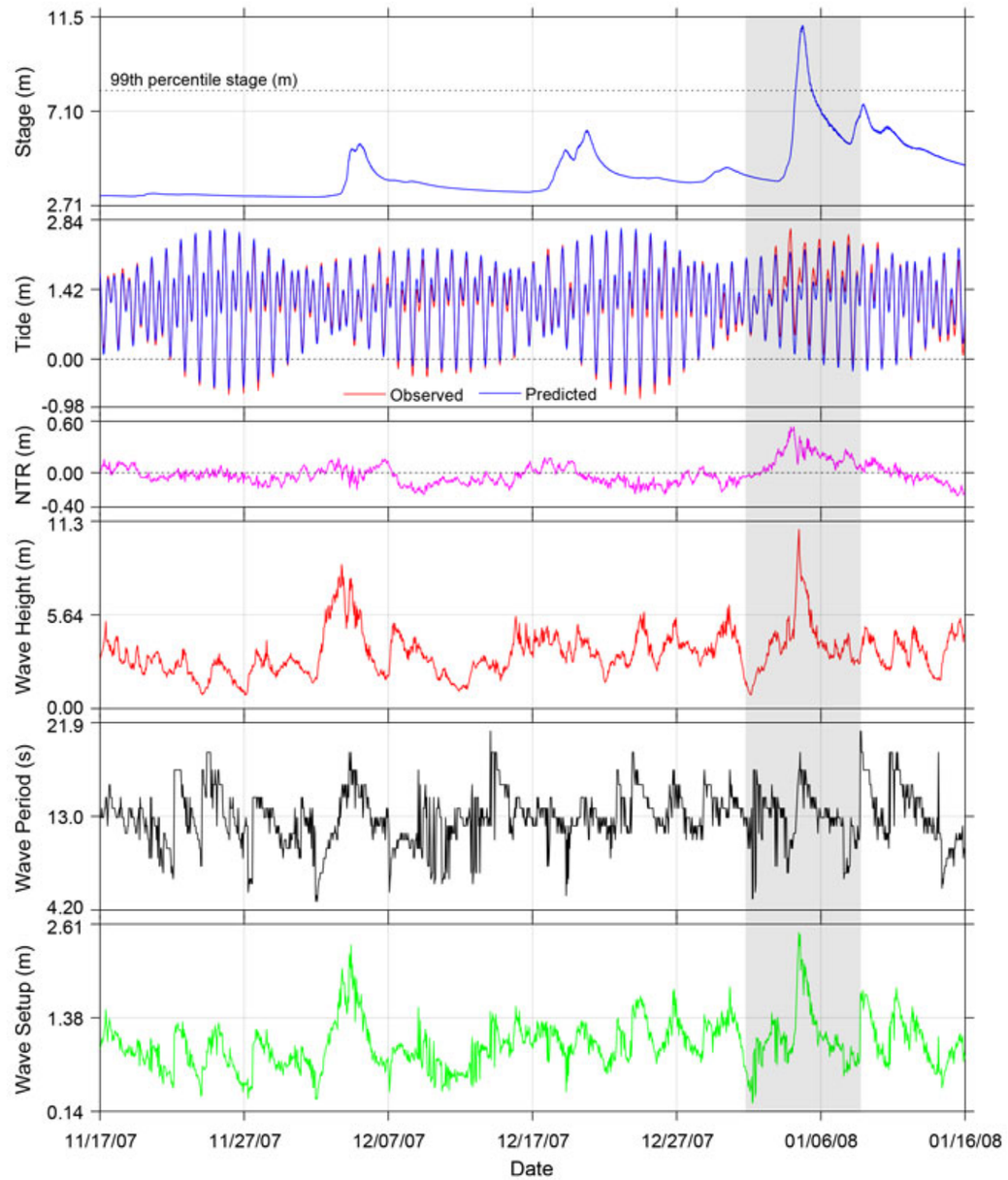


**Figure 3. Time series of stage, tidal water levels (observed, predicted, and nontidal residual), and wave (height, period, and setup) data from Eel River in California. The shaded area represents a typical extreme river discharge event time series (peak stage ± 4 d).**

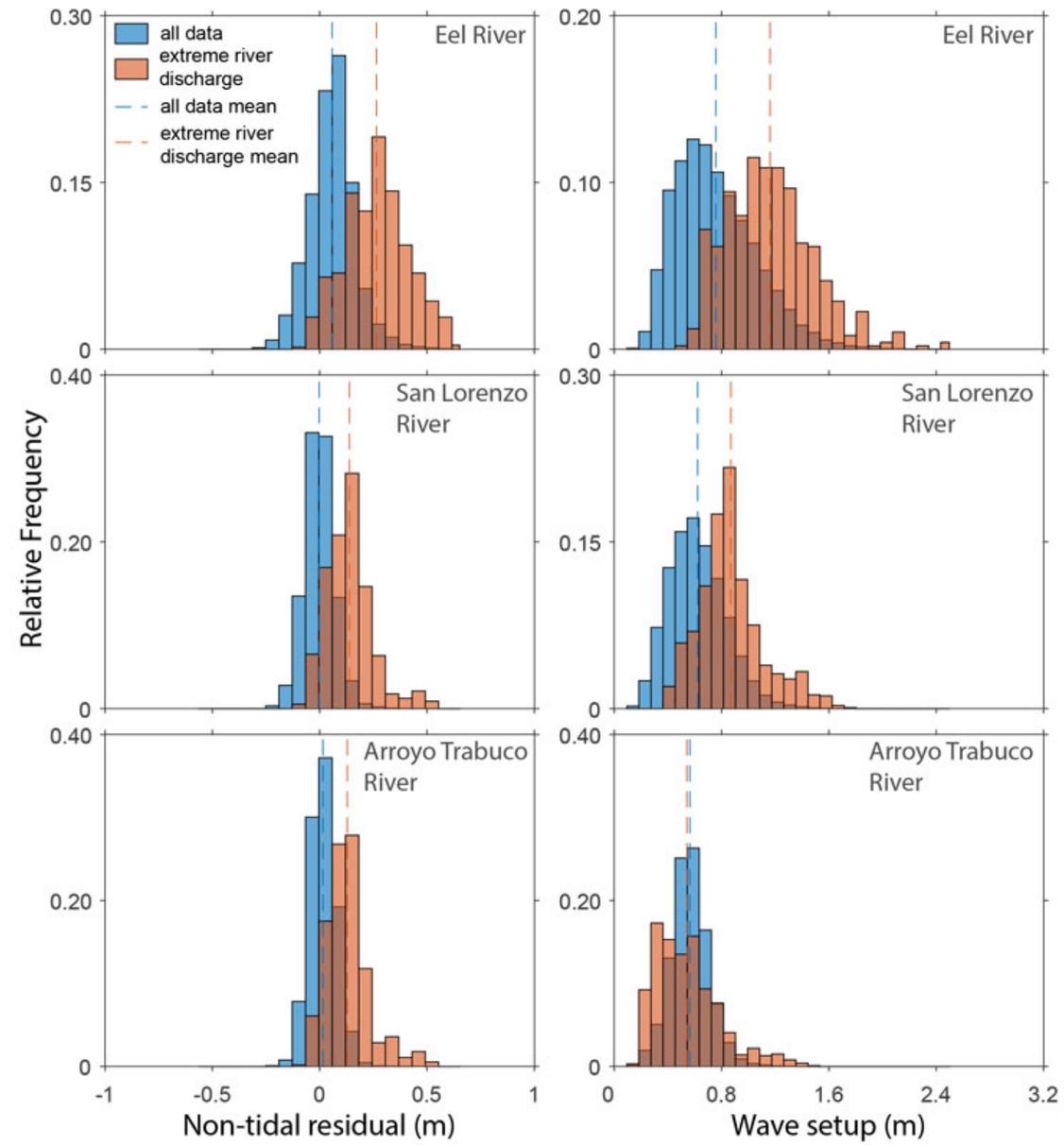


**Figure 4. Histograms showing distributions of nontidal residual and wave setup data during extreme river discharge events and entire study periods for Eel, San Lorenzo, and Arroyo Trabuco rivers in California.**

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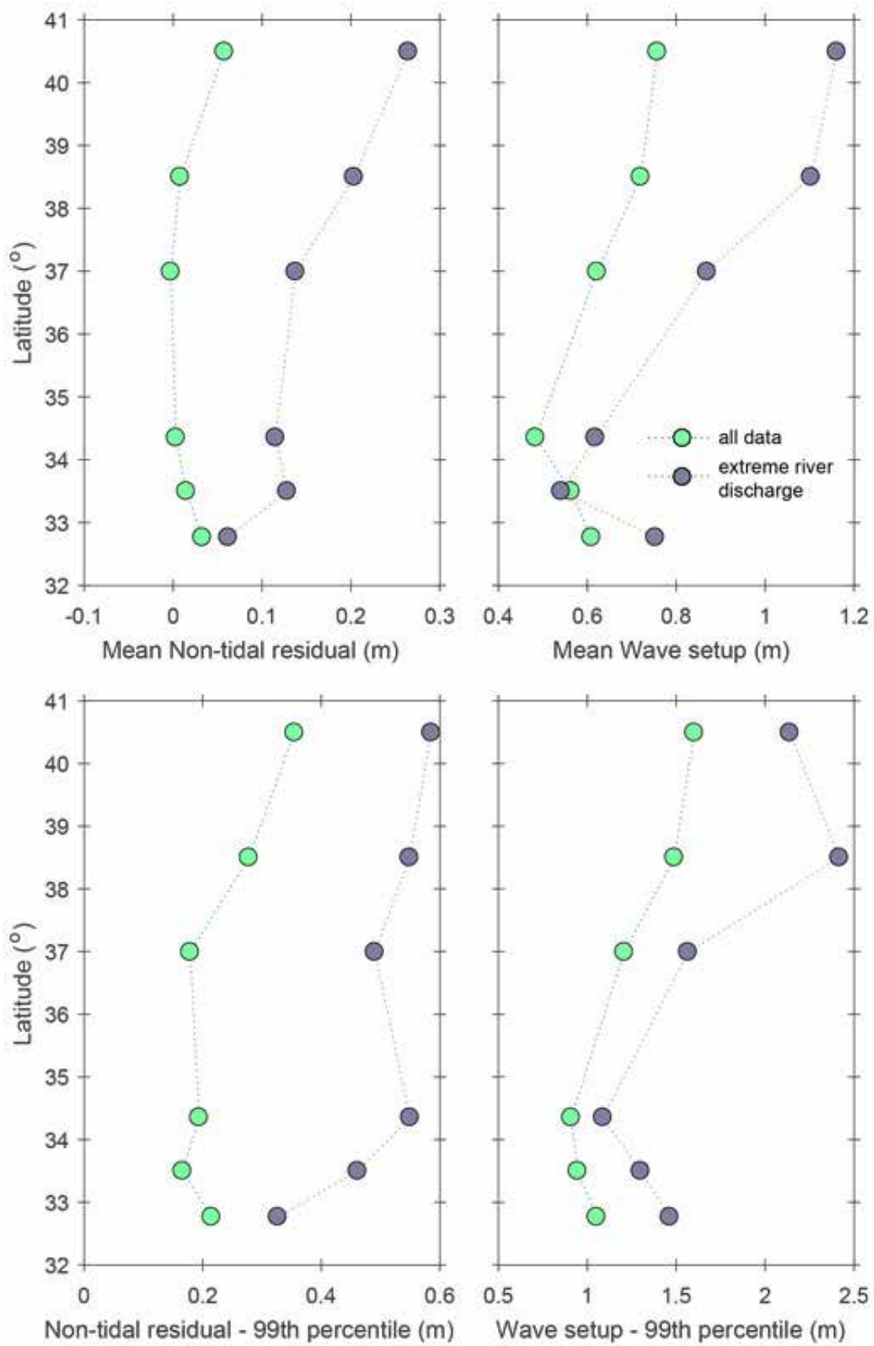


**Figure 5. Variations of the mean and 99th percentile nontidal residual (m) and wave setup (m) with latitude along the coast of California.**

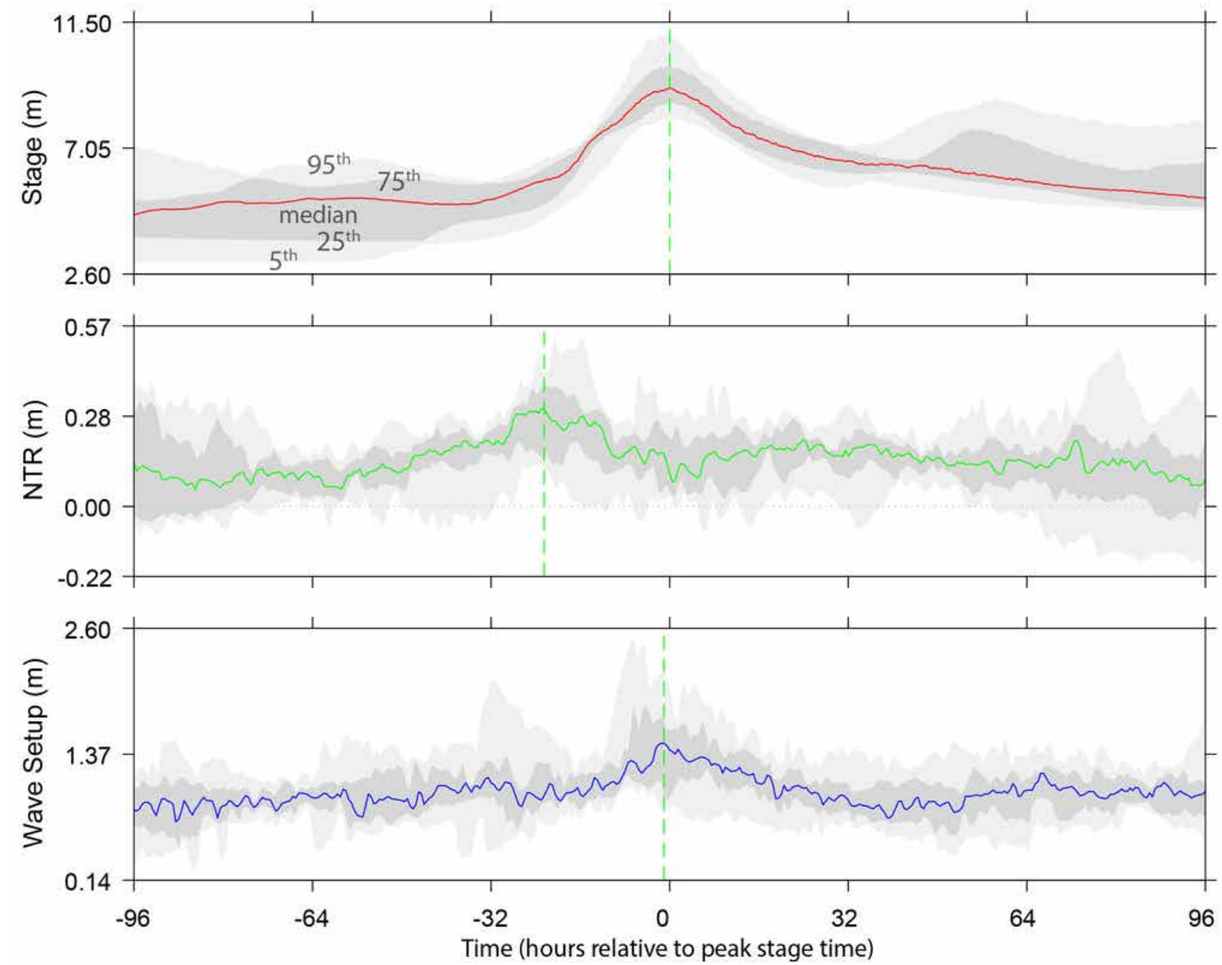


**Figure 6. Time-series plots of aggregated (n = 8) Eel River stage (m), nontidal residual (m), and wave setup (m) events data. The annotations are the computed percentiles. Vertical dashed lines mark the median peaks of the plots.**

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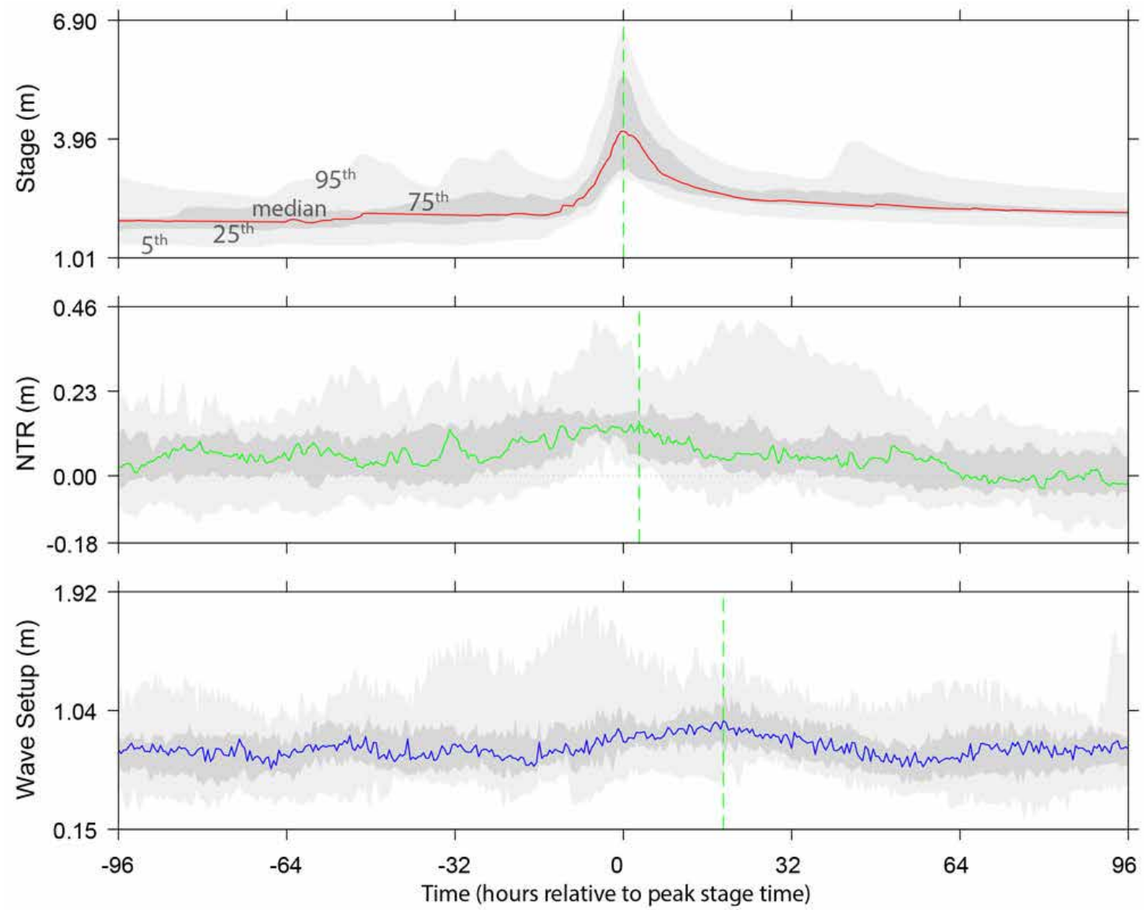


**Figure 7. Time-series plots of aggregated (n = 17) San Lorenzo River stage (m), nontidal residual (m), and wave setup (m) data. The annotations are the computed percentiles. Vertical dashed lines mark the median peaks of the plots.**

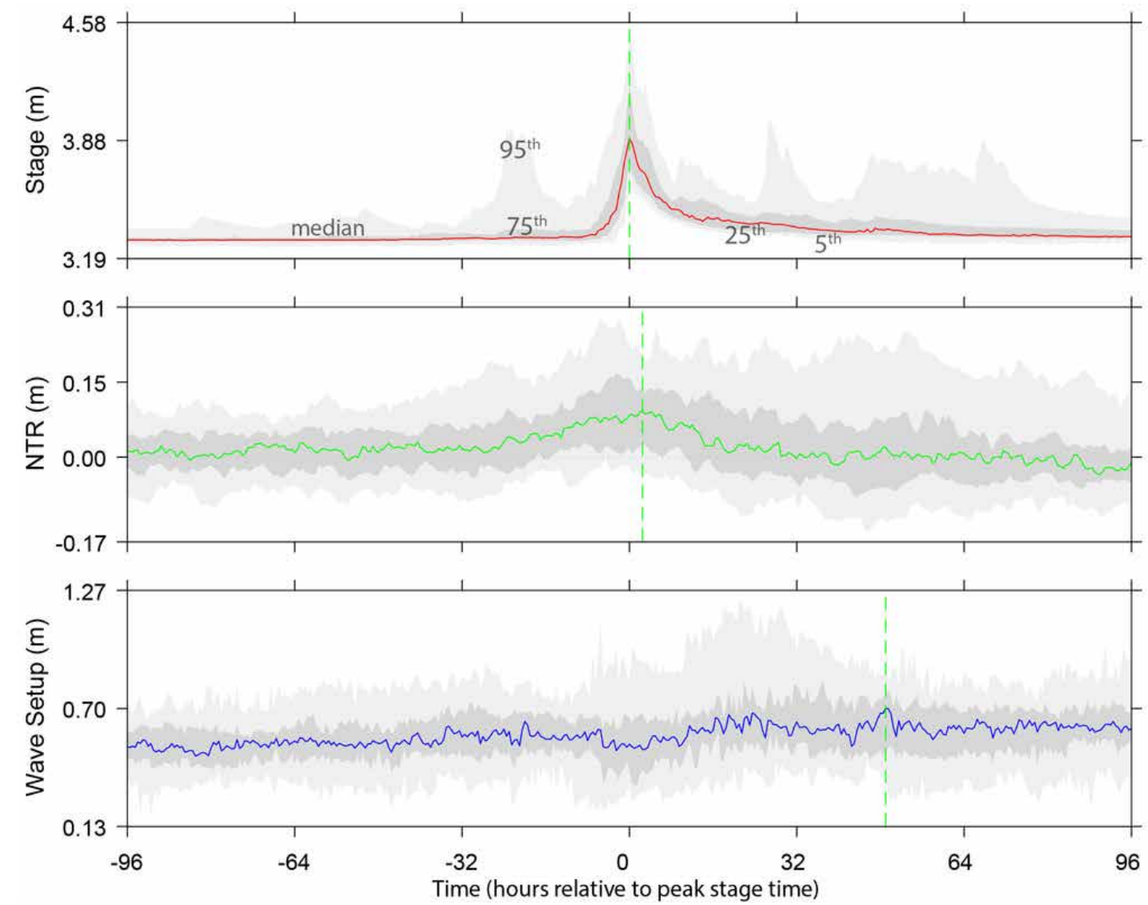


**Figure 8. Time-series plots of aggregated (n = 24) Arroyo Trabuco River stage (m), nontidal residual (m), and wave setup (m) data. The annotations are the computed percentiles. Vertical dashed lines mark the median peaks of the plots.**

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**Cover image: Lujiazui Center Area, Shanghai, China.** Lijiazui is located on the bank of the Huangpu River in Pudong New Area, Shanghai City, facing the Bund on the other side of the river. It has become a symbol of modern Shanghai. The Lujiazui Area is a locus of many multinational banks and is one of the most influential financial centers in China. The 2016 International Conference on Water Resource and Environment (WRE2016) was held in this area during July 23rd-26th, 2016. (Photograph taken by Shulin Wang, Changsha City, Hunan Province, China).

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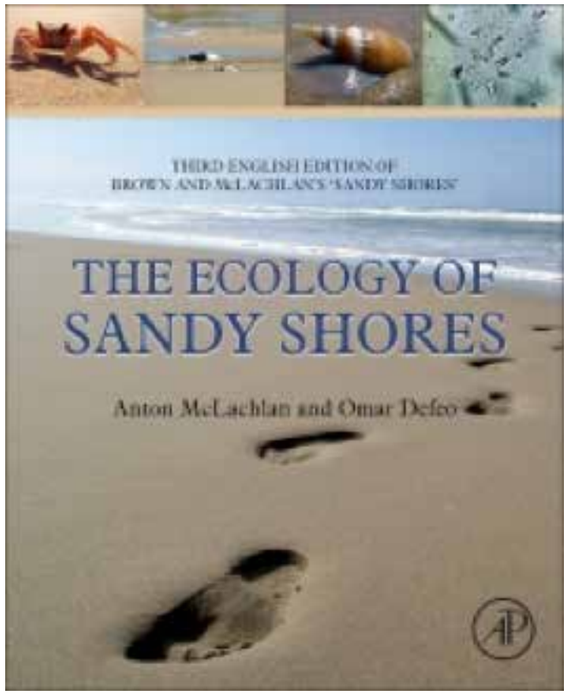


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## About the Authors:

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Dr. McLachlan has had a long and established career in beach ecology. He has worked throughout the world and has headed up multiple departments and research institutions including: the Director for the Institute for Coastal Research, Chair of the Dept. of Zoology, and Dean at Sultan Qaboos University in Oman. He has over 90 publications to date.

**Omar Defeo**

Dr. Defeo has been active in the field of marine sciences since receiving his Ph.D., in 1993. His fields of interest are human impact in coastal marine communities and populations, stock assessment and management, population dynamics of exploited marine stocks and sandy beach ecology. He has won many awards for his research and consultancy work, including the 2010 Elsevier Scopus Prize for Uruguay. He has published over 130 works to date.

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# Direct Observations and Modeling of Summertime Coastal Circulation Patterns in the Western Bohai Sea

# Direct Observations and Modeling of Summertime Coastal Circulation Patterns in the Western Bohai Sea

**Chuanxi Xing, Qian Zhao, Zhanming Hu, and Yongqing Liu**

National Marine Environmental Monitoring Center
Dalian 116023, P.R. China

## ABSTRACT

Eutrophication of the coastal waters in the western Bohai Sea results in serious environmental problems. In summer, severe brown tide frequently happens in the Qinhuangdao coastal areas, causing enormous losses to the local fishery. A survey array with four sets of seabed-based current observation systems equipped with acoustic Doppler current profilers was deployed in September 2013 to investigate the hydrodynamic background of the brown tide. The observations suggest that the shore currents flow generally northward and offshore currents flow southward during the survey period. The coastal circulation system and its formation mechanisms are studied with a three-dimensional nested-grid ocean circulation model. The model results suggest that coastal currents form a clockwise eddy-shaped circulation system with a diameter of 65 km. Numerical sensitivity experiments imply that the tides and summer monsoons generate the observed coastal circulation system. The combined effects of the tidal residual currents and wind-induced currents transport water northward and shoreward, resulting in a higher water level in the north of Qinhuangdao. The barotropic pressure gradient then produces southward pressure compensation flows. Consequently, the northward shore currents and the offshore southward compensation flows form the clockwise eddy-shaped circulation. The summer monsoons are important driving forces to generate the observed coastal circulation system. Because the summer monsoons are periodically occurring meteorological processes of this region, the observed coastal circulation system is anticipated to appear every summer. The environmental problems in the Qinhuangdao coastal areas are mainly induced by the land-based pollution discharges. Combined with observations on the surrounding land-based pollution discharges, the information obtained through this study could be used to track the nutrient transport and eventually help to mitigate adverse phytoplankton blooms.

**ADDITIONAL INDEX WORDS**: *Summertime Qinhuangdao coastal circulation, seabed-based current observation system, formation mechanisms, summer monsoons, barotropic pressure gradient forces.*

## INTRODUCTION

The Bohai Sea is composed of Liaodong Bay (LDB), Bohai Bay, and Laizhou Bay. The Qinhuangdao coastal areas are located in the western Bohai Sea and near the southern mouth of LDB (Figure 1).

The circulation of LDB is strongly influenced by winds and tides because of its shallow depths (Kwan, 1957). Although the residual currents are weaker in magnitude than the tidal currents (Liu, 1990; Xu *et al.*, 2006), with mean velocities of less than 5 cm/s, the circulation of LDB attracts the attention of researchers because of its significant effects on nutrient transport.

Kwan (1962) suggested that the summertime circulation pattern of LDB was anticlockwise after analyzing historical observations from 1950s and earlier.

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Based on long time series, *in situ* current observations from multiple stations in LDB, Zhao *et al.* (1995) believed, however, that the circulation in LDB was basically clockwise all year. The current observations from different stations along the LDB coast shown in the study by Liu (1990) indicated that at least in spring the circulation was clockwise.

Various ocean circulation models have been applied to simulating the circulation in LDB, as well as the study of its formation mechanisms. Dou, Zhang, and Zhang (1987) developed a two-dimensional circulation model to compare the influences of different forces on the circulation in the Bohai Sea and found that the surface winds were the most important driving forces, while the twisting coastlines and varying topography modified the circulation. Miu and Liu (1989) came to similar conclusions as Dou, Zhang, and Zhang (1987). By applying more realistic winds to the ocean circulation model, Zhao *et al.* (1995) simulated the circulation in LDB and found that the circulation pattern was clockwise. In recent studies (*e.g.*, Bi, 2014; Zhou *et al.*, 2017), the general circulation in the Bohai Sea and LDB has been simulated with more advanced ocean circulation models, and the model results implied that in addition to the traditional large-scale circulation, smaller-scale circulation systems exist in the coastal areas. The coastal smaller-scale circulation systems constitute important parts of the circulation system of LDB, and these smaller-scale circulation systems are, to a degree, more important for the development of the marine ecosystem.

Because high quality, *in situ* current observations are lacking, the circulation system in the coastal areas of western LDB has not been well studied. The Qinhuangdao coastal areas host the largest aquiculture of the Bohai Sea and form the most famous health resort in northern China. Eutrophication of the Qinhuangdao coastal areas induced by land-based pollution discharges attracts increasing attention from the public. In recent years, the Qinhuangdao coastal areas have been haunted by serious brown tides of a toxic-substance-producing phytoplankton species, *Aureococcus anophagefferens* (State Oceanic Administration Staff, 2013). The brown tide contaminates the environment and causes great damage to the local aquiculture. Furthermore, the dead organic materials consume enormous dissolved oxygen (DO) at the bottom layers. Figure 2 shows the variation in summer bottom DO concentration in recent years. The summer bottom DO has been on a declining trend from 1980 to 2016. In 2016, low bottom DO concentration of 2 mg/L was measured, and the bottom layers reached the hypoxia level. Because the coastal circulation system is the main transporter of the nutrients (Klemas, 2012), to mitigate the adverse impacts of the land-based pollution discharges on the marine ecosystem, the circulation system needs to be examined and studied.

Figure 3 shows a satellite image of the sea color of the Qinhuangdao coastal areas when the brown tide occurred. The distribution of the surface chlorophyll concentration implies the trajectories of the summertime coastal currents. It is implied that the coastal circulation system first induced the water volume to accumulate along the coastline from Qinhuangdao to Tuanshan Cape, and then around the south of Tuanshan Cape, the water body moved SE. To examine this coastal circulation system, survey cruises in September 2013 were organized to deploy a current survey array.

In this study, first the Qinhuangdao coastal circulation system is analyzed by direct observations, and then numerical experiments are conducted to investigate the formation mechanisms of the observed circulation system.

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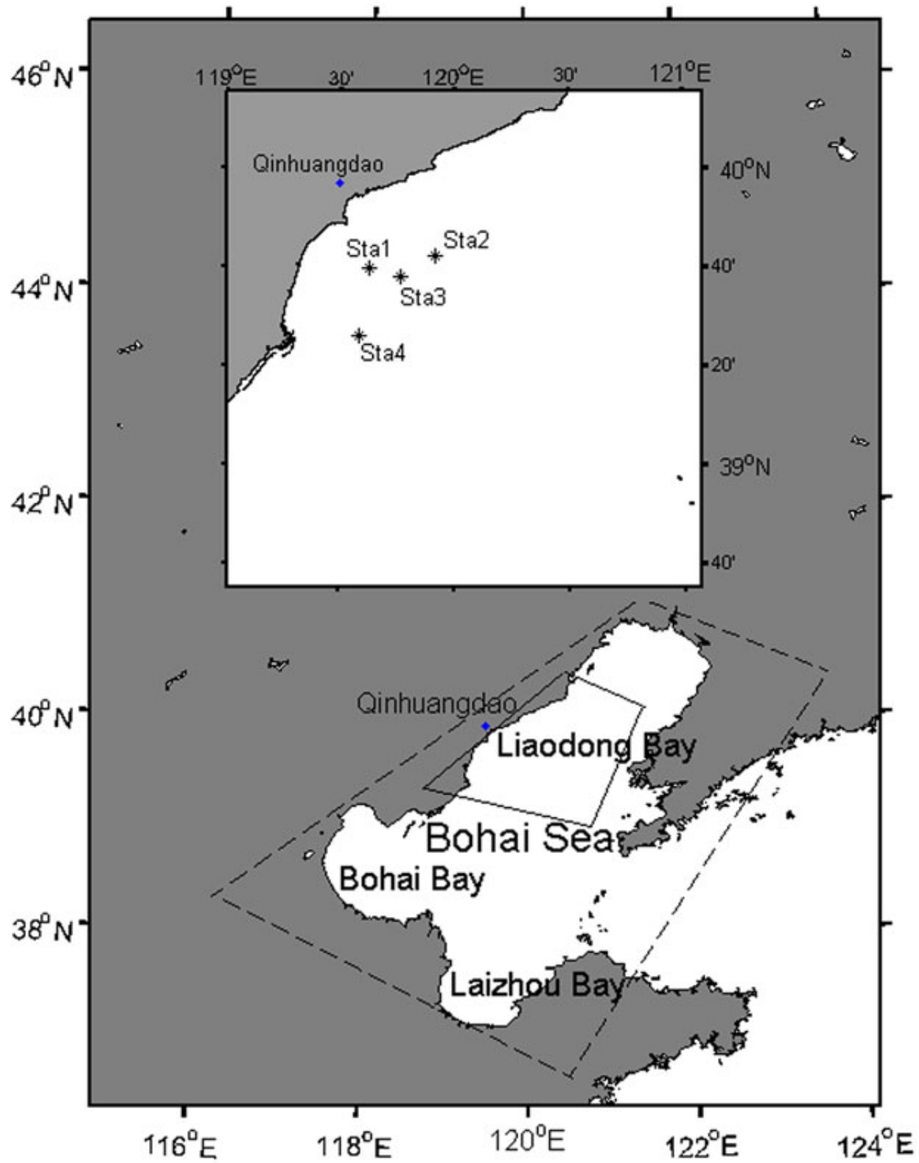


**Figure 1. The Bohai Sea and its three bays (LDB, Bohai Bay, and Laizhou Bay). The model domains of the BTS and QCS are denoted with dashed line and solid line, respectively. The nested map shows the locations where the four seabed-based current observation systems are deployed (Sta1–Sta4). The current survey array was deployed in the aquiculture and health resort functional zone, where huge economic loss is caused by the brown tide.**

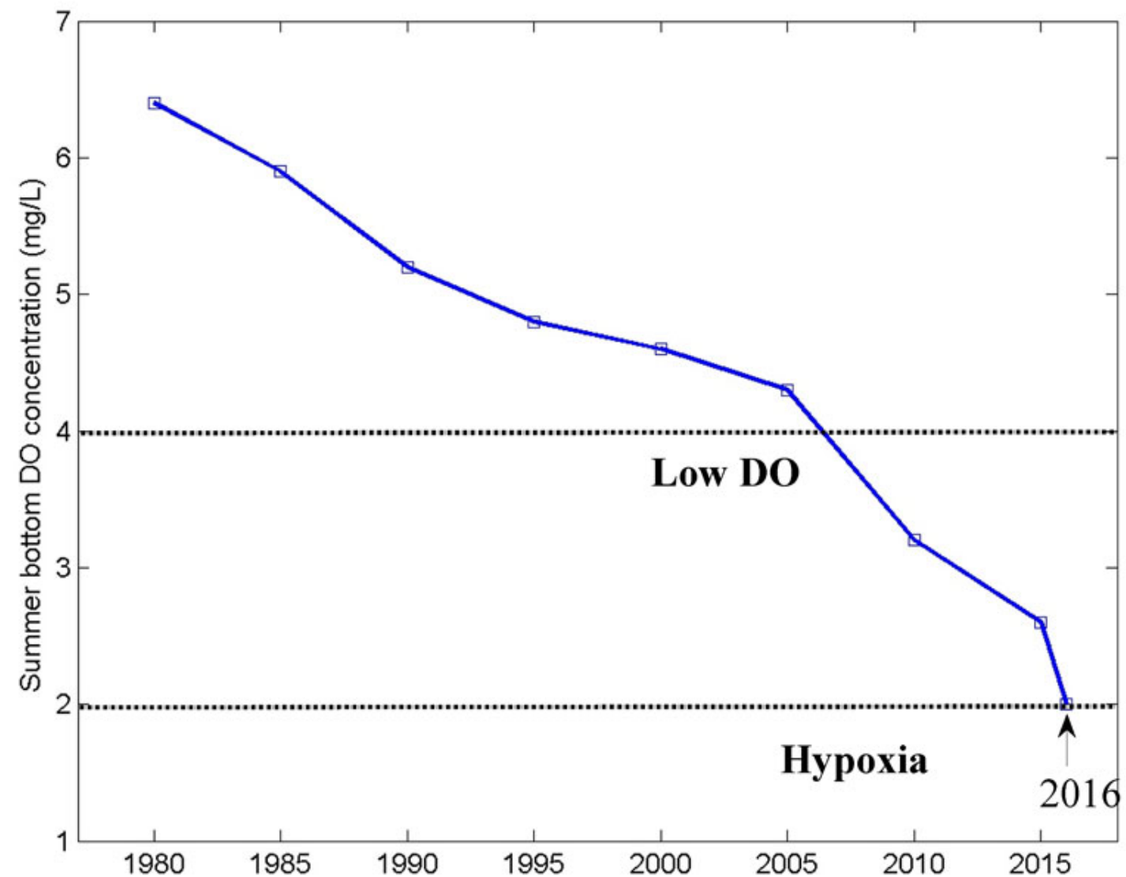


**Figure 2. The variation of the mean summer bottom DO concentration in the Qinhuangdao coastal areas from 1980 to 2016. The bottom DO concentration is observed to decline gradually from 1980 to 2016. Taking DO concentration of less than 4 mg/L as the low DO concentration level and less than 2 mg/L as hypoxia (Diaz, 2001; Wiseman *et al.*, 1997), in 2007, the summer bottom DO concentration reached the low DO concentration level, and in 2016, the bottom DO concentration reached hypoxia.**

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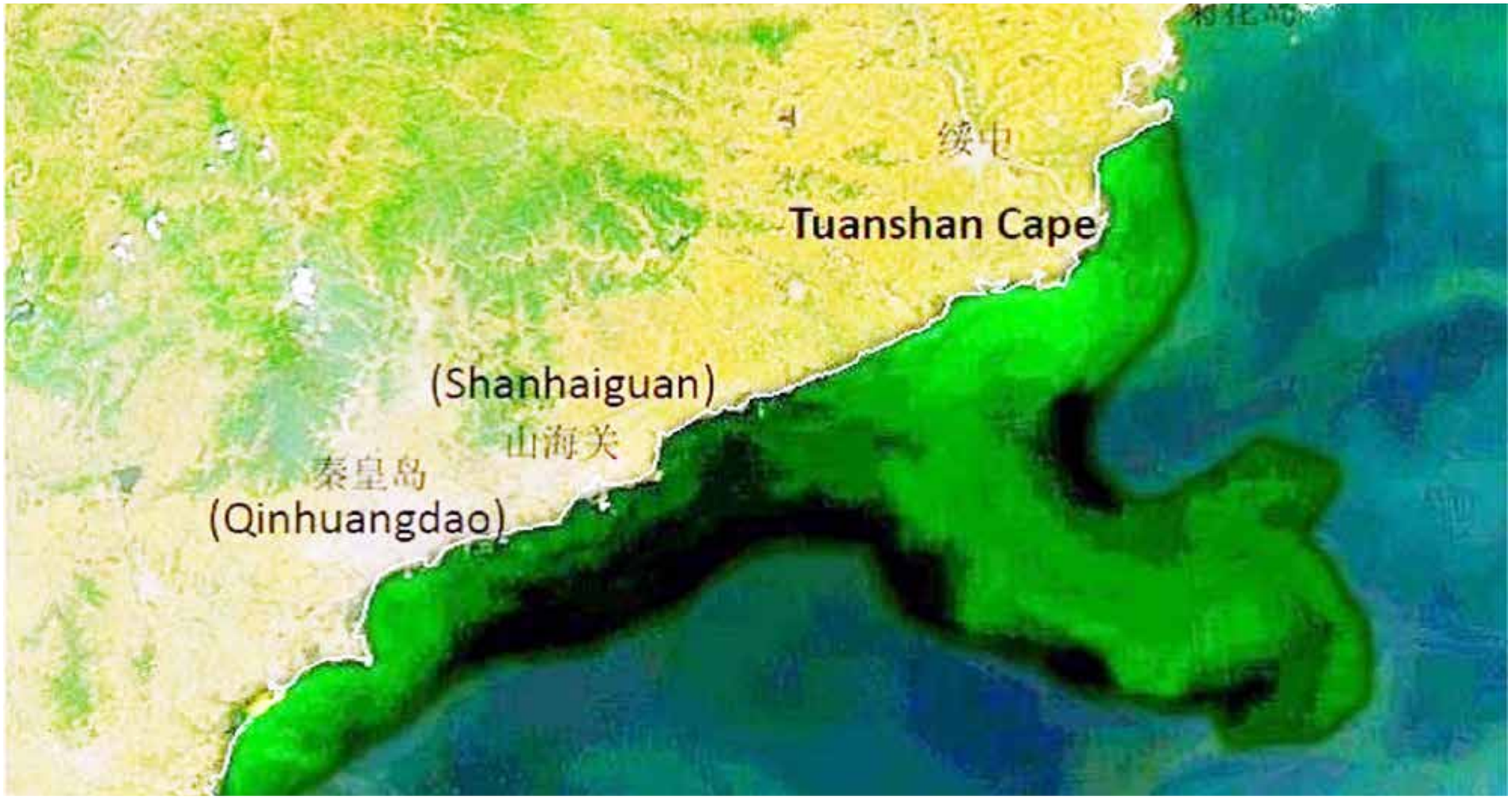


**Figure 3. Satellite image of the sea color of summer 2013 in the Qinhuangdao coastal areas at the peak of the brown tide (the higher chlorophyll concentration is denoted in lighter green; satellite image from State Oceanic Administration Staff, 2013). The distribution of the chlorophyll concentration implies that the coastal currents push the water body shoreward, resulting in an accumulation of the water body along the coastline from Qinhuangdao to Tuanshan Cape. South of the Tuanshan Cape, the water body moves SE.**

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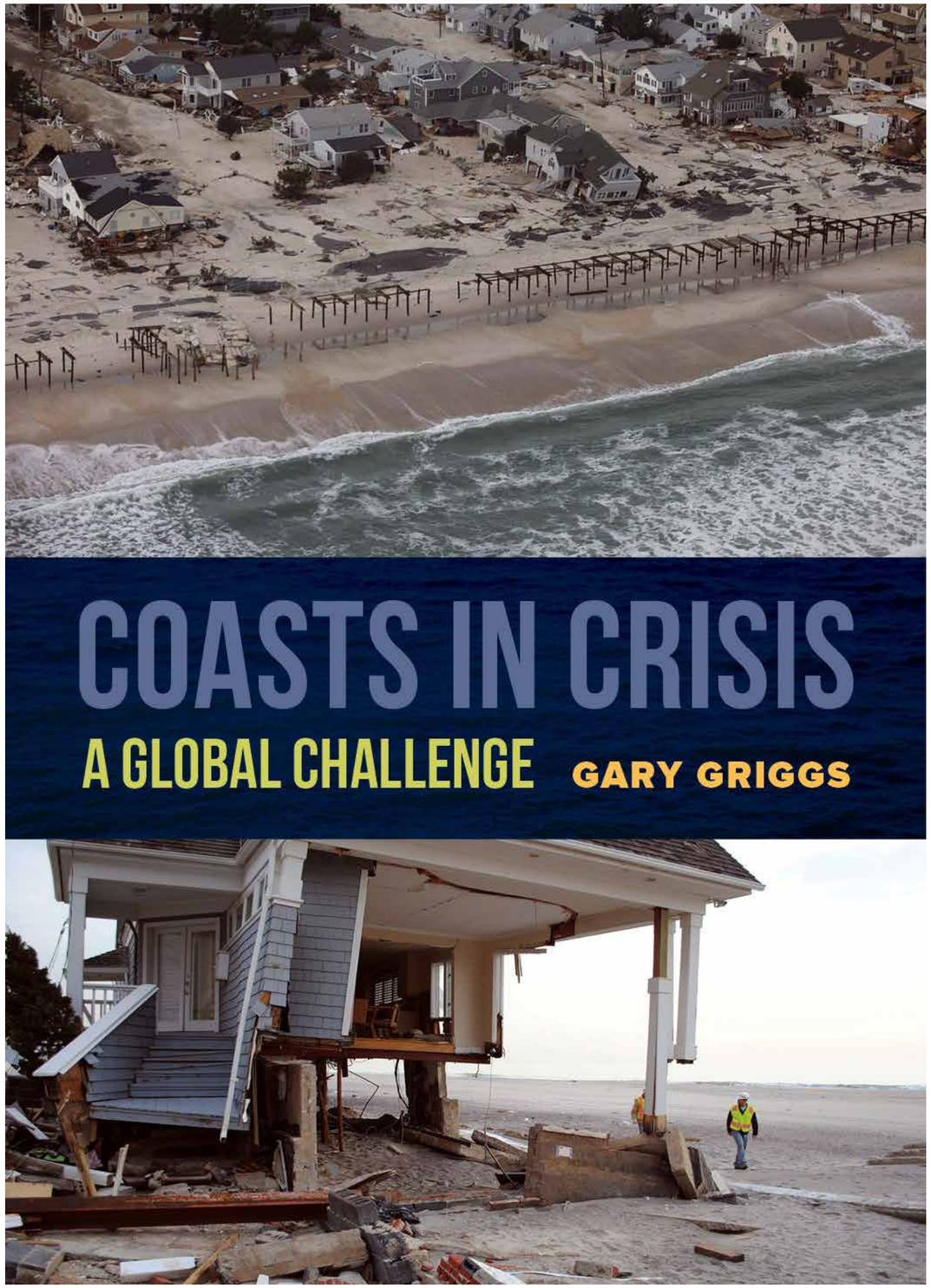


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"All around the world, population and economic development are increasingly concentrated in coastal regions. This means our planet's coastal zones are both ever more vital to societal well-being and increasingly stressed by development and population. Nobody understands these natural and human dynamics better than Gary Griggs. Written with Griggs's trademark clarity and passion, *Coasts in Crisis* provides a global perspective on the challenges and opportunities that are present for us all."—Kathryn D. Sullivan, Former NOAA Administrator and NASA Astronaut

"*Coasts in Crisis* is a comprehensive and accessible book that should become a must-read for anyone who is concerned about the future of the life support system on Earth that sustains us all. Human activities have vastly altered these critical habitats and it's time to invest in understanding and protecting them for the future. Gary Griggs's book is a great place to develop such understanding and build momentum toward this goal."—Julie Packard, Executive Director, Monterey Bay Aquarium

**About the Author:**

Dr. Gary Griggs is Distinguished Professor of Earth Sciences at the University of California, Santa Cruz. He is author (or coauthor) of *Introduction to California's Beaches and Coast, Living with the Changing California Coast*, *California Coast from the Air*, *The Santa Cruz Coast (Then and Now)*, and *Our Ocean Backyard*. Dr. Griggs is also a member of the *Journal of Coastal Research* (JCR) Editorial Board and serves on the Coastal Education & Research Foundation (CERF) Board of Directors.


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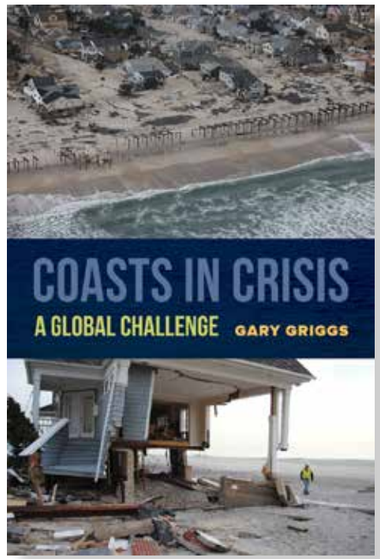


## Coasts in Crisis

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GARY GRIGGS

"This is a must-read for all of us working toward an ocean ecosystem that we would want to hand off to future generations."
**—John Laird, California Secretary for Natural Resources and Chair of the Ocean Protection Council**

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"A comprehensive and accessible book that should become a must-read for anyone who is concerned about the future of the life support system on Earth that sustains us all."
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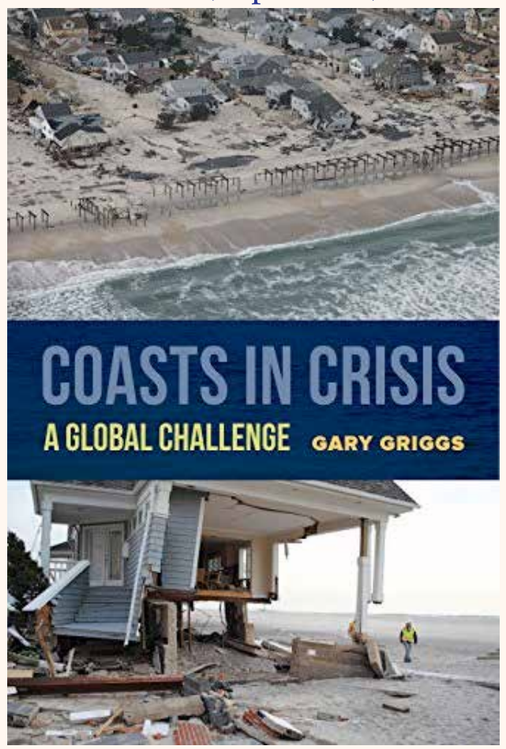
# BOOK REVIEW

***Coasts in Crisis: A Global Challenge***. Griggs, G., 2017. Oakland, California: University of California Press, 360p., 174 color images. ISBN: 9780520293618, $USD 85.00 (Hard-cover); ISBN: 9780520293625, $USD 29.95 (Paperback); ISBN: 9780520966857, $USD 29.95 (eBook).




It is a rare occurrence these days to sit down with a book and find everything you need within just those pages. Usually, I find myself reaching for another volume to reference an area of study that was not covered in the text I initially sat down with. Not so with the recently published *Coasts in Crisis: A Global Challenge*. Gary Griggs has written a wonderful account of how coastal regions are formed and subsequently affected by the constant barrage of natural and human interactions. The book first brings you on a historical journey of early human settlement of the coastal zone. This then leads into more modern themes, such as urban expansion, coastal megacities, population increases, coastal hazard vulnerability, and hu-man impacts. But that is only the first part of the message, which is an introduction to humans and coasts.

For the second part of the book, Dr. Griggs covers the natural processes and hazards affecting coastal regions. He talks about coastal tectonic hazards, including subduction zones and transform plate earthquakes, tsunamis, and volcanoes. Storms, waves, coastal erosion, and shoreline retreat are also discussed, which then leads the reader into an intriguing description of climate change and sea-level change as we know it today versus future projections. One of the moments that really struck me while reading this part of the book was when Dr. Griggs offered his list of the top five U.S. cities most vulnerable to a hurricane landfall. In the chapter on Tropical Cyclones, Hurricanes, and Typhoons, Dr. Griggs predicts that the fifth most vulnerable location is in fact the Houston–Galveston, Texas area. That listing was recently given validity only a few weeks before this review was written, when Hurricane Harvey devastated the Houston–Galveston area in August of 2017.

The third (and final) part of the book centers around the impacts of human activities on coasts. These key topics include marine pollution (*e.g.*, wastewater, organic wastes, nitrification, algal blooms, and pathogens), plastics/marine debris, petroleum (*i.e.* impacts of exploration, development, production, and transport), coastal power plants (*e.g.*, thermoelectric, nuclear), renewable energy from the coastal zone (*e.g.*, wind, hydrokinetic, ocean thermal energy conversion), groundwater (*i.e.* subsidence and seawater intrusion), desalination, carbon dioxide, climate change, ocean acidification, coral reef health and survival, overfishing, aquaculture, and aquatic invasive species.

It is easy to recommend this book to all coastal researchers and managers as an essential part of their home library collection. With many color photographs and illustrations, Dr. Griggs offers us a volume that is not only intellectually stimulating, but also visually stunning. He promotes further discussion by always asking the same question at the end of every chapter: Where do we go from here? And that is the central question that should be addressed when delving into the myriad of topics covered in this book: Where exactly do humans and the stability of the coastal region go from here?

Christopher Makowski
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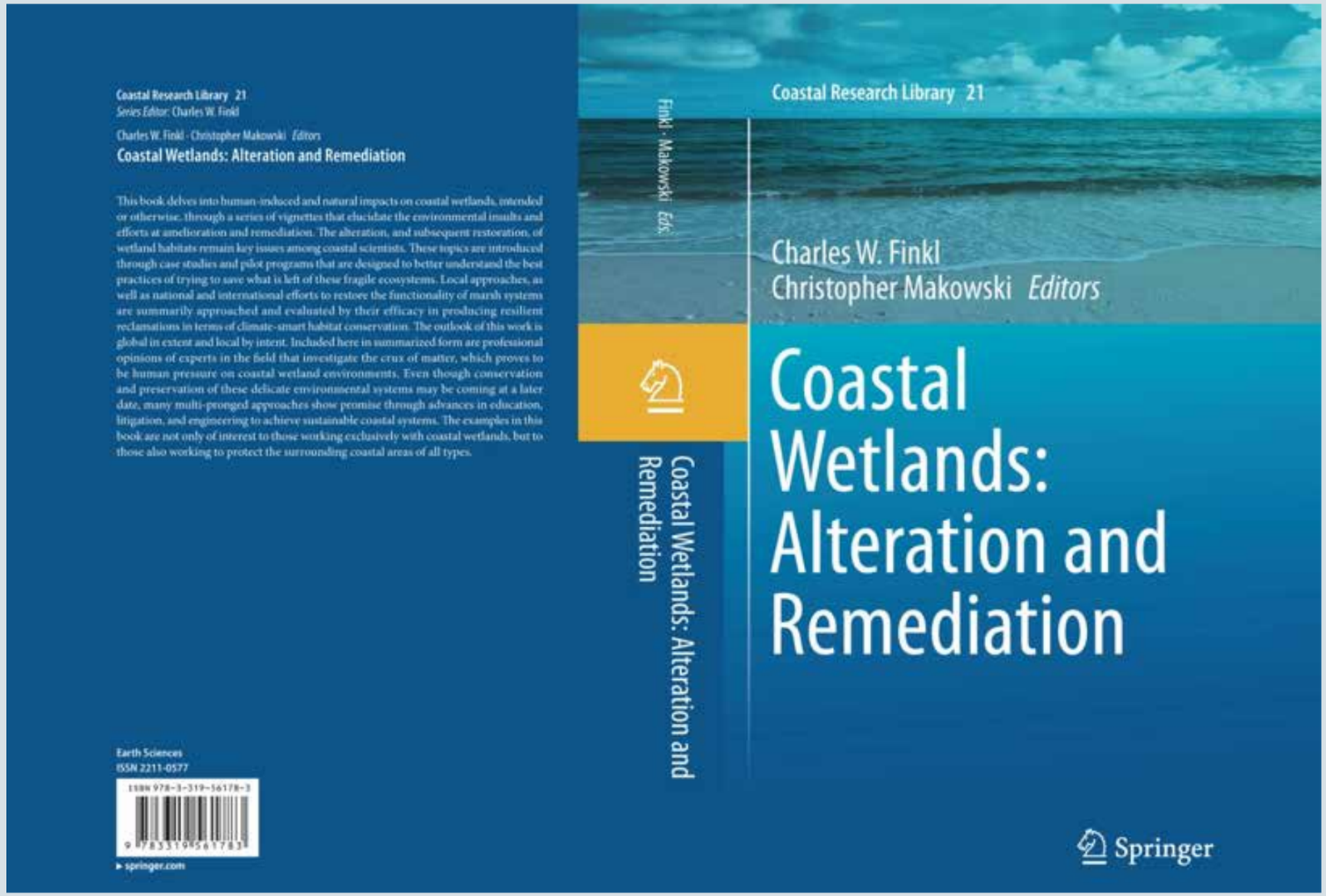


This book delves into human-induced and natural impacts on coastal wetlands, intended or otherwise, through a series of vignettes that elucidate the environmental insults and efforts at amelioration and remediation. The alteration, and subsequent restoration, of wetland habitats remain key issues among coastal scientists. These topics are introduced through case studies and pilot programs that are designed to better understand the best practices of trying to save what is left of these fragile ecosystems. Local approaches, as well as national and international efforts to restore the functionality of marsh systems are summarily approached and evaluated by their efficacy in producing resilient reclamations in terms of climate-smart habitat conservation. The outlook of this work is global in extent and local by intent. Included here in summarized form are professional opinions of experts in the field that investigate the crux of the matter, which proves to be human pressure on coastal wetland environments. Even though conservation and preservation of these delicate environmental systems may be coming at a later date, many multi-pronged approaches show promise through advances in education, litigation, and engineering to achieve sustainable coastal systems. The examples in this book are not only of interest to those working exclusively with coastal wetlands, but also to those working to protect the surrounding coastal areas of all types.

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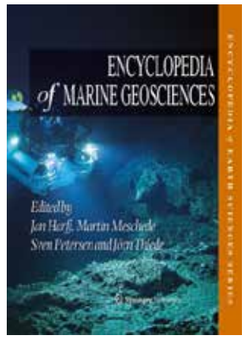

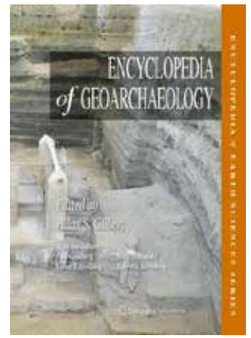

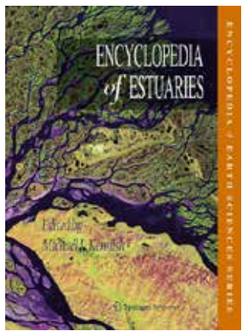

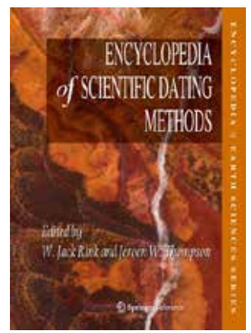

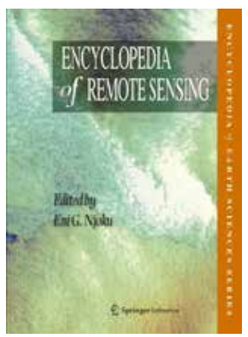

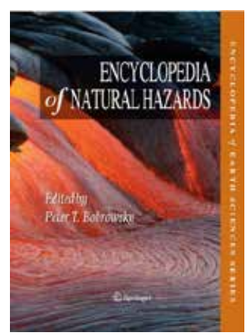


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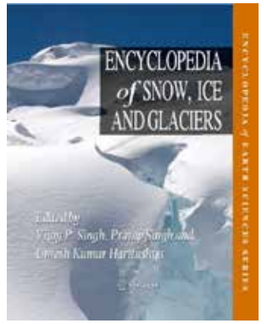

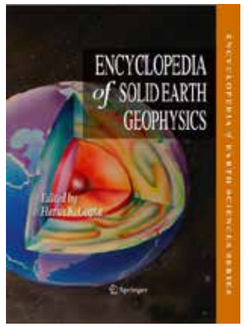

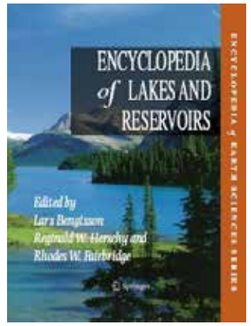

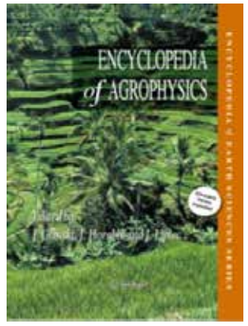

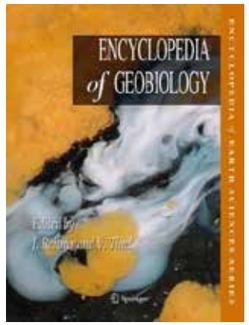

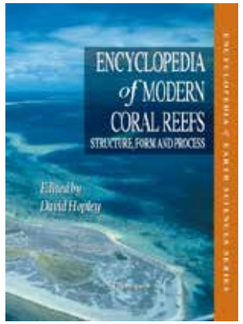


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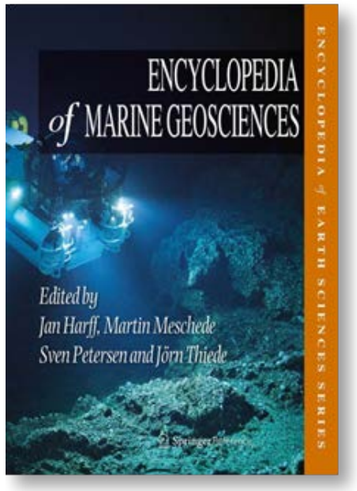


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## The Editors:

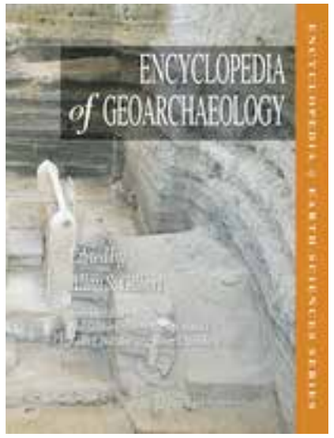
***Jan Harff*** is Professor of Geosciences and Seafloor Geology at the University of Szczecin, Poland. His previous research focused on sedimentary basin analysis at the Central Institute for Physics of the Earth (ZIPE, subsequently the GeoForschungs Zentrum, GFZ), Potsdam, and marine geology at the Leibniz Institute for Baltic Sea Research Warnemünde and the University of Greifswald, Germany.He cooperates, on a permanent basis, with marine research institutes of the Chinese Academy of Sciences, Chinese universities and the Guangzhou Marine Geological Survey, Guangzhou, China. His research interests concern marine geology in general, sedimentology, coastal geology, palaeo-oceanography, palaeoclimatology, mathematical geology and basin modelling. In addition to having authored and co-authored numerous research papers and having served as editor of other scientific publications, he acted as corresponding editor of "Modeling of Sedimentary Systems" (Springer, 1999) and "The Baltic Sea Basin" (Springer, 2011).

***Martin Meschede*** is Professor of "Regional and Structural Geology" at the Institute of Geography and Geology, University of Greifswald, Germany. His research interests focus on geodynamic processes at plate margins, subduction, large igneous provinces, exhumation, paleogeography, paleoclimatology, basin evolution, and glacial tectonics. He participated in several marine research expeditions, among these are the Joides Resolution of IODP and a diving cruise with Shinkai 6500. Besides a number of scientific publications, he is author and coauthor of several textbooks on plate tectonics, structural geology, and regional geology of Germany.

***Sven Petersen*** is a senior researcher at GEOMAR, Helmholtz Centre for Ocean Research Kiel in Germany. His research focuses on understanding the processes that form and change seafloor hydrothermal systems and associated mineral deposits with time. He participated in more than 30 research cruises to submarine hydrothermal systems in the Pacific, Atlantic, and Indian Ocean. Major aims of his research are to understand their chemical variability, the use of mobile drilling techniques and geophysical methods to investigate their sub-seafloor extent as well as the use of autonomous underwater vehicles for their exploration.

***Jörn Thiede*** is the leader of the KÖPPEN-Laboratory of the Institute of Earth Sciences of Saint Petersburg State University. He worked 1967-1987 at the universities of Aarhus (Denmark), Bergen (Norway), Oregon State University in Corvallis (USA), Oslo (Norway) and Kiel (Germany) and learned to sail the world's oceans to understand their history. Afterwards he pursued the foundation of GEOMAR. In 1997 he joined The Alfred Wegener Institute-Helmholtz Centre for Polar and Marine Research. In 2008 he served at the Geocenter Denmark as well as at UNIS (Longyearbyen/Svalbard) and in 2011 was invited to join the St. Petersburg State University (Russia).

# Encyclopedia of Geoarchaeology: A Review




***Encyclopedia of Geoarchaeology,* edited by Allan S. Gilbert, 2017. Encyclopedia of Earth Sciences Series. (Series Editor Charles W. Finkl). Springer Publishing, Dordrecht, Netherlands. xxix + 1046 pages, 158 b/w illustrations, 310 illustrations in color. $549.00 (Print/eBook). ISBN: 978-94-007-4827-9 (Print), 978-1-4020-4409-0 (eBook).**

Reviewed by David Kilby, Department of Anthropology, Texas State University.

*The Encyclopedia of Geoarchaeology* is the latest in a series of 35 reference volumes in the Encyclopedia of Earth Sciences Series published periodically since the mid-1970s by Springer. Originally conceived in 1981 by Rhodes Fairbridge, this particular volume in the series stalled under a change in publishers (Gilbert 2017:xxviii). It was resurrected and brought to completion 35 years later by Allan S. Gilbert along with Associate Editors Paul. S. Goldberg, Vance T. Holliday, Rolfe D. Mandel, and Robert S. Sternberg. The result is an impressive tome that is international in scope and ranges temporally from paleoanthropology to ethnogeoarchaeology.

The volume consists of 165 individual entries ranging in length from brief summaries (less than a full page for specific sites or localities) to chapter length treatments of foundational topics (*e.g.*, Remote Sensing, Site Formation Processes). Although the entries are organized alphabetically, they can be divided informally into three general categories: geoarchaeological concepts, methods, and significant locations. Not included are biographical entries of pioneers and major figures of geoarchaeological research. I suspect this was considered and eschewed, perhaps to avoid deliberation over whom to include (especially considering that due to the relative youth of the field, many of those very pioneers are still around to enjoy the volume, while others are contributors). It bears mentioning that the contributions of many of these pioneers are reviewed in a thorough historical entry (Geoarchaeology, History).

Just under half of the entries (74) cover general geoarchaeological concepts and foundations. Many subjects might serve as succinct chapters of a general textbook (*e.g.*, Archaeological Stratigraphy, Geomorphology, Paludal Settings, Soils), and are afforded broad treatment. Others address more specific topics and issues (*e.g.*, Burned Rock Features, Metals, Tells) and are appropriately focused. Some physiographic areas and their characteristic processes are given specific attention (*e.g.*, Arctic, Plains, Shorelines); others are conspicuously absent in comparison (deserts, mountains, and woodlands come to mind), though these are often addressed indirectly under other entries.

Specific field and laboratory methods are the subject of 39 entries. These entries are among the most important in the volume, as they provide authoritative guides to complex and often esoteric knowledge and techniques (*e.g.*, Data Visualization, Isochron Dating, Neutron Activation Analysis). It is worth noting that many of these methodical advances would not yet have been developed when the volume was first conceived, and this highlights the editorial challenge of keeping entries up to date for later editions.

Entries focused on specific sites or archaeological localities comprise the remaining 52 contributions. On the whole, these entries provide brief overviews of classic sites and projects (*e.g.*, Eastern Sahara Combined Prehistoric Expedition, El Mirón Cave, Olduvai) that are associated with fundamental applications and advancements in geoarchaeology. As such they provide useful case studies of the implementation of geoarchaeology in understanding of sites, time periods, and regions.

This volume represents an ambitious undertaking and the result is impressive. The editors and contributors are to be commended for accomplishing their goal of producing a volume that "defines terms, introduces problems, describes techniques, and discusses theory and strategy…in a language…accessible to students and nonspecialists" (Gilbert 2017:xxviii) The price is potentially prohibitive for many individuals, but the depth and breadth of the information it presents make it an authoritative if not essential volume for institutional and academic collections, whether as part of the full series or as a stand-alone reference.

# Trends in the Normalized Difference Vegetation Index for Mangrove Areas in Northwestern Mexico

# Trends in the Normalized Difference Vegetation Index for Mangrove Areas in Northwestern Mexico

**Francisco Flores-Cárdenas, Olivia Millán-Aguilar, Luis Díaz-Lara, Lidia Rodríguez-Arredondo, Miguel Ángel Hurtado-Oliva, and Marlenne Manzano-Sarabia**

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## ABSTRACT

Impacts of climate forcing on mangrove ecosystems have been highlighted by several authors. Nowadays, free access to Landsat imagery represents an opportunity to explore the likely impacts of climate variability on mangrove ecosystems using extended time series of vegetation indices—such as the Normalized Difference Vegetation Index—as proxies of health status. A comparison of time series of Normalized Difference Vegetation Index for mangrove areas located in La Paz (Baja California Sur, Mexico) was performed and the linear trend was evaluated for statistical significance. A significant and negative trend was observed for mangroves located in areas with limited freshwater inputs. In addition, a low but still significant correlation was observed between Normalized Difference Vegetation Index anomalies and the Multivariate El Niño Index for the 1993–2011 period. Analysis of time series suggested that mangroves located in areas with hydrologic stress are responding with a health decline and a weak response to El Niño Southern Oscillation events.

**ADDITIONAL INDEX WORDS**: *ENSO, NDVI, Landsat TM 5, remote sensing.*

## INTRODUCTION

Mangroves are a crucial component of coastal ecosystems, as they regulate nutrient filtering and provide habitat and nursery areas for several terrestrial and aquatic species. In addition, mangroves produce large amounts of detritus that contribute to enhanced productivity. They are fragile ecosystems, being sensitive to changes in water and soil salinity, tidal currents, temperature, storms, and other environmental stressors (Holguin *et al.*, 2006; Kovacs, 1999). According to Rodríguez-Züñiga *et al.* (2013), mangrove coverage in Mexico comprises 764,486 ha, while 9604 ha of mangroves have been reported lost from 2005 to 2010. According to that report, mangrove coverage in Baja California Sur comprises 26,694 ha; these mangroves are characterized by poor structure explained by a predominant arid environment and a generalized lack of freshwater inputs (Félix-Pico *et al.*, 2006; Holguin *et al.*, 2006; López-Medellín and Ezcurra, 2012). Various aspects of mangroves in NW Mexico have been studied before, *e.g.*, changes in coverage, physical-chemical parameters, carbon sequestration, nutrient fluxes, ecological role of species, and fragmentation levels (Arreola- Lizárraga *et al.*, 2004; Berlanga-Robles and Ruiz-Luna, 2007; Carrasquilla-Henao *et al.*, 2013; Ezcurra *et al.*, 2016; Félix-Pico *et al.*, 2006; Flores-de-Santiago, Kovacs, and Flores-Verdugo, 2012; Holguin *et al.*, 2006; Rodríguez-Zúñiga *et al.*, 2013; Whitmore *et al.*, 2005).

*In situ* data are most accurate to characterize the status of mangrove ecosystems, but performing long-term monitoring of large areas implies diverse associated costs and logistics. Satellite data can be used to derive various indices to characterize both marine and terrestrial ecosystems. Several indices have been proposed to study vegetation (*e.g.*, Ratio Vegetation Index, Difference Vegetation Index, Soil Adjusted Vegetation Index; Kovacs *et al.*, 2009; Pas-

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tor-Guzmán *et al.*, 2015), and ratio-based indices such as the Normalized Difference Vegetation Index (hereafter referred to as NDVI) are most commonly used for mangrove studies (Meza-Díaz and Blackburn, 2003). Nevertheless, satellite monitoring of the health status of mangroves in NW Mexico has been performed by a few authors (*e.g.*, Alatorre *et al.* [2016] reported a spatial relationship between areas of greatest loss of vegetation activity and those with anthropogenic activities, *i.e.* shrimp farms in the study area). Nowadays, the no-cost access to Landsat imagery provides a unique opportunity to study phenology and trends for mangrove forests because of the imagery's acceptable spatial and temporal resolution. Landsat TM 5 data (spatial and temporal resolution of ~30 m and 16 d, respectively) is available from 1984 to 2011. The objective of this study was to analyze NDVI trends (1993–2011) and related seasonal and interannual variability in La Paz, Baja California Sur, Mexico.

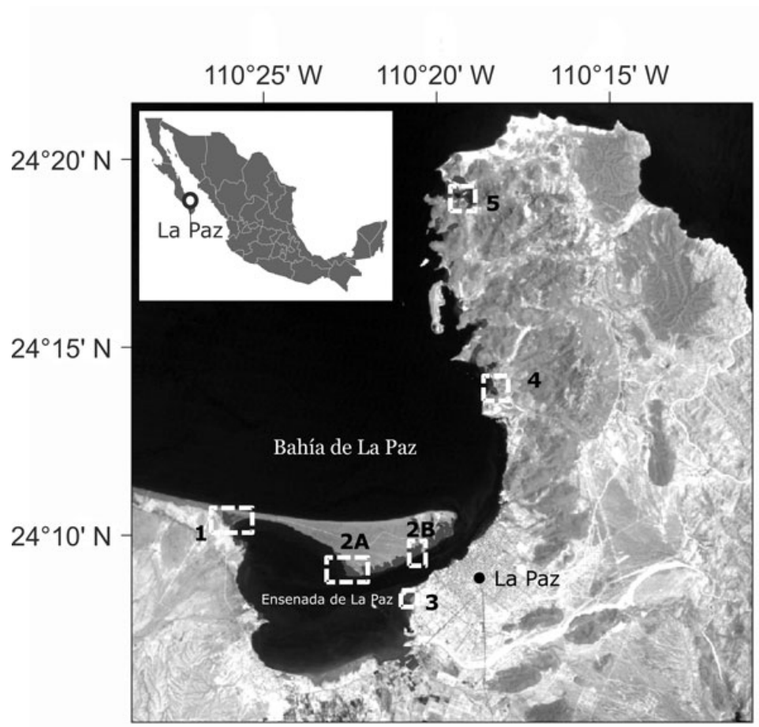


**Figure 1. Study area in La Paz, Baja California Sur, Mexico, showing mangrove areas (dark gray; CONABIO, 2016). Time series of NDVI were calculated for six mangrove areas (dashed boxes): (1) Zacatecas, (2) Mogote A and Mogote B, (3) Conchalito, (4) Enfermería, and (5) Balandra.**

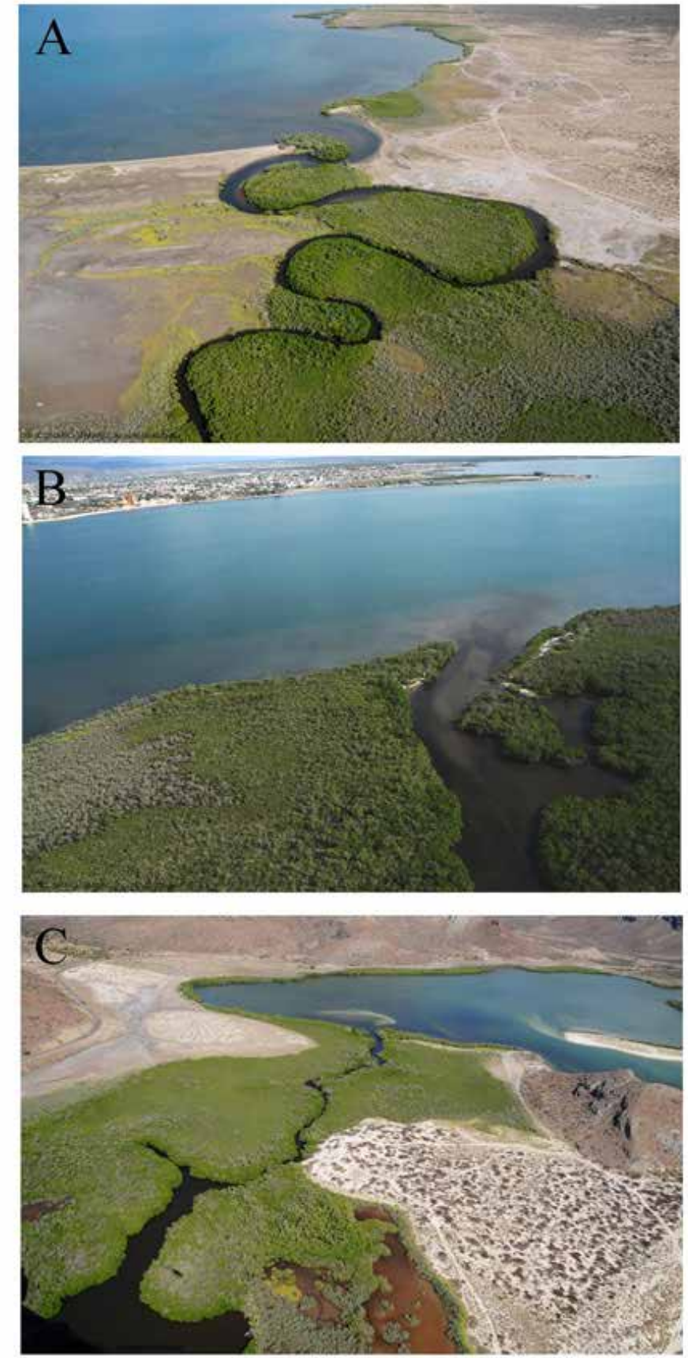


**Figure 2. Aerial photographs of mangroves areas: (A) Zacatecas, (B) Mogote B, and (C) Balandra (CONABIO-SEMAR/J. Acosta-Velázquez, 2008).**

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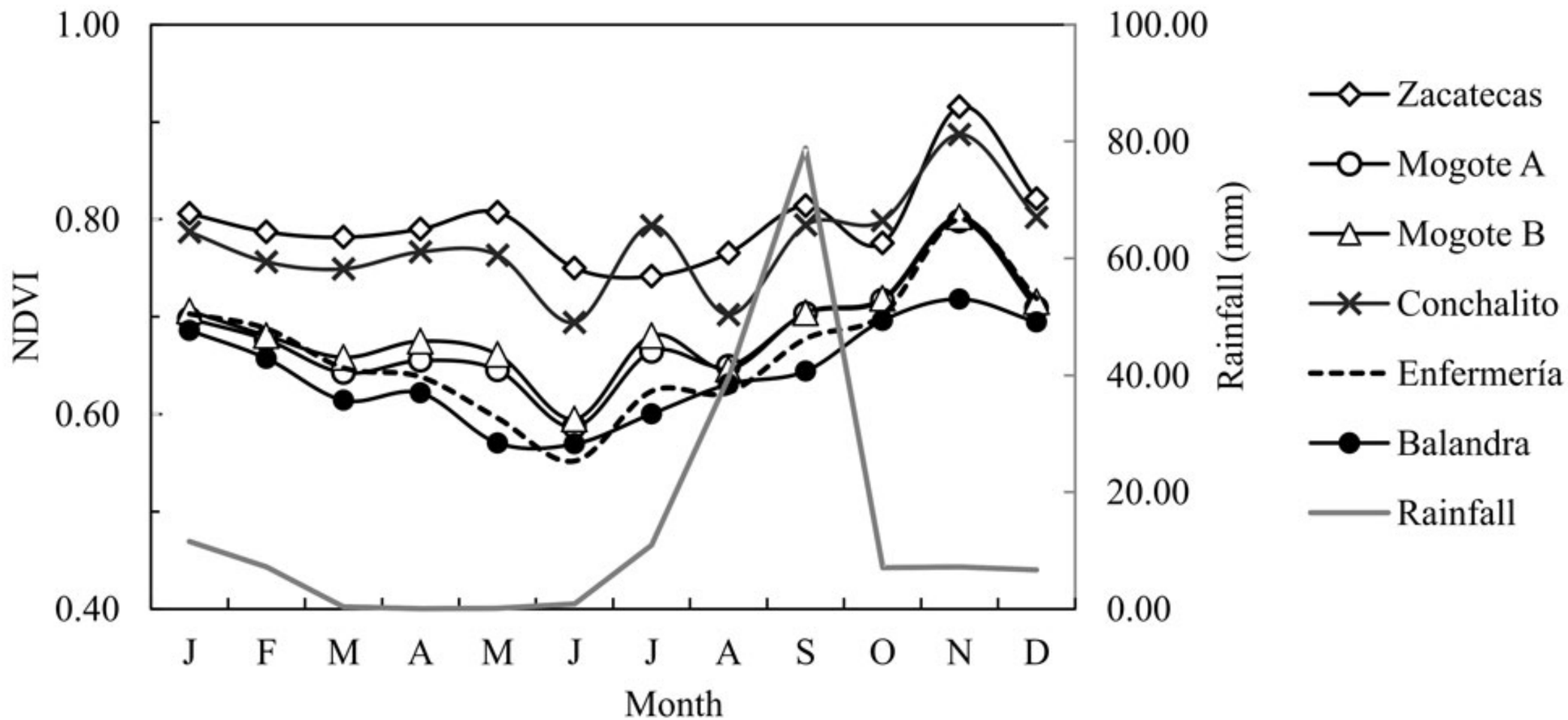


**Figure 3. Mean seasonal cycle of NDVI in six mangrove areas in La Paz, Baja California Sur, Mexico. Rainfall climatology (gray line) was calculated for the period 1993–2009.**

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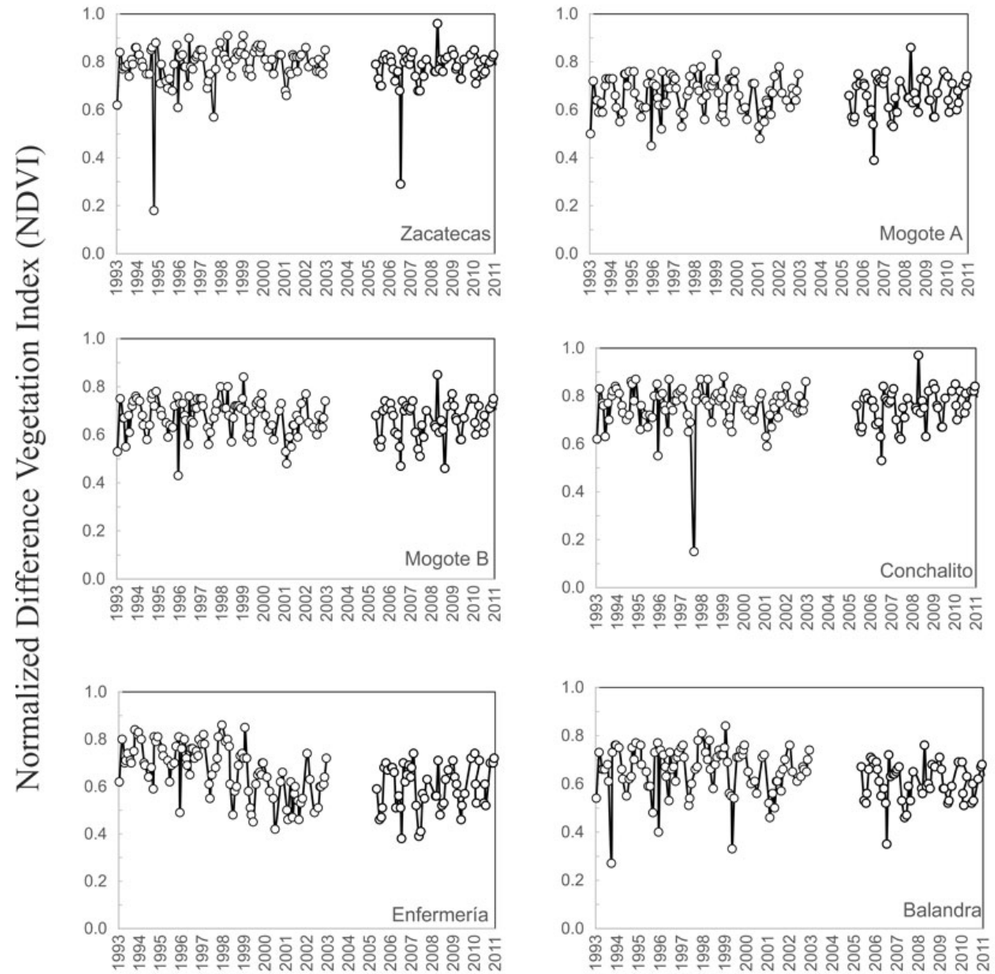


Figure 4. Monthly time series of NDVI corresponding to six mangrove areas in La Paz, Baja California Sur, Mexico.

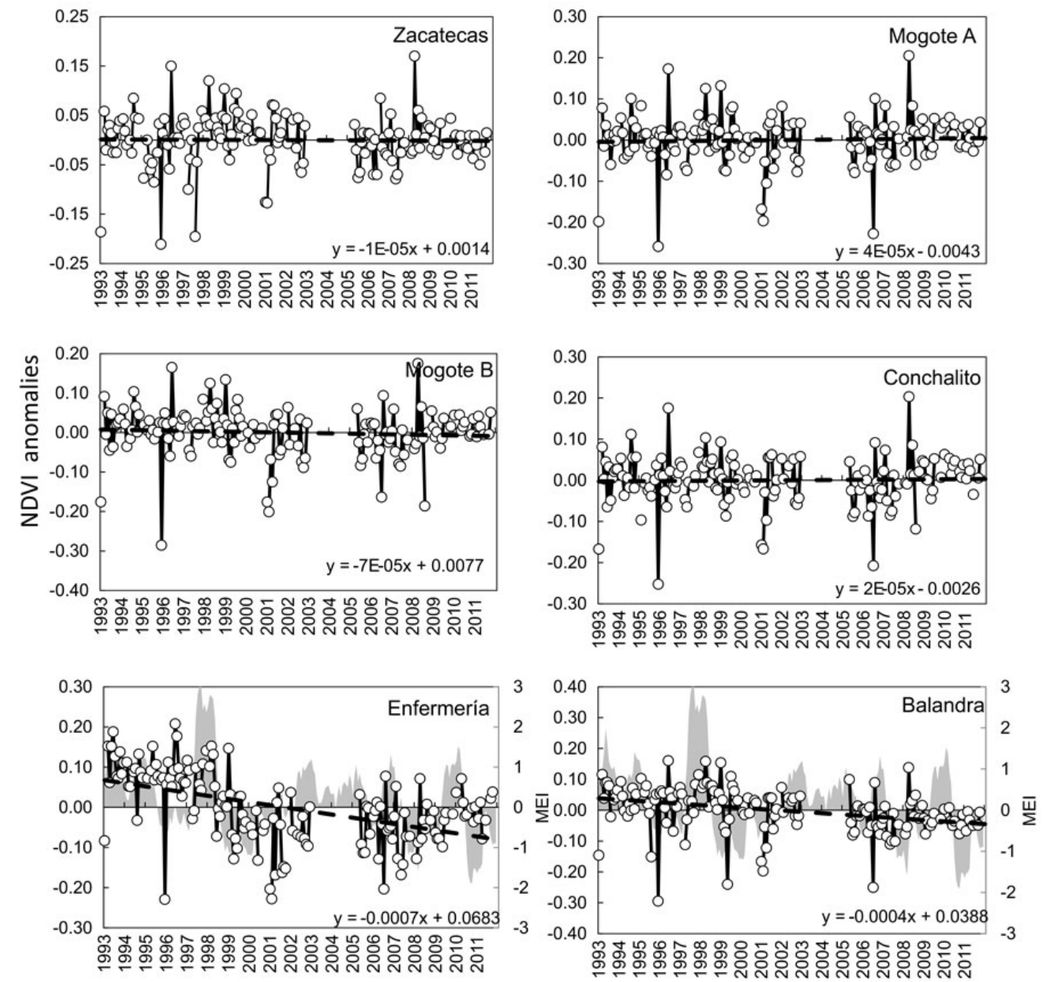


Figure 5. Time series of NDVI (anomalies) corresponding to six mangrove areas in La Paz, Baja California Sur, Mexico. The Multivariate El Niño Index is shown in two panels (Enfermería and Balandra). The trend (dashed line) is shown on each panel. The slope was statistically different from zero for Enfermería and Balandra (F-test, $p < 0.05$).

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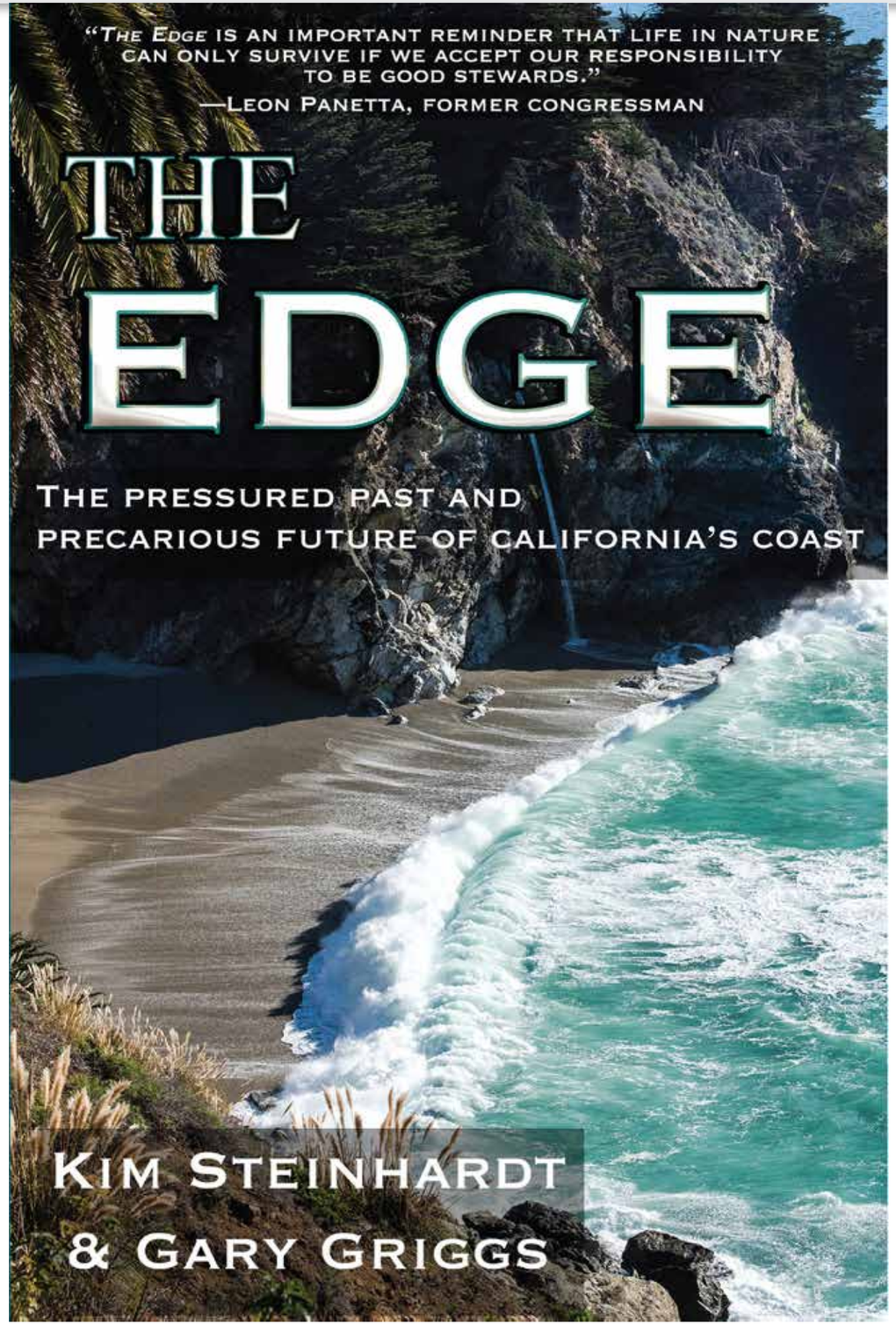


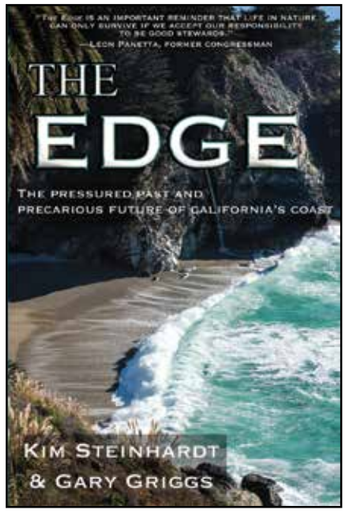

## Advance Title Information

# The Edge

### The Pressured Past and Precarious Future of California's Coast

### by Kim Steinhardt and Gary Griggs

### Publication Date: October 1, 2017

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The Pacific coast is the most iconic region of California and one of the most fascinating and rapidly changing places in the world. Densely populated, urbanized and industrialized — and also home to complex, fragile ecosystems — the coast is the place where humanity and nature coexist in a precarious balance that is never perfectly stable.

***The Edge: The Pressured Past and Precarious Future of California's Coast*** is a dramatic snapshot of the California coast's past, present and probable future in a time of climate change and expanding human activity. Written by two marine experts who grew up on the coast, ***The Edge*** is both a celebration of the coast's natural and cultural uniqueness and a warning of the many complex changes that threaten that uniqueness.

As ocean levels rise, coastal communities are starting to erode, and entire neighborhoods have been lost to the sea. Coastal ecosystems and wildlife that were already stressed by human settlement now face new dangers. The competing impacts of climate change, housing and commercial growth, commercial fisheries, oil drilling and production, and environmental advocacy all combine to define the future of the region.

***The Edge*** examines the current state of the coast's natural and social environments, gives the historical causes for the coast's present endangerment and offers informed projections on possible scenarios of the coast's future. A masterful and sweeping synthesis of environmental and social science, ***The Edge*** presents a comprehensive portrait of the history, people, communities, industries, ecology and wildlife of the California coast.

**Audience:** Readers interested in environmental issues, marine wildlife, climate change and California history.

**About the Authors:** A widely recognized marine wildlife photographer, former administrative law judge, and a long-time conservation advocate, **Kim Steinhardt** delivers popular lectures and photographic programs on coastal conservation and ocean stewardship issues for aquariums and marine centers, universities, state parks and other audiences. **Gary Griggs** has written or co-authored nine books about the coast and coastal issues both in California and globally. As a Distinguished Professor of Earth and Planetary Sciences at the University of California at Santa Cruz, he is known for his expertise in oceanography and coastal geology. He serves as the director of the Institute of Marine Sciences at UC Santa Cruz.

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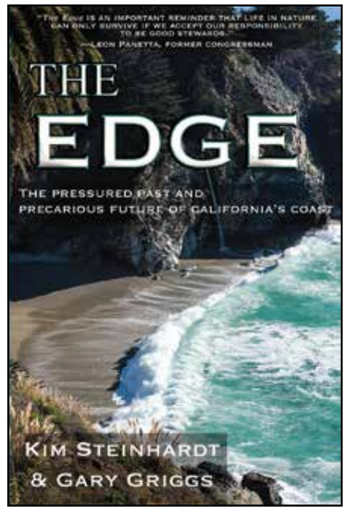
# Blending science, history and ecology, *The Edge* presents a dramatic portrait of California's breathtaking and endangered coastline

## "*The Edge* is an important reminder that life in nature can only survive if we accept our responsibility to be good stewards." —from the Foreword by former congressman Leon Panetta




The Pacific coast is the most iconic region of California and one of the most fascinating and rapidly changing places in the world. Densely populated, urbanized and industrialized — and also home to complex, fragile ecosystems — the coast is the place where humanity and nature coexist in a precarious balance that is never perfectly stable.

Two marine experts who grew up on the coast present a dramatic snapshot of a region undergoing massive change in ***The Edge: The Pressured Past and Precarious Future of the California Coast*** (Craven Street Books, October 2017).

Written in clear language for the layperson, ***The Edge*** presents an accessible survey of a huge range of topics, from sea-level rise to the history of offshore oil drilling to the health of the sea otter population. ***The Edge*** examines the current state of the coast's natural and social environments, gives the historical causes for the coast's present endangerment and offers informed projections on possible scenarios of the coast's future.

A fascinating blend of science, history, sociology and ecology, ***The Edge*** is both a celebration of the coast's natural and cultural uniqueness and a warning of the many complex changes that threaten that uniqueness.

In this era of rapid climate change, the threats to the California coast are serious. As glaciers melt and ocean levels rise, coastal communities are starting to erode, and entire neighborhoods have been lost to the sea. Coastal

–more–

ecosystems and wildlife that were already stressed by human settlement now face new dangers.

But the coast has its heroes and defenders as well. ***The Edge*** presents exciting profiles of the people, organizations and programs that are working to maintain the coast's equilibrium, biodiversity and capacity to support wildlife. Co-authors Kim Steinhardt and Gary Griggs give their personal stories of how their coastal childhoods and personal love of the ocean fostered their commitments to environmental research and activism. Each chapter includes testimonies from ordinary Californians on what the coast means to them and why they think it is worth protecting.

Among the topics covered in ***The Edge*** are:

—A migrating edge: The line where the land meets the sea is never static, and now climate change is steadily eroding the California coastline. ***The Edge*** gives a lucid explanation of the science of sea-level rise, how rising waters are reshaping the California coastline, and how nature is whittling away at coastal land, transforming the California real estate market.

—Oil on the edge: One of the most contentious issues on the coast is offshore oil drilling. ***The Edge*** outlines the science of petroleum formation, the history of oil industry in California, and how oil drilling has repeatedly challenged and galvanized the environmental movement.

—Sea otter survival: Cute, playful and photogenic, sea otters have long been the poster child for coastal wildlife preservation. ***The Edge*** profiles the sea otters' pivotal role in the history of California, their comeback from the verge of extinction, and the ongoing threats this remarkably resilient species still faces.

—Additionally, ***The Edge*** covers the history of human settlement in California, the successes and failures of the environmental movement, detailed accounts of wildlife and human activity, and more.

A masterful and sweeping synthesis of environmental and social science, ***The Edge*** presents a comprehensive portrait of the history, peoples, communities, industries, ecology and wildlife of the coast.

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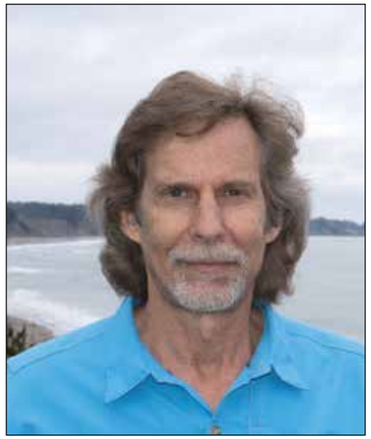
# About Kim Steinhardt

## Co-Author of *The Edge*

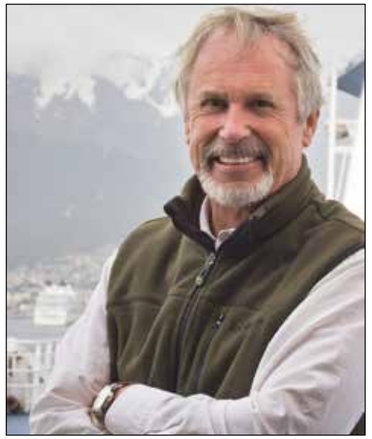


**Kim Steinhardt** delivers popular lectures and photographic programs exploring the universe of sea otters and coastal conservation for aquariums and marine centers, universities, state parks, and other audiences. He has been recognized for his award winning marine wildlife photography and is currently working with National Geographic on publication of a book of his sea otter images and coastal storytelling. He has also served as an advisor regarding sea otters for the NatGeo Kids Explore My World series and, for the last five years, has written a newsletter column about marine wildlife and the ocean. As a long-time conservationist drawing on his former service as a California state administrative law judge, litigator and public interest advocate, he helps translate ocean conservation concerns to the public to build support for citizen action and legislative policymaking.

For more information on ***The Edge*** (Craven Street Books, October 2017) or to arrange an interview with co-authors **Kim Steinhardt** and **Gary Griggs,** please contact Jaguar Bennett at Craven Street Books, (800) 345-4447,Publicity@QuillDriverBooks.com.

# About Gary Griggs

## Co-Author of *The Edge*



**Gary Griggs** has written or co-authored nine books about the coast and coastal issues both in California and globally. As a Distinguished Professor of Earth and Planetary Sciences at the University of California at Santa Cruz, he is known for his expertise in oceanography and coastal geology. He is a frequent contact for news media on questions of climate change, sea-level rise, coastal erosion and other related issues. He has written a popular biweekly newspaper column ("Our Ocean Backyard") for nine years, and is in high demand for talks throughout California. He serves as the director of the Institute of Marine Sciences at the University of California at Santa Cruz, which includes the Long Marine Laboratory and the Seymour Marine Discovery Center, a popular educational destination for tens of thousands of visitors each year.

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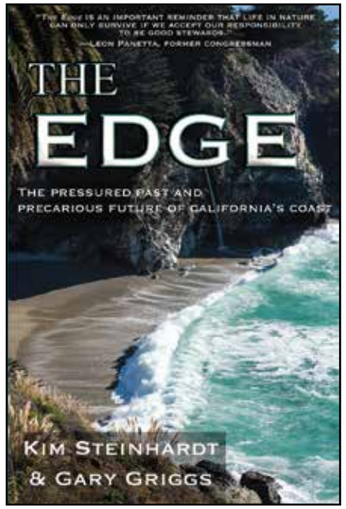
# Advance praise for *The Edge*




"***The Edge*** is an important reminder that life in nature can only survive if we the living accept our responsibility to be good stewards. The legacy of the beauty of our coastline that was passed on to us must be protected for future generations. ***The Edge*** is a comprehensive portrait of the Pacific coast and why we are responsible for its future."
—from the Foreword by **Leon Panetta**, former congressman and chair of the Pew Oceans Commission

"This book captures the magic of the coast. It has an intimate blend of nature, science, politics, policy, culture, history, and adventure, and there is a well-informed urgency that gives readers more than just the information and heightened awareness they need to bring about real change to our ocean policies and practices: It is a personal call to action. Dive in!"
**—Sam Farr**, former congressman and ocean advocate

"Steinhardt and Griggs have created a delightful and insightful tour of California's coastal edge, past, present, and future. They do a masterful job of weaving together the interconnections of the changing natural world over different time scales with the changing societal landscape and human interventions to modify the coastal edge as population grew and societal priorities changed. Their discussions of how those interventions were shaped by clashes between conservationists and those with strong economic motivations are infused with some of their own values. In combination with the first two chapters that introduce the reader to the backgrounds of the authors, these personal views enhance the narrative. Their stories of the boom and bust cycles of many of our fisheries and of populations of marine mammals have many lessons for us today, not only for resource managers, but for everyone concerned with human rights. I recommend this book to all who are interested in one of the most beautiful coasts in the world."
**—Jerry R. Schubel, Ph.D.**, President and CEO, Aquarium of the Pacific

"Kim Steinhardt and Gary Griggs each have had a long love affair with the California coast. You can see it in their personal stories, and how they worry about the long-term effects of human interaction between land and water. This is a must read for anyone who shares their love for the coast and concern for its future."
**—John Laird,** California Secretary for Natural Resources, and Chair of the California Ocean Protection Council

For more information on ***The Edge*** (Craven Street Books, October 2017) or to arrange an interview with co-authors **Kim Steinhardt** and **Gary Griggs,** please contact Jaguar Bennett at Craven Street Books, (800) 345-4447,Publicity@QuillDriverBooks.com.

# The Impact of Sand Nourishment on Beach Safety

LETTERS TO THE EDITOR

# The Impact of Sand Nourishment on Beach Safety

**John Fletemeyer†, John Hearin‡, Brian Haus§, and Andrea Sullivan††**

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Beaches in the United States and around the world have enormous economic, social, and recreational value. In the United States, Houston (1996, 2013) placed the value of beaches at $1.2 trillion annually, and in Florida, Murley (2003) reported that the 825 miles of sandy beaches had an annual impact of $41.6 billion in revenue at that time. The economic value of beaches, particularly those devoted to public recreation, is highly dependent on the aesthetic quality of the beach. However, more than one-half of U.S. beaches are considered to be critically eroded, putting this critical resource at risk.

Beach sand-nourishment programs are increasingly employed to protect coastal development and recreational beaches from the impacts of erosion and to maintain beaches as rates of sea-level rise increase (Table 1). Beach sand-nourishment projects are generally believed to be the most-effective, soft-armoring method for mitigating the impact of erosion and, consequently, for helping to maintain and enhance the recreational value of beaches (Gill *et al.*, 2006) (Figures 1 and 2). Although effective, beach-nourishment projects are known to have potentially negative environmental effects if careful consideration is not made to match sand sources with the hydrodynamics, ecosystem functions, and recreational uses of a particular beach.

Sand for projects comes from two sources: terrestrial quarries and offshore (canals, ports, and borrow pits). Sand is deposited on the beach by hydraulic pumping (Figure 1) or truck haul and then spread over the beach with a variety of heavy equipment, including dozers, backhoes, and graders (Figure 2). Both the physical characteristics of the sand deposited and the methods used for the nourishment must typically meet strict engineering specifications, regarding the potential mobilization of the sand, and environmental standards, related to preserving water quality and nesting habitat for endangered or threatened species, such as sea turtles and/or shorebirds.

Because additional sand must be placed somewhere, renourishment significantly alters the beach morphology and near-shore bathymetry no matter what source, sand characteristics, and deposition methods are used, until natural processes can return the beach to its natural state. On some nourished beaches, those alterations may persist for several years (Hearin, 2014). At John U. Lloyd Beach State Park, for example, 3-m escarpments caused by nourishment remain more than 5 years after the fill was placed (Figure 3).

Only recently (Chester, 2013), has it been considered that such highly perturbed beach morphologies may be negatively affecting the safety of some renourished recreational beaches. Although ample anecdotal evidence (some of which will be presented here) and National Ocean Lifeguard statistics suggest that beach nourishment and the accompanying morphological changes in the beach are contributing to an increase in serious aquatic accidents and drownings, there has not been sufficient research conducted to firmly establish and

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quantify those impacts (Fletemeyer, 2014). Such research is necessary to develop protocols for project design, implementation, and monitoring to reduce the risks to a beach.

Examples of the anecdotal evidence suggesting that there may be negative impacts on beach safety resulting from beach restoration projects are numerous. In Ocean City, Maryland, a lawsuit alleged that a beach-nourishment program substantially modified the natural state of the beach, producing sandbars that were more favorable for rip current formation. This was deemed the proximate cause of a fatal drowning event involving a 24-year-old man. (Sullivan, 2006). Other serious accidents have been blamed on beach nourishments, including the Labor Day, rip-current drowning of a 13-year-old boy on John U. Lloyd Beach, Florida (Figure 4), and a spinal injury resulting in quadriplegia of a man on Naples Beach, Florida.

A growing body of statistics on aquatic incidents also suggests there may be a link between beach renourishment aquatic accidents. Data collected by the United States Lifesaving Association reports that, at Ocean City, Maryland, there was a 297% increase in serious aquatic accidents (87 to 345) in 2006, the year after the beach was nourished (Sullivan, 2006). After a second nourishment program in 2010, accidents increased by 31% (233 to 306) (Chesler, 2013). At Cape May, New Jersey, following a nourishment program completed in 2007, there was a 192% increase in accidents (12 to 35). The most serious injuries sustained were head, spinal, and shoulder dislocations, mostly by teenage males. Given that statistical evidence for a link between renourishment and beach safety, there remains a question of what, specifically, is the cause of the increases in serious injuries and deaths.

Recent studies have pointed to the modified beach morphology altering the nearshore hydrodynamic response to incoming waves and thereby causing increased numbers of incidents related to rip currents. Hearin (2017) analyzed data collected by the Brevard County, Florida Ocean Rescue Division, between 2011 and 2016, which indicated that there was an increase in rip-current rescues and preventive rescues in the North Reach after the most-recent beach nourishment project in 2014 (Figure 5).

Rip currents are responsible for at least 100 fatal drownings on American beaches every year (Lushine, 2011; Lushine *et al.*, 1999), and flash rip currents are often the most deadly because they materialize quickly, unexpectedly, and sometimes during moderate surf conditions (Fletemeyer, 2017; Slattery *et al.*, 2011). On Delray Beach, Florida, after a beach nourishment project in 2008, the number of "flash" rip currents significantly increased from three identified for the 120-day, prenourishment monitoring period, to observations of rip currents on 22 of 100 days after the completion of the nourishment program (Figure 6). In most cases during those 22 days, multiple rip currents were observed along the 3.8-km study area. Fletemeyer (2017) reported that rip-current drowning events are more likely to occur during moderate surf conditions because bathers are more likely to enter the water than during times when the surf is heavier and appears more ominous looking.

The physical links between the renourishment and the increase in rip currents on Delray Beach was attributed to vertical escarpments exceeding 3 m, which regularly formed during periods of moderate and heavy surf conditions (Figure 7 ) and on changes in the compaction of the beach sand. After the completion of the nourishment program in 2008, escarpments were noted on more than 40% of the 3.8-km beach during the first 40 days after nourishment. These escarpments prevented wave energy dissipation, which would typically occur on those otherwise, naturally sloping beaches with wide planforms. Instead, when waves contacted the escarpment barriers, the wave energy was reflected offshore (backwash) increasing the likelihood of rip-current formation. Escarpments with vertical profiles exceeding 3 m were also observed on John U. Lloyd Beach, 5 years after the completion of a nourishment project (Figure 3).

In addition, a significant increase in sand compaction reduced the infiltration of sea water and, consequently, further increased wave backwash. Sand compaction data were collected using a cone penetrometer (as shown in Figure 3) from Delray Beach, John U. Lloyd Park Beach, and Ft. Lauderdale Beach, Florida. Those data showed that shear-compaction values doubled after nourishment. When combined, those conditions promoted flash rip currents during moderate- and heavy-surf environments and, consequently, represented a public safety hazard.

Hearin (2012, 2014) conducted research into the recurring beach-nourish-

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ment projects on the North Reach of Brevard County, Florida, and those projects' impacts on the morphological modal beach state and the associated surfing wave environment. The North Reach of Brevard County has been nourished on three different occasions (2001, 2005, 2014) with sediment from the Canaveral Shoals II borrow site. The composite median grain size of the Canaveral Shoals II borrow site is significantly coarser than the native beach profile (Hearin, 2014; Olsen, 2002), as shown in Figure 8. Additionally, the fill template slope for these projects was 1:15, which is much steeper than the native beach profile slope, which varies from 1:50 to 1:100 (FDEP, 2011; Olsen, 2002). The coarser fill sediment, coupled with the steeper fill profiles, changed the morphological modal state, as defined by Wright and Short (1984), of the beaches in the North Reach from dissipative to intermediate reflective.

The intermediate-reflective modal beach state is defined as a tide-modified system with relatively straight, moderately steep, narrow, usually coarser and cusped, reflective high-tide beach, fronted by a lower-gradient, relatively featureless, intertidal zone, and a wave-dominated low-tide surfzone, usually characterized by bar and rip morphology. At high tide, waves break across a narrow, continuous surfzone. At low tide, a wider surfzone has rips. (NIWA, 2017). Consequently, the surfing wave environment in the North Reach was transformed from a low-intensity beach break, which broke consistently over a wide surfzone, into a tidally dependent beach break, with very narrow surfzones at higher tides and a much higher incidence of plunging breakers (Figures 9 and 10). Sediment-data collections and beach-profile surveys conducted after fill was added suggest that this intermediate modal state persisted for 3–5 years after the fill projects (Hearin, 2014).

In conclusion, several significant morphological changes in beaches have been documented after beach-nourishment projects (Piatkowski, 2002). We believe that these changes could be elevating the probability of rip-current formation on recreational beaches and may have contributed to the increase in accident rates being reported by lifeguards on some recently nourished beaches. These physical changes include the following:

(1) Steeper beach profiles (Dean, 2002; Hearin, 2014; Kraus, 2005; Piatkowski, 2002);
(2) Escarpment barriers forming at or near the high-tide line (Fletemeyer, 2010; Schmitt *et al.*, 2003);
(3) A narrower beach planform (Dean, 2002; Hearin, 2014; Piatkowski, 2002);
(4) A significant increase in sand compaction and hardness (Ehrhart and Roberts, 2001; Fletemeyer, 2010; Nelson *et al.*, 1987);
(5) A significant change in the nearshore bathymetry (Dean, 2002; Hearin, 2014);
(6) A higher incidence of plunging waves breaking closer to shore (Hearin, 2012).

Despite evidence cited above, the authors believe that caution is necessary when attempting to correlate beach nourishment with an increase in serious accidents and drownings. After the completion of a nourishment program resulting in a widened beach, a larger bathing load is to be expected. Consequently, this factor may partially account for more accidents. Nevertheless, considering the increased reliance on nourishment to solve beach-erosion problems and the economic importance of beaches to coastal communities, the authors believe that the subject certainly warrants further research.

In the future, beach-nourishment policies and designs should include measures devoted to promoting beach safety, including the reduction of escarpments and minimizing the likelihood of rip-current formation (Sullivan, 2017). At the very least, until more research on this subject is completed, warnings signs should be strategically placed on beaches that have been recently nourished.

**Figure 1. Hydraulic dredging in Manalapan, Florida.**

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**Figure 2. Mechanical nourishment involving dump trucking sand on the beach in Ft. Lauderdale, Florida.**

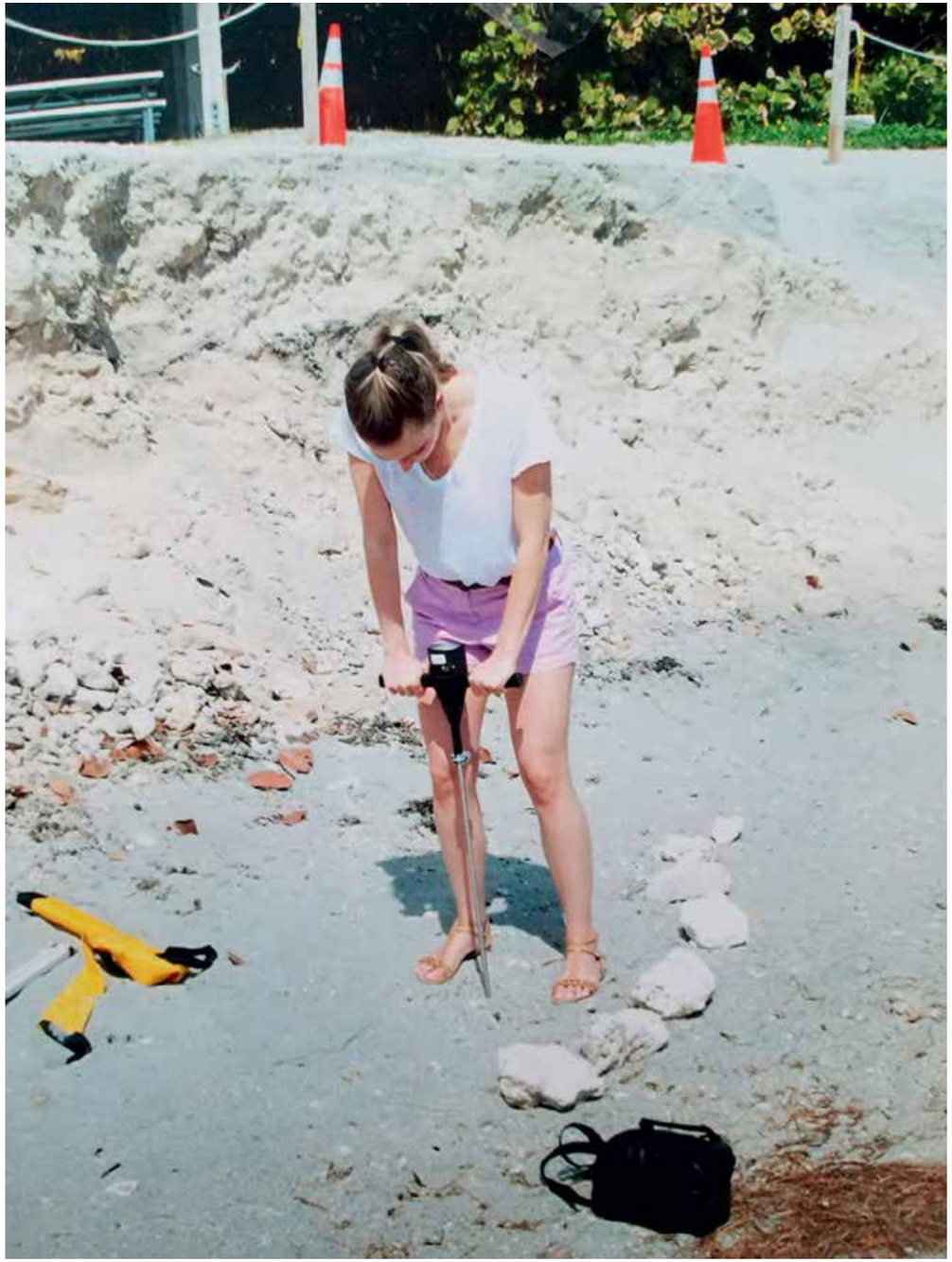

**Figure 3. Beach escarpments on John U. Lloyd Beach State Park, Florida, 5 y after a beach nourishment project. A. Sullivan is demonstrating the use of the cone penetrometer used to monitor compaction of sand after nourish-ment.**

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**Figure 4. Site of the tragic drowning of a 13-y-old boy on John U. Lloyd Beach after a nourishment project.**

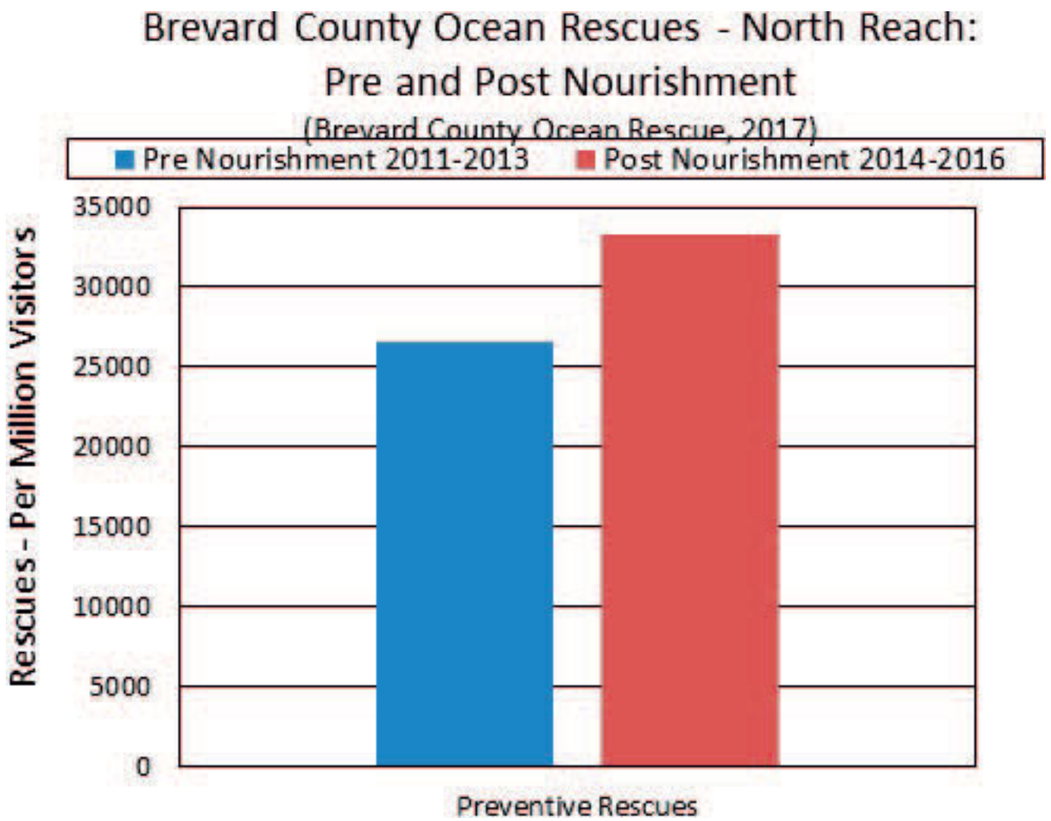


**Figure 5. Preventive rescues in the North Reach of Brevard County, Florida: before and after beach nourishment in 2014. Preventive rescues are defined as rescues in which swimmers receive warnings regarding unsafe conditions (typically rip currents) without being physically touched by the lifeguards. The data have been normalized per million visitors to remove any impact from variations in beach visitations.**

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Figure 6. A flash rip current observed on Delray Beach after a nourishment project.

Figure 7. A typical escarpment on Delray Beach after a nourishment project.

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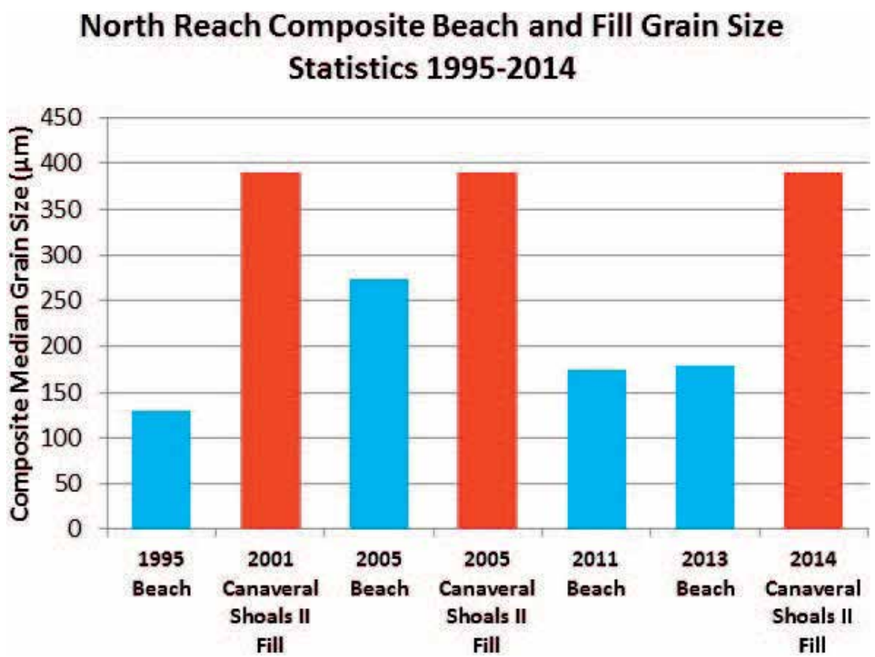



**Figure 8. Composite, median grain size of the beach and borrow site fill sediment for the North Reach of Brevard County, Florida (Hearin, 2014).**

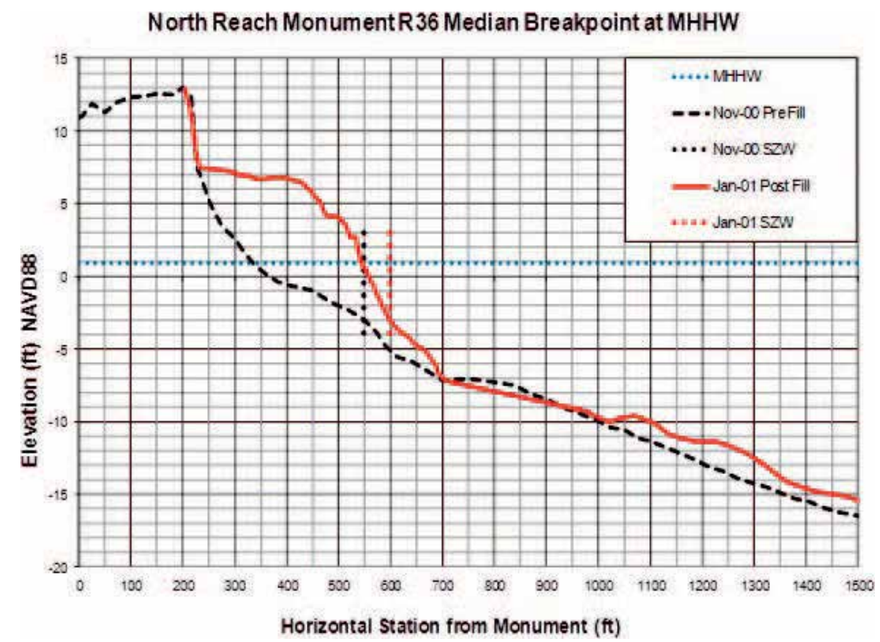
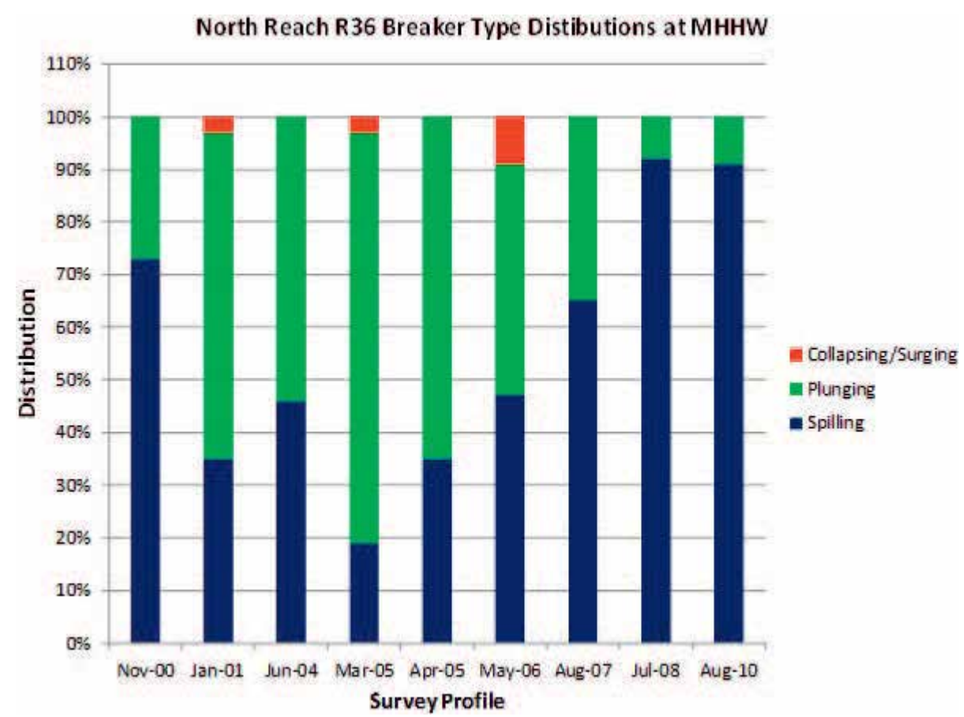



**Figure 9. Beach slope and median surfzone width at high tide in the North Reach of Brevard County, Florida: before and after fill (Hearin, 2012)**

**Figure 10. Distribution of wave breaker types during high tide in the North Reach of Brevard County, Florida. Analysis based on various beach-profile surveys taken before fill (November 2000 and June 2004) and after fill (January 2001, March 2005 through August 2010).**



# IN MEMORIAM

## Paolo Antonio Pirazzoli (1939–2017)

Paolo Pirazzoli was an associate editor of the *Journal of Coastal Research* since 1985, when the inaugural issue was published. He was a long-time friend who will be very much missed. The following are a sampling of comments about the man and his professional accomplishments. Above are some recent photos, arranged in a collage, of Paolo during his last fieldworks and research activities. He was active until the end, a wish probably held by most of us.

Paolo Antonio Pirazzoli was born in Venice (Italy) in 1939 and became a naturalized French citizen in 1979. Paolo had educational and professional backgrounds in civil engineering, coastal geomorphology, and physical geography. Perhaps most notably, he was the international leader of International Geological Correlation Programme (IGCP)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United Nations Educational, Scientific and Cultural Organization–International Union of Geological Sciences Project 200 "Sea-Level Correlation and Applications" (from 1983 to 1987), which included more than 600 participants from 67 countries. Paolo also actively participated in several subsequent IGCP international research projects related to sea-level changes in the Quaternary.

Paolo was a partner in several European Commission (EC) research projects, including: "Investigation of Past and Future European Sea-Level Changes and their Impacts" (1987–90); "Climate Change, Sea-Level Rise and Associated Impacts in Europe" (1991–93); and "Relative Sea-Level Changes and Extreme Flooding Events around European Coasts" (1993–95). He also took part in the EC project "Storminess and Environmentally Sensitive Atlantic Coastal Areas of the European Union" (1997–2000), in the interregional (U.K.-France) project "Beaches at Risk" (2003–05), and in several scientific cooperation programs between France and Greece (1990–91), France and Italy (1996–97 and 1999–2000), and France and Hong Kong (2001–03). In the late 1990s, Paolo participated in a working group of the City of Venice for an assessment of safeguard activities against flooding in the lagoon. More recently, he was an active partner in the French project related to near-future sea-level extremes "Discobole" (2004–07; http://discobole.cetmef.equipement.gouv.fr/discobole).

Paolo's field experience includes geomorphological surveys in several countries around the Mediterranean area, the Pacific region (Japan, Taiwan, French Polynesia), Africa (Senegal, Mauritania, Kenya), and the Indian Ocean (Seychelles, Indonesia, Iran, French "Iles Eparses").

He published several books and more than 250 professional papers in scientific journals. In addition to being an associate editor of the Journal of Coastal Research (published by the Coastal Education and Research Foundation), he served as the editor of *Global and Planetary Change* (Elsevier) since its foundation in 1989.

Beyond being an excellent scientist and accomplished researcher, Paolo was a wonderful colleague, teacher, and mentor. He loved his professional research activities and was active until the very last moment. His most recent (last) paper was published in September of 2017. He served science with pride, honesty, and dignity, as was his whole attitude towards life.

A few years ago, in the beginning of winter, for 10 continuous days, he went swimming and diving along the rocky coasts of the Euboean Gulf from sunset to sundown. He was there, always first, with a smile and a willingness to pass on his knowledge and experience. When he went back home, he had open-heart surgery. A few months later he was fearless, proud, tireless, in the central Aegean, swimming and diving in the middle of nowhere in the name of research!

Nothing could stop Paolo from accomplishing what he wanted, as he was truly dedicated to science. Paolo was a great teacher and a unique mentor to all those who came in contact with him. Paolo is now gone, but he will always be here in our hearts! Because of his high morals and inviting character, his amicable personality helped to shape the persona of many of his colleagues in a positive way. This remarkable attribute of Paolo's personality was reflected in his down to earth approach to life and work, so much so that all those who came in contact with this remarkable man appreciated his humility. In a word, Paolo was a beacon that showed the life, the way, and honor for many of us.

Niki Evelpidou (Greece)
Charles W. Finkl (U.S.A.)

## INVITATION

It is with great pleasure that we invite you to the International Coastal Symposium (ICS2018), to be held from Sunday 13th – Friday 18th May 2018 at the Haeundae Grand Hotel, Haeundae Beach, Busan, Republic of Korea. The theme is 'Safe Coasts Beyond Climate Change and Coastal Development'.
The International Coastal Symposium (ICS) is now in its 15th edition and this is the first time in Asia.

The Symposium is co-hosted by Korea Institute of Ocean Science & Technology (KIOST) and Korean Society of Coastal Disaster Prevention (KSCDP), under the auspices of the Coastal Education and Research Foundation (CERF) and the Journal of Coastal Research (JCR).

The ICS brings together delegates from all over the world to collaborate and discuss the most current coastal research studies and projects. The proceedings of the conference, published as peer-reviewed papers in the Journal of Coastal Research, represent an invaluable resource for coastal scientists, engineers and managers.

Dr. Jae-Seol Shim
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Prof. Insik Chun
Co-Chairman of ICS2018
Ph.D./PE/Professor
Coastal & Harbor Engineering/
Department of Civil Engineering/ Konkuk University
ischun@konkuk.ac.kr

## PROGRAM

| Date | May13 (Sun.) | May 14 (Mon.) | | May 15 (Tue.) | | May 16 (Wed.) | | May 17 (Thu.) | May 18 (Fri.) | May 19. (Sat) |
|---|---|---|---|---|---|---|---|---|---|---|
| Am. | | Opening Plenary, Keynote Speech | | Keynote Speech | | Keynote Speech | | Keynote Speech | Field Trip | Field Trip (Optional) |
| Pm. | | Session 1~5(6) | POSTER | Session 1~5(6) | POSTER | Session 1~5(6) | POSTER | Session 1~5(6) | | |
| | Welcome Reception | | | | | | | Conference Dinner | | |

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## CALL FOR ABSTRACTS

**Abstract submission system is opened from 1st March 2017.**

The ICS2016 Scientific Program Committee invites authors to submit an abstract for either an oral or poster presentation. The conference theme is 'Safe Coasts beyond Climate change and Coastal development'.

### Abstract Guidelines

Please ensure you submit your abstract as a Word document. The abstract template is shown by .

### Themes

Abstracts can be submitted from all areas of coastal science, from Geology to Coastal hazards. The themes* are:

- Rivers and Estuaries
- Tidal inlets
- Dunes and Beaches and Coasts
- Coastal Biology and Ecology
- Coastal Geology
- Continental shelves and slopes
- Coral reefs
- Climate and Sea level change
- Coastline and Estuarine evolution
- Blue carbon
- Coastal hazards
- Hydrodynamics
- Coastal engineering
- Marine renewable energy
- Coastal management
- Managing the coasts of Busan

## KEY DATES

| | | | |
|---|---|---|---|
| 1st Mar. 2017 — Call for abstract submission | 30th June 2017 — Abstract submissions Close | 1st Aug. 2017 — Authors advised of acceptance of abstracts | 1st Aug.~ 31st Oct. 2017 — Paper submissions |
| 1st~30th Nov. 2017 — Paper reviewed | 31st Dec. 2017 — Final papers submitted | 1st Aug. 2017~ 28th Feb. 2018 — Early bird registration | |

## REGISTRATION FEES

| Category | | USD | KRW |
|---|---|---|---|
| Early Bird Registration Until 28 February 2018 | Full Registration | 700 | 800,000 |
| | Student | 450 | 500,000 |
| Standard Registration From 1 March 2018 | Full Registration | 900 | 1,000,000 |
| | Student | 600 | 700,000 |
| Early Bird Registration | CERF Member (5% discount) | 665 | 750,000 |

All registration packages include

- Welcome Reception on Sunday 13 May
- Attendance at all conference sessions
- Conference Dinner on Thursday 17 May
- Choice of a number of full day field trips on Friday 18 May
- Arrival tea & coffee, morning tea, lunch and afternoon tea for the duration of the conference

## CONTACT

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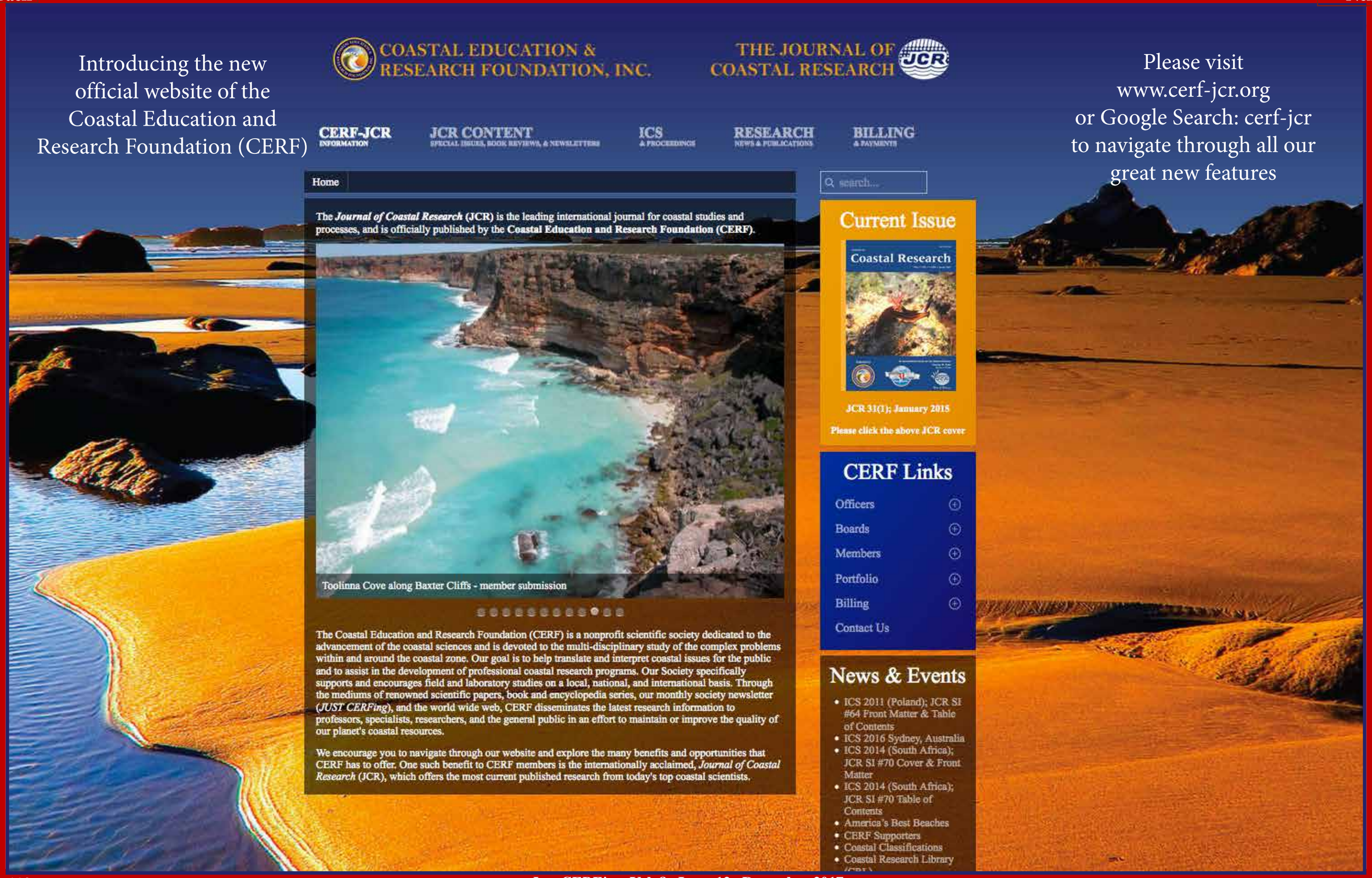
Please visit www.cerf-jcr.org or Google Search: cerf-jcr to navigate through all our great new features



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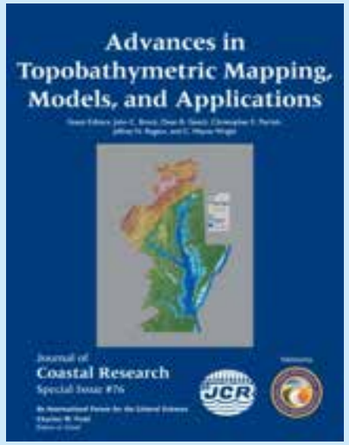


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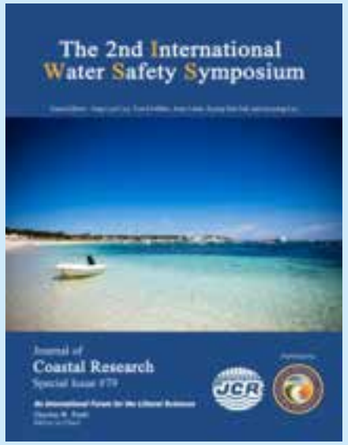


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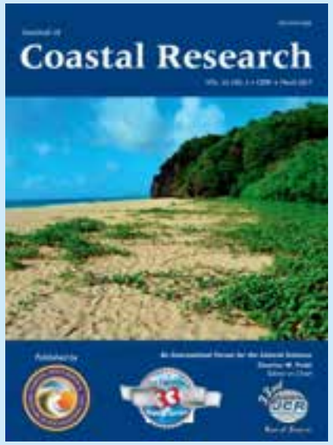


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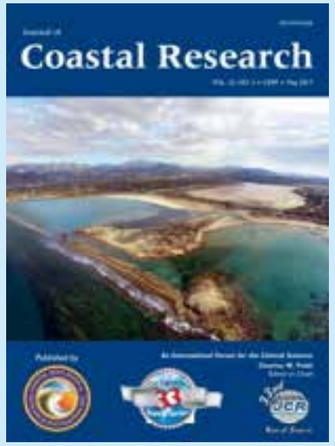


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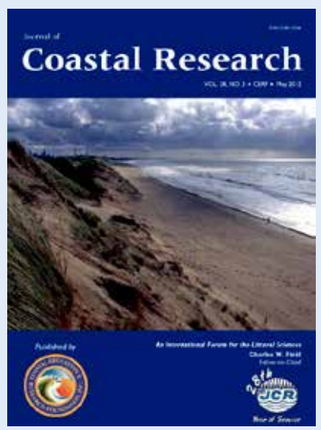
# Publish Your Coastal Photographs in the JCR!

As a CERF member, you have the unique opportunity to become a published photographer in our internationally renowned journal!

All possible submissions must depict some coastal or underwater/marine scene and must be high-quality (>300 dpi) image files in either a jpg, tiff, or gif format. In addition, a short caption must accompany the photograph. The caption should include the specific location of the photograph, the date taken, the geological or coastal significance, and your CERF member contact information (full name, title, phone, email, and CERF member number). Example captions can be found on the Gallery page of this website.




While most submissions will be selected for either the CERF website or inside the JCR, a chosen few will actually be selected to be the cover image of a JCR Issue! So dust off those cameras and submit your photos.

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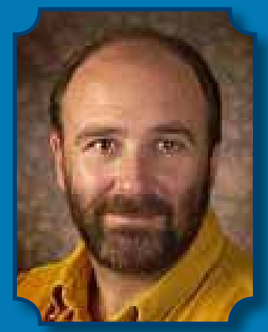

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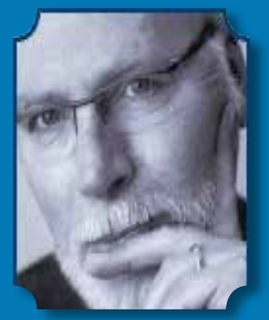

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# *A Special Acknowledgement To:*
# Professor Dr. Charles Lemckert
## CERF-JCR Lifetime Member

We are proud to acknowledge Professor Dr. Charles Lemckert as the Coastal Education & Research Foundation's first ever Lifetime Member. Dr. Lemckert has always showed great support for CERF and the JCR, and even served as the Chair and Organizer of the 9th International Coastal Symposium (ICS) at Griffith University (Queensland, Australia) in 2007. We are honored to have Dr. Lemckert as a Lifetime Member and warmly recognize his devotion to our coastal research society.

Professor Lemckert has active research interests in the fields of physical limnology, coastal systems, environmental monitoring techniques, environmental fluid dynamics, coastal zone management and engineering education. Along with his postgraduate students and research partners he is undertaking research studies on water treatment pond design (for recycling purposes), the dynamics of drinking water reservoirs, the study of whale migration in South East Queensland Waters, end ocean mixing dynamics.

**Selected Publications:**

Ali, A.; **Lemckert, C.J.**; Zhang, H., and Dunn, R.J.K., 2014. Sediment dynamics of a very shallow subtropical estuarine lake. *Journal of Coastal Research*, 30(2), 351-361.

Dunn, R.J.K.; **Lemckert, C.J.**; Teasdale, P.R., and Welsh, D.T., 2013. Macroinfauna Dynamics and Sediment Parameters of a Subtropical Estuarine Lake—Coombabah Lake (Southern Moreton Bay, Australia). *Journal of Coastal Research*, 29(6A), 156-167.

Ali, A.; **Lemckert, C.J.**, and Dunn, R.J.K., 2010. Salt fluxes within a very shallow subtropical estuary. *Journal of Coastal Research*, 26(3), 436-443.

Brushett, B.A.; King, B., and **Lemckert, C.J.**, 2011. Evaluation of met-ocean forecast data effectiveness for tracking drifters deployed during operational oil spill response in Australian waters. *In*: Furmańczyk, K.; Giza, A., and Terefenko, P. (eds.), Proceedings from the International Coastal Symposium (ICS) 2013 (Plymouth, United Kingdom). *Journal of Coastal Research,* Special Issue No. 64, pp. 991-994.

**Lemckert, C.J.**; Zier, J., and Gustafson, J., 2009. Tides in Torres Strait. *In*: da Silva, C.P. (ed.), Proceedings from the International Coastal Symposium (ICS) 2009 (Lisbon, Portugal). *Journal of Coastal Research*, Special Issue No. 56, pp. 524-528.

**For a complete list of Dr. Lemckert's publications or his contact information, please visit:**
**https://www.canberra.edu.au/about-uc/faculties/arts-design/courses/undergraduate/arts-in-architecture/tabs/staff/architecture-staff/lemckert,-prof.-charles**

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# *A Special Acknowledgement To:*
# Professor Yong-Sik Cho
## CERF-JCR Lifetime Member

We are proud to acknowledge Professor Yong-Sik Cho as a Lifetime Member of the Coastal Education & Research Foundation. Professor Cho, Yong-Sik received his bachelors and masters degrees from Hanyang University in February 1981 and August 1988 respectively, and his Ph.D. from the School of Civil and Environmental Engineering of Cornell University in January, 1995. The title of the thesis is Numerical Simulations of Tsunami Propagation and Run-up (Advisor: Professor Philip L.-F. Liu).

He had continuously worked at Cornell University as a Post-Doctoral Associate after graduation. From March of 1997, he had been employed as an Assistant Professor at the Department of Civil and Environmental Engineering at Sejong University and then moved to Hanyang University in March, 2000. From February 2003 to January 2005, he had served as the Chair of the Department of Civil and Environmental Engineering at Hanyang University. Professor Cho has served as the Director of Innovative Global Construction Leader Education Center, a government enterprises sponsored by the Ministry of Education, Science and Technology, and the Chair of Graduate Studies of the Department of Civil and Environmental Engineering since 2006.

Professor Cho has published 52 journal papers in prominent international journals registered in Science Citation Index such as *Coastal Engineering*, the *Journal of Coastal Research*, the *Journal of Fluid Mechanics*, the *Journal of Hydraulic Research*, *Physics of Fluids*, the *Journal of Geophysical Research*, the *Journal of Engineering Mechanics*, *and Ocean Engineering*. He has also published 120 papers in domestic journals and about 360 proceedings in international and domestic conferences. Professor Cho has also registered eight patents.

**Selected Publications:**

Kim, Y.-C.; Choi, M., and **Cho, Y.-S**., 2012. Tsunami hazard area predicted by probability distribution tendency. *Journal of Coastal Research*, 29(5), 1027-1038.

**Cho, Y.-S**., 2012. Numerical study for spreading of a pollutant material in coastal environment. *Energy Sources*, Part A, 34(16), 1459-1470.

**Cho, Y.-S.**; Kim, T.-K.; Jeong, W.-C., and Ha, T.-M., 2012. Numerical simulation of oil spill in ocean. *Journal of Applied Mathematics*, 2012, 1-15.

**For a complete list of Professor Cho's publications or his contact information, please visit: http://civil.hanyang.ac.kr/coast/**

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## *A Special Acknowledgement To:*

# Professor Ya-Ping Wang
# CERF-JCR Lifetime Member

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DEGREES AND DIPLOMA

July, 2000: Ph.D. (Marine Sediment Dynamics), Institute of Oceanology, Chinese Academy of Sciences (China)
July, 1997: M.Sc. (Coastal Geomorphology and Sedimentology), Department of Geography, Nanjing Normal University (China)
July, 1994: B.Sc. (Geomorphology and Quaternary Geology), Department of Geo-Ocean Sciences, Nanjing University (China)

RESEARCH INTERESTS

Marine Sediment Dynamics; Benthic Boundary Layer Processes; Estuarine and Coastal Morphodynamics

RESEARCH PROGRAMMES (PI)

Monitoring and Development of support system on seabed topographical changes in Pearl River Estuary and Taiwan Shoal. Ocean special funds for scientific research on public causes (No. 201105001-2). 2011-2014. RMB 1,570,000 (about USD240,000).

Simulation on the evolution and realignment of North branch, Changjiang Estuary (No. BK2010050). Jiangsu Key NSF. 2010-2012. RMB 250,000 (about USD38,000).

Physical processes near bottom boundary layer in shallow seas with strong tides and high turbid water. China NSF (No. 40876043). 2009-2011. RMB 500,000 (about USD77,000).

Study and strategy on typical marine hazards of Hainan. Comprehensive Survey and Evaluation Program of Coastal Sea, Hainan Province (No. HN908-02-05). 2008-2011. RMB 250,000 (about USD38,000).

Sediment dynamics and associated environment response in intertidal area and estuary. Program for New Century Excellent Talents in University(No. NCET-06-0446). 2007-2009. RMB 500,000 (about USD77,000).

Wave-current dynamic processes and tidal basin system evolution over tidal flats. China NSF (No. 40576040). 2006-2008. RMB 380,000 (about USD58,000).

The estuary evolution by human activity impacts and associated hazards potential analysis. Jiangsu NSF (No. BK2006131). 2006-2008. RMB 75,000 (about USD12,000).

Siltation hazard and strategy on major embayment and estuary. National Comprehensive Survey and Evaluation Program of China Coastal Ocean (No. 908-02-03-08). 2005-2009. RMB 250,000 (about USD38,000).

Physical oceanography and marine meteorological survey in Jiangsu coastal sea. National Comprehensive Survey and Evaluation Program of China Coastal Ocean (No. JS-908-01-01). 2005-2009. RMB 921,000 (about USD140,000).

SELECT PUBLICATIONS; Refereed Publications (English papers only)

Huang, H; **Wang, Y.P.**; Gao, S.; Chen, J.; Yang, Y., and Gao J., 2012. Extraction of morphometric bedform characteristics from profiling sonar datasets recorded in shallow coastal waters of China. *China Ocean Engineering*, 26(3), 469-482.

Yunling Liu, Y.; **Wang, Y.P**.; Li, Y.; Gao, J.; Jia, J.; Xia, X., and Gao, S., 2012. Coastal embayment long-term erosion/siltation associated with P-A relationships: A case study from Jiaozhou Bay, China. *Journal of Coastal Research*, 28(5), 1236-1246.

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## *A Special Acknowledgement To:*

# Professor Nicholas K. Coch, Ph.D., C.P.G

## CERF-JCR Lifetime Member

We are proud to acknowledge Professor Dr. Nicholas K. Coch as a Lifetime Member of the Coastal Education & Research Foundation. Dr. Coch received his Ph.D. in 1965 from Yale University with a specialization in sedimentology and coastal geology. In 1967, he joined the faculty at Queens College of the City University of New York (CUNY). He is now a Professor of Geology in the School of Earth and Environmental Sciences at Queens College of C.U.N.Y. and a member of the Doctoral Faculty of CUNY at the Graduate Center. He has co-authored two college geology textbooks (PHYSICAL GEOLOGY) and is the author of GEOHAZARDS (Pearson). In 2008, he received the President's Award for Teaching Excellence at Queens College and the John Moss Award For Excellence in College Teaching from the National Association of Geology Teachers. His research studies since 1967 have included sedimentation on the Moon, as a Principal Investigator in NASA's Lunar Sample Study Program, and shipboard studies of continental shelf, coastal and estuarine areas in the Northeast, as well as ground and aerial studies of the effects of hurricanes on coasts and urban centers.

His recent research deals with the effects of hurricanes on coasts, urban centers and inland areas, in predicting hurricane damage and in critically analyzing our coastal management policies in a time of sea level rise. He has carried out ground and aerial studies of most recent hurricanes as well as forensic studies of older (16th-20th century) hurricanes.

He is a Fellow of the Geological Society of America and a Member of The American Meteorological Society, Society of Sedimentary Geologists, National Association of Geology Teachers, American Association of Petroleum Geologists and is a Certified Professional Geologist.

Dr. Coch is an expert on Northern Hurricanes and has been a consultant to the N.Y. City Emergency Management Organization and the N.Y.S. Office of Emergency Management. He has presented hurricane seminars to emergency management and government officials in every county in southern New York as well as insurance, reinsurance and risk management groups nationwide. In 2003, he was chosen as a Sigma Xi Distinguished Lecturer for 2004-2007, and presented lectures on his research at educational and research facilities in the U.S. and Canada.

Programs including aspects of his hurricane research have aired on the CNN, PBS, Weather, Discovery, History and National Geographic Channels, and in local, national and international news programs and periodicals.

**Selected Publications:**

**Coch, N.K.**, 2015. Unique vulnerability of the New York-New Jersey Metropolitan Area to Hurricane Destruction. *Journal of Coastal Research*, 31(1), 196-212.

**Coch, N.K.**, 2013. A field course in tropical coastal geology. *Journal of Coastal Research*, 29(6A), 214-225.

**Coch, N.K.**, 2006. The unique vulnerability of the Northeast U.S. to hurricane damage. Geologic Society of America, Abstract with programs, National G.S.A. Meeting (Philadelphia, Pennsylvania).

**For a complete list of Dr. Coch's publications or his contact information, please visit:**

**http://www.qc.cuny.edu/Academics/Degrees/DMNS/sees/People/Pages/FacultyResearch.aspx?ItemID=23**

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# *A Special Acknowledgement To:*

## Hany Elwany, Ph.D.

## CERF-JCR Lifetime Member

**President, Coastal Environments**
**2166 Avenida de la Playa**
**La Jolla, California, U.S.A.**

We are proud to acknowledge Dr. Hany Elwany as a Lifetime Member of the Coastal Education & Research Foundation. Dr. Elwany received a B.S. degree in Engineering from Alexandria University in 1971. In 1977, he completed his Ph.D. at the University of Dundee, United Kingdom. He obtained an additional B.S. degree in Mathematics and Statistics at Alexandria University in 1980. Dr. Elwany has extensive experience with nearshore oceanography, coastal processes, coastal engineering, and estuarine dynamics. He was the principal investigator for the physical oceanographic program of one of the largest environmental studies ever conducted on the U.S. west coast (at San Onofre). He has conducted in-depth studies of Nile Delta erosion, particularly since the construction of the Aswan Dam. His experience also includes projects involving optimization, numerical modeling, structural dynamic analysis, design of offshore structures, and data analyses, simulation, and dynamic modeling of ocean and coastal conditions. As an educator, both at Liverpool and Alexandria Universities, he taught courses in dynamics, statistics, numerical analysis, computer applications, and maritime engineering.

Dr. Elwany also serves as the President of Coastal Environments, a unique multi-disciplinary oceanographic, coastal engineering, and environmental consulting firm. Coastal Environments, founded in 1988, is comprised of over 30 professional associates, all experts in their respective fields. Technical specialties include coastal and ocean engineering, engineering geology, oceanography, marine biology and geology, environmental analysis, economics, statistics, and computer programming/modeling.

**For more information about Dr. Elwany and Coastal Environments, please visit:**

**http://coastalenvironments.com/**

 *Continued on Next Page* 

*A Special Acknowledgement To:*

# Björn Kjerfve, Ph.D., Chancellor

## CERF-JCR Lifetime Member

**American University of Sharjah**
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We are proud to acknowledge Dr. Björn Kjerfve as a Lifetime Member of the Coastal Education & Research Foundation. He is the former Dean of the College of Geosciences and was a Professor of Oceanography at Texas A&M University, 2004-2009. While at Texas A&M, he oversaw four academic departments, the Texas Sea Grant Program, and the Integrated Ocean Drilling Program (IODP), including the 475'ocean sciences drilling vessel, D/V JOIDES Resolution. Kjerfve was previously Professor of Marine and Geological Sciences at the University of South Carolina, 1973-2004, and served as the Director of the Marine Science Program, 2000-2004. He received Ph.D., M.S., and B.A. degrees from Louisiana State University (Marine Sciences), University of Washington (Oceanography), and Georgia Southern University (Mathematics), respectively.

Professor Kjerfve's expertise is coastal and estuarine physical oceanography. He has published some 12 books and 250 scientific journal papers, book chapters, and reports; has supervised 14 Ph.D. dissertations and 24 M.S. theses, and taught more than 6,000 oceanography students. His research includes problem-solving in estuarine and coastal waters as well as climate change and has attracted $20 million in research funding for 90 projects. Dr. Kjerfve's field research has taken place along the East and Gulf coasts of the USA, the Caribbean, Brazil, Mexico, Colombia, Chile, Thailand, Malaysia, the Persian Gulf, Papua New Guinea, and Australia. Dr. Kjerfve was elected as a corresponding member of the Academia Brasileira de Ciências, the Brazilian Academy of Sciences in 2012. Dr. Kjerfve has served as the President of the World Maritime University from 2009 to 2014. He now has the great honor of serving as the fourth Chancellor of the American University of Sharjah in the UAE.

Selected Publications:

Cavalcante, G.H.; **Kjerfve, B**.; Bauman, A.D., and Usseglio, P., 2011. Water currents and water budget in a costal mega-structure, Palm Jumeirah Lagoon, Dubai, UAE. *Journal of Coastal Research*, 27(2), 384-393.

Cavalcante, G.H.; **Kjerfve, B**.; Knoppers, B., and Feary, D.A., 2010. Coastal currents adjacent to the Caeté Estuary, Pará Region, North Brazil. *Estuarine Coastal and Shelf Science*, 88(1), 84-90.

Medeiros, C. and **Kjerfve, B**., 2005. Longitudinal salt and sediment fluxes in a tropical estuary: Itamaracá Brazil. *Journal of Coastal Research*, 21(4), 751-758.

Perillo, G.M.E. and **Kjerfve, B**., 2005. Regional estuarine and coastal systems of the Americas: An introduction. *Journal of Coastal Research,* 21(4), 729-730.

For a complete list of Dr. Kjerfve's publications or
his contact information, please visit: http://www.aus.edu

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# *A Special Acknowledgement To:*

## Associate Professor Wei Zhang, Ph.D.

## CERF-JCR Lifetime Member

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**Hohai University**
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**http://www.hydro-lab.cn/index_english.asp**

Dr. Wei Zhang works as an associate professor of Harbor, Coastal, and Offshore Engineering in State Key Laboratory of Hydrology-Water Resources and Hydraulic Engineering, Hohai University. He focuses on the tidal current, sediment and salinity movement and transportation laws of estuaries and coasts. Dr. Zhang has published over 20 papers in recent years, including five papers indexed by SCI and EI. He took part in one Key Project of National Nature Science Foundation of China, one 95th Year Key Science and Technology Project for the Ministry of Transport, and two Science and Technology Research Projects of Guangdong Province. He has also led youth projects for the National Nature Science Foundation.

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# *A Special Acknowledgement To:*

# Charles Thibault

## CERF-JCR Lifetime Member

**Department of Earth Sciences**
**The University of Memphis**
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Chuck Thibault is currently a Ph.D. candidate at the University of Memphis and a Geologist for EarthCon, Inc. Mr. Thibault received his M.S. from the University of Washington (Geology) and a B.S. from the University of Memphis (Geology). His research interests include coastal and environmental hydrogeology and coastal geomorphology. His current research investigates the movement of storm surge generated saline water plumes through coastal surficial aquifers. Mr. Thibault's field research has taken place along the U.S. coasts of Mississippi, Louisiana, and Washington, and on the eastern coast of Kamchatka, Russia.

**For more information, please contact Mr. Thibault at: cthibalt@memphis.edu**

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# *A Special Acknowledgement To:*
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We are proud to acknowledge Dr. Erik Van Wellen as a Lifetime Member of the Coastal Education and Research Foundation. Dr. Van Wellen received M.Sc. degrees from both the Artesis Antwerpen (Civil Engineering) and the University of Liverpool (Maritime Civil Engineering). In 1999, he subsequently received his Ph.D. from the University of Plymouth with a specialization in sediment transport modeling. He has authored several papers in prominent international journals and conference proceedings.

He has research interests in the fields of natural marine sediment dynamics and mechanically driven sediment transport, renewable energy, carbon-economics, operational optimization, data analyses and mathematical simulations. During his time on the EuDA (European Dredging Association) Environment Committee he fostered a keen interest in Integrated Coastal Zone Management strategies and how to best balance the competing interests of developments such as harbor facilities, coastal defenses, tourism infrastructures and coastal environment conservation; including how best to strike a balance with mitigation and compensation.

He has previously worked as a commercial diver; and since 1999 has worked for the DEME Group (Dredging, Environmental and Marine Engineering) where he has held several operational, technical and commercial roles in a worldwide setting and is currently employed as an international Project Director.

He is a Fellow of the Institution of Civil Engineers and a Fellow of the Royal Geographical Society, a Member of the Chartered Institute of Arbitrators and a Member of the CEntral Dredging Association. Dr. Van Wellen is a Registered Professional Engineer in continental Europe (EUR ING), the UK (CEng) and internationally IntPE(UK). He is considered an expert in such matters as Civil Engineering, Maritime Construction and Dredging; and has considerable knowledge in the field of contract law and alternative dispute resolution. He also has several patents related to aforementioned technical fields registered to his name.

When not working on engineering or maritime construction projects he can be found teaching diving as a Staff Instructor for the Professional Association of Diving Instructors or actively involved in conservation work such as Dive Against Debris or Project AWARE Shark Conservation. His outstanding underwater photographs have graced the cover of the *Journal of Coastal Research* (JCR) more than once.

**For a complete list of publications and more information, please contact Dr. Van Wellen *via* Skype on: vanwellenerik.**

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# *A Special Acknowledgement To:*

# Frédéric Bouchette, Ph.D.
## CERF-JCR Lifetime Member

**Associate Professor of Littoral Dynamics**
**Geosciences Montpellier**
**UMR 5243 – University of Montpellier / CNRS**

Following a M.Sc. in physics and mechanics, Fred Bouchette received his Ph.D. in March 2001 from the University of Montpellier, South of France. The title of the thesis is Wave/Seabottom Interaction: The Liquefaction Process (free translation from French; advisor: Professor M. Séguret). After his Ph.D., Fred had been employed at the University of Montpellier as an associate professor in the department of Geosciences. From 2008 to early 2011, he had moved to the Institute of mathematics and modeling of Montpellier for a three years long stay. Then, until 2012, he has been hosted as an invited professor in the METOS laboratory at the University of Oslo, Norway. He is now back to the University of Montpellier in the same department of Geosciences.

From 2002, Fred was asked to build a scientific staff on littoral hydro-morphodynamics called GLADYS (www.gladys-littoral.org). From that time, the group GLADYS has grown progressively. At now, Fred co-leads the group GLADYS, which rallies most of the scientists working on littoral hydro-morphodynamics along the French Mediterranean Coast, with distinct approaches ranging from applied mathematics to geosciences.

The scientific activity of Fred Bouchette concerns the development of concepts and methods in relation with the dynamics of shallow water environments. He studies the domain that extends from a few tens of meters of water depth at sea to the coastal watershed onshore, with a strong emphasis on the littoral area and the shoreline itself. He has worked in Spain, Taiwan, Canada, Norway, Chad, Italy, Greece, Switzerland, Tunisia, in the French Alps and in the Gulf of Lions (Mediterranean Sea). As testified by his publications, his research combines various points of view from geophysics to geology, including applied mathematics, civil engineering, quantitative geomorphology, with a strong connection to coastal archeology and the analysis of littoral hazards. Nevertheless, his heart's passion still lies with geophysics and applied mathematics.

Presently, Fred Bouchette actively works on the conceptualization of the growth of long term shoreline instabilities such as cuspates or sand spits. On that topic, his last contribution for the *Journal of Coastal Research* (JCR) is the following proceeding:

**Bouchette, F.; Manna, M.; Montalvo, P.; Nutz., A.; Schuster, M., and Ghienne, J.-F., 2014. Growth of cuspate spits. *In*: Green, A. and Cooper, J.A.G. (eds.), *Proceedings from the International Coastal Symposium (ICS) 2014 (Durban, South Africa)*. *Journal of Coastal Research*, Special Issue No. 70, pp. 47-52.**

Fred Bouchette has published>50 papers and short papers in international journals such as *Coastal Engineering*, *Journal of Coastal Research*, *Discrete and Discontinuous Dynamical Systems*, *Journal of Geophysical Research, Sedimentology, Continental Shelf Research*, *Quaternary Research, Ocean Engineering, Marine Geology, and Climate Research*. Most of his works were performed with and for students. He has contributed to more than 80 proceedings in international or domestic conferences. Fred Bouchette also heads the scientific development of a HPC numerical platform for coastal engineering (www.mirmidon.org).

**For a complete list of publications and more information, please visit:**
**www.bouchette.org**

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## *A Special Acknowledgement To:*

# Dr. Stephen P. Leatherman

## CERF-JCR Lifetime Member

**Department of Earth & Environment**
**Laboratory for Coastal Research**
**Florida International University**
**Miami, FL 33199**
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We are proud to acknowledge Dr. Stephen P. Leatherman as a Lifetime Member of the Coastal Education and Research Foundation (CERF). Dr. Leatherman is Professor and Director of the Laboratory for Coastal Research at Florida International University. He received his Ph.D. in Environmental (Coastal) Sciences from the University of Virginia, and completed his undergraduate degree in Geosciences at North Carolina State University.

Prior to joining FIU, Stephen was Professor and Director of the Laboratory for Coastal Research at the University of Maryland; Director of the National Park Research Unit at the University of Massachusetts, Amherst; and Assistant Professor in the Department of Geology at Boston University.

Stephen has authored or edited 16 books, including Sea Level Rise: Causes and Consequences; Barrier Island Handbook; Overwash Processes; Cape Cod: From Glaciers to Beaches; and America's Best Beaches. He has also authored over 200 journal articles and technical reports, including articles in both Science and Nature.

Stephen has provided expert testimony multiple times for the U.S. Senate and U.S. House of Representatives. He was also the on-screen host and co-producer of the 1992 film "Vanishing Lands", winner of three international film awards, including the Golden Eagle.

**For more information, please contact Dr. Leatherman at:**
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# *A Special Acknowledgement To:*

# Dr. Philip D. Osborne

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We are proud to acknowledge Dr. Philip D. Osborne as a Lifetime Member of the Coastal Education and Research Foundation (CERF). Dr. Osborne is the Principal Senior Coastal Geomorphologist at Golder Associates [British Columbia, Canada]. Of particular note was when a Certificate of Achievement in the technological and ecological safety contribution category was presented to Dr. Osborne by Confidence Capital and the Organization for Security and Co-operation in Europe (OSCE) in recognition of Golder's contribution in the field of promoting environmental and industrial safety. Dr. Osborne gave a presentation at the organization's 2nd International Conference on "Onshore and Offshore Oil Spills: Prevention and Response" conference held in Almaty, Kazakhstan in March 2013, where his topic was the Experimental Offshore Air & Water Quality Monitoring System (AWQMS) for the D-Island. He spoke about Golder's experience with the installation and first year of operation of the water quality monitoring system in the North Caspian Sea being used to establish project baseline and an early warning system for project related environmental impacts.

Established in 1960, Golder is a global, employee-owned organization driven by the purpose to engineer earth's development while preserving earth's integrity. Their goal is to help their clients find sustainable solutions to the challenges society faces today including extraction of finite resources, energy and water supply and management, waste management, urbanization, and climate change. Golder does this by providing a wide range of independent consulting, design and construction services to their clients in specialist areas of earth, environment, and energy.

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# *A Special Acknowledgement To:*

# Dr. Yoshi Saito

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We are proud to acknowledge Dr. Yoshiki Saito as a Lifetime Member of the Coastal Education and Research Foundation (CERF). Dr. Saito (D.Sc.) is the Prime Senior Researcher and Leader of the Coastal Sedimentology Research Group for the Institute of Geology and Geoinformation (IGG) at the Geological Survey of Japan (GSJ), AIST. His principle research interests are shallow marine sedimentology, modern sedimentary processes, sequence stratigraphy, strata formation, and human impacts. Current projects that Dr. Saito is working on include deltas in Southeast and East Asia, strata formation, sequence stratigraphy, morphodynamics, and modern sedimentary processes of deltas and incised-valley fills, with close links to sea-level changes, climate changes and human impacts. His credentials also include Leader of the Asian Delta Project (IGG/AIST), Co-Leader of IGCP-475 "Deltas in the Monsoon Asia-Pacific region: DeltaMAP", Leader of CCOP "Integrated Geological Assessment of Deltas in the SE and E Asian region: DelSEA-II" Project, and Leader/Chief Coordinator of JSPS AA Science Platform Program "Mega-Delta Watching in Asia: Networking and Capacity Building.

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# *A Special Acknowledgement To:*

# Prof. Dr hab. Kazimierz Furmańczyk

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We are proud to acknowledge Prof. Dr hab. Kazimierz Furmańczyk as a Lifetime Member of the Coastal Education and Research Foundation (CERF). Dr. Furmańczyk is currently Full Professor at the University of Szczecin and co-founder (with prof. S. Musielak) of the Institute of Marine and Coastal Sciences (IMCS). His active research interests include morphodynamics of the coastal zone using remote sensed methods. Since 1991, Dr. Furmańczyk has been a Polish coordinator of several EU Projects: BASYS, CoastLearn, EUROSION, MESSINA, and MICORE. Together with his staff, he has also participated in the SatBałtyk project (Satellite monitoring of the Baltic Sea) since 2009. Dr. Furmańczyk is also responsible for lecturing at Erasmus (IP) international summer schools: on ICZM in Porto (2002) and Ponta Delgada (2003); on *Multidisciplinary Approach to Flood Risk Analysis - IMARA* in Italy (2010-2012); *Multirisk Assessment and Mitigation in Europe MIRAME* in San Giovanni Valdarno - Italy (2013) and Aveiro – Portugal (2014); and also at the Erasmus Mundus study on *Water River and Coastal Management* in Faro - Portugal. He served as the Chair and Organizer of the 11th International Coastal Symposium (ICS) at Szczecin University (Poland) in 2011.

In 1999, Dr. Furmańczyk received the Fulbright Senior Grant when he visited the University of Florida in Gainesville. He was also given a German DAAD grant for visiting the Christian Albert University of Kiel. Dr. Furmańczyk is an initiator and editor of a periodic: *ICZM in Poland – present state and perspectives*, edited by University of Szczecin. Since 2005, he has edited 5 volumes and has several achievements in research of the South Baltic coastal development regularities, which were provided in numerous papers. Recently, the greatest achievements of his staff are: construction of a prototype of *Early Warning System – Storm impact forecasting* www.micore.eu and construction of sub-system, SatBaltic - Coast" as a part of SatBałtyk system www.satbaltyk.pl

**Selected Recent Publications:**


- Musielak, S.; **Furmańczyk, K.**, and Bugajny N., in press. Factors and processes forming the Polish Southern Baltic Sea coast on various temporal and spatial scales. *In*: Harff, J.; Furmanczyk, K., and von Storch, H. (eds.), *Coastline changes of the Baltic Sea from South to East - Past and Future Projection*. Coastal Research Library (CRL), Dordrecht, The Netherlands: Springer International Publishing.
- Bugajny, N. and **Furmańczyk, K.**, in press. Comparison of short-term changes caused by storms along natural and protected sections of the Dziwnow Spit, Southern Baltic Coast. *Journal of Coastal Research*.
- **Furmańczyk, K**. and Musielak, S., 2015. Polish spits and barriers. *In*: Randazzo, G.; Jackson, D.W.T., and Cooper, J.A.G. (eds.), *Sand and Gravel Spits.* Coastal Research Library (CRL), Volume 12, Dordrecht, The Netherlands: Springer International Publishing, pp. 181-195.
- Bugajny, N. and **Furmańczyk, K**., 2014. Dune coast changes caused by weak storm events in Miedzywodzie, Poland. *In*: Green, A.N. and Cooper, J.A.G. (eds.), *Proceedings from the International Coastal Symposium (ICS) 2014* (Durban, South Africa). *Journal of Coastal Research*, Special Issue No. 70, pp. 211-216.


For more information, please contact Dr. Furmańczyk at:
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## *A Special Acknowledgement To:*

# Dr. Gonzalo Malvárez

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# *A Special Acknowledgement To:*

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Dr. Fatima Navas is head of the "Coastal Environments" Research Group (RNM-911) and Profesora Titular at Universidad Pablo de Olavide in Seville (Spain). She is also Sponsor Associate at Ulster University (UK). She has extensive experience in coastal processes, integrated coastal zone management, coastal tourism and spatial data information and mapping. Her research focuses in coastal morphodynamics, environmental impacts caused by human activities in coastal areas, sustainable management for tourism development in the Mediterranean, as well as storminess and environmentally sensitive coastal areas of the European Union. She is involved with the design and implementation of higher education programs, both graduate and postgraduate, as well as participated in numerous research projects, such as the EU ECHO Civil Protection FLOOD-CBA, ECOSHAZ, FLOOD-CBA#2, EU FP7 Program PEGASO, MEDINA Projects, and EU MED Program COASTGAP, among other projects. Her scientific work has been published in international impact index journals such as, for example, *Geology*, *Marine Geology*, *Journal of Coastal Research*, *Journal of Coastal Conservation*, *Journal of Tourism Management, and Coastal Engineering.*

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# *A Special Acknowledgement To:*

# Prof. Tetsuya Kusuda

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**The University of Kitakyushu**
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**Research Fields:**

1. Urban Water and Wastewater Systems
2. Aquatic Environmental Conservation
3. Water resources and efficient use
4. Water pollution control
5. Principles of Environment

**Specific Research Themes:**

1. Integrated planning of water circulation system in watersheds
2. Water use and reuse
3. Water pollution control and rehabilitation in rivers and coastal zones
4. Principles of Environment- sustainable society
5. Appropriate technology for environment

**Select Publications:**

Arao, S.; Mihara, S.; Kohara, R.; Sasaki, Y.; Hiratuka, S., and **Kusuda, T.**, 2017. Energy losses at three-way circular drop manholes with three pipes considering the drop gap between two influent pipes with different diameter. *Journal of Hydrological Engineering,* 73(4), 685-690.

Makhmudov, K.; Mitani, Y., and **Kusuda, T.**, 2015. Forecasting of a Condition of Groundwater in Arid Areas According to Climatic Factors. *Journal of Water Resource and Protection,* 7, 463-470.

Makhmudov, K.; Mitani, Y., and **Kusuda, T.**, 2015. Interpolation of Climatic Parameters by Using Barycentric Coordinates. *World Journal of Environmental Engineering,* 3(1), 1-6.

Usmanove, S.; Mitani, Y., and **Kusuda, T.**, 2015. Evaluation of Interporpolation Methods for Spatial Modeling of Reference Evapotransspiration Using Modifies Hargreaves Equation. *Journal of Arid Land Studies,* 25(3), 141-144.

 *Continued on Next Page* 

# *A Special Acknowledgement To:*

# Prof. Paul S. Kench

## CERF-JCR Lifetime Member

**Head of School**
**School of Environment**
**Faculty of Science**
**University of Auckland**
**http://www.env.auckland.ac.nz/people/p-kench**

**International Collaboration:**

Development of a Rapid Carbonate Budget Assessment Protocol for Coral Reefs (2010-2012). This Leverhulme funded Network is establishing and testing new methodologies for the assessment of coral reef health. The project involves researchers from the U.K., Australia, USA, Canada and New Zealand and is currently working at reef sites in the Caribbean (Belize, Bahamas and Bonnaire) and will extend this work to the Indo-Pacific in the near future.

Changing Waves and Coasts in the Pacific (2012-2015). This is a joint research initiative with SPC-SOPAC, University of South Pacific (Fiji), UNESCO-IHE (Netherlands), CSIRO and The University of Auckland. The project aims to improve understanding of coastal hazards in small Pacific islands and will undertake detailed field investigations in Fiji and Tuvalu.

REEForm is a working group of the International Association of Geomorphologists. REEForm was established to enhance research effort into the geomorphic understanding of coral reefs and reef landforms. The international network has undertaken research projects in the Maldives and Great Barrier Reef.

**Select Publications:**

**Kench, P.S.**; Thompson, D.; Ford, M.R.; Ogawa, H., and McLean, R.F., 2015. Coral islands defy sea-level rise over the past century: Records from a central Pacific atoll. *Geology*, 43(6), 515-518.

**Kench, P.S.**; Owen, S.D., and Ford, M.R., 2014. Evidence for Coral Island Formation During Rising Sea Level in the Central Pacific Ocean. *Geophysical Research Letters*, DOI: 10.1002/2013GL059000.

Perry, C.T.; **Kench, P.S.**; Smithers, S.G.; Riegl, B.; Yamano, H., and O'Leary, M.J., 2011. Implications of reef ecosystem change for the stability and maintenance of coral reef islands. *Global Change Biology*, 17(12), 3679-3696.

**Kench, P.S.**; Smithers, S.G.; McLean, R.F., and Nichol, S.L., 2009. Holocene reef growth in the Maldives: Evidence of a mid-Holocene sea-level highstand in the central Indian Ocean. *Geology,* 37(5), 455-458.

**Kench, P.S.**; McLean, R.F., and Nichol, S.L., 2005. New model of reef-island evolution: Maldives, Indian Ocean. *Geology*, 33(2), 145-148.

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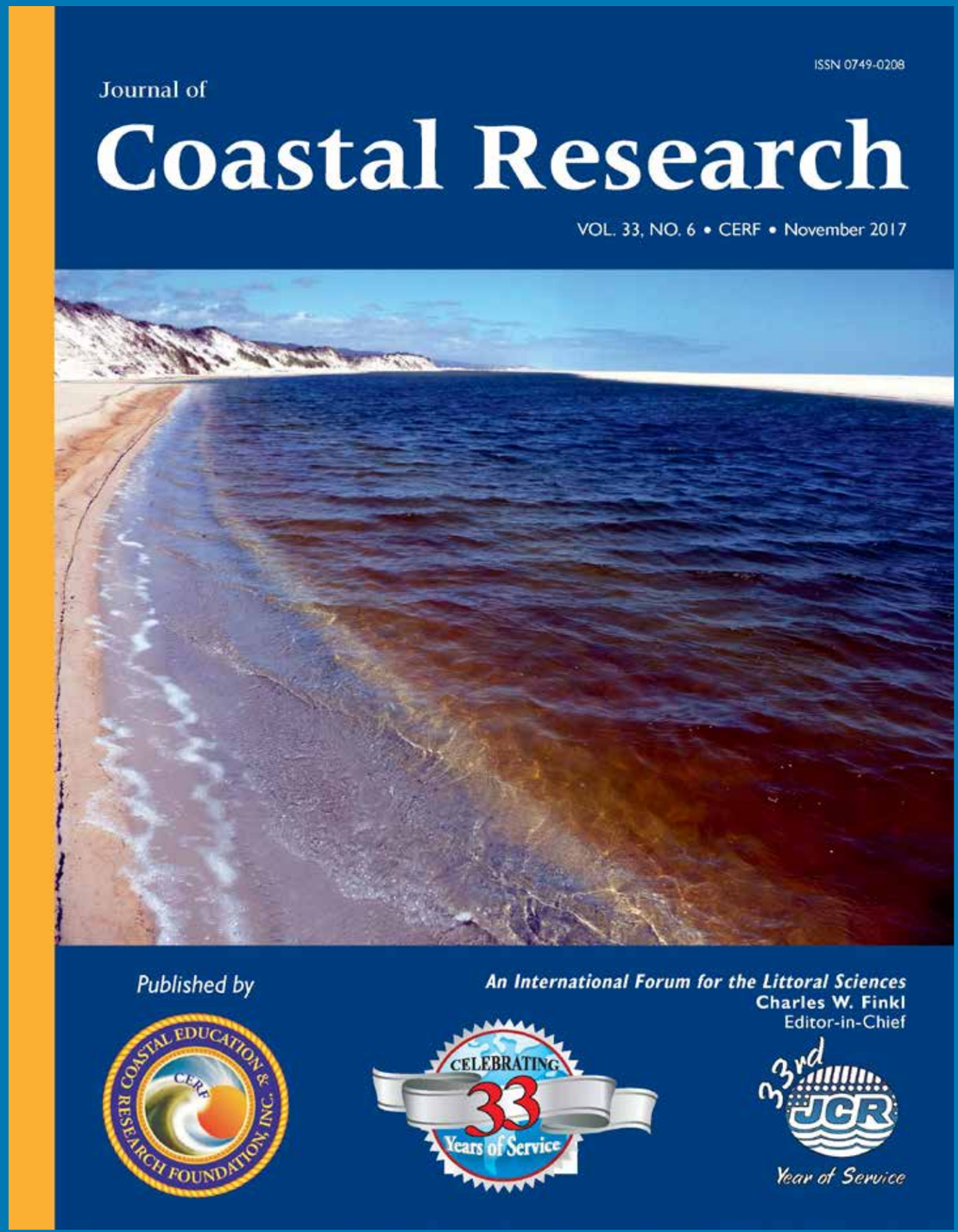


## COVER PHOTOGRAPH:

# Warren River, Yeagarup Dunes, Western Australia

Warren River, Yeagarup Dunes, Western Australia. Coastal features of the Warren River outlet in the region of the Yeagarup Dunes along the wave- and wind-dominated sandy southern coast of Western Australia. Evident in this image, from left to right, is (1) the steep front of the dune terrain of the mainland dune coast with the steep sandy slope formed by wave erosion during storms, and by the prevailing strong winds; this dune front forms the main shore along this sector of sandy coast; (2) a shore-parallel lagoon that is a river channel cut into the upper part of the beach, now impounded by a beach berm; the waters of the shore-parallel lagoon are fresh to weakly brackish and tannin-stained having been recently derived from river flooding; when his image was taken, the lagoon was two metres deep, its width some 75-100 m, and it was several hundred metres long – the lagoon was detached from the main more permanent river outlet; (3) to the far right is the beach berm that is barring the lagoon; seaward of the beach berm is seawater of the Southern Ocean with normal marine salinity.

This type of shore-parallel lagoon of berm-impounded river water results from the interplay of floodwater discharge of tannin-stained freshwater from the Warren River that meets a high-energy wave-dominated coast. Normally, the river would discharge its flood waters directly into the ocean but, under prevailing wave conditions, a bar-and-berm is continually being constructed at times sufficiently to bar the river discharge; river flow then is diverted laterally (usually westwards) for hundreds of metres and up to 2500 m along a depression leeward of a shore-parallel berm system, carving a channel until it reaches a location where it can cut across the berm and form a new outlet. With concomitant decreasing river flow (as hinterland flooding recedes) and the prevailing building of a beach berm, the new river outlet is sealed, and the recently carved linear channel with its riverine water is trapped between the main more permanent mouth and its recently formed diverted mouth to form the tannin-stained freshwater body. With ongoing building of the beach berm and aeolian transport, the connection between the lagoon and the more permanent river channel is lost and the lagoon becomes an isolated depression until beach processes and aeolian transport fill and bury it (Semeniuk and Semeniuk, 2011). (Photograph taken November 2009 by Vic Semeniuk, V & C Semeniuk Research Group, Warwick, Western Australia.)

## LITERATURE CITED

Semeniuk, C.A. and Semeniuk, V., 2011. Dune slacks in coastal Western Australia. *Journal of the Royal Society of Western Australia*, 94, 503–532.

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CERF continues to provide our members with the most up-to-date, professional features of the society. We encourage you to please visit our Foundation's website at http://www.cerf-jcr.org to see all the new content that has been added.

Next issue of *Just CERFing* coming January 2018.

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