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Coastal and Marine Geography[1]

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Introduction

The 1990s witnessed a significant increase in popular interest in the US regarding the geography of the world's coastal and marine spaces. Factors motivating this renewed interest included growing public environmental awareness, a decade of unusually severe coastal storms, more frequent reporting of marine pollution hazards, greater knowledge about (and technology for) depleting fishstocks, domestic legislation on coastal zone management and offshore fisheries policies, new opportunities for marine mineral extraction, heightened understanding of the role of marine life in maintaining the global ecosystem, new techniques for undertaking marine exploration, the 1994 activation of the United Nations Convention on the Law of the Sea, reauthorization of the US Coastal Zone Management Act in 1996, and designation of 1998 as the International Year of the Ocean.

Responding to this situation, the breadth of perspectives from which coastal and marine issues are being encountered by geographers, the range of subjects investigated, and the number of geographers engaging in coastal-marine research all have increased during the 1990s. As West (1989a) reported in the original *Geography in America* volume, North American coastal-marine geography during the 1980s was focused toward fields such as coastal geomorphology, ports and shipping, coastal zone management, and tourism and recreation. Research in these areas has continued, but in the 1990s, with increased awareness of the importance of coastal and marine areas to physical and human systems, geographers from a range of subdisciplines beyond those usually associated with coastal-marine geography have begun turning to coastal and marine areas as fruitful sites for conducting their research. Climatologists are investigating the sea in order to understand processes like El Niño, remote sensing experts are studying how sonic imagery can be used for understanding species distribution in three-dimensional environments, political ecologists are investigating the ocean as a common property resource in which multiple users' agendas portend conflict and cooperation, and cultural geographers are examining how the ocean is constructed as a distinct space with its own social meanings and "seascapes."

Despite (or perhaps because of) this expansion in coastal-marine geography, the subdiscipline remains fragmented into what we here call "Coastal Physical Geography," "Marine Physical Geography," and "Coastal-Marine Human Geography." Clearly, to fully understand coastal-marine spaces one must integrate both the human and the physical and the coastal and the marine, but few are achieving this integration. Even within the three sub-subdisciplinary labels that we use to organize this chapter, there are divisions among groups of scholars who could benefit from each others' work and prosper through collaboration. Coastal geomorphologists tend to focus either on applied issues surrounding the instantaneous impact of human manipulation or issues in coastal dynamics, but few bridge these literatures to examine human/physical process interaction in coastal systems. Coastal-zone political ecologists have little overlap with those who are involved in designing tourism promotion schemes for coastal areas. The AAG’s Coastal and Marine Geography Specialty Group (CoMa) can play a role in facilitating this cross-fertilization within the subdiscipline as well as promoting outreach to non-geographers who research related topics.

Reflecting the current state of coastal-marine geography, the next three sections of this chapter review recent trends in coastal physical, marine physical, and human geography. This is followed by a brief discussion of CoMa, its history, and the role that it has undertaken in bridging some aspects of the subdiscipline. The chapter concludes with a discussion of future directions for coastal-marine research in geography.

Coastal Physical Geography

Physical geographers have contributed to various aspects of coastal geomorphology during the recent decade, employing a multitude of techniques and methodologies on a wide range of morphologies (Mossa, Meisburger, and Morang 1992; Morang, Mossa, and Larson 1993). Philosophically, there are the traditional dichotomies between basic and applied inquiry, between intensive empirical observations and broad regional explanatory description, between modern process-response studies and historical approaches examining Holocene (or older) evolutionary systems, between studying an altered site or a natural system, between refinements of technology and instrumentation and the application of analytical tools. There is no single best way to contribute to the body of knowledge, and there is no reason for every scientist to parrot the same approach or technique. Diversity of approach and contribution is an attribute in itself and it fosters progress. As ably described by Sherman and Bauer (1993a), there are a variety of scales and approaches in coastal geomorphology and it is more important that the inquiry have a basis in theory and be cognizant of the existing literature than whether it is on one side or the other in a dichotomy.

Very basic inquiry regarding the mechanics of wave and sediment interaction to drive sediment transport in the nearshore zone has slowly revealed the processes that control the temporal and spatial scales of beach change. Whereas much of this research is within the realm of geophysics and engineering, the highly-instrumented inquiry of Greenwood and his collaborators and students (Greenwood, Osborne, and Bowen 1991; Osborne and Greenwood 1992; Aagaard and Greenwood 1994) has produced insights into the significance of wave groupiness and infragravity wave frequencies as causative factors in suspended sediment transport. Others have pursued the subharmonic and/or infragravity wave frequency theme in relating components of beach morphologies to higher energy densities at these longer wave periods (Jagger, Psuty, and Allen 1991; Bauer and Greenwood 1992; Allen *et al*. 1996). The important issue of mobilization of sediment on the beach face has been a particular focus of Horn (1997). Summary statements on basic processes and responses in the beach and nearshore zone were included in a special issue on Coastal Geomorphology in *Geographical Review* (Sherman 1988).

The process-response paradigm in coastal geomorphology is that larger storms beget larger waves and currents which, in turn, drive more sediment transport and create permanent changes at the coast. Although the eastern seaboard of the US is often battered by subtropical cyclones (hurricanes), the mid-latitude cyclones accompanied by strong frontal winds (northeasters) are more frequent bearers of high waves and storm surge along the Mid-Atlantic and North Atlantic shores. Through a series of papers that began more than a decade ago, Dolan and Davis (1992; 1994) have developed a well-recognized northeaster-storm intensity scale that has a foundation in weather and storm wave characteristics, and expands into a measure of storm-induced damage. Importantly, this effort synthesized a broad range of data into the domain of coastal change and used an inherently geographical approach to spatially organize and partition coastal storm characteristics. A further extension of the interest in coastal storms was generated by Engstrom (1994; 1996) who brought a geographical and geomorphological perspective to descriptions of storms from a previous century.

Coastal dunes of all shapes and sizes are worshipped for their role as an ecological niche in the midst of dense coastal development. The Coastal Zone Management Act specifically calls for the creation and enhancement of dunes in the coastal zone. There is increasing recognition of the variety of dune features that exist at the coast (Nordstrom, Psuty, and Carter 1990) and the interplay between the beach and coastal dunes (Psuty 1988). The measurement of sand gains and losses in the dunes and the exchanges of sediment from the beach to the dune have been conducted along many shorelines (Davidson-Arnott and Law 1996; Gares *et al*. 1996; N. Jackson and Nordstrom 1997). The research has led to a series of site-specific descriptions and categorizations of dune types and their interaction with local dynamics (McCann and Byrne 1989; Gares 1992). In addition, there has been growth of a developmental model of the spatial/temporal evolution of the coastal foredune and the coastal dune system within the framework of beach/dune interaction. This follows the concept of a developmental sequence produced by Short and Hesp (1982) and Hesp and Thom (1990) and elaborated on by Psuty (1988) and Sherman and Bauer (1993b), and recognizes sediment budget as a formational variable (Psuty 1992b).

Further contributions involve the very difficult task of elucidating and improving eolian transport equations in the multi-varied coastal foredune system where it will take development of improved instrumentation before measurements appropriate to model testing can be accomplished. Bauer and Namikas (1998) have constructed a rapid response saltation trap that could greatly improve our understanding of the application of transport equations to dune development.

Interest in regional coastal geomorphology is directed primarily toward barrier beach systems and their spatial/temporal evolution and displacements. Stone and McBride developed empirical data sets and models that relate barrier island shifts on the Gulf Coast to regional sediment budget and to alongshore/cross-shore transfers (Stone *et al*. 1992; McBride and Byrnes 1997; Stone and McBride 1998). They point to step-wise non-periodic shifts accompanied by short-term oscillations. A similar approach has been used to study changes on more-localized barrier spits in other locales (Davidson-Arnott and Fisher 1992; Ollerhead and Davidson-Arnott 1993). A blending of sea-level rise effects, beach displacement, and stages of barrier island transgression is presented by Dubois (1995) in a multi-scaled integration of the coherence of beach morphology within a spatially-mobile and transgressing barrier island. Further, the opportunity for three-dimensional analysis of the barrier with ground-penetrating radar (Jol, Smith, and Meyers 1996) provides another perspective on morphological development. Whereas most of the geomorphological research is in the beach, dune, and nearshore region, McBride and Moslow (1991) treat processes and characteristics of offshore sand ridges which are spatially-related to the presence of inlets in the barrier island system along the East Coast and to sediment leakage from the ebb-tidal deltas as the barrier island system transgresses inland.

Coastal change caused by human interaction with natural processes adds another level of investigation (Walker 1988; Nordstrom 1994; 2000). Many studies provide examples of the localized human modifications that drive further human manipulative responses (Walker 1990a; b), often in association with structures in the water (Nakashima and Mossa 1991; Psuty and Namikas 1991) or with buildings (N. Jackson *et al*. 2000). Cultural modifications of the coastal environment have been instrumental in reworking the form and sediment distribution to such an extent that it would be perilous to ignore the limitations established by human-induced topography or human manipulations of the sediment budget in developed areas.

Most coastal geomorphological studies have been directed toward sandy shorelines rather than bedrock or cliffed coasts despite the worldwide presence of bedrock coasts. Trenhaile (1987) is a leading researcher on rocky coasts and has produced an excellent synthesis of bedrock coastal processes and geomorphology. At the local scale, Lawrence and Davidson-Arnott (1997) examined erosion of a bluff and the adjacent submarine platform and several other studies examined shingle beaches (McKay and Terich 1992; Sherman, Oxford, and Carter 1993) to determine changes in spatial accumulations of coarse materials.

Despite the strong emphasis on modern day processes, there remains a thread of inquiry that harkens back to the roots of American coastal geomorphology and the identification of coastal features associated with paleolakes in the tradition of Gilbert and his classic study of Glacial Lake Bonneville (Gilbert 1890). Currey (1990) has revisited much of Gilbert's Great Salt Lake study area and he continues to develop the Quaternary sequences of paleoshorelines in the interior basins at a variety of scales. Sack (1994) likewise carries on this field of inquiry.

Research into bays and estuaries has generated several major thrusts. Characteristics of beach/dune features of the lower energy estuarine environments in the northeastern US have been a focus of N. Jackson and Nordstrom (1992), whereas Armbruster, Stone, and Xu (1995) described the responses of beaches on the inland margins of Gulf Coast barrier islands in association with the passage of hurricanes and cold fronts. Nordstrom (1992) has developed a comprehensive framework of the processes and responses appropriate to beaches on shorelines of estuaries. He has also expanded into broader ecological issues of estuarine systems (Nordstrom and Roman 1996).

Estuarine-based research has considered issues of sedimentation and wetland development as part of the mix of sea-level rise and changing sediment availability. Reed (1990; 1995a) focused on wetland characteristics and composition in coastal Louisiana, leading to models of wetland changes and adaptations on decadal time scales in association with varying sediment supply and relative sea-level rise rates. Kearney (1996) expanded the concepts of wetland deterioration associated with sediment deficits into decadal and centurial time. Psuty (1992a) generated a model that relates vertical and horizontal displacements of wetlands to rates of sea-level rise and sediment delivery on centurial and longer time scales. In a different climatic context but in a similar sedimentation/sea-level relationship, Ellison (1993) and Ellison and Stoddart (1991) identify responses in mangrove communities. Important concepts that are emerging from these and similar investigations (Phillips 1992; 1997) concern the non-linearity of the changes and the relaxation times inherent in any modification to a system that is exchanging sediment spatially and temporally.

Although most shorelines are eroding in the presence of sea-level rise and a negative sediment budget, coastal zone population continues to increase. The inevitable result is increased concern for the manifestations of human development, for the economic value, and for the amenities of the coast. This has led to heightened interest in coastal dynamics and to improved knowledge of shoreline change, rates of change, and forecasts of future shoreline positions. A common form of establishing shoreline erosion rates is to secure the oldest surveyed shoreline position (usually mapped in the mid-nineteenth century) and compare it with shorelines from aerial photos and recent surveys. Some of the modern GIS registration techniques have improved comparisons of shorelines from historic maps and aerial photos. The additional incorporation of kinematic GPS shoreline determination and LIDAR imagery (Daniels, McCandless, and Huxford 1999) into the spatial matrix has resulted in the analysis of shoreline changes which together cover more than a century.

Whereas establishment of the displacement of the shoreline by this comparative means has value, there are hazards in extending the past trend into the future. Dolan, Fenster, and Holme (1991) and Fenster, Dolan, and Elder (1993) called attention to the episodic variation in shoreline position in many of the data sets based on relatively few points derived from historic data, and suggested that the sampling period will strongly influence the derived trend. Crowell, Douglas, and Leatherman (1997) agreed with the problems associated with the use of a few data points and suggested that sea-level rise curves can be used as a surrogate for site-specific shoreline change rates. Obviously, there are complicating factors related to human manipulations of shoreline position which will also modify future trends, but that is a variable that could be woven into the fabric of analysis and could be another component of the application of this approach.

In the midst of a multitude of empirical observations of barrier island and estuarine change is the inescapable conclusion that the annual and decadal scales are non-linear, and that whereas many of the centurial time domains may have a trend there is a lot of scatter about any sort of trend line. Evidence continues to come forth regarding the difficulty of applying a narrow cause and effect relationship when the system itself is dynamic and sediment budgets are anything but constant.

In the original *Geography in America* volume, West (1989a) indicated that coastal geomorphologists were strong in empiricism but needed to strengthen their contributions to the theory side of the subdiscipline. Coastal geomorphologists are still strong in data gathering and observational science, and this is inherent to geomorphology. However, there has been a broadening perspective of conceptual themes, theoretical frameworks, and methodological approaches that are providing integrative vehicles for our inquiry. Importantly, the geographical geomorphologists are incorporating human activities as a process in landform evolution and are contributors in the emerging holistic approach to the very dynamic coastal zone.

Marine Physical Geography

The Coastal Zone Management Act of 1972 defines the coastal zone as a transition from land to the US territorial sea, consisting mainly of the swash zone, bays, dunes, estuaries, intra-coastal developments and waterways, coastal wetlands, marshes, and the like. But what of the open sea, often beyond sight of land? This is the domain of marine geography, which involves the understanding and characterization of space, place, and pattern of the open water and ice found seaward of the coast. American geographers have contributed little to marine research until recent decades, although the first textbook of modern marine science, written by Lt. Matthew Fontaine Maury of the US Navy in 1855, was entitled *The Physical Geography of the Sea* (Maury 1855). It was the post World War II exploitation of offshore resources, as well as the environmental movements of the 1960s arising from coastal population and industrial growth, that directed some geographers to open water (West 1989a). But even today there are very few geographers working in this domain.

The study of marine physical geography received a major boost in the 1990s with the rise of earth system science (ESS) (Williamson 1994). The goal of the US Government-sponsored ESS initiative is to obtain a scientific understanding of the *entire* earth system (atmosphere, oceans, ice cover, biosphere, crust, and interior) on a global scale. ESS seeks to describe how component parts of Earth and their interactions have evolved, how they function, and how they may be expected to continue evolving at all time scales (Nierenberg 1992). The recent emphasis on ESS, particularly with regard to the oceans, stems from the realization that many of Earth's resources are diminishing rapidly. A further factor is the growing awareness that an environmentally secure future requires a more integrated and coordinated approach toward understanding the consequences of global change, both for humanity and for managing global resources. Geographers have responded to these issues by broadening their focus beyond traditional boundaries.

Important emphases of ESS during the 1990s have been the study of synoptic weather patterns over the oceans, tracking and modeling of El Niño, mapping of water quality and pollution, and determination of various biophysical properties of the oceans, including temperature, chlorophyll pigments, suspended sediment, and salinity. Geographers involved in these studies have relied mainly on remote sensing techniques that are often ground truthed with vessels at sea. For example, Siegel and Michaels (1996) have evaluated the role of light in the cycling of carbon, nitrogen, silica, phosphorous, and sulfur in the upper ocean. Their shipboard data have provided an "optical link" to global ocean color imagery derived from the SeaWifs satellite sensor (Garver, Siegel, and Mitchell 1994). Lubin *et al.* (1994) and Ricchiazzi and Gautier (1998) have assessed the impact of seasonal ozone depletion on the intensity of surface radiation in the Antarctic and how this affects the ecology of the Southern Ocean. Geographers have participated in numerous field campaigns to Palmer Station, Antarctica to determine the ecological processes linking annual pack ice extent to biological dynamics of different trophic levels (R. Smith *et al.* 1998). Washburn *et al.* (1998) have used high frequency radio radar to map ocean surface currents off the California coast to interpret changes in the populations of various marine species. Schweizer and Gautier (1997) have launched an ambitious series of multimedia educational materials and workshops on El Niño, replete with both multispectral satellite imagery and shipboard sea surface temperature maps.

ESS has also played a role in the creation of the Ridge Interdisciplinary Global Experiments (RIDGE) program, a successful research initiative of the US National Science Foundation in the 1990s that will be continued into the next century. RIDGE was launched in response to the growing realization that knowledge of the global mid-ocean ridge (seafloor-spreading centers) is fundamental to the understanding of key processes in a multitude of disciplines, including marine biology, geochemistry, physical oceanography, geophysics, and marine geology (National Research Council 1988). This has prompted several major coordinated experiments on the seafloor, involving multiple arrays of instruments (Wright 1999) for the study of geological, physical, chemical, and biological processes within and above the seafloor (Detrick and Humphris 1994). The resulting data range from measurements of temperature and chemistry of hydrothermal vent fluids and plumes, to the microtopography of underwater volcanoes, to the magnitudes and depths of earthquakes beneath the seafloor, to the biodiversity of hydrothermal vent fauna. Geographers have been involved in the first implementations of GIS to support these investigations both at sea and onshore (Wright 1996), as well as in the development of a long-term scientific information management infrastructure for the data (Wright, Fox, and Bobbitt 1997). The current state-of-the-art in marine (and coastal) applications of GIS is summarized in Wright and Bartlett (2000), an international collaborative effort between geographers, oceanographers, geodetic scientists, computer scientists, and coastal managers.

The International Year of the Ocean (1998), sponsored by the United Nations, has called attention to an increasing need for investigations into deep ocean, island, and coastal management, all in the context of ESS. Specifically, Chapter 17 of the 1992 UN Conference on Environment and Development's *Agenda 21* report calls for the assessment and management of fisheries, a de facto guarantee of biodiversity protection (Vallega 1999). Kracker (1999) has quantified aquatic landscapes via a traditional landscape ecology approach, incorporating underwater acoustic remote sensing techniques in determining abundance and distribution patterns for regions of intensive fish production.

Human Coastal-Marine Geography

The 1990s were a period in which marine and coastal areas became an increasingly significant object of study for human geographers interested in environmental planning, resource management, and development policy, as well as related topics in cultural, political, and economic geography. Coastal areas, in particular, have presented a growing range of issues of concern for human geographers. Although the coastal zone comprises just seventeen percent of the contiguous US' land area, it is home to fifty-six percent of the country's population. 3,600 people are added to the coastal zone daily, increasing population density in U.S. coastal areas from 187 people per square mile in 1960, to 273 in 1994, and to a projected 327 in 2015 (NOAA 1998). Growth rates of coastal zone populations are similarly dramatic around the world, and a host of research topics are associated with this increased population density. Marine areas also present numerous topics for human geographic research. During the 1990s, the rate of extraction of living resources from marine areas has remained at (or, for many species, above) maximum sustainable yields, extraction of non-living resources (especially petroleum) from marine areas has continued to play an important role in the world economy, and global shipping, which had plateaued during the recession of the 1980s, increased again during the 1990s with a commensurate increase in world trade.

This increased importance of coastal and marine areas to society has been matched by increased attention from human geographers (H. Smith and Vallega 1991). Complementing the extensive work on coastal hazards conducted by physical geographers, a number of coastal-marine human geographers have turned their attention to the human aspects of hazard creation, risk assessment, environmental perception, mitigation policies, and evacuation procedures. While most of this literature has focused on storm-related coastal hazards (Meyer-Arendt 1992; Baker 1995; Platt 1995; Clark et al. 1998; Dow and Cutter 1998), a smaller body of research has been produced on marine hazards associated with shipping and resource extraction (Argent and O'Riordan 1995; Dow 1999a, b).

The ever-increasing size of ships and the tightness of their schedules has led to an interest in the attendant changes in the shipping industry, the viability of individual ports, and the implications of transportation space's transformation into one seamless surface of intermodal transportation flows. A number of geographers have researched the impacts of containerization and shipping industry organization on port location and related industries (Slack 1993; Slack, Comtois, and Sletmo 1996). Other geographers have placed changes in shipping technology and shipping regulations within the overall history of change in the global political-economic system (Hugill 1993; Steinberg 1998).

A secondary effect of containerization has been the abandonment of downtown ports and small-city ports in favor of a small number of very large, capital-intensive terminals. This has led to urban decay in old port areas and to opportunities for urban waterfront renewal, a subject that has attracted attention from scholars whose approaches range from studying the potential of waterfront renewal projects for stimulating economic development (Meyer-Arendt 1995; West 1989b), to focusing on the political-economic forces that drive renewal programs (Kilian and Dodson 1995; DeFilippis 1997), to researching and critiquing the representations of maritime life in the marketplaces and maritime festivals that often are the centerpieces of waterfront renewal projects (Goss 1996; Kilian and Dodson 1996; Atkinson and Laurier 1998; Laurier 1998; Steinberg 1999b).

Whereas tourism promotion is a pressing issue for the nation's decaying urban waterfronts, it is also a concern in other coastal and marine spaces. With tourism's rise as a global industry, the development and marketing of coastal and marine recreation spaces has taken a leading role in many countries' development strategies (Orams 1999). In some instances, tourists are encouraged to enjoy the ocean and its resources from the vantage point of a beach, in other instances from a cruise ship, and in other instances from the underwater perspective of the scuba diver. Geographic research on coastal and marine tourism typically goes beyond an investigation of its potential for economic development to include environmental, cultural, and political issues as well. Contributors to Wong's (1993) volume discuss how coastal recreation both reflects and impacts local environments (see also, Meyer-Arendt 1991), Trist (1999) uses political ecology to analyze the images of the Caribbean Sea promoted by the marine tourism industry and the various demands of yachting, cruise ships, and diving on the Caribbean island of St. Lucia, Young (1999a) studies political and cultural conflicts concerning whale watching in Mexico, while Laurier (1999) focuses on the perceptions of the ocean held by recreational yachters.

This cultural-political turn in the study of coastal and marine tourism is part of a larger trend wherein the sea is becoming an increasingly popular topic for scholars who utilize a combination of cultural geography, cultural ecology, political economy, political ecology, and/or discourse analysis to interpret the ways in which various cultures perceive the sea and allocate access to its diverse resources (Nichols 1999; Young 1999b; Glaesel 2000). Recently, this perspective has been joined with one that emphasizes the ocean as a "socially constructed" space that is discursively and materially shaped by societies as they use the ocean. Proponents of this constructivist view stress that the ever-changing social construction of ocean-space serves to limit and enable further social uses of the ocean (Steinberg 1999b) and that in many social systems the ocean is a space that unites, rather than divides, land-based societies (Lewis and Wigen 1999).

Along with this fusing of political geography and cultural geography, there has been a continuation of research in the "classical" political geographic tradition, centering primarily on marine boundaries and international conventions that regulate exploitation of the ocean’s resources (Earney 1990; Glassner 1990; Blake 1992) as well as issues in ocean management policy. In this area also, the field of inquiry has expanded recently, as scholars have integrated the study of marine boundaries with research on marine tenure systems, property rights, and territoriality in their efforts to investigate the legal norms that underlie marine boundaries between and within societies (S. Jackson 1995; Schug 1996; Scott and Mulrennan 1999; Steinberg 1999c).

The AAG's Coastal and Marine Geography Specialty Group (CoMa)

Recognition of the importance of the global ocean came early to the AAG. The first organized meeting of the Marine Geography Committee (MGC) of the AAG was held in 1970 in San Francisco, where it sponsored a session of six papers covering coastal geomorphology, fisheries, marine law, coastal research in Europe, the urban-maritime interface, and developing federal coastal interests and research funding. The first Chair was Evelyn Pruitt. Although Committee membership was limited to a handful of geographers who were appointed, participation in the MGC–sponsored sessions at the Annual Meetings of the AAG gradually increased, and by 1978 a Marine Geography Directory listed 84 persons. When specialty groups were created by the AAG in 1979, the MGC structure was dissolved and the broad membership was reconstituted as the Marine Geography Specialty Group, which in 1981 was re-christened the Coastal and Marine Specialty Group (CoMa). In comparison to the first meeting in 1970, at the 1999 annual meeting in Honolulu CoMa (with a membership of 170) sponsored five special sessions, featuring 24 paper presentations.

During the 1990s, about 85% of presentations in CoMa-sponsored sessions concerned coastal topics. However, presentations on non-coastal marine topics roughly tripled over the course of the decade. This shift accompanied a dramatic increase in research into global earth systems, along with rising interest in global environmental concerns, global change, and the effects of human-induced change. Further, the ocean and coastal areas have drawn increasing attention from human geographers interested in policy, resource management, and development issues. Coastal-marine geographers are broadening the range and depth of physical, cultural, and economic issues initiated by the interest group, expanding upon initiatives begun decades earlier.

Starting in 1991, CoMa has recognized outstanding professional contributions by a coastal/marine geographer by conferring the Richard Joel Russell Award (President of the Association of American Geographers (1948), President of the Geological Society of America (1957), and member of the National Academy of Sciences (inducted in 1959)). Six members have received the honor to date (Table 1).

Table 1. Richard J. Russell Award recipients

Year	Recipient	Institution
1991	H. Jesse Walker	Louisiana State University
1992	Filmore Earney	Northern Michigan University
1993	Norbert P. Psuty	Rutgers University
1996	Karl F. Nordstrom	Rutgers University
1997	Douglas J. Sherman	University of Southern California
1999	Bernard O. Bauer	University of Southern California

While much of the work performed by US coastal and marine geographers has been directed at the CoMa community, there have been sustained efforts to reach beyond CoMa, beyond the subdiscipline, and beyond the United States. There is a natural affinity between coastal and marine geographers and the Coastal Commission of the International Geographical Union. Whereas the IGU Coastal Commission has a broad topical range, most of the American involvement has been in the realm of coastal geomorphology and in Commission leadership. Norbert Psuty was the Vice-Chair (1984-1992) and Chair (1992-1994) of the Coastal Commission, and he was Editor of its semiannual newsletter (1984-1996). Douglas Sherman is presently on the Board of the IGU Coastal Commission. Among Commission products contributed by American geographers were the Coastal Geomorphology Bibliography, 1986-1900 (Sherman 1992), the *Journal of Coastal Research* Special Issue on Dune/Beach Interaction (Psuty 1988), the special section in the *JCR* on wetlands (Reed 1995b), and the Special Issue of the *Zeitschrift für Geomorphologie* on Rapid Coastal Changes (Kelletat and Psuty 1996). American geographers also contributed to IGU Coastal Commission publications on coastal recreation and tourism (Fabbri 1990; Wong 1993). The IGU/American collaborative effort should get a boost in the future as a result of the OCEANS program, an IGU initiative dedicated to cooperation with UNESCO's International Oceanographic Commission (Vallega 1999).

American coastal geomorphologists are active in the quadrennial Conference of the International Association of Geomorphologists and have contributed to several follow-up publications (Paskoff and Kelletat 1991; Sherman and Bauer 1993a). They are represented in publications from two major coastal geomorphological symposia: *Coastal Sediments '91* (Kraus, Ginerich, and Kriebel 1991) and *Large Scale Coastal Behavior '93* (List 1993). An international coastal geomorphology memorial symposium honoring Bill Carter was held in association with the 1994 San Francisco AAG meeting, and it resulted in a volume dedicated to his memory (*Journal of Coastal Research,* Summer 1996). Recently, Paul Gares and Douglas Sherman organized the 1998 Binghamton Symposium in Geomorphology with the theme of Coastal Geomorphology. Of the presentations, slightly under half were by American geographers. Other major initiatives undertaken by coastal-marine geographers include a 1999 focus section of *The Professional Geographer* on ocean-space (Steinberg 1999a), a 1999 issue of *Geographical Review* devoted to the concept of world-regions defined by ocean basins (Wigen and Harland-Jacobs 1999), and a volume on the marine and coastal applications of GIS (Wright and Bartlett 1999).

These edited volumes and special issues bring together geographers using a variety of methodologies and perspectives, and may form the basis for a more unified and coherent subdiscipline of coastal and marine geography, expanding upon the beginnings chronicled by West (1989a). The contributions of the 1990s detailed in this chapter demonstrate that much has been accomplished, but that much also remains to be done.

Future Opportunities

There are numerous research agendas remaining in coastal and marine geography. In coastal physical topics, human manipulation of coastal topography and sediment budget are probably underappreciated and subsumed as a small perturbation in either the instantaneous time scale or that of the Holocene or longer. However, many of the contemporary issues in applied coastal geomorphology are part of the decadal, up to centurial time scale. This is the time scale of interest to humans and the time scale that they influence. Recognition of the changes that are possible within this range and the influence of humans, therefore, is a task with strong feedback relationships.

Much physical geography research is addressing the non-linear nature of change in the marine and coastal zone, whether it be sea-level rise, sediment delivery, storminess, human intervention, nutrient flux, biomass production, etc. This is in recognition of the need for an improved understanding of the importance of scale in any inquiry and the bringing together of instantaneous models with developmental history models. Consideration of the aperiodic nature of natural processes contributes to the understanding of the oscillations of resources in a management context. Increasingly, there must be more recognition of the spatial/temporal role of humans in affecting aspects of the coastal and marine system.

There are many unsolved issues in the effective management, visualization and analysis of marine and coastal data, particularly with regard to GIS. Marine physical geography is relatively youthful, and thus there are huge opportunities for geographers, particularly in mapping the parts of the ocean that are out of reach of satellite sensors, (e.g., the water column and the ocean floor). To realize these opportunities, geographers must continue to collaborate with geographers working in corollary subdisciplines (e.g., remote sensing, GIS, geomorphology, etc.) and also with classically-trained oceanographers, ocean engineers, and marine policy specialists.

Human geographers are expanding their productivity in marine and coastal issues in many of the traditional areas, while also testing their skills in uncharted waters. The areas of hazards, tourism, and trade remain major research domains, but they have been joined by an increasing emphasis on issues of culture, representation, and resource-competition. The challenge for human geographers is to merge the study of conceptual issues in the human-ocean relationship with practical problem-solving in ocean management.

In many ways, the aforementioned divisions of “coastal physical,” “marine physical” and “human” are arbitrary, reflective of the current state of affairs, but definitely on a continuum toward total integration, particularly in light of increasing human-induced environmental threats to the health of the oceans. Solving these problems will require interdisciplinary, collaborative efforts across the social and natural sciences. These new directions do not so much supplant the more traditional lines of coastal and marine geographical research as they complement them, and there should be a body of literature developing in the next decade that fuses traditional with innovative perspectives into an improved analytical understanding of the complex interactions that transpire in coastal and marine systems.

Notes

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