On March 8, 2008, the Coastal Working Group met in Orlando Florida, and began working on our ***short term goals***. As listed in the CSDMS Strategic Plan (http://csdms.colorado.edu/wiki/index.php/CSDMS_docs), these are:

- Evaluate present knowledge of processes in coastal environments (nearshore, inner shelf, barrier islands, sandy coastlines, rocky coastlines, estuaries, lagoons and marshes, eolian, deltas)—including the human component of those systems (i.e. direct couplings between human manipulations and landscape evolution in deltas and coastlines)—and identify the numerical models presently in use.
- Identify gaps in knowledge and areas where model development is needed—both poorly understood phenomena requiring basic research and exploratory modeling, and better understood systems for which model reliability should be improved.
- Define proof-of-concept questions—questions that require linking together models of different environments, preferably spanning between coastal and terrestrial or marine environments. These should be examples of types of interesting and relevant scientific questions, but should have known answers, to allow evaluation of the pilot modeling endeavor.

We broke into smaller groups to address the first two points in four sub environments: i) nearshore and inner shelf (relatively small scales, < km and < yr); ii) coastlines, inner shelf and islands (larger scales); iii) estuaries and marshes; and iv) deltas. (Eolian environments, lacking a representative at the meeting, were discussed remotely.)

Some of the break out groups identified numerous models that need to be added to the list of extant coastal models (http://csdms.colorado.edu/wiki/index.php/Coastal_Mo). Updating of that list is underway.

The reports from each group regarding ***key gaps in knowledge and modeling capabilities*** in each of the sub-environments are listed below. Some needs were articulated by most or all of the groups, chiefly:

1) Space- and time-scaling and the need to develop parameterizations. Different models are required to address different questions at different scales, but the processes at different scales interact. Thus we need to 'up-scaling' or parameterize of the effects that smaller- and faster-scale processes collectively have on larger-scale processes. (As a common example, ripples and small scale bedforms affect—and are in turn affected by—currents and sediment transport patterns on scales much larger than those of the small bedforms). In many cases, parameterizations need to be devised or improved.
2) Cohesive and mixed sediments; we are only recently beginning to understanding and model the processes involved.
3) Human actions need to be incorporated. Coastal environments are affected by land use and direct human manipulation (such as beach stabilization). Coastal change, in turn, affects human development. The two-way coupling likely play a first-order role in steering the evolution of many coastal landscapes, but our ability to model these couplings, and the resulting feedbacks, is in its infancy.

4) Linking models of different sub-environments represents a ubiquitous challenge—one of the central challenges of CSDMS!

The major research/modeling needs pointed out by the break out groups include:

- Estuaries and Marshes: The study of biological-physical interactions and the resulting morphodynamics are in their infancy, and we need to entrain biological specialists to move forward in understanding and modeling capabilities.
- Deltas: Data needed as input for long-term evolution models (e.g. historical bedloads), as well as data about forcing on long and shorter timescales, is often in short supply. Modeling efforts need to concentrate on interactions between fluvial processes (e.g. avulsions) and shoreline evolution/delta morphology, as well as river-mouth processes.
- Nearshore and Inner Shelf (relatively short and small scales): Feedbacks resulting from nonlinear couplings (including across scales) limit the ability to make specific predictions—and therefore test simulation-type models. Data assimilation should be incorporated to improve predictive ability.
- Coastline Evolution (relatively long and large scales): Our ability to model coastlines involving substrates other than mobile sand is limited: i) We need to learn how to handle erodibility and composition effects, and for long-term rocky-coastline evolution, complex bathymetry and sediment pathways including nearshore canyons, as well as how shelf/canyon bathymetry co-evolves with the coastline; ii) Similarly, arctic coastline change involves unmodeled processes such as ice push and thermal erosion; and iii) modeling of carbonate coastlines is not as well developed as is sandy-coastline modeling. In addition, modeling cross-shore transport on long timescales, including dune development and how that interacts with event-scale transport, needs to be further developed.

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The working group as a whole also discussed ***how to evaluate models***. We agreed that models with different goals (ranging from gaining basic understanding to providing detailed and accurate simulations of natural systems for the purpose of making quantitatively reliable predictions) should be evaluated in different ways. Rather than simply designating models as 'good' or 'bad' (or somewhere in between), we agreed that ultimately each model in the Working Group's toolkit should come with descriptions of the intended uses of the model, as well as how well the model does what it is supposed to do, in the experience of its users. The process of generating such extensive metadata should start with the information about the model initially provided by its contributor (intended uses, required input, etc.), and then the working group and the larger community can progressively add information, including how well the model performs (numerical stability and ease of use as well as scientific and/or practical value).

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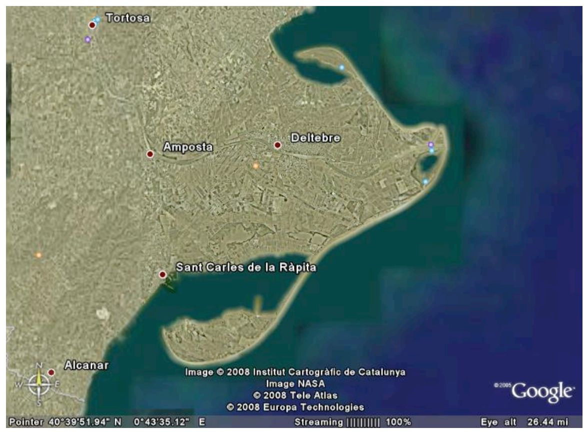
In the last segment of the meeting, we initiated the discussion about ***possible proof-of-concept projects***, the third of the short-term goals. Although most of the Working Group members had not yet considered what projects could meet the criteria listed above, the Chair tossed out one example:

How do land-use changes in hillslope/mountain environments affect coastline evolution, via altered fluvial sediment loads? The evolution of the Ebro Delta, Spain provides one known instance that we could try to reproduce, in which progressive deforestation in the mountainous watershed lead to the emergence of the delta, where an estuary previously indented the rocky coastline (Montsia Museum, Ebro Delta, Spain). Subsequently, reforestation and development in the watershed have reduced sediment loads, apparently causing the balance between wave driven sediment transport and fluvial delivery to shift and leading to a shift in the morphological evolution of the delta (Ashton and Murray, Coastal Dynamics '05), producing the current distinctive shape (Figure below).

A proof-of-concept project should involve modeling challenges, and yet should be achievable within 5 years; models of the component environments should already exist. For the Ebro Delta example, candidate models would include the CHILD and Ashton-Murray models of terrestrial and coastal landscape evolution, respectively, and the moving-boundary nature of the coupling would provide a significant challenge.



Working group members stated that impressive data sets are available to evaluate this modeling project, ranging from millennial scale to modern processes, and that coupled models that were successful in this case study could also be applied to other wave-influenced deltas including the Brazos and Danube deltas. Working Group members agreed to propose other possibilities, and to discuss them in coming weeks and months. As a start, we will post the information above under the Projects section of the Coastal Working Group page (http://csdms.colorado.edu/wiki/index.php/Coastal_Projects), with which we can all interact.

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More generally, ***our task as a Working Group***—including those who were unable to attend this initial meeting, is to continue all these discussions via the interactive CSDMS website (http://csdms.colorado.edu/wiki/index.php/Main_Page). Onward!

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Reports of the sub-environment small groups:

Estuaries and Marshes

(presented by Marco Marani, for Geyer, Lanzoni, and Sanford)

Channel network ⇔Marshes ⇔Tidal flats ⇔subtidal platforms ⇔channel network

Marshes and Tidal Flats
wetting/drying - important issue need to see large scale models to see overall system
structured/unstructured

-sediment supply
-settling
-trapping by vegetation
-production of organic sediment
-hyrodynamic circulation and waves – waves in very shallow (1m or less) environments need to be incorporated into these models
-biostabilization/bioturbation - important to involve professional biological process people
-veg. dynamics
-M.P.B. (microphytobenthos) dynamics

- gap in community (rather than modeling): shift in equilibrium – tidal flats to marsh – resuspended in wind waves in shallow environments “a matter of someone actually doing this”

- time and spatial scales vary by what the modeler is looking for

Channels Challenges
-fluid muds
-mixed sediment beds (sand/mud)
-bed evolution/structure
-flocculation (biological effects)
-frontal/fine scale process
again- upscaling
-linking subenvironments

Shallow Sub-Tidal – a very open topic
-wave effects
-shore/bank erosion – submarshes and lateral erosion
-submerged grasses and MPB
-oysters, etc
+channel issues

Upstream/Downstream Coupling
Riverine Inputs (from other models)
-loading as function of t &Qr
-size distribution
Ocean – very site specific
-physical forcing variables (including waves)
-bedload inputs (implementation)
-suspended load

General Issues
-upscaling of parameterization of subgrid processes
-incorporation/coupling with biological processes

-linking sub-environments and external domains

Methodologies
-structured grid
-unstructured grid
-wetting & drying
-hybrid (1-, 2-, 3-D models)
-long-term morphodynamic modeling
-temporally explicit vs. statistical approaches

Deltas

Ashton (reporting), Drake, Fagherazzi, Giosan, Hanes, Lanzoni, and Wolinsky

Challenges/ Context:

- Deltas are really complicated
- Many mechanisms of sediment transport
  - Bedload/ suspended load / gravity currents
  - Waves/fluvial/tidal currents
  - Interactions with biology
- Bridges disciplinary boundaries (source matters, it is a sink)
  - Terrestrial WG
    - Updrift BC (e.g. measurement of bedload)
    - Understanding of lowlands (fluvial)
  - Marine WG
    - Forcing BC
    - Marine sediment interactions (sources and sinks)
  - More likely preservation of these activities
- Modern studies focusing on highly anthropogenically affected systems (sediment supply, land use, subsidence)
- Strong need for high-resolution field investigations of shorter-term change to feed models (bridging short-term and geologic scales -> decadal)

Existing Models

High resolution:

- Delft-3D (high-resolution, detailed hydrodynamic coupled w/ morphologic change)
  - Flow, waves, etc.
  - Several promising recent investigations
  - Much discussion of limitation in timescales in present application
  - Several successful recent applications to selected environments, over many timescales
  - successful efforts tend to
    - limit processes
    - controlled boundary conditions (SF ebb tidal)
    - investigate short change
    - use morphologic scaling factor
  - does data exist to test?
- Many others (DHI, HRW, CSTM, Telemac)

Stratigraphic evolution

- SEDFLUX
- SedSim
- Dionysus
- ‘Exxon Model’
- QDSSM
- (Many industry-based applications)
- Cross-shore Geometric moving boundaries (Swenson, etc.)

Intermediate-term (centennial-millennial)

- SEDFLUX
- Cross-shore (Neidoroda and Swift, etc.)
- Morphodynamic plan-view models (100-1000’s of years)
    - avulsion
    - waves (lobe-lobe interaction)
    - Overeem, Fagherazzi, Wolinsky, Ashton, Jerolmack, etc.

Decadal

-
- Using coastal models?

Limitations/Future directions:

- Often inadequate historical data (e.g. bedload, etc.)
- Develop capabilities to make models updatable to accommodate real-time changes/measurements
    - Integrate current streams of real-time data
    - LIDAR
    - Bathymetry
    - Plumes, chemistry, suspended sed, bedload
- Specific sites for future concentrated investigations?
    - River – Wax Lake, LA
    - Waves - Danube, ??
    - Tide – Fly (PNG), Skagit
    - Arctic – thermokarst, McKenzie
    - Mixed - ??
- Components:
    - Improved representation of geotechnical approaches
    - Understanding of bifurcations and avulsion (centennial scale)
    - Delta mouth bar interactions (waves, plumes, etc.)
- Different scales of behavior *and* prediction are of interest

Modeling?

- Dynamic ‘input’ model needs (incomplete, yet these are probably needs for many)
    - Meteorology
    - Waves
    - Tides
    - Fluvial water, sediment flux (quantities and characteristics)
    - Subsidence/tectonics
    - Land use/cover

- Sea level
- Interoperable models (example)
  - River avulsion and wave-induced shoreline evolution

Nearshore and Inner Shelf (relatively small scales; < km, < yr)
Tom Lippman reporting for Calantoni, Hsu, Seitzinger, Hoesktra, and Voulgaris

1. Goals
   - Understand processes assoc. with
   hydrodynamics
   hydrography
   sediment transport/bathymetric evolution
   solute transport
   air-sea interaction

2. Prediction
   - Test our understanding of the process
   - Forecasts

3. Boundary Conditions
   - seaward
   - landward
   - bottom
   - surface
   - lateral

4. Scales (temporal and spatial)
   - small, meso, large

5. linkages
   - time
   - space (horizontal, vertical)
   - regional

6. Data Assimilation
   - time varying boundary conditions
   - diverging forecasts
   - appropriate data

Limitations

- Coupling
  – Grids, variables, up/down scaling

- Feedback
  - Across scales

- Assimilation
  - Nudging, inverse, data types

- Evaluation
  - Motivate measurement needs

<u>Large-Scale Coastal Morphodynamics</u> (> km, > yr)
Scott Peckham reporting for Moore, McNamara, and Perrie

<u>Existing models</u> (* = not on current list):
Coastline Evolution model (Ashton, Murray et al.)
"Shoreline" model (S. Peckham)

BarSim (stratigraphic model, storm-frequency based)

Engineering models:
SBEACH, GENESIS

Morphologic behavior:
*Cowell (shoreline translation model)
*GeomBest
*Panel model: Steve and de Vriend (piecewise linear)
CST
Sequence4
*SLOSH
QDSSM

*storm-surge models (TAOS)
*wave run-up models (XBeach)

*Macnamara's 3D Barrier island/humans model (MatLab)
*BIT (Barrier Island Translation) (Sergio)

*Mike Walkden shore platform evolution, soft-rock cliff

<u>Gaps in knowledge:</u>
rocky (inhomogeneous) coastlines, grainsize issues (not sand), complex contours, immature shelves, canyons,
arctic coastlines: ivus (ice push), permafrost,

impact of humans, carbonate coasts, impact of biology and geochemistry (e.g. worms, mangroves, vegetation stabilization),
more generally: sediment stabilization/erodibility,
cross-shore transport (in both directions), coastal dunes
storm surge, full 3D modeling, links to tidal-inlet dynamics, impact of extreme events

leap-frogging between hydrodynamic models and coastline or stratigraphic models (bridging the gap between small and large time/space scales)

recovery periods vs. impact of extreme events

Eolian

Andreas Baas reporting remotely

For coastal dune development I'm aware of a 2D transect model (called SAFE) with full-blown airflow fluid dynamics and coupled sediment transport, there may be one or two other models around that work on the same principle; then you have the fully 3D cellular automata model like DECAL. The 2D transect models are restricted in the fact that they can not consider fully 3D landscapes, and they can also not handle separation flow very well (wake behind a foredune, for example). The 3D CA model is limited to providing a statistical approach that allows an exploration of kinds of landscape, but it's probably not sufficiently restrained enough to apply to real-world specific situations. In the context of the working group I think the key challenge is to connect the back-beach/coastal dune system with the sediment inputs from the beach and near-shore zone, and that one itself probably linked through to inner shelf environments.