Anlage B2

zum Ergebnisbericht des BMBF-Forschungsprojektes MinHorLam

Minderung von Hochwasserrisiken durch nicht-strukturelle Landnutzungsmaßnahmen
in Abflussbildungs- und Überschwemmungsgebieten
– eine transdisziplinäre Studie zur Effektivität solcher Maßnahmen –

Ergänzende inhaltliche Informationen
Teil 2
Hydraulische Vergleichsrechnungen
(AP 2)

April 2010

Description of work and results

in the scope of

Hydraulic calculations and consultation related to schematic flood plain situation within the framework of the MinHorLam-project

Worked out by Ryszard Ewertowski and Hilmar Messal during 15 and 16 of February 20010

21 February 2010, Poznan

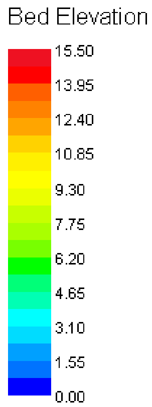
Contents

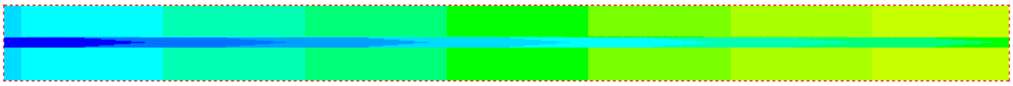
1. Initial works (before Hilmar Messal's arriving).

Building Finite Element mesh (network) based on obtained Channel-Foreshore data based on Hilmar Messal's orography data

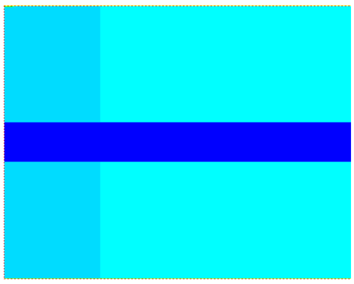
1.1. For River2D System

A) Preparation bed scatter points files including boundary of the simulation area, bed feature break lines and roughness data for "Orographie_longit-slope-025_lateral-horiz" case - Oro_ls025_lat_horiz.BED file.





Bed elevation of modeling area

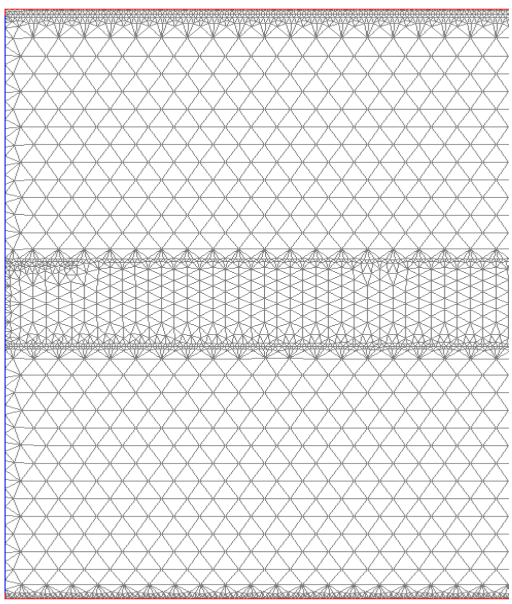


Downstream boundary area

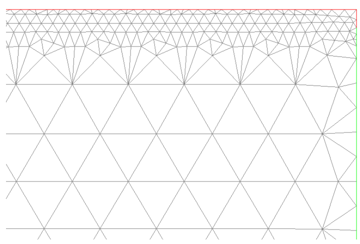
Upper boundary region

B) Building of finite element mesh based on bathymetry from Oro_ls025_lat_horiz.BED file taking into account channel-foreshore features and R2D requirements (only triangle elements with linear shape functions and appropriate quality parameters fulfilled).

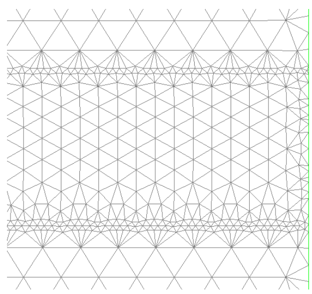
Mesh of FE for River2D - total number of nodes: 52847, total numbers of elements: 98488.
This is the contents of Oro_ls025_lat_horiz_b.msh file.



Part of FEM near downstream end

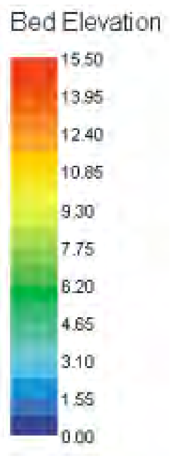


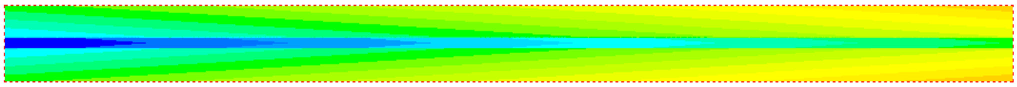
FEM near longitudinal boundary



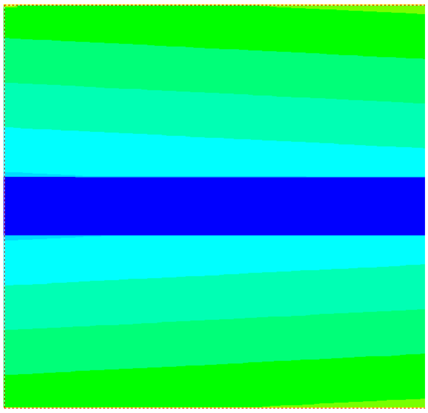
FEM in channel-foreshore transition

C) Preparation bed scatter points files including boundary of the simulation area, bed feature break lines and roughness data for "Orographie_longit-slope-025_lateral-uphill" case - Oro_ls025_lat_uphill.BED file.

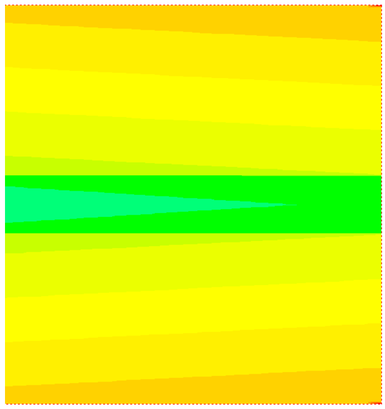




Bed elevation of modeling area



Downstream boundary area



Upper boundary region

D) Building of finite element mesh based on bathymetry from Oro_ls025_lat_uphill.BED file. The horizontal structure of the FEM is the same like in the Oro_ls025_lat_horiz_b.msh case. Only spatial interpolation of vertical coordinates at each network's node was required based on bathymetric data for the "uphill" case.

1.2. R2D trial simulation of steady flow

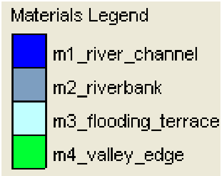
For the trial run one need to create the initial CDG file by copying the Oro_ls025_lat_horizontal/uphill.BED file and adding the following data items:

- Definition of upper and lower boundary strings
- Boundary conditions for both strings
- Starting water level fulfilled the upper boundary bathymetry
- Numerical parameters for transient process of achieving steady flow solution (total time, min and max time step, accuracy criterion)
- Physical parameters (Eddy viscosity, ground water storativity and transnissivity)
- The way of Jacobian matrix treatment

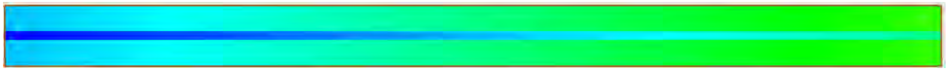
After defining all necessary parameters the initial run of River2D simulation has been carried out successfully although its results due to wrong input discharge assumed would serve only as indicators for further simulations.

1.3. For SMS (Surface Water Modeling System)

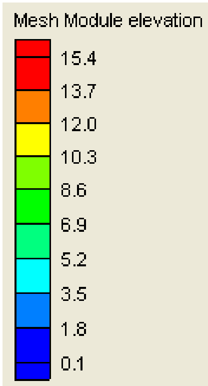
SMS system is based upon triangle and quadrilateral finite elements with quadratic shape functions (each triangle has 6 nodes and each quadrilateral has 8 nodes). The based bathymetrical data was the same as for River2D but the process of building a successful simulation model is more complicated and it appeared to be much more complicated.

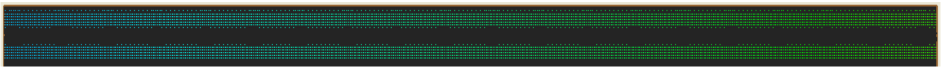


Bed material zones (for roughness data)

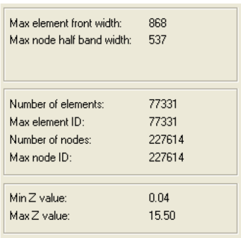


Bed elevation (horizontal foreshore case)

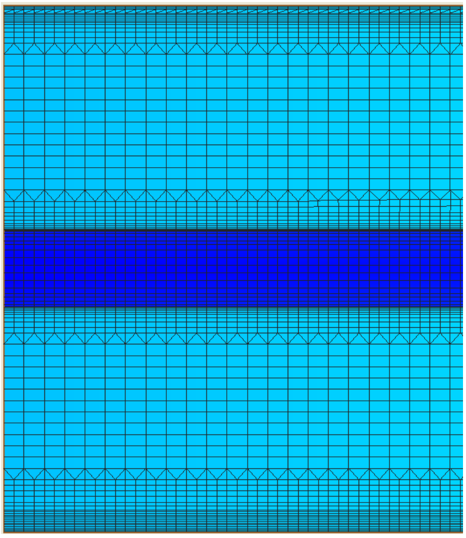




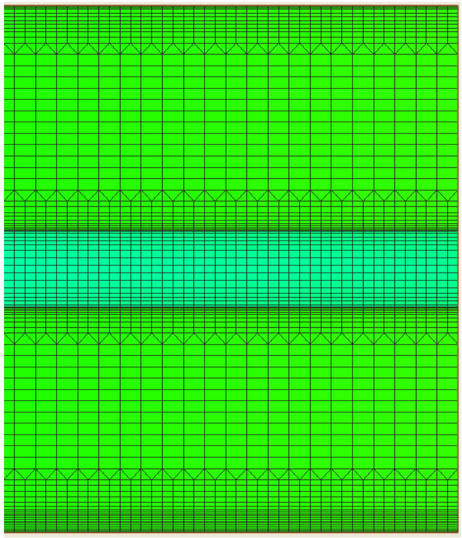
FEM discretisation



Size of FEM

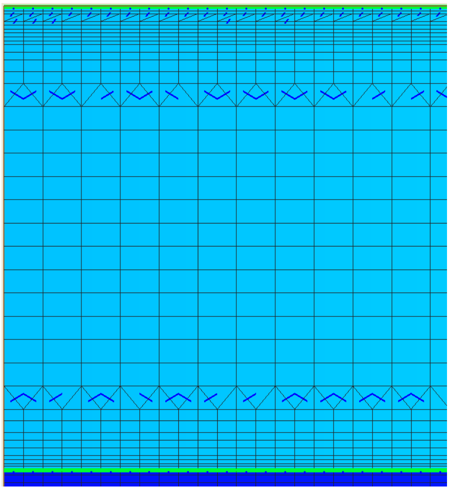


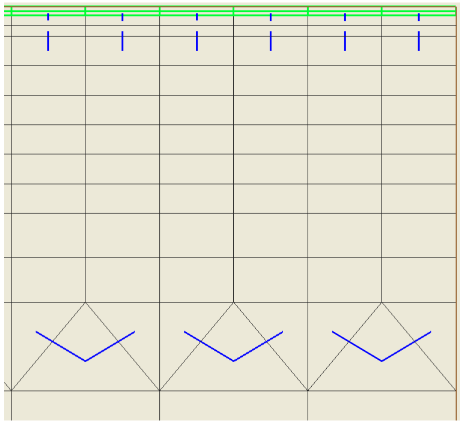
Lower part of FEM



Upper part of FEM

Parameters of mesh quality checking and improvement



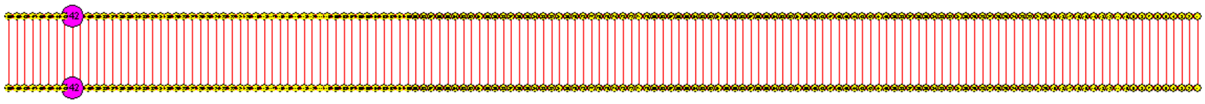


Quality check of FEM

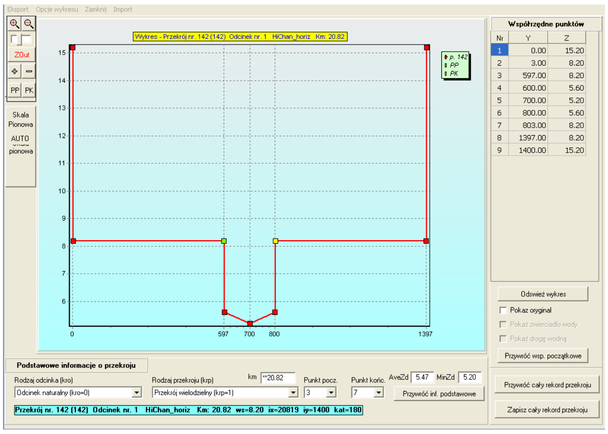
Initial run of HD module in the frame of SMS has been finished with lack of convergence. The FEM should still be improved but there are some limitations and obstacles, among other such phenomena like Stack Overflow, limitation of RMA2 and hard lock failure

1.4. For 1-D RiNFlow model

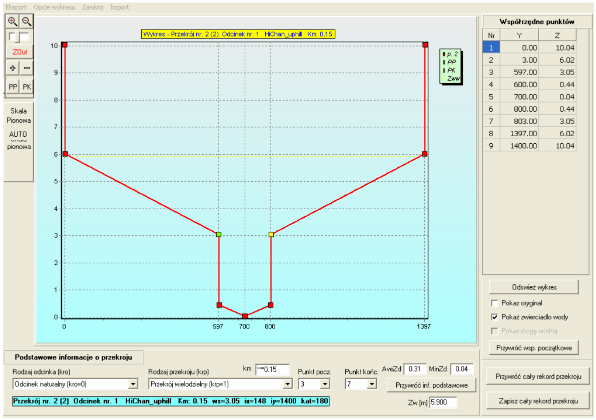
The modeling system has been made by R. Ewertowski for simulation steady and unsteady flow in river and channel networks based on 1-D Saint-Venant equations. Here it has been applied for Hilmar Messal's orographies for test purpose.



Bathymetry and topology – one river branch of 22 km and bed slope of 0.25 ‰. Total number of cross-sections: 150



Cross-sections: foreshore horizontal case

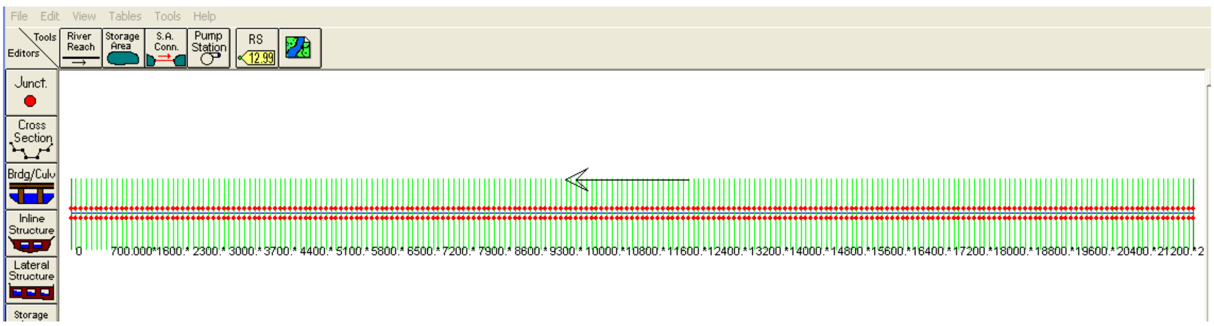


Cross-sections: foreshore uphill case

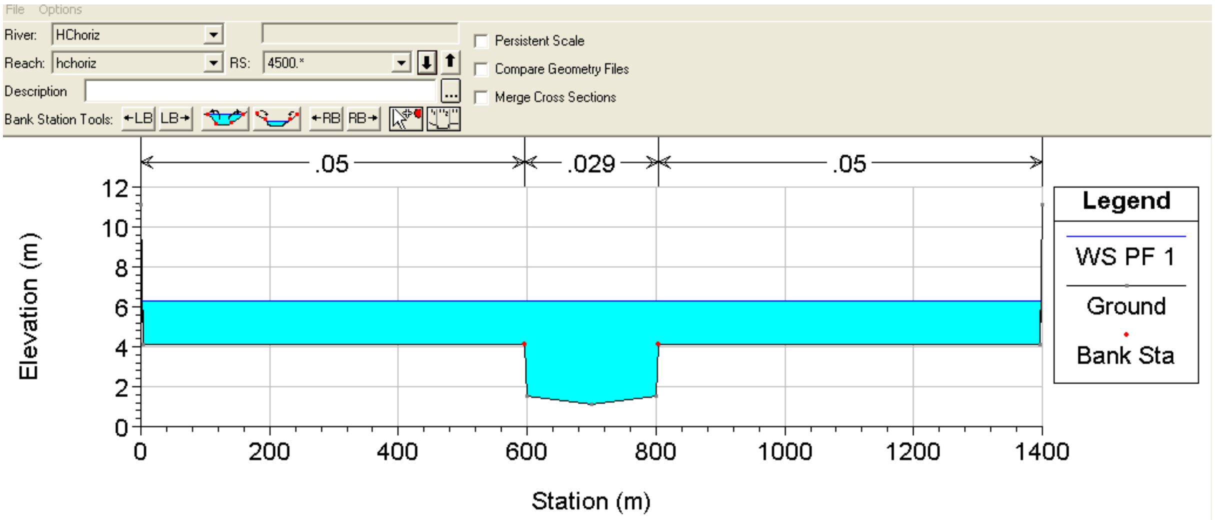
Results of RiNFlow for both orographies cases are presented in the Point 2 of this document.

1.5. For 1-D HEC-RAS system

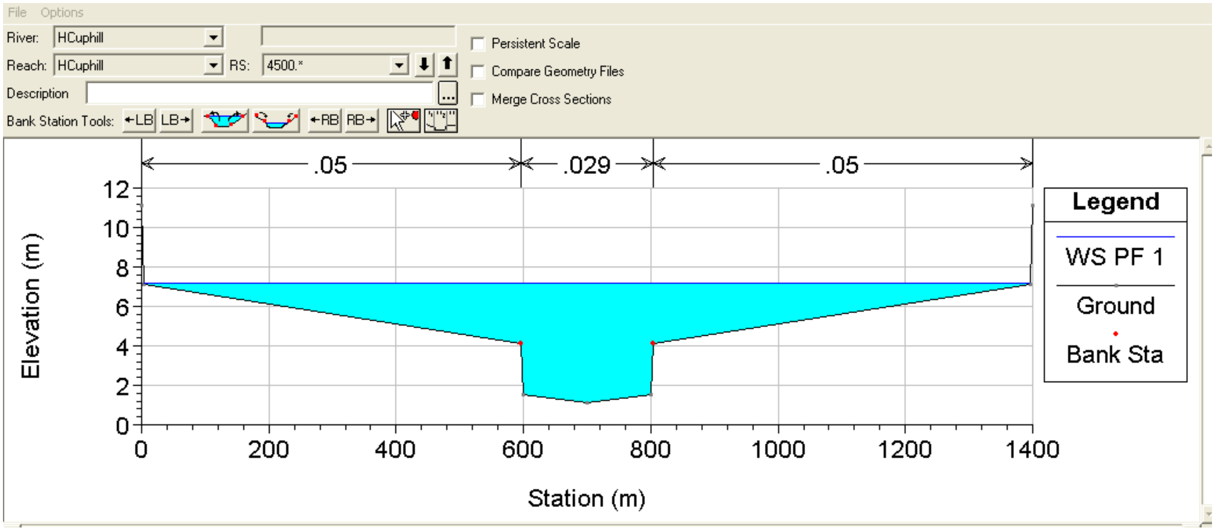
Simulation steady and unsteady flow in river and channel networks based on 1-D modeling system o HEC-RAS. Here it has been applied for Hilmar Messal's orographies for test purpose.



Simulation Plan in the HEC-RAS environment – one river branch of total length 22 km with bed slope of 0.25 ‰ and 220 cross-sections. The same plan has been created for both cases of orographies.



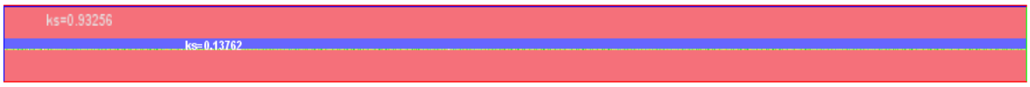
Cross-section definition and water-level result of HEC-RAS calculation In „horizontal" case



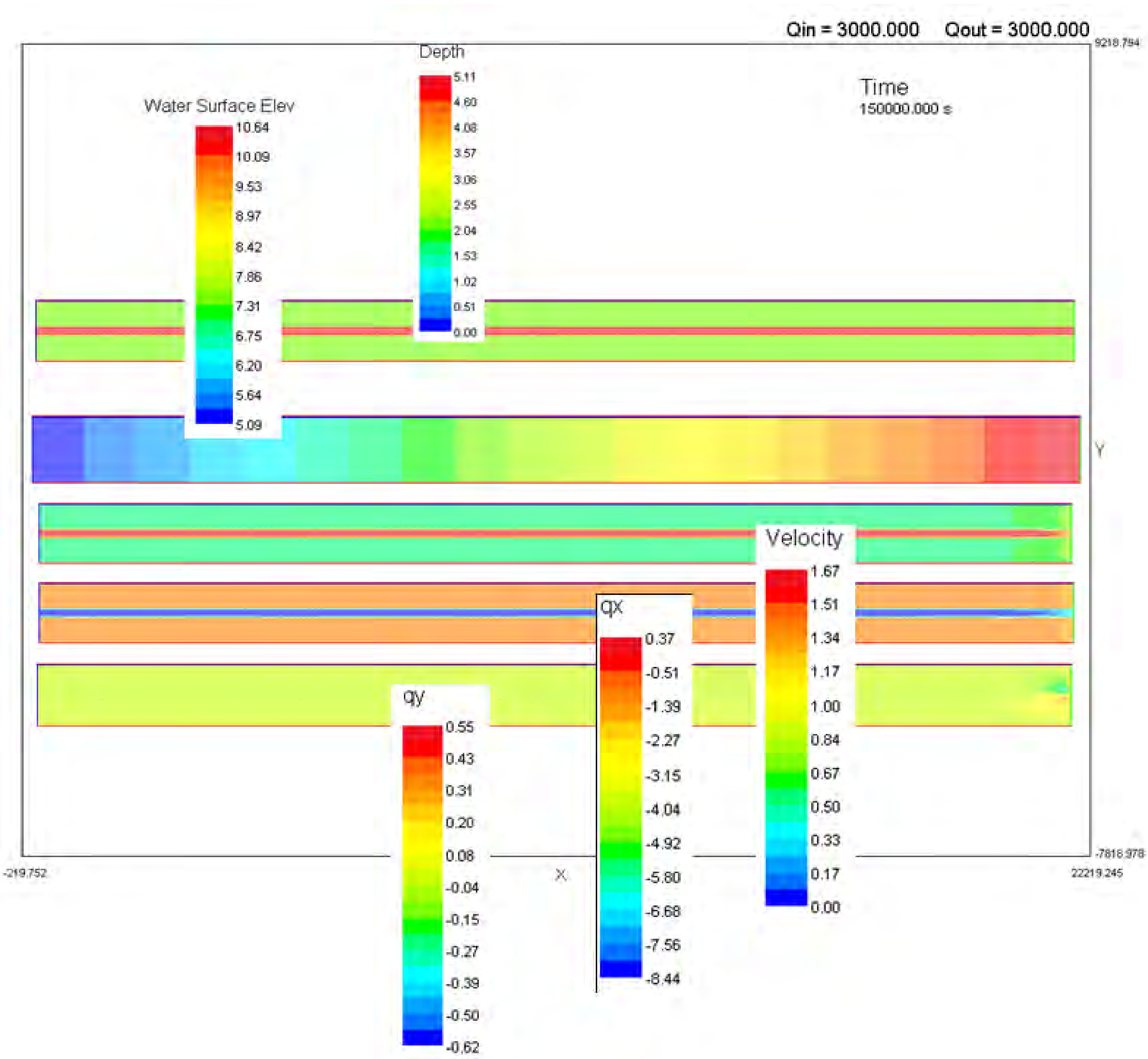
Cross-section definition and water-level result of HEC-RAS calculation In „uphill" case

2. Solution Analyses

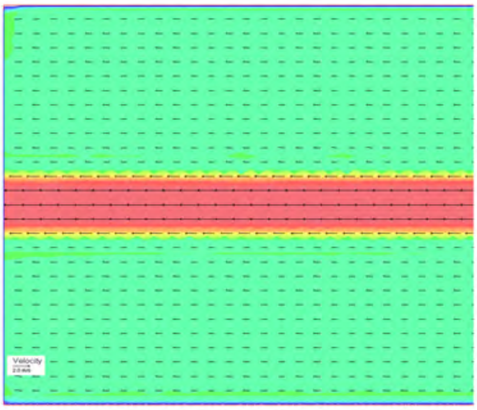
2.1. River2D simulation for foreshore lateral case



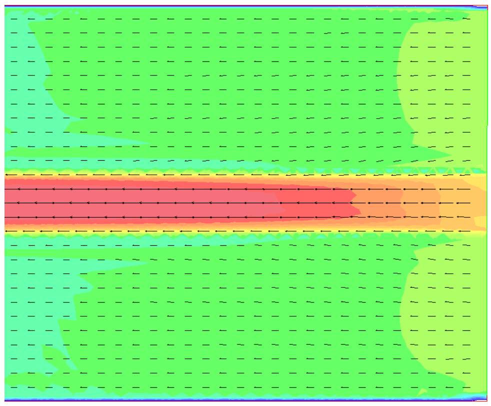
Roughness parameter: effective roughness height k_s



Composed picture of River2D solution for steady peak flow for Oro_ls025_lat_horiz_b.msh. It displays graphically the solutions contained in the Oro_ls025_lat_horiz_finsol_v0_93.CDG file: water level, depth, velocity magnitude, q_x and q_y discharge components.

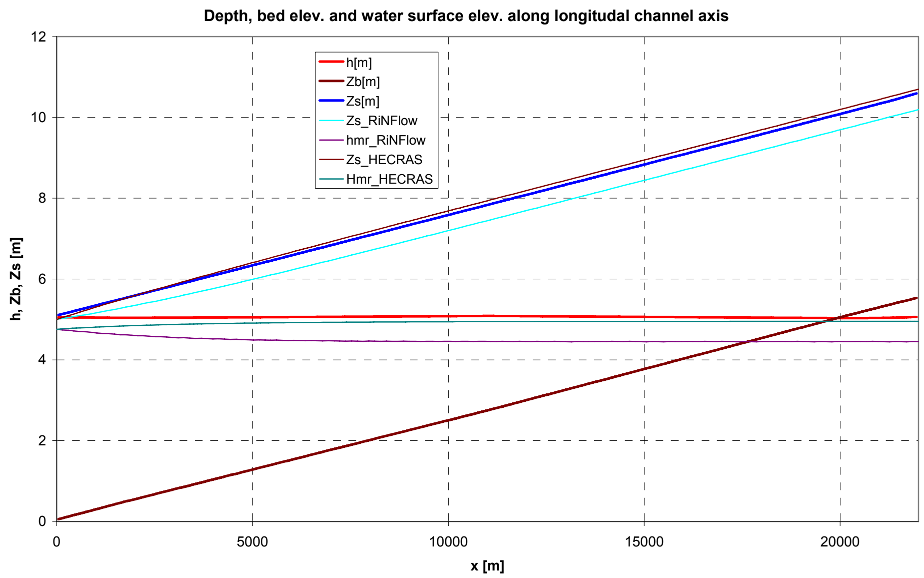


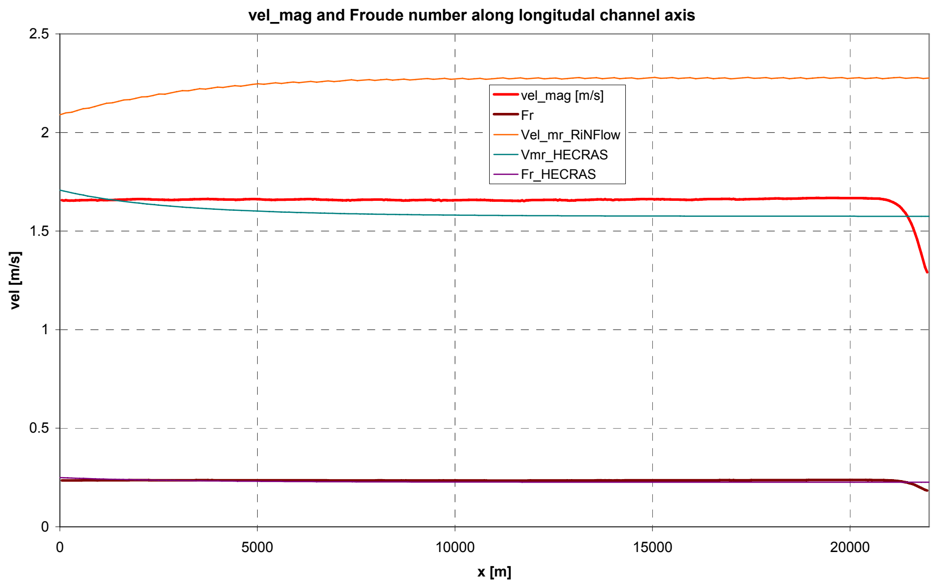
Velocity field near lower boundary



Velocity field near upper boundary

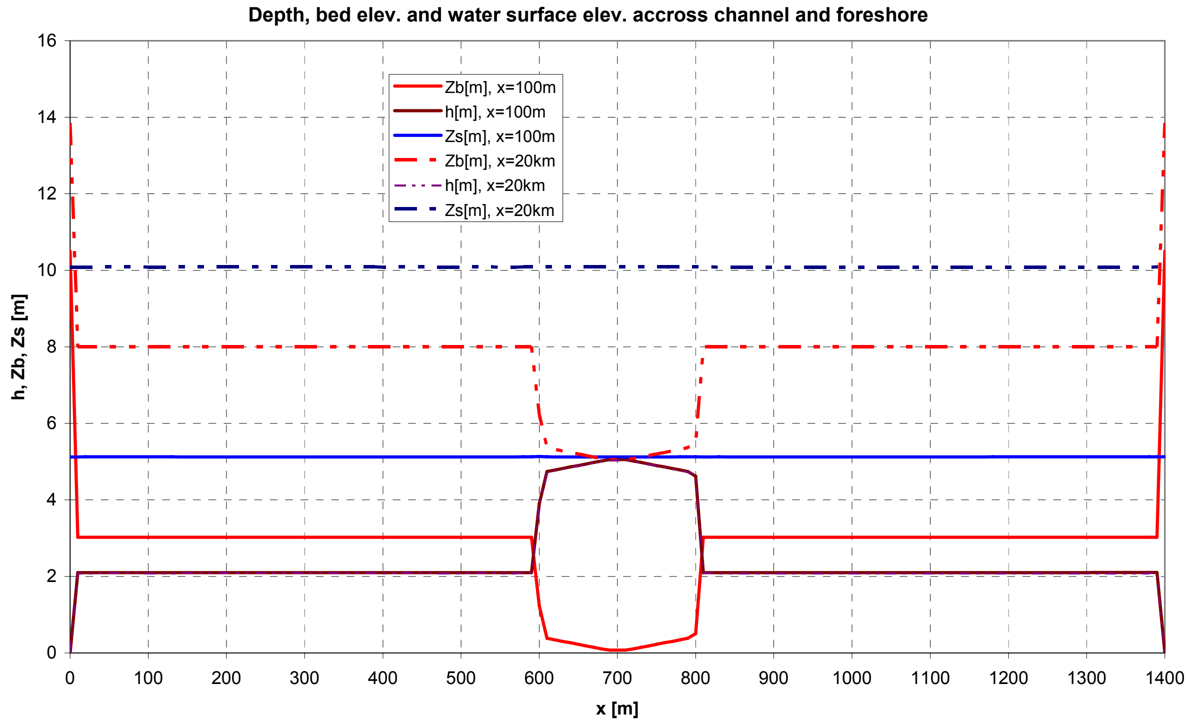
Through selecting appropriate string of nodes it is possible in the River2D modeling system to obtain longitudinal profiles along channel axis. Those results have been exported to EXCEL and composed with results of 1-D models.



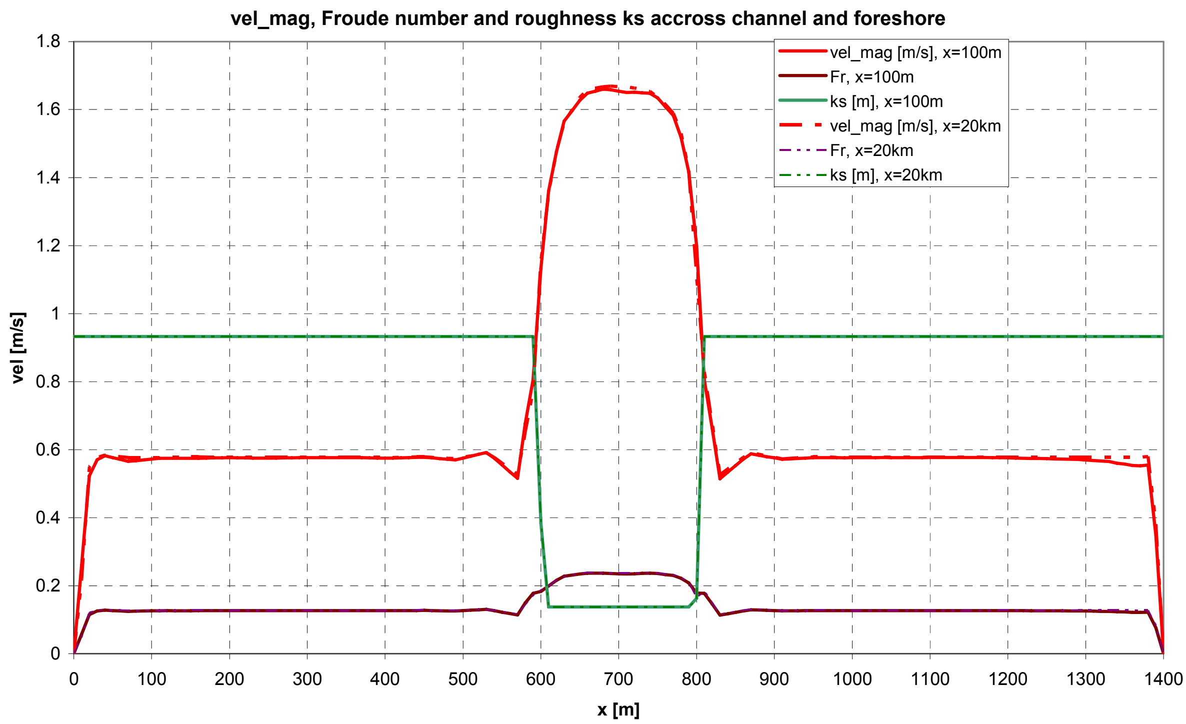


Longitudinal profiles of Z_s, depth, bed (upper) and velocity and Fr (lower graph)

Using similar method it appeared to possible to get cross-sectional profiles of obtained results. Results along two cross-sections: for x=100m and for x=20000 m have been presented here on each picture (horizontal foreshore case):



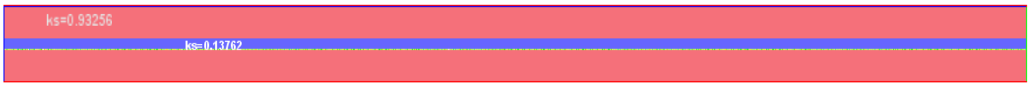
Bed level, water depth, water surface elevation along cross-sections at x=100m and x=20 km



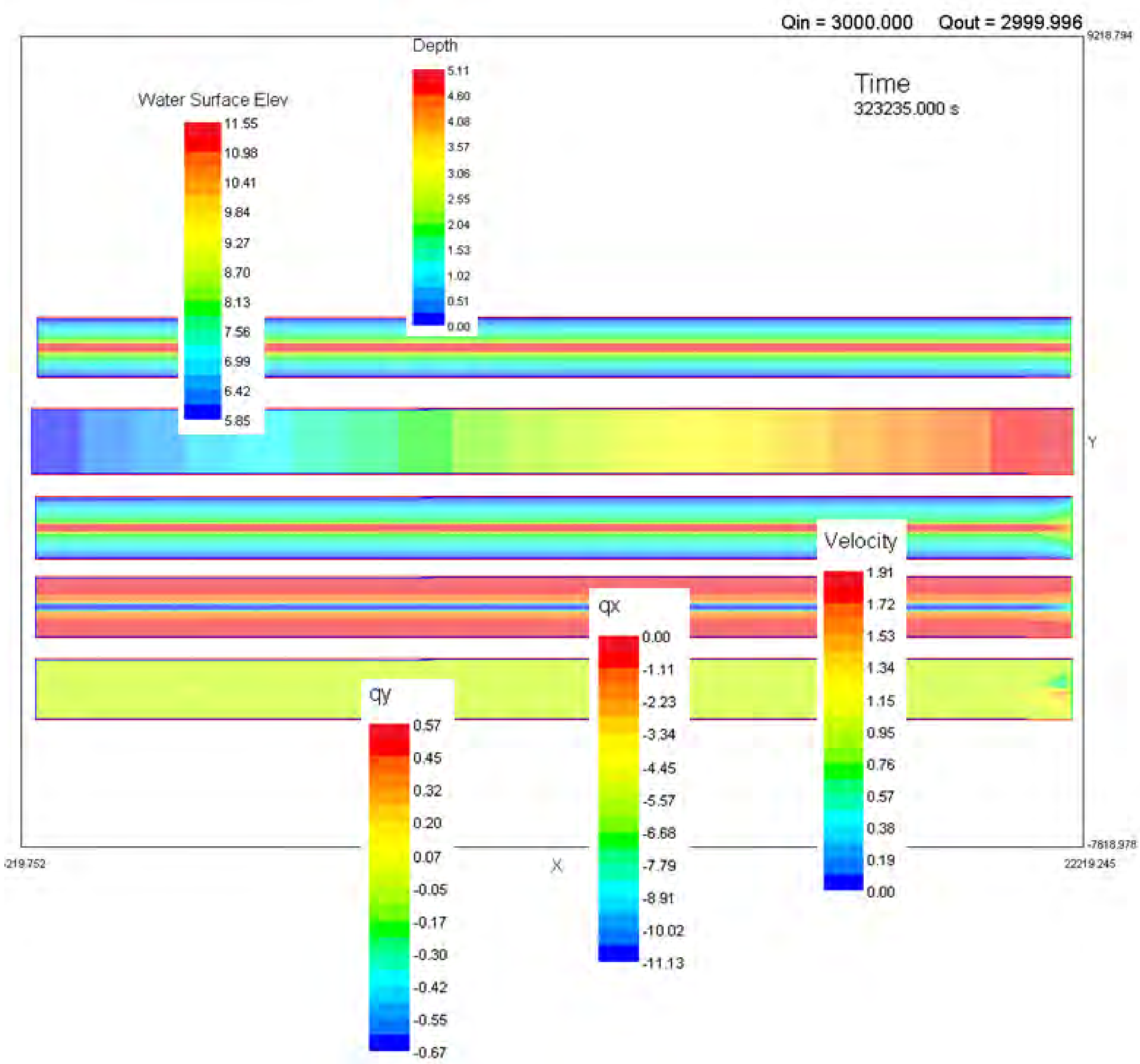
Flow velocity, *Fr* number and k_s value along cross-sections at x=100m and x=20000 m

2.2. River2D simulation for foreshore uphill case

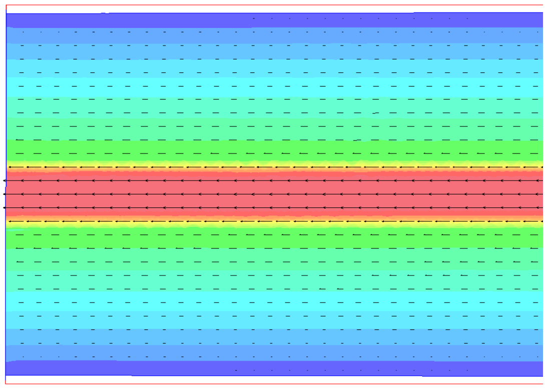
Distribution of roughness coefficient k_s is the same like for foreshore horizontal case.



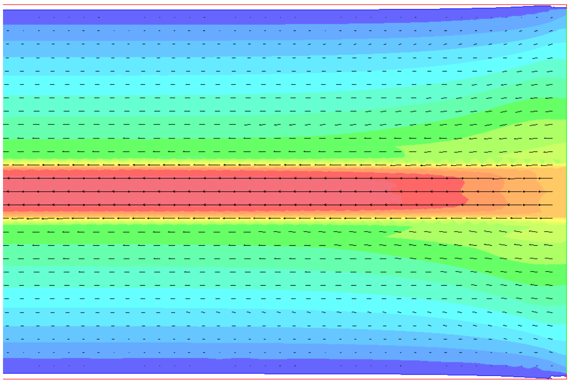
Roughness parameter: effective roughness height k_s



Composed picture of River2D solution for steady peak flow for Oro_ls025_lat_uphill_b.msh. It displays graphically solutions contained in the Oro_ls025_lat_uphill_finsol_v0_90.CDG file: water level, depth, velocity magnitude, q_x and q_y discharge components.

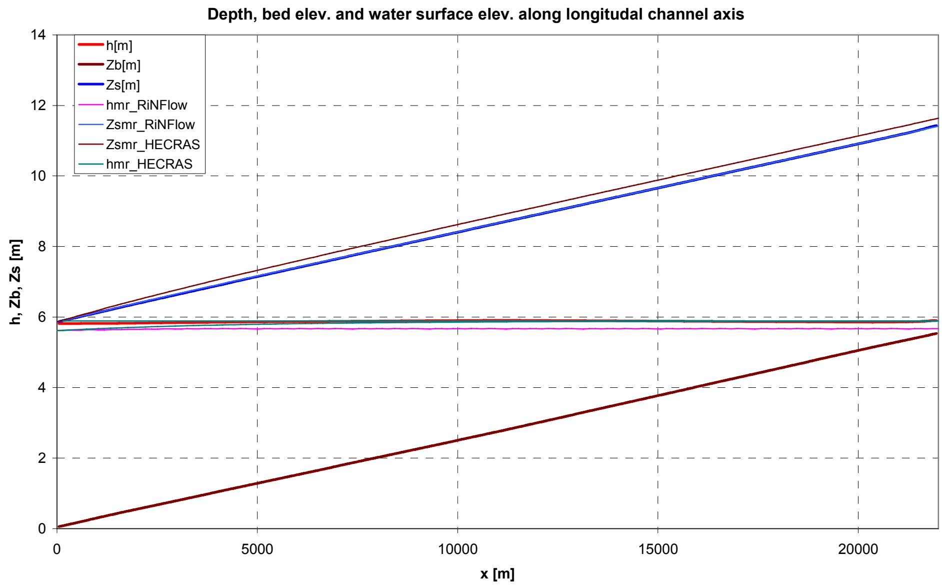


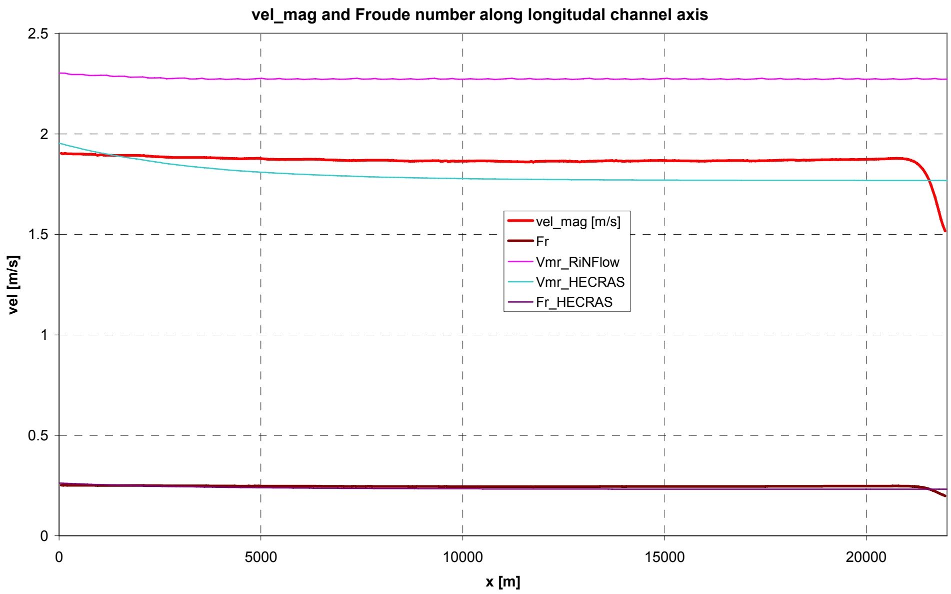
Velocity field near lower boundary



Velocity field near upper boundary

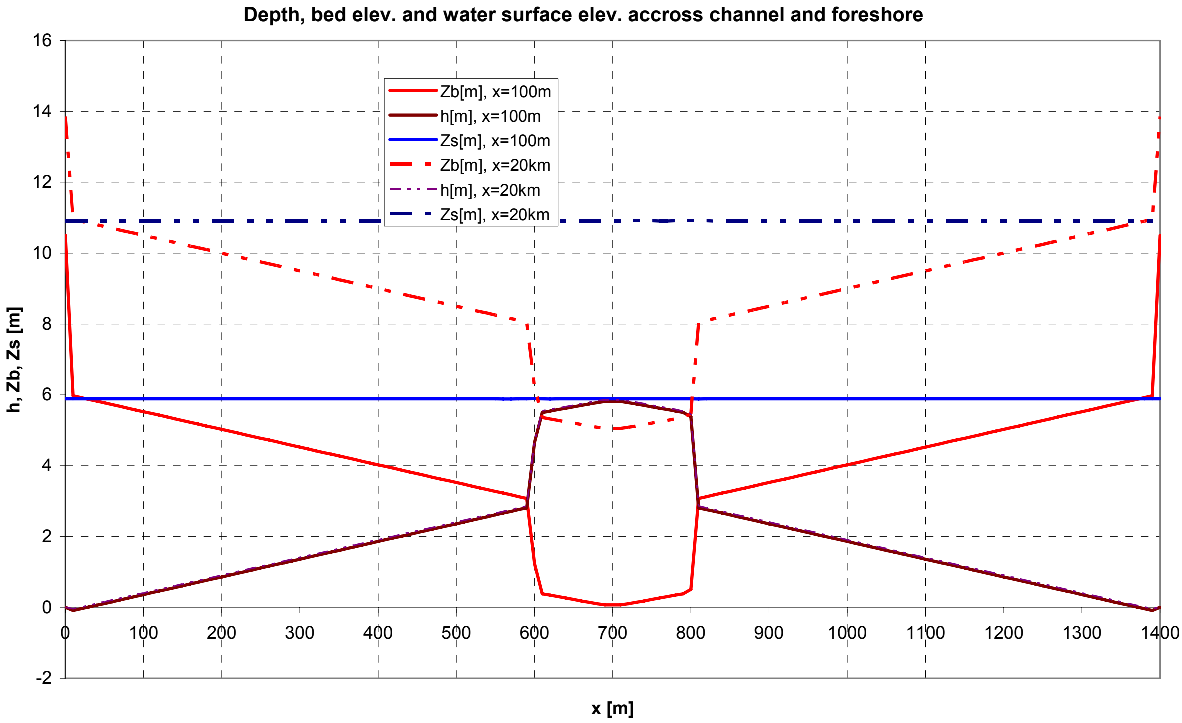
Similarly like in "horizontal" case, one can obtain from River2D solution longitudinal profiles along channel axis. Those results have been exported to EXCEL and composed with results of 1-D models.



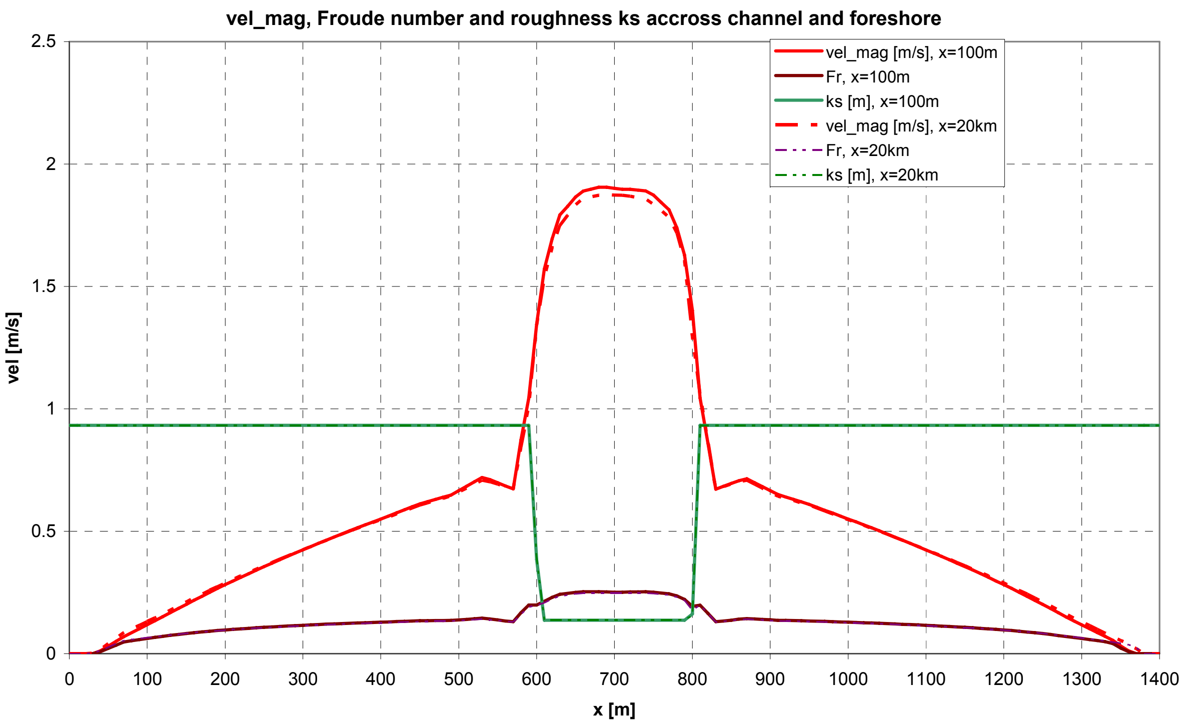


Longitudinal profiles of Z_s, depth, bed (upper) and velocity and Fr (lower graph)

Similar to previous case one can obtain also cross-sectional profiles of obtained results. Results along two cross-sections: for x=100m and for x=20000 m have been presented here on each picture (uphill foreshore case):



Bed level, water depth, water surface elevation along cross-sections at x=100m and x=20 km



Flow velocity, *Fr* number and k_s value along cross-sections at x=100m and x=20000 m