New Digital Geoscience Maps of U.S. Continental Margins: Insights to Seafloor Sedimentary Character, Aggregate Resources and Processes

Overview

Continental shelf margins are diverse and increasingly important sedimentary landforms that serve a variety of purposes: recreation, benthic habitats for fisheries, commerce, transportation national defense operations, waste disposal and engineering activities (i.e. oil and gas platforms, pipelines, cables, wind energy generation). Continental shelf margins also contain hard mineral resources such as aggregate sand and gravel. Because margins are increasingly important, comprehensive and integrated databases are needed for a systematic approach to seafloor mapping. A variety of thematic maps are central for decision making and wise management of coastal ocean reserves. Examples are regional-scale base maps displaying thematic geoscience information such as seafloor geomorphology and geology, sediment character and texture, roughness, and critical shear stress. The new usSEABED software system provides a mechanism for compiling diverse seabed datasets of U.S. margins from across the marine science community. The USGS is using usSEABED to map benthic habitats and conduct national assessments of offshore sand and gravel resources for use as potential sand sources for beach nourishment purposes. The new geologic maps used for the sand and gravel assessments are also providing fresh scientific insights into the character and geologic history and evolution of U.S. continental margins (Fig. 1).

Coastal erosion and land loss resulting from complex natural processes (ie. storms, sea-level rise, sediment starvation) and man-made alterations (ie. dams, dredging, coastal engineering structures), often with unintended consequences, are pervasive for all coastal regions of the United States, as well as for much of the world. (NRC, 1990; NRC, 1995; Heinz Center, 2000) Development in the coastal zone continues to increase and demographic projections show these trends will continue, placing more people and development at risk. With the prospects of future climate change causing increased storminess and accelerating global sea-level rise, coastal regions are likely to experience increased erosion, inundation, and storm-surge flooding in future decades.

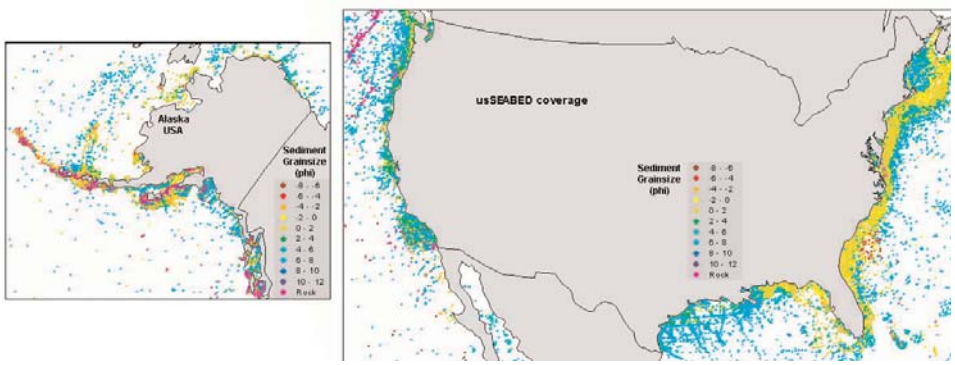

Fig. 1. Coverage of marine sediment data currently in the usSEABED system for U.S. continental margins, showing sample locations and sediment mean grain size in phi units based on the Wentworth classification. Sand-size sediment matches values ranging from -1 to 4 phi.

Beach nourishment is increasingly viewed for developed coasts as a cost-effective and environmentally sound method of mitigating coastal erosion, reducing storm and flooding risk, and restoring degraded coastal ecosystems. For beach nourishment to be viable, however, large volumes of high quality sand are necessary and must be located close to the intended project beaches. (NRC, 1995)

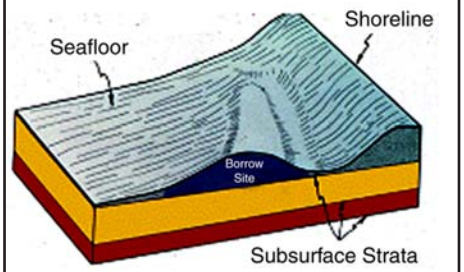

Fig. 2. Marine sand bodies, having diverse origins and evolutionary histories, can be buried or exposed at the seafloor and often have been greatly modified by Holocene marine transgression and modern shelf processes. Inner to mid-shelf marine sand bodies of the types listed often offer the best potential source for high quality sand for beach nourishment and ecosystem restoration projects.

Marine sand bodies (ie. linear shoals, paleochannels, ebb-tide shoals, Fig. 2) on inner to mid-shelf regions (~10 to 40m depths) are increasingly attractive sand sources for beach nourishment. The geologic character, geometry, and distribution of these sand bodies, however, are highly variable as a result of the complex sea-level history and associated marine processes that have affected shelf margins during the past 20,000 years, since the Last Glacial Maximum (Williams, 1992).

Assessing Marine Sand and Gravel Resources

To meet the need for a unified database of marine sediments and a digital geologic map series of seafloor texture and character, the USGS has undertaken the Marine Aggregate Resources and Processes Project (MARP), a new national assessment with federal, state, and academic partners. The primary objectives of MARP are to increase scientific understanding of the Quaternary shelf history, the sedimentary character pertaining to sand supply and sand budgets for coastal-shelf systems, and to better understand the character and distribution of offshore sand and gravel resources, potentially suitable as sand sources for beach nourishment projects.The MARP project is implementing a series of regional assessments and ultimately a national mapping of seafloor sedimentary character and assessment of marine sand and gravel resources around the United States. This study is responding to an increasing demand for geo-

referenced point data and geologic maps of seafloor sedimentary character, data on aggregate resources for beach nourishment and coastal restoration, and ediment texture information for characterizing benthic habitats.

Five themes are emphasized:

1. Compilation of marine geologic and geophysical data
2. Evaluation and synthesis of existing maps and reports
3. Digital data integration and imterpreta tion
4. Understanding shelf history and processes of marine sand body evo lution
5. Dissemination of results via the web, reports, and maps

Results

In continental margins regions of dense high quality data coverage, such as the New York Bight (Fig. 3) and south central Louisiana (Fig. 4), usSEABED is being used to generate gridded or point maps of seafloor sedimentary character that include sand content and sediment character information, which is critical for assessing resources. Map outputs can also be generated depicting a variety of other seabed parameters (e.g. areas of hardground, texture classifcation, color, carbonate percent, organic carbon percent, seafloor roughness, sediment shear stress) important for sand and gravel assessments, understanding contiental margin evolution, as well as many other potential applications

Conclusions

Geologic and other thematic digital maps of U.S. continental margins are essential for scientific research and marine exploration, mineral resource assessments, applications in environmental projects, national defense and seafloor engineering applications. The USGS and the University of Colorado, in partnership with federal and state agencies and academia, are developing a new software system - usSEABED - that is capable of accommodating a wide range of diverse seabed character datasets that can be processed efficiently and used to produce databases and thematic maps. To date over 140 datasets have been incorporated into the usSEABED system. Outputs of sediment character and texture from usSEABED are being combined with high-resolution bathymetry, backscatter data, and subbottom seismic-reflection profiles and cores to conduct a national assessment of offshore sand and gravel. Such marine sand bodies are increasingly being considered and used for nourishment of eroded beaches. Regional assessments are being conducted in New York Bight, Louisiana, Hawaii, and the Gulf of Maine. Output from usSEABED is also finding application in characterizing seafloor habitats for protecting and managing fisheries. The products from these studies offer promise of providing new scientific understanding to the character and development of U.S. continental margins and the information critical to facilitate decision making by resource managers.

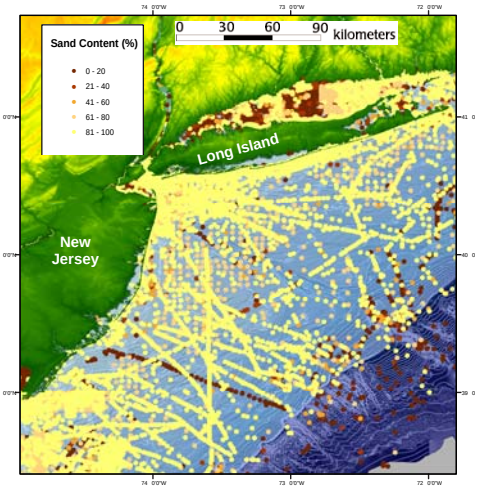

Fig. 3. Sand distribution based on usSEABED. Sand (and gravels) dominate the seafloor due to the complex glaciofluvial history of Long Island and the shelf margin and subsequent reworking of the seafloor during the Holocenemarine transgression to the present time.

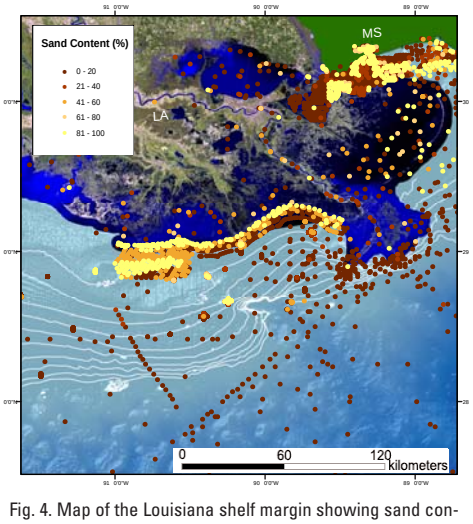

Fig. 4. Map of the Louisiana shelf margin showing sand content based on usSEABED output. Muddy sediments dominate due to Mississippi River discharge; however, fine to medium sand is present on the inner shelf in ebb-tide deltas, paleochannels, and drowned paleobarrier shorelines, such as Ship Shoal and probably Outer Shoal.

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