Coastal Working Group Goals (5 years +) and steps toward them

Overarching Goals

1. Improve the understanding of, and ability to forecast, how a broad range of coastal environments evolve, including the effects of: the dynamic feedbacks among physical, biological, and human processes; interactions between different environments along coastlines; and interactions among coastal, terrestrial, and marine environments--all under a range of climate and human management scenarios. (Initial goals for the next five years listed as 'specific science goals' below.)

2. Address societally relevant science questions, and assemble a set of model tools facilitating investigation of coastal impacts and vulnerability, and their variability--and to enhance the ability of coastal managers and policy makers to use and interpret the modeling tools and results (in collaboration with the Education and Knowledge Transfer Working Group, key stakeholders, and decision makers).

Specific Science Goals (SSG's) Under these Umbrellas, and Steps Toward Them

SSG1 To improve understanding of and ability to hindcast/forecast past and possible future *delta evolution on decadal to millennial time scales, as affected by couplings between terrestrial, fluvial, coastal, wetland, floodplain, subsidence, ecological and human processes*, ultimately including coupling between 1) long-term changes in delta morphology/ecology and 2) storm-event impacts to morphology, vegetation, and human dynamics and infrastructure. Based on a recent Working Group Meeting report (as well as the CSDMS 2.0 proposal), the science questions that a suite of coupleable delta-evolution model components can be used to address include:

- What are the fundamental controls on delta size, shape, and elevation?
- How might deltas change as dams are removed and sediment flux is restored to a pre-dam level?
- How do human manipulations of fluvial processes on deltas alter delta evolution?
- What determines the extent of wetlands, under various scenarios of human manipulations, relative sea-level rise (including subsidence) and upstream land-use changes?

- How do storm surge and flooding threats vary among different scenarios?

Short Term Step (1 - 2 years)

- Begin to build on the coupling between CHILD and SEM (Seascape Evolution Model) to develop a suite of coupleable models to achieve the long-term delta-evolution goal. Specifically, construct a model component for dynamic river avulsions (requires community effort), and couple CEM to SEM (CSDMS Integration Facility effort).

- Discuss the possibility of establishing a particular site, or sites, for the community to focus study on, in addition to the Wax Lake Delta that the Delta Dynamics Collaboratory (an NSF Frontiers of Earth System Dynamics project). Desirable attributes for additional sites include the availability of data sets appropriate for model testing and inter-comparison, and conditions that contrast with those at the Wax Lake Delta, including more significant human presence and manipulation (possibilities include the Gambia Delta—please see the initial plans for the Coastal Vulnerability Initiative).

Medium Term Steps (3 + years)

- Add to the delta-evolution coupleable-component model suite a model (or models) of wetland and floodplain accretion, and couple the existing subsidence component (coupleable) to the others in the suite.

- Couple long term delta evolution with storm surge models; run a hydrodynamic model (e.g. ADCIRC) on the morphology resulting under various climate and human-manipulation scenarios to assess how storm impacts vary.

- Better determine the role of organic sediment accretion and vegetation dynamics in delta evolution.

- Improve our ability to reproduce delta morphology using hydro- and sediment-dynamic models (e.g. Deft3D) more realistically.

- Record the stratigraphic record of delta ecomorphodynamic evolution— e.g. under what conditions the stratigraphic signal is dominated by forests vs. topsets—under various climate, sea-level-rise, and human-forcing scenarios (the capability exists within SedFlux components).

- Add human-dynamics modeling components, ranging from traditional economic analytic approaches to agent-based models of how human react to changing coastline morphology and rates of change.

SSG2 To improve our understanding of and ability to forecast how the *morphology, ecology, and human components of sandy coastal environments co-evolve under different scenarios of changing storm climate, sea level rise, and human manipulation*--including coastal environments ranging from urban to undeveloped.

Short Term Steps (1 - 2 years)

- Identify what models should be included in the model suite to address sandy coastline eco-human-morphodynamics

- Decide on criteria that would determine which sites would be useful for benchmarking and intercomparison, after determining which models we want to test (possibilities for developed sites include the New Jersey Coast—please see the initial plans for the Coastal Vulnerability Initiative).

Medium Term Steps (3 + years)

- Investigate, using coupled hydrodynamic, eolian, ecological, and human-development models, how storm impacts and post storm recovery processes on sandy coastlines depend on ecomorphodynamic state and on human development patterns, and under what climate and human forcing scenarios thresholds may cause rapid and dramatic shifts in the morphologic/ecologic/development states.

- Improve our understanding of biological processes and interactions between biological and physical processes.

- Increase the involvement of social scientists in these investigations

SSG3 To improve our understanding of and ability to forecast how *rocky and soft-cliffed coastlines change over time, as human manipulations (e.g. river damming and coastal armoring) and changes in climate affect interactions between cliff erosion, sediment production, and sediment redistribution*--and how these interactions affect coastal communities.

Short Term Steps (1 - 2 years)

- Identify what models should be included in the model suite to address rocky coastline human-morphodynamics, in addition to CEM Rocks (the version of CEM including lithological variations, cliffs, and nonlinear interactions between cliff erosion rate, sediment production, and beach sediment redistribution).

MediumTerm Steps (3 + years)

- Add a BMI to CEM Rocks and other prioritized rocky-coastline models

- Conduct model experiments addressing rocky coastline evolution, and how it interacts with local engineering projects (including river damming, cliff defenses, jetties, groynes, and beach nourishment).

Science-Facilitation Goals (SFGs)--In Support of SSGs, and More Broadly

SFG 1 Provide open access to a toolbox of stand-alone and linkable models and modules that represent the scientific state of the art—while continually adding to it as knowledge and modeling capabilities improve.

a. enhance the efficiency of scientific advance, as individual scientists and research groups use the models in the toolbox, both stand-alone and linked, to address new intra- and inter-environment questions (with minimal need for new model development).

b. allow the broader community—including educators and environmental managers—to use state-of-the-art science and modeling capabilities (and animations) when addressing landscape and ecosystem evolution, global change (including direct human manipulations of landscapes as well as climate change) and exposure to natural hazards.

Short Term Steps (1 - 2 years)

- Update evaluation of 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.

- Continue to gather available models; reach out to researchers with useful models that are not yet contributed to the CSDMS, making them available to other scientists and the broader community.

- During year 1, prioritize MODEL X for the roadmap (community effort for BMI development, followed by Integration Facility effort for CMI; see below). Priority targets include: SWAN; ADCIRC; and a simple fluvial avulsion component based on the Jerolmack/Paola model.

- Identify the models to add to the CSDMS coupleable-component toolbox (i.e. the next 'roadmap' models) in years 2 and 3, based partly on successes during year 1. Priorities in addition to those listed above under short-term steps may include a version of CEM including rocky-coastline dynamics, and the Barrier Island ecomorphodynamic model.

THE CSDMS 2.0 ROADMAP:

ROADMAP to componentize a model:

1. Identify a community need

2. Identify a specific model.

3. Refactor model to comply with BMI standards (task of model developers). Documentation on CSDMS wiki http://csdms.colorado.edu/wiki/BMI_Description. CSDMS IF to offer support through Skype or work with developer(s) at the IF. BMI seminars will be given at meetings.

4. Generate XML– GUI file for component (developers & IF staff)

5. Provide input and output test data (developers)

6. Test stand alone component on CSDMS HPCC (IF staff)

7. Component help pages created (developers & IF staff)

8. Component tested for a coupled simulation.

9. Coupled run simulations lead parties to publishable paper

Medium Term Steps (3 + years)

- Identify the models to add to the CSDMS coupleable-component toolbox (i.e. the next 'roadmap' models) in years 4 and 5.

- Encourage the coastal science community to propose to funding agencies scientific projects that will help fill gaps in knowledge and gaps in modeling capabilities.

- Persuade the modeling community to continue to adopt CSDMS protocols as new models and model components are developed, so that models can be more readily shared and in some cases linked to other models and components.

- Encourage the community to undertake the linking of specific models of different environments (within and beyond coastal environments); to broaden our thinking to include scientific questions we don’t currently entertain, and to write proposals to address such questions involving multiple environments. Roadmap projects we identify will provide examples.

- Collaborate with the EKT WG (and end users/stakeholders) to facilitate future use of the toolbox, and interpretation of model results; for example, what information needs to be provided along with the model toolbox to help non-modelers understand various sources of uncertainty?

SFG 2 Increase model benchmarking and model intercomparison activities, by enhancing the accessibility of key data sets (targeted to model-testing needs), and groups of data sets (e.g. a range of variables measured in one region, or the same variables measured in a range of different environmental settings).

Short Term Steps (1 – 2 years)

- Determine the most appropriate data sets (and sets of data sets) form model testing (comparing models to nature) and intecomparison (comparing models to models)

- Discuss the most appropriate ways to test and compare models--e.g. reproducing specific time/space changes (short term) vs. statistical comparisons (longer term morphodynamics and ecomorphodynamics)

- Seek out data rich sites involving significant perturbations to the background conditions, because the relatively rapid re-adjustments provide challenging targets for models to reproduce. (One possible example: in the Netherlands, a recent massive beach nourishment project is being very closely monitored, providing data appropriate for testing coastline-change models.)

- Begin to gather data sets most needed to test, benchmark, and compare models

- Notify the community that the open-source GIS package GRASS can be useful for model testing, benchmarking and intercomparison, facilitating analysis of, for example, sediment volumes, or dune characteristics.

Medium Term Steps (3+ years)

- Evaluate and describe the uses, intended goals, and limitations of the available models; which of them are designed to address abstract, basic science questions; which are designed to provide detailed and accurate simulations of processes and evolution in either specific locations or generic environment types; which fall between these end members; and how well do the models accomplish their goals (e.g. numerical fidelity and stability)? This large task will require significant community input, via the CSDMS wiki, as well as through peer-reviewed journal articles.

- evaluate the uncertainty that results from stochastic initial and boundary conditions (i.e. suite of model runs using different initial, boundary, or forcing conditions will produce different results in detail), as well as that from parameter uncertainty, model imperfections, and forcing input error.

- Encourage the community to engage in model testing, benchmarking, and intercomparison activities.

SFG 3 Compile a set of coupleable, interchangeable process-oriented model components (tools) representing, for example, hydrodynamics, sediment dynamics, and ecological dynamics, that can be used to address morphodynamic (and ecomorphodynamic) evolution in a range of contexts.

Short Term Steps (1 – 2 years)

- Target process-oriented models to add to this tool suite through the roadmap process. Initially prioritized candidates include a wave-transformation model (e.g. SWAN), a coastal hydrodynamic model (e.g. ADCIRC), and a generic bed-elevation model (may require significant model development).

Medium Term Steps (3 + years)

- Sequentially add more models to this suite, including vegetation-dynamics models (likely separate models for different vegetation types—e.g. seagrass, marsh grass, and dune grass) .