WORKSHOP

ON

MODELLING OF HYDROLOGIC SYSTEMS

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Glossary of Modelling Terms

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Glossary of Modelling Terms

Aspect ratio: An element's length to width ratio. Long, slender elements with an aspect ratio greater then 15 may cause stability problems.

Base to Plan comparisons: The process of identifying differences in numerical model results between existing conditions and revised conditions, usually a change in geometry.

Boundary break angle: A boundary break angle is the angle at the node on the "land edge" boundary connecting two elements together.

Boundary conditions: Water levels, flows, concentrations, stage/discharge relationships, etc., that are specified at the boundaries of the area being modeled. A specified tailwater elevation and incoming upstream discharge are typical boundary conditions.

Boundary effect: A consequence of dissimilarities between the model boundary conditions and the conditions occurring in the prototype at the location of the model boundaries. This effect may be minimized if the model's boundaries are far from the area of interest.

Boundary node: Any node which lies along an exterior element edge, or demarcates the wet/dry interface.

Cold start: A model run using initial conditions that are not expected to be close to conditions as solved by the model, i.e., a level water surface elevation and velocity values of zero.

Continuity: The term continuity refers to conserving mass within the model.

Convergence: The process of obtaining a solution by way of an iterative solution technique, such as the Newton-Raphson method.

Convergence parameters: The difference between previous and present values of intermediate solutions during the iteration process should approach zero with each successive iteration. If they do not, the solution is said to diverge.

Corner node: Defines a vertex of an element. A point within the mesh that has an (x, y) coordinate and z depth. If an element has three sides, then it has three corner nodes.

Curved boundary: An optional aesthetic means to outline key landmarks within the computational domain. A quadratic curved side is created by assigning (x, y) coordinates to the mid-side node of an element. Curving can help conserve mass in the transport models.

Data field: A specific location on a record (card in TABS programs) in a data file where a data value occurs.

Datum: The horizontal plane to which soundings, ground elevations, or water surface elevations are referenced.

Delta time step: The increment of prototype time between two time steps.

Diverge: The inability of the numerical model to achieve convergence by the iteration technique.

Dynamic: A simulation in which the boundary conditions are changing with time. The variables being investigated will change with time.

Element: A segment, triangle, or quadrilateral shape composed of corner nodes and mid-side nodes. An element must be 'connected' to a neighboring element. An element is composed of a list of nodes in a counterclockwise fashion and may define a 1, 2, or 3 dimensional problem. A line segment defines a one dimensional area, a triangle or quadrilateral defines a two dimensional area, while the three dimensional area is defined by adding layers to an element.

Exit boundary: A boundary condition location at which flow exits the mesh.

Field data: Data which has been collected at an existing, physical site, used when verifying the simulation.

Finite element: A method of solving the basic governing equations of a numerical model by dividing the spatial domain into elements in each of which the solution of the governing equations is approximated by some continuous function. This method lends itself well to the river/estuarine environments because of its diversity in computational mesh (element size, shape, orientation), flexibility of boundary conditions, and continuity of the solution over the area.

Flow fields: The domain in which the water flows.

Free-surface flow: A fluctuating water surface elevation. A numerical model which can calculate a changing water surface elevation is a free-surface model. Models designated as "rigid lid" do not permit free-surface calculations.

Front width: The number of equations in the numerical model's solution matrix that are assembled simultaneously.

Galerkin method of weighted residuals: The Galerkin method of weighted residuals is a finite element method which requires that the integral of the residual times the weighting functions should equal zero.

Gauss point: Sampling location within the element used for numerical integration. There are 9 Gauss points for a triangle and 16 Gauss points for a quadrilateral.

Gradient: The difference between the bottom elevation of any two corner nodes of an element.

Hot start: The process of supplying the numerical model a set of initial conditions which were obtained from the results of a previous simulation.

Ill-formed elements: Elements which do not conform to the rules for constructing a finite element mesh.

Inflow boundary: A boundary condition location at which flow enters the mesh.

Iteration: Repeating a sequence of instructions a specific number of times, changing parameters and obtaining a new solution each time, until a predetermined condition is met.

Leaking: A description of the inability of a mesh to properly hold water. Some modelers refer to a 'leak test' as a means to check out a mesh. Leaks, or "oozes", are a result of poor element shapes, large boundary break angles, and/or erroneous boundary condition specifications.

Mean sea level (MSL): The average height of the sea surface for all stages of the tide over a 19 year period, usually determined from hourly height readings.

Mesh: A collection of nodes and elements which defines the domain of the study area.

Mid-side node: A node between two corner nodes in an element.

Node: A point containing an x, y, and z coordinate which defines a location in space. Mid-side nodes (x, y, z) are linearly interpolated from adjacent corner nodes, unless the element side is curved.

Null point: A location in a mesh where there is no net fluid transport (no flow).

One dimensional element: A line segment composed of two corner nodes and one mid-side node. The geometry is defined by cross section (a straight bottom line between corner nodes) and reach length. The calculated velocity is averaged over the cross section.

Peclet number: Defines the relationship between element properties, fluid velocity, and eddy viscosity.

Prototype: Field data or physical model data. The original, or basis for the new study.

Run control file: Used for some numerical models, a run control file is an input data file which provides parameters that control the simulation run.

Spin-up: The process by which a model moves from an unrealistic set of initial conditions to more realistic results that represent a solution that is not strongly influenced by the initial conditions.

Steady state: A simulation in which the boundary conditions are static. The variables being investigated do not change with time.

Tailwater: The water surface elevation at the exit boundary.

Transition element: A special 'T' shaped 5-node element which makes the transition between a one dimensional element and a two dimensional element.

Two delta-X: A numerical instability which presents itself as a high value followed by a low value followed by a high value... at the corners of the elements. When contoured, a two delta-X oscillation looks like a case of mesh measles.

Two dimensional element: A triangle (3 corner nodes and 3 mid-side nodes) or quadrilateral (4 corner nodes and 4 mid-side nodes) shape which defines the geometry in two space coordinates, and averages over the third space coordinate. In a two dimensional horizontal model, the averaging occurs over depth. In a two dimensional vertical model, the averaging occurs over width. Several two dimensional horizontal elements aligned side by side may accurately define the bottom elevation of a navigation channel.

Verification: The process by which we gain confidence in the ability of our model to predict behavior of the prototype. Field data, like the model results, are only an approximation of reality and must be treated with skepticism. In many instances, the primary adjustments to be made are to the geometry, boundary conditions, roughness, and eddy viscosity. These adjustments are made interactively until the model agrees satisfactorily with field (prototype) observations.

Water column: An elemental projection in the z direction. The water profile from the surface to the bottom of the water body.

Well formed element: An element with the proper aspect ratio, shape, angle, plane, and depth variation along the element (gradient).