

ESTPROC INTERNAL PROJECT NOTE

ESTPROC 1ST Annual Workshop: 1-2 October 2002 Southampton Oceanography Centre

Outline notes prepared by Alison Houghton (01/11/02)

Meeting Notes: Day 1

Attendance

Richard Whitehouse	HRW
Mike Dearnaley (Day 2)	HRW
Nigel Tozer	HRW
Alison Houghton	HRW
David Prandle	POL
Andrew Lane	POL
Keith Dyer (Day 1)	UPL
Andy Manning	UPL
Emma Defew	GML
Paul Norton	ABP
Ian Townend	ABP
John Harris	ABP
Natalie Frost	ABP
Chris Jackson	ABP
Ivan Haigh	ABP
Dano Roelvink	WLD
Han Winterwerp	WLD
Mindert de Vries	WLD
Frederico Maggi	WLD
John Widdows	PML
Reg Uncles	PML
Iris Moeller	CCRU
Mike Collins	SOES
Doros Paphitis	SOES
Nico Booij	DHH
Jonathan Rogers	Mouchel – representing Funders

1 Welcome: Michael Collins

2 Introduction to meeting: Richard Whitehouse

7 months since kick off meeting 1/3 way through the project.

Aim of workshop is to take stock of progress and agree way forward.

Agree model sensitivity tests and agree datasets for purchase

Whole project is data driven – 15 sites already being used.

Clear any issues before Day 2

Management Activity

3 steering group meetings

Progress report to funders in July

Inception report published September 2002

All reports have to be in standard EA format

RJSW to provide information on standard EA report template

- Goal: Increase use of project website
- Goal: Log publications
- Goal: Interaction – see matrix on p35 of Inception report
 - Tidal flat sedimentation
 - Mudflats/saltmarshes
 - Integrated modelling
- Goal: Deliver 10 objectives as listed on p3 of Inception report January 2003

Feedback from funders

Inception report accepted

Link with other DEFRA funded projects

WPs show that there will be good use of available data and reference to past projects

Appreciate difficulties associated with working as a large consortium

Appendix 3 – very impressed

Very promising project with excellent science and scientists

Monitoring of parallel research council projects and initiatives

3. Logistics – Doros Paphitis

Dinner Kutis brasserie 7-8pm

Presentations (summary only)

4. David Prandle – POL

Request for estuarine data – where can this data be found

Experimental work

1D estuarine equations

General purpose models – several versions of model based on different time-scales and forcing mechanisms.

Both 1D and 2D models- models are essentially very simple

The 1D model will be circulated by 04/10/2002

Andrew Lane

Model name: POLSPM1

1-D model of suspended sediments

First of a suite of models (1D, 2D and 3D) of suspended sediment dynamics

User friendly format

5. Nigel Tozer – HRW

Summary of progress

Hydrodynamics

- Preliminary work under way

- Liason with data providers SWAN in Japan
- Experience with LIDAR data

Objectives

Improve representation of shallow water processes in community wave model SWAN

Incorporate effects of vegetation

Consider both stationary and non stationary versions of SWAN to incorporate full tidal cycle

Progress

Liason with SWAN developers in Japan/ PHRI

Data sets:

- Stour/Orwell
- Nordenay Seegat
- Great Yarmouth/Scroby Sands
- Others (Delta flume tests – New DEFRA beneficial use projects next 12-18 months)

Not aware of existing data relating to the effects of vegetation – qualitative assessment only?

Waves – alternative objectives

Improving wave affected mud transport on intertidal areas

Richard Soulsby will be working on representation of shear stresses on smooth beds

Dendritic systems

Improved representation

Application to salt marsh systems

Progress:

No formal work completed

Experience gained using LIDAR data on dendritic systems

Biological interactions

Awaiting results from biologists and identification of modelling tasks

Objectives:

Review and comment on findings in this subtask

Review and aid the development of biology driven fieldwork

6. Nico Booji DHH

ONR test bed

Next SWAN release imminent

Suggestion on further development

ONR test bed – designed to compare wave models

Oceanic (non stationary tests) possibly no of interest to ESTPROC

Coastal (stationary tests)

Academic tests- verification of wave model

Lab tests – Calibration

Field tests – quality control difference between computed and observed results:

4 categories:

- Growth curves
- 4 tidal inlets
- 2 open coasts
- 1 shallow lake

Further tests will be carried out to ensure that all scenarios are considered
In particular, rocky coasts and vegetated coastal areas will be tested

- Next SWAN release
- New: Diffraction,
- Improved: Quadruplets, surf breaking

Suggestion: Add vegetation dissipation to SWAN. This has already been attempted in a previous version where stiff surface piercing stalks were used to represent mangrove forests

Suggestion: provide a well-documented test with vegetation to ONR test bed.

Question: Performance of SWAN in very shallow intertidal areas

Question: SWAN doesn't differentiate between dissipation by wave breaking and dissipation by bed friction.

7. Andy Manning– PML

Estuarine Flocculation

Data acquisition

- INSSEV – In-situ settling velocity
- Samples @0.5m above bed
- Mounted on a steel bed frame
- Can obtain visual real floc images
- Fractal dimensions
- Porosity
- Dry mass
- Concentration distributions

Data sources

Processing & data base compilation

- Two primary subgroups identified: Macroflocs and microflocs (160microns boundary)
 - Profile of sediment transport (POST) – EMCs, OBS mounted on INSSEV frame
- Very large data sets accumulated

Examples of results

- In-situ Tamar Estuary
- COSINUS project- Collaboration with University of Grenoble
- Gironde Estuary

Initial empirical models

- How can floc data be incorporated into existing models
- Data sets statistically analysed – multiple regression analysis
- Macrofloc model valid for SPM up to 8g l^{-1}

No correlation between microfloc settling velocity and spm concentration

Microfloc settling velocity appears to be dependent solely on turbulent shear stress

Workshops and publications

- Institute of physics London
- STRAEE workshop
- University of Ferrara Italy
- Sediment Transport in European Estuaries Workshop
- Paper and poster presentation

- Total of 5 papers submitted to JCR special edition
- 6 additional publications in collaboration with other researchers

8. Keith Dyer

Tamar measurements using POST system

Measurements of suspended sediment variability at various stages of the tidal cycle

Future work: investigation of near bed fluid mud layers.

Paper manuscript prepared

9. Han Winterwerp & Dano Roelvink

Input

- Detailed bathy, sediment data, vegetation, CASI, LIDAR
- Model bathy, bed composition, vegetation
- Intra tidal, intra event processes
- (See presentation)

Hydrodynamics and morphology

- Combined waves and currents in meso-mega tidal estuaries
- Main goal: Predicting accurate and smoothly adapting patterns of wave parameters and bed shear stresses over channels and shoals

Wave modelling

- Input from flow model

Classical approach

- Run flow model over tide
- Export flow fields
- Run stationary wave model

Problems

- Many iterations per run
- Temporal interpolation inaccurate when patterns move horizontally
- Solutions
- Use smaller time intervals
- Use quasistationary and instationary approaches: Find out which is most suitable

Wave modelling

- When using small time intervals in updating wave field, simple coupling structure is possible
- Waves flow and transport solved almost simultaneously waves updated 10-20 flow steps
- Wind and offshore wave conditions may vary during simulations allowing detailed hindcasting

Future work

- Compare stationary and instationary approaches with measured data
- Start working on improving physics.

SEDIMENTARY PROCESSES

Flocculation (TU DELFT)

- Tidal flat simulations
- Tidal flat dynamics is key to fine sediment balance in estuaries and lagoons
- Waves
- Bed shear stress (interaction hydrodynamics, turbulence – sediment)

- Sediment structure and strength

Study on the evolution of floc size distribution and settling velocities

- Experiments will use settling column with turbulence generators
- What happens to the structure of the flocs when they disintegrate

Sedimentation processes: Bed shear stress

Sediment induced buoyancy effects:

- Damping of turbulence, hence decreased mixing
- Reduction of effective bed shear stress: Chézy may reduce to $>100m^{1/2}/s$

Modification of boundary conditions for log profile k and ϵ

Sedimentation rate

Formulation of Krone $D=W_s c(1-\tau_d/\tau_b)$ for $\tau_b < \tau_d$ alternative formulation proposed which allows simultaneous erosion and deposition

Deposition = sediment flux

Pdf for bed shear stress

Re-analysis of Krone's expt

Conclusion: τ_d does not exist, but is in fact the same as threshold for erosion

Biological interactions

Integrated field work and modelling in the Western Scheldt

Saltmarsh and mudflat fieldwork May-December 2002

Monitoring of:

- Physical parameters
- Biological parameters

Application to Humber

- Data and literature review
- Basic Delft 3D model of Humber available
- Further elaboration of theory and conjectures
- Sensitivity of 3D model
- Gross transport of fines
- Sediment composition (sand-mud mixtures)
- Effect of benthos

START UP WORKSHOP

10. Paul Norton

1 – Impact of extreme events

To provide better representation of small scale dendritic channels in hydrodynamic models

Possible approaches:

- 1D network model with floodplains
- Structured/unstructured grid schemes 2d/3d
- Raster/cellular models:
 - (1) LISFLOOD, Bates and de Roose 2000
 - (2) CEASAR, Coulthard, 2001

Description of channel systems:

- Elevation within tidal frame
- Bedslope
- Area/volume

- Fractal dimension
- Sediment properties

Model development

- Raster model
- Cellular model
- Comparison between 1d 2d and 3d approaches

2 – Interrogation of existing data

- Model application
- Southampton Water
- Humber
- Gwent Levels, Severn Estuary
- Tollesbury Creek (LIDAR data required)

Deliverables

- Dendritic channels in coarse grid models
- Modelling tool for dendritic channels
- An integrated approach

3 – Near bed stresses

- Model development
- Investigate effect of form drag in 1DV models
- Representation of bed roughness
- Develop expression for bedform model- apply Vongvisessomjai et al approach
- Model application
- Delta flume
- India project

4 – Sedimentary processes

- Disseminate findings from consolidation tests
- Intertidal conditions
- Fresh/saline water

Workshop for soil/sediment experts (month 16) to be arranged by Ivan Haigh

- Sediment transport models
- Field measurements

5 – Mudflat erodability model

Further development of rule based model to predict mudflat communities from environmental variables

Fieldwork programme – December 2002 & June 2003 Humber Estuary

Process and analyse data

Incorporate surface erodability into benthic model

Data management

- Collation of meta-data
- Electronic form to be accessible on website
- Information required: description, source, keywords, geographical location
- Use of STEM system

11. Reg Uncles PML

Tidal and seasonal dependence of intertidal mudflat properties and currents in the partially mixed Tamar estuary

In-situ annular flume for measuring erosion properties of inter-tidal sediments

ADCP sections across the estuary.

800m wide section across the estuary from a small mudflat on the Cornish side of the Tamar to a large saltmarsh on the Devon side.

Greater the mass of benthic diatoms on mud flat, the higher the erosion threshold.

12. John Widdows – PML

Theme 3 – Biological Interactions

Specific objectives PML in months 1-24

- Experimental flume and field validation studies quantifying the impact of key biota on near bed hydrodynamics sediment erosion and deposition
- Modelling results of flume experiments with *spartina* and *salicornia* with the aim of incorporating effects of biota on sediment erosion and deposition in models
- Numerical models of mudflat and saltmarsh including wave induced bed shear stress at Skeffling and Tamar sites.

Biological processes/ mechanisms

Biostabilisation

- Armouring/biofiltration/biodeposition
 - Enhanced sediment cohesion
 - Filamentous binding
 - Flow and wave attenuation/ physical protection of sediment/ skimming flow
- Spartina reduces erosion by 30-50%

Biodestabilisation

- Burrowing and deposit feeding on surficial sediment
- Increasing bed roughness and turbulence (eg mussel clumps, burrowing bivalves)
- Grazing and faecal pelletisation of sediment
- Bioresuspension can be significant (annular flume test with mysids)

BIOSED Model: comparison of intertidal net erosion or deposition under different wave heights with *Spartina* saltmarsh.

Comparing effects of different *Spartina* stem heights on intertidal sediment dynamics

Question of how to include vegetation effect in BIOSED?

13. Doros Paphitis: SOES

Hydrodynamics

Contribute towards the improved understanding of the nearbed shear stresses with particular reference to combined wave and current regimes

Data autonomous benthic recorders (ABRs)

Deployments

Three ABRs in a cross shore transect at Hythe Soton water intertidal mudflat.

One ABR at Hythe intertidal mudflat (2002 for 40 days): high frequency data at every high water. Waves, currents and turbidity

2. Sediments

Improve present understanding of dynamic sedimentary processes for the further development of formulae and algorithms used in numerical modelling.

Specific objectives

- Review of relationship between bed sediment sorting and other basic statistical parameters of grain size distribution and sediment transport pathways
- Improve representation of bedload in sediment transport models
- Influence of sediment sorting

3 Biology

Put in presentation

Methodology

Sub rounded quartz sand

Steady flow recirculating flume with a rectangular cross section

Experimental design

14. Emma Defew: Gatty Marine Laboratory

Broad objectives

- Lead review of biological process parameters that affect the stability erodibility and deposition of sediments
- Develop a database to accept transect based bio-sedimentary data
- Investigate the importance of multivariate statistical parameters

BIOPTIS project

Provided large data set of sediment stability measurements for tidal mudflats

Sediment stability maps

Objective: to find a predictive relationship, which will permit the identification of proxy parameters

Stable vs. unstable sediments: comparison table

Looking ahead

Within the next 6 months:

- Complete review
- Test database with recently collect field data from HIMOM

15. Iris Moller: CCRU

Wave attenuation over intertidal surfaces

Cambridge Coastal Research unit will act as major providers of data for ESTPROC project

Long term sedimentary data on saltmarsh and mudflat processes.

Variability

- Input conditions
- Surface properties – topography (creeks, salt pans, vegetation)
- Upscaling (from effects of individual saltmarsh plants to whole swards)

Data from Stiffkey (Norfolk) and two sites along the Dengie peninsula (Essex)

FINAL SESSION DAY 1: DISCUSSION KEY DATASETS

Chair: Richard Whitehouse, Paul Norton

Available datasets

- LIDAR (+CASI for better DTM) ~ has to be combined with hydrodynamic data
- DEFRA uptake project (data from ERP 1)
- HR Wallingford (flow/sedimentary data from commercial/ research projects)
- ABPmer (ditto)
- POL surges
- *Different data requirements*** How are the different datasets to be integrated?

OTHER DATA

- Delta flume experiments
- LOIS/LISP
- INTRMUD

Do we know if we can accurately model estuaries? EMPHASYIS examined this question

Coastal monitoring needs

Data required:

- Waves in estuaries

Suggestion: A proforma for required data is needed. This should outline what kind of data is required and what format it should be presented in.

Based on the various presentations, it is clear that significant advances have been made in the study. It is essential to consolidate and derive full use from the data already in use before seeking to acquire more from external sources.

An inventory of available data should be produced for each of the chosen estuaries.

It is estimated that it will take 2-3 years to produce data that is significantly better than that which is already available.

DEFRA – state of the seas report: coastal strategy studies

Define requirements of coastalgoos

Define UK monitoring strategy

Sensitivity testing DISCUSSION Chair Richard Whitehouse, David Prandle

Overfitting of formulae + models to datasets

Detailed modelling is averaged out over the total length of the estuary

It is essential not to lose sight of the aims of the project, nor the stochastic nature of estuaries.

In brief: What are the maximum likely responses of estuaries to anthropogenic and natural forcing mechanisms over time?

Is it economical to collect field data that will support models covering whole estuarine systems?

ESTPROC 1st Annual Workshop 1-2 October: Southampton Oceanography Centre

MEETING NOTES DAY 2

Welcome by Richard Whitehouse – brief summary of day 1

Format for reports clarified

Formal published reports should conform to the standard DEFRA/EA format (as per inception report)

Other reports do not need to be in this format

David Prandle

Overview of task 1: Hydrodynamics

Objectives

Improve

- Modelling of waves
- Prediction of extreme events
- Representation of bed shear stress
- Interrogate data – interrelationships/ correlations

Links between dynamical forcing, bathymetric evolution and SPM

- It is not possible at present to predict with certainty how an estuary will evolve over the next 100 years
- It is necessary to consider the estuarine system as a whole – this poses significant problems for the modelling community

Modelling

Isolated processes

WISE/SWAN

Whole estuary: MIKE 21, DELFT 3D, TELEMAC, POLCOM

	Model	
Theory		Data

The nature of the exposure of UK estuaries to different hydrodynamic forcing mechanisms is extremely diverse.

Erosion

Ko Influenced by chronology, flora and fauna

Settling

Ws Influenced by concentration, Ri, turbulence

Flocculation Influenced by turbulence

There is a need to identify KEY INDICATORS that can actually be measured or identify proxy parameters

HOT SPOTS

- Wetting and drying
- Phasing
- Marsh cliff
- Extreme events
- Fluid mud 'luctocline'
- Clapotis

CYCLES

- Tides
- Spring- neaps –chronology, bed shear stress, consolidation, ko
- Seasonal
- NAO
- Trends (ms²)

SORTING

- Existing stability vs historical balance

Han Winterwerp

Phase 2: Sedimentary processes

First year progress

	Integrated modelling	
Tidal flat sedimentation	Mudflats	saltmarshes
Hydrodynamics	sedimentary processes	biology and sed. processes

Summary of individual contributions given on day 1 on sediments:

Keith Dyer

Tamar data on turbulent flow and sediment parameters show:

- Strong damping and drag reduction by high concentrations
- Inverse Reynolds stress profiles and
- Subsequent effect on mixing

Mindert de Vries

Scheldt data

4 autonomous stations with EMF, OBS pressure sensors sampling

10 EMF / pressure sensor combinations for measurements of transects

Iris Moeller

Dengie peninsula

Correlating SP erosion data threshold and chlorophyll a levels

Reg Uncles

Shear stresses on mudflats and EPS
Mini rigs data

Integration

Necessary condition: Multi disciplinary studies – well on course but not sufficient to satisfy requirements for integrated modelling at present

Further collaboration:

- Flocculation
- Wave attenuation over salt marshes
- Effect of biota on erodability
- Joint Tamar experiment channel flat interaction

Integrated modelling

- Humber
- Dengie
- Tamar
- Testing algorithms and sensitivity analysis
 - Overall sediment budget
 - Sediment composition and sorting (sand-mud)
 - Effect of biota

John Widdows

Theme 3 biological interactions

Objectives

To develop an understanding of the interactions between biological life and sedimentary processes within estuaries

Key questions

- Which biota are influencing sediment erosion and accretion
- What are the different biological processes
- Can we quantify processes and improve parameterisation of models
- When scaling up, can we use proxies or single biological variables
- Can we predict communities from physical environmental data and can we relate changes in communities to changes in sediment erodibility

Spatial heterogeneity

Biota will change longitudinally (salinity) and laterally (shore height and air exposure)

Can the occurrence of key biota be predicted from the physical properties of the habitat and can changes in sediment erodibility be related to changes in communities?

No significant relationship between observed and predicted occurrence of species in estuaries based on habitat suitability

Problems due to heterogeneity caused by grazing and predation pressure season and inter annual cycles in recruitment extreme events and human activities

Can sediment stability be predicted from single proxy parameters?

Multivariate approach is required (biological and physical parameters)

Database of transect based biosedimentary data

Temporal variation

- Tidal/diurnal

- Seasonal
- Inter-annual
- Decades/ Centuries

Conclusions

Benthic communities are complex and spatially and temporally variable

Rarely able to apply a simple proxy to predict sediment erodability

Even if we cannot predict the composition of benthic community we are improving the understanding of the role of key species acting as bio engineers

Aim to predict sediment stability from knowledge of community structure and function

Biological processes and mechanisms influencing sediment erodability

Biostabilisation

Armouring and biofiltration/biodeposition

Enhanced sediment cohesion

Filamentous binding

Flow attenuation physical protection of sediment, skimming flow over vegetation

Macrophytes density dependent reduction of near bed flows and sediment erodability

Salt marsh plants

Wave attenuation on Essex marshes exceeds levels predicted by earlier physical scale models

Spartina and salicornia density

Dependent flow attenuation sediment erosion and deposition seasonal changes for salicornia

Strong links between theme 1 and theme 2 in project

Bio destabilisation

Burrowing and deposit feeding on surficial sediment

Increasing bed roughness and turbulence eg mussel clumps etc.

Grazing and faecal pelletisation of sediment

Bio resuspension

Models

- Modelling of bio mediated sediment transport in the intertidal
- Effect of changes in wave height on erosion and deposition

Review of relevant biological processes in sediment dynamics

- Validation biosedimentary database
- Analysis and synthesis of existing data sets for field studies
- Improved calibration of flumes and comparison with bed shear stresses in field
- Quantifying density dependent effects of biota on currents bed shear stresses erosion and deposition
- Field validation of exp studies

- Modelling of interaction between waves and biological parameters

There are instances when burrowing molluscs such as cerastoderma can act as biostabilisers of sediment. If there is a sufficient density of coverage, these molluscs can have an armouring effect, thus protecting the sediment from erosion.

NEXT STEPS: Richard Whitehouse

POL 1D model

Andy Lane to circulate model to all partners (readme file will be included). W/C 7th Oct

Website

Executive summary + link to main body of the report. Not to include any sensitive material

ERP 1 metadata list

Workshop report 14th

Full Inception Report

Links (Emphasys + others)

Inventory of metadata

Format

Wish list DEFRA strategy

LIDAR & CASI – Dengie (Iris)

Mapping onto objectives – Jan 03

Progress report – Jan 03

Scheldt data collection opportunities Dec 02

Humber Dec 02, Jun 03

Tamar experiment 2003

Review of biological effects ‘wrapper’ – website Dec 02

ABP workshop Mar 03 – soil/seds

Workshop for whole group open mtg Feb-Apr 03

May 03

Individual meetings