Operational Coastal Service Systemfor Disaster Prevention and Sustainable Coastal Development

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Abstract:This speech mainly covers following parts. They are necessity of coastal engineering information, disaster preventionocean & coastal economy; basic coastal engineering data bases; coastal prediction modeling system; promotion of coastal information industry; conclusion. In early 90's, GOOS was initiated by IOC,WMO, UNEP and ICSU to monitorGlobal Climate Change and do Ocean Service. In early 2000's, GEOSS was used in Weather Forecasting, Disaster Reduction,Ocean Resource, Climate Change,Ecological Forecasts, Energy Resources. Real-time Data Exchange of Ocean Data is important, but not satisfactory at present. To Solve it,Ocean Plays Major Roles in GEOS Development and Global Climate Studies, butnot much experience/practice in real-time oceandata exchange, especially in developing countries.Establishment of Operational Ocean and Coastal Service System are essential inSolving Local,National Problems as well as Global Problem.

Coastal Engineering Services

Coastal Engineering Services have two parts. One is coastal hazard reduction, another is coastal and ocean industrial activities. Coastal hazard reduction is for proper design of coastal development and timely prediction of local sea state. Coastal and ocean industrial activities require efficient, safe operation and sustainable development of ocean economy.

Now, Protection of human life becomes more important in the future. There are so many examples of wave induced hazards along the coast: Overtopping & Inundation by severe storm, Beach erosion, Meteorological tsunami, Rip current at beach, Swell wave run-up. And most of these occur at Surf-zone & Swash-zone.

How to Simulate Surface Elevation and Flow? Example of Sandong Prov. Blue Economy Coastal Dev. Plan requires basic engineering data bases and coastal modeling system for planning, design, construction, operation stages. So, there will be many users of Coastal Eng. Data Product, such as: Coastal and Ocean Industries, Public, Government Agencies. And the Users Demand include Long-term statistical prediction (through long-term hindcasting) for Plan, design for coastal and offshore structures or development; Nowcast and Short-term prediction for coastal disaster prevention and Coastal & ocean services for safe and efficient marine operation.

Now, there are problems in present Coastal Engineering Services. Firstly, there is not attention on Basic Data Bases to support all the engineering problems. Secondly, there is no service to the specific users. Thirdly, local Governments ignore "BLUE" when implementing Blue Ocean Economy. And, don't have enough technologies to cope with coastal Hazard.

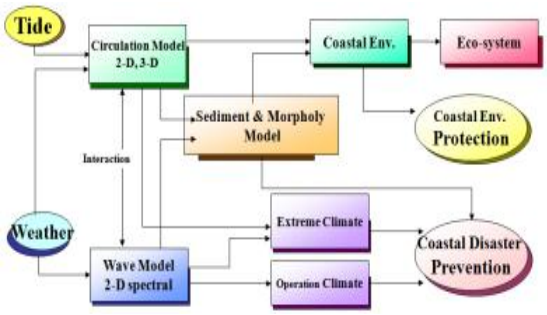
Basic Elements for Coastal Data Product using Numerical Models

Basic elements for coastal data product using numerical models are coastalmodels, Fine mesh depth grids, Boundary and Initial Conditions.Proper Preparation of Boundary Condition,both sea-surface and offshore, is most important.

Intra Structure for Coastal & Ocean Serviceis Basic Data Bases, Operation Service for Government and Industry, Primary Data Bases which requires Meteorological Input, Tide, Depth Grid and secondary Data Bases(data product using primary data).

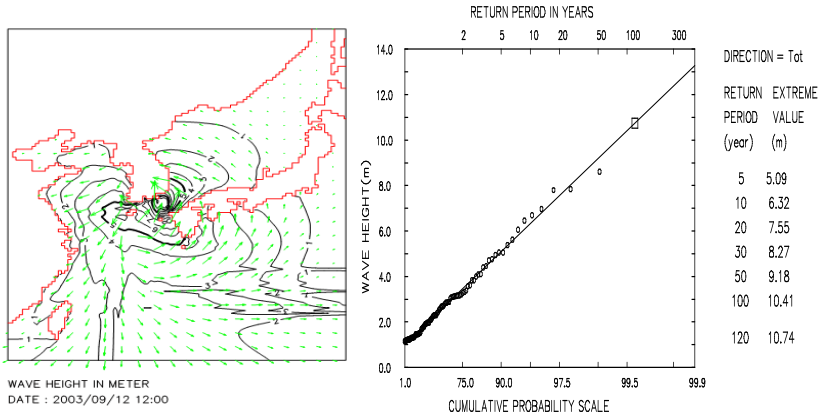
Basic Data Bases for efficient predictionsystem

Development of coastal information system fromthe basic of tide and meteorological input forcoastal engineering applications

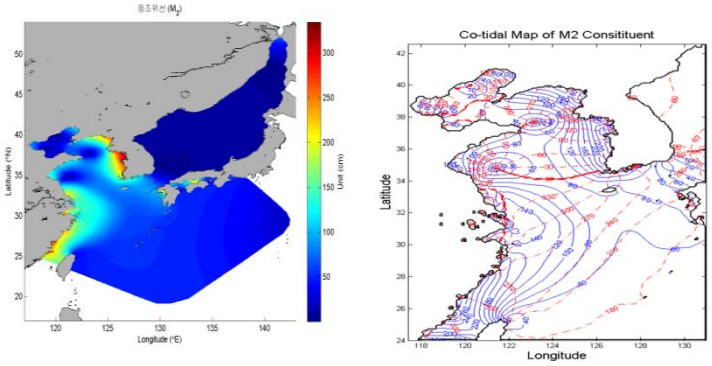


Associate Data Bases

Example of space distribution and extreme statistic analysis

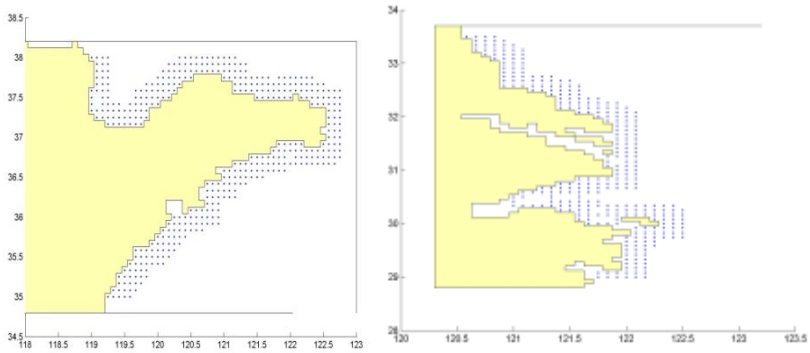


Example of estimation oftide harmonic constant



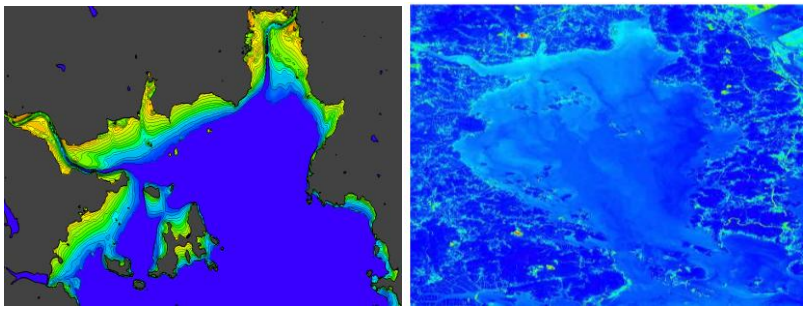
Example of grid points around Shandong Peninsula and Yangtze Estuary for rapid

retrieval of hourly time series of wave and wind data and associate data products



Example of Improvementof Basic Data Bases

UpgradeDepth Grid Data using LANDSAT-8 (Kang, YQ, 2014)(16 times of previous- Space Resolution: 30 m)

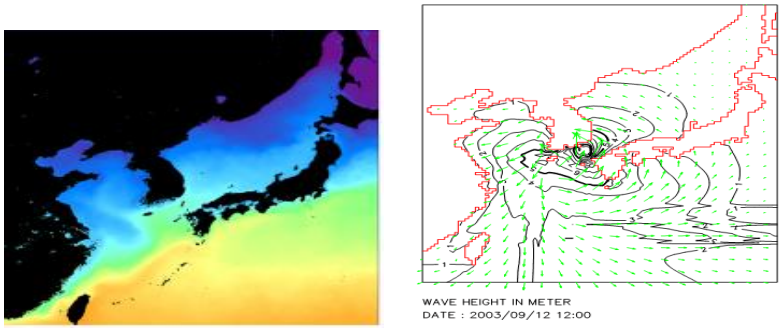


Depth contour (20 cm interval) at tidal flat using Example of LABDSAT-8 data:band 4 (red)
63 LANDSAT 7 Images

Air-sea interaction at Air-Sea Interface

Temperature is Different (Tw-Ta) between Air and sea, in research, it need high resolution daily SST from Satellite Remote Sensing and Ocean Model. Besides, roughness at Surface waves is important too. In Open Water, Cd s parameterized as a function of wind speed. For fetch limited case (coastal waters, near typhoon center, etc.), Cd is controlled by Waves.Using long-term wave hindcasting data as input for re-analysis using regional weather model (WRF).

Example of daily SST analysis using MODIS satellite data, after compensation for cloud-covered area (Dr. Y.Q. Kang)**,** Which can be used as input for WRF model together with results of long-term wave simulation to produce fine mesh(4 km) meteorological input data for ocean models.



Coastal Modeling System

Coastal ModelingSystem has two parts:Hinscast and Long-term Prediction; Nowcast and Short-term Forecast.

Interfacing of coastal model with regional (ocean and weather models)is link with application modules, such as:sediment transport, morphology, oil spill, SAR,sea-outfall, marine transportation, construction, and so on.

Surfzone & Swash-zone is an important zone for research. Most coastal development, coastal Hazard (disaster),coastal Erosion and morphology change happens in there.

Conventional approach to study this domain is to couple of two models: time averaged equation of motion and wave energy conservation eq.

Now, the new approach is to use Phase(wave) resolving modelby solving wave motion using equation of motion. It is simple. Using this approach, people can automatically handle the wave induced processes, wave setup, long-shore current, rip current, wave runup, overtopping.

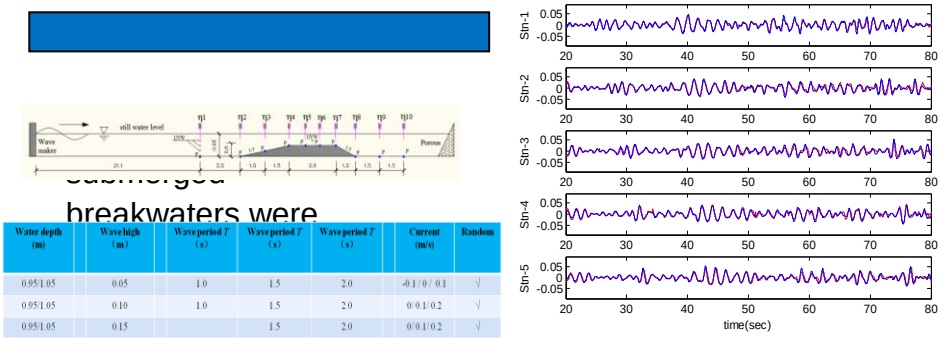
Conventional Coastal Models

Conventional coastal models couple mean flow and wave spectral model. Time averaged flow is used.Wave is calculated from wave spectral model. But this approach has limitation. Coupling (the impact of waves on circulation)is not accurate when wave is non-linear and propagates over rapidly changing water depth. And, no information on time evolution of wave motion(just wave spectral information are available).

In fact, most of the natural coastal hazards occur at surf &swash-zone is highly non-linear, so detailed wave motion needed. Conventional coastal models are not enough.

An example of OUC experiment:

Time series of surface elevation and sub-surfacepressure and velocity were measured using wave, pressure and ADV current sensors at the location marked above.



ComparisonModelvs. Observation

Symbol	Description	Example
M1:	Circulation	ROMS,POM
M2:	Wave spectral	WAM,WWIII

M3:	Coastal Wave Spectral	SWAN
M4:	M1+M3,Coupled	ROMS,Delft3D
M5:	Wave-resolving	Bussinesq, SWASH,
M6:	CFD Model	FOAM,FLOW3D

Area	GridSize(order)	Model	Examples
Regional Ocean	100 0 m	M1& M2	ROMS,FVCOM,WAM
Coastal Waters	100 m	M4	ROMS,Delft3D,..
Surf-zone	10 m	M4or M5	Delft3D,SWASH..
Swash-zone	1 m	M5or M6	SWASH,CFD
Near structure	0.1 m	M6	CFD(OpenFOAM,FLOW 3D)

Mostcoastal hazards occur at Surf& Swash-zone. The better approach to research these issues is to couple model(M5) and empirical model, or wave resolving model (M5, M6).

There are some guides to use coastal prediction systemunder construction in different domain. Basic Coastal Modeling System for rather wide coastal waters: flow & wave spectral coupled model (M4). Surf-zone: both approaches (M4 & M5). Swash-zone: SWASH, XBeach Model (M5)Delft3D + empirical eq. (M4+empirical eq.)

The model can implementlong-term simulation to produce basic coastal eng. data bases and short-term forecasting system for the coastal waters.And further, interfacing with Global & Regional Ocean Model, and Interfacing with CFD model for local application.

Process Based Morphology Change Model

Coastal areas are particularly sensitive to climate variability and change, such as sea-level rise and possible intensification of typhoon. Concern about the change of coastal environments with change of natural environmental force and human activities is increasing.Empirical models(using equilibrium profile) are not valid for storm waves, andnot valid for steep bottom slope, land reclamation, beach nourishment. In order to build system for long-term morphology change prediction, process based model, basic data base & fast simulation, lab. & field experimentis used.