Po River morphodynamics modelled with the open-source code iRIC

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CIRI • EDILIZIA E COSTRUZIONI
CENTRO INTERDIPARTIMENTALE PER LA RICERCA INDUSTRIALE
UNIVERSITÀ DI BOLOGNA

INFRASAFE Project

Intelligent Monitoring for Safer Infrastructures

POR FESR 2014-2020 - ASSE 1 - AZIONE 1.2.2

General objective

- creation of an integrated monitoring and diagnosis system, based on available technologies, to be used in channels, floodplains, riverbanks, embankments and road infrastructures to enhance their safety by allowing timely interventions.

Duration 01.04.2016 - 31.03.2018

www.infrasafe-project.com

POR FESR EMILIA-ROMAGNA 2014/2020

UNIONE EUROPEA
Fondo europeo di sviluppo regionale

RegioneEmilia-Romagna

INFRASAFE project

www.infrasafe-project.com

Objectives

-monitoring and management of hydraulic structures and interconnected risks;
-development of innovative modelling and measurement techniques;
-creation of guidelines to manage watercourses and hydraulic structures affected by flooding events;
-creation of a early warning system;
-involvement of local SMEs to improve their operational working capacity.

Main partners

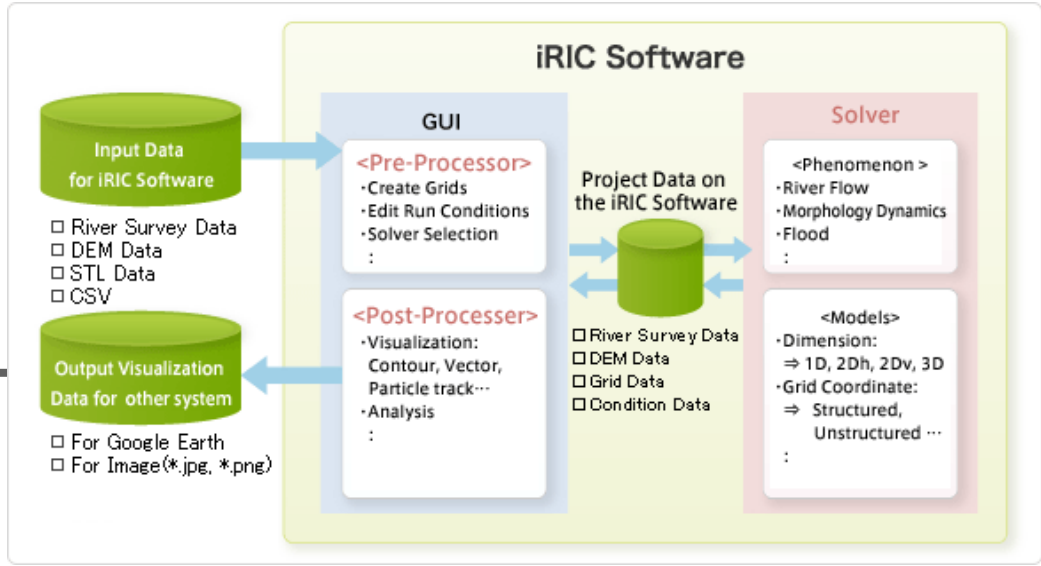
- University of Bologna: CIRI-EC, CIRI-ICT, DICAM
- Tuscia University: DIBAF
- Warrant Innovation Lab
- Proambiente

Po River at Ostiglia

iRIC model

i-ric.org

iRIC Software
Changing River Science



iRIC (International River Interface Cooperative) is a river flow and riverbed variation analysis software package combining the functionality of MD_SWMS, developed by the USGS (U.S. Geological Survey) and RIC-Nays, developed by the Foundation of Hokkaido River Disaster Prevention Research Center.

The software consists of three parts: pre-processor, post-processor, and solver.

The pre-processor creates calculation conditions (hydrologic conditions, calculation methods, etc.) from survey data such as river survey data, DEM or geometric configurations.

The postprocessor permits to visualise the results in terms of vectors, contours, maps and graphs, easily exportable.

The user can select one of 14 solvers, depending on the problem under study (1D-3D).
In the future, new solvers will be added to the iRIC suite.

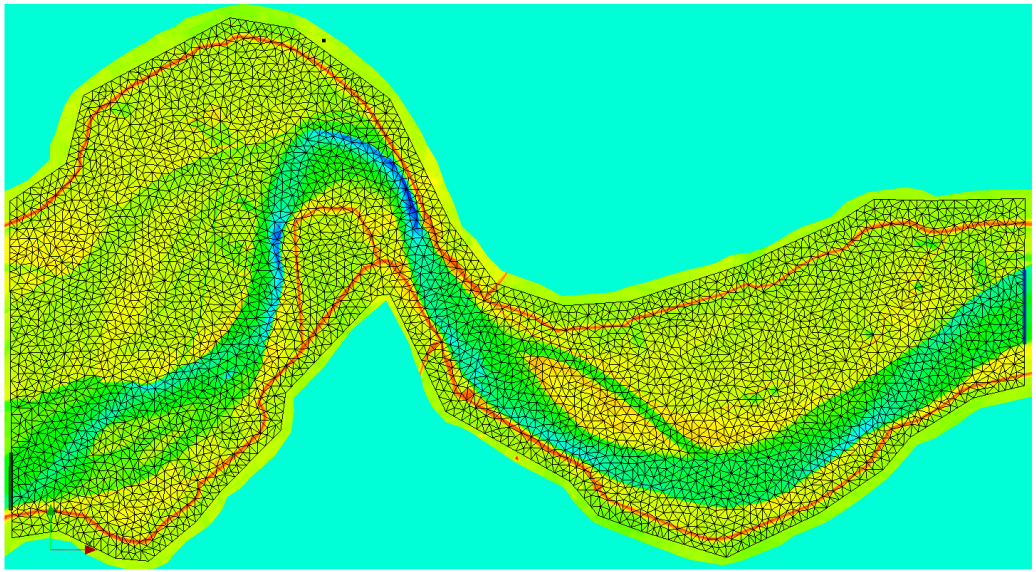
iRIC model: Mflow_02

i-ric.org

Mflow_02 is an analysis solver to calculate 2D plane unsteady flow and riverbed variation by unstructured grid, using the FEM in orthogonal coordinate system (Cartesian coordinate system).

Unsteady flow conditions are computed given the boundary conditions in terms of discharge (upstream) and water level (downstream).
Sediment transport is calculated assuming a movable bed composed by non-uniform material.

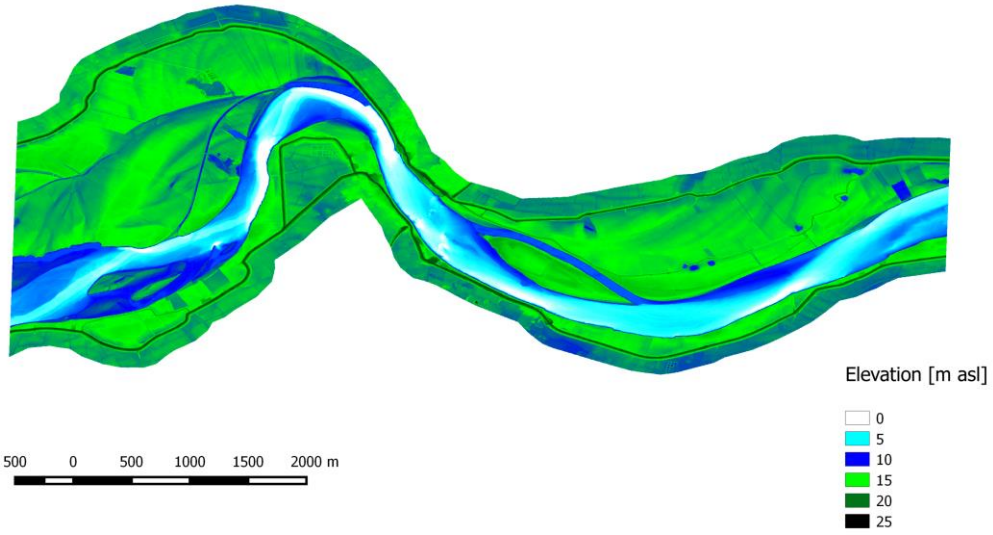
Aiming to produce boundary conditions for detailed 3D models, preliminary simulations of the large scale morphodynamics were performed using the version 3, released in Oct. 2016.

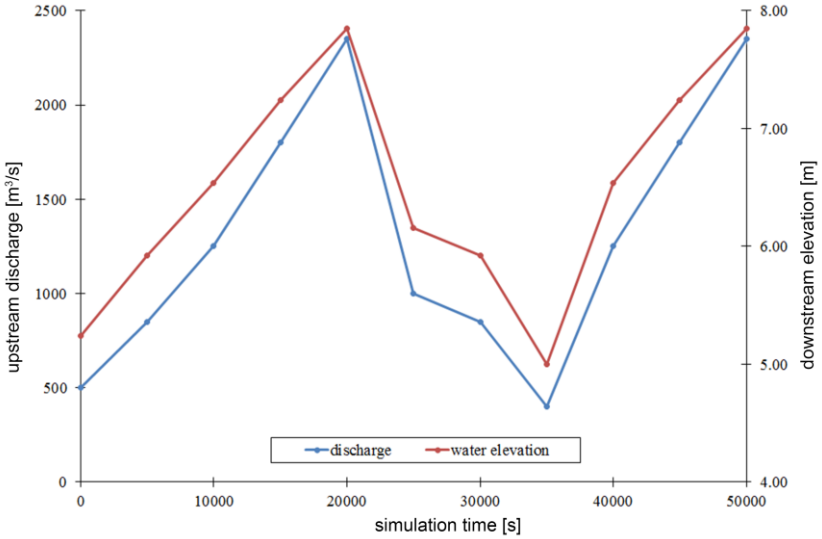


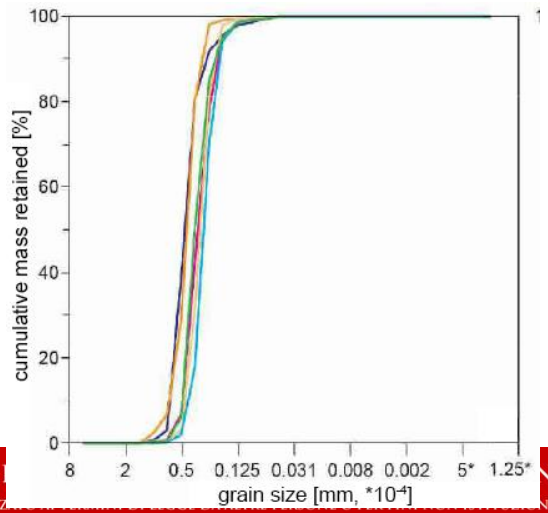
Input data

geometry, hydrology, grain-size composition

2 m DEM (2005)







Modelling parameters

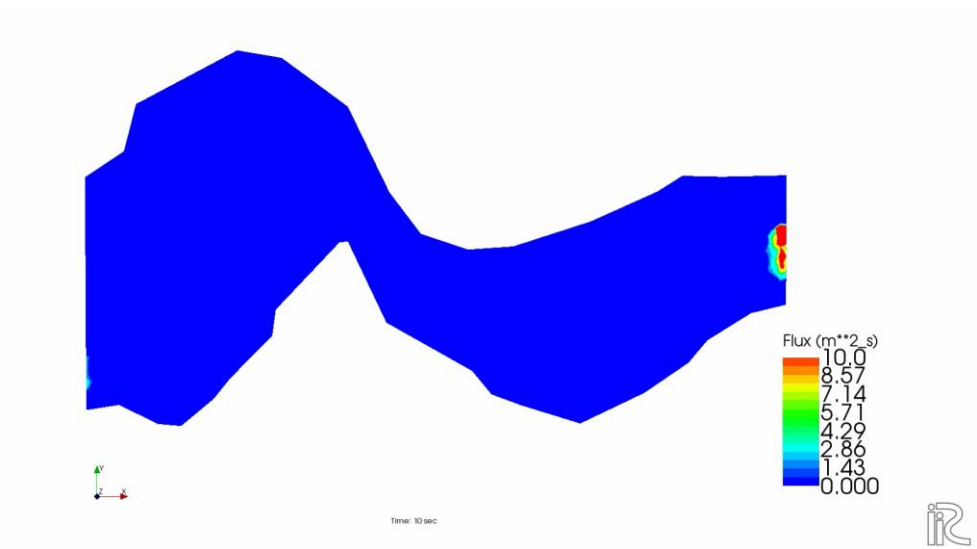
- **grid** ==> 4776 triangular cells, having an area A<3000 m^2/element
- **boundary conditions** ==> **upstream** flow discharge, **downstream** water elevation
- **sediment transport** ==> M.P.M formula, exchange layer of 1 m
- **bed roughness** ==> 0.035 channel, 0.06 floodplains
- **time step** ==> 0.5 s (water/sediments); 14 h simulation time

- **bridges** ==> not simulated, because of cells resolution

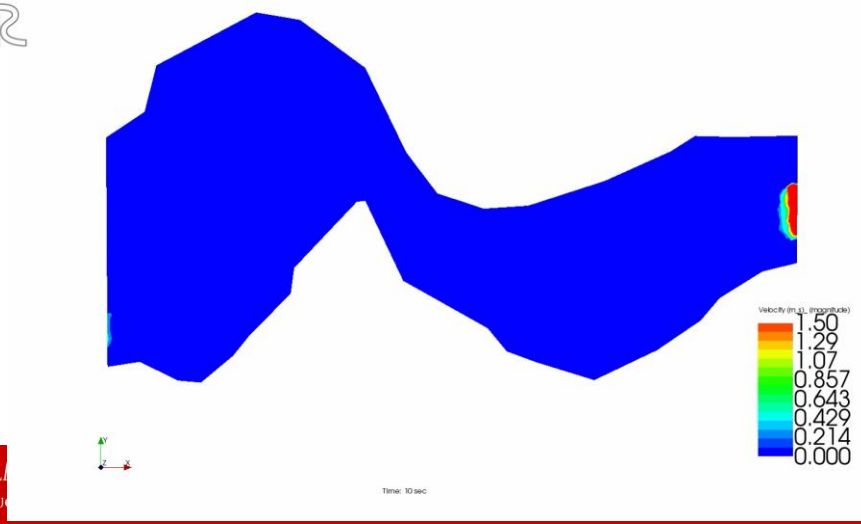
Preliminary results

liquid phase

water flow

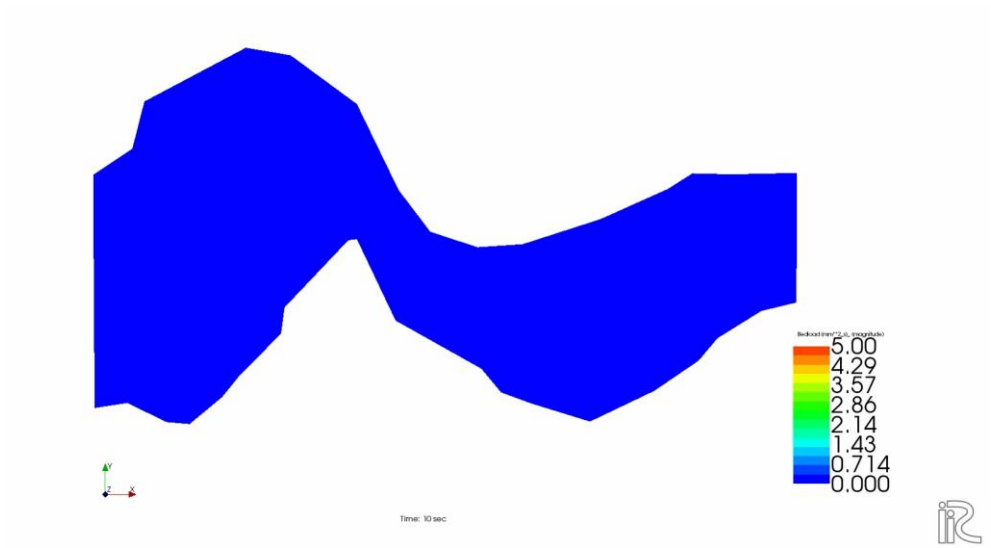


mean velocity



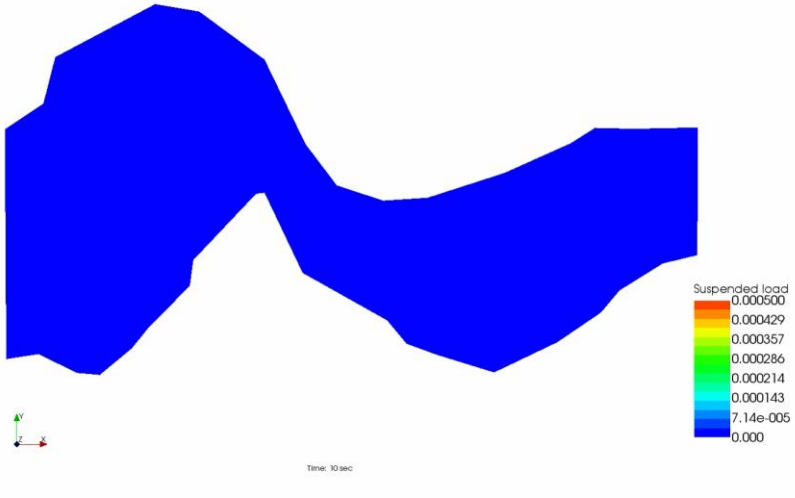
Preliminary results

solid phase



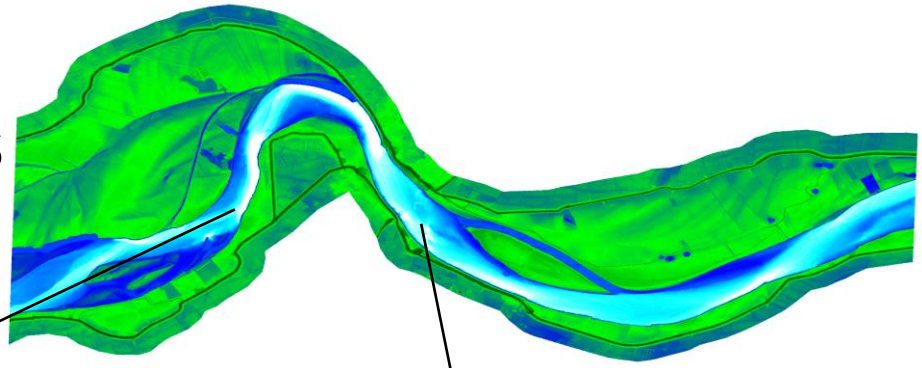
bed load

suspended load

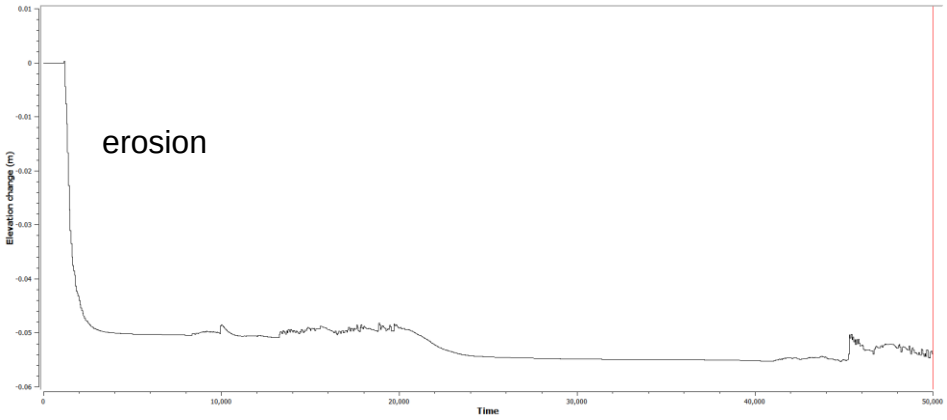


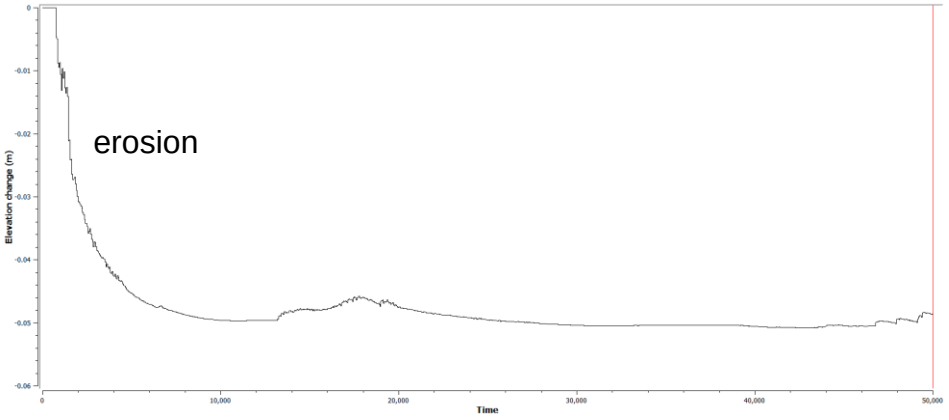
Preliminary results

temporal evolution

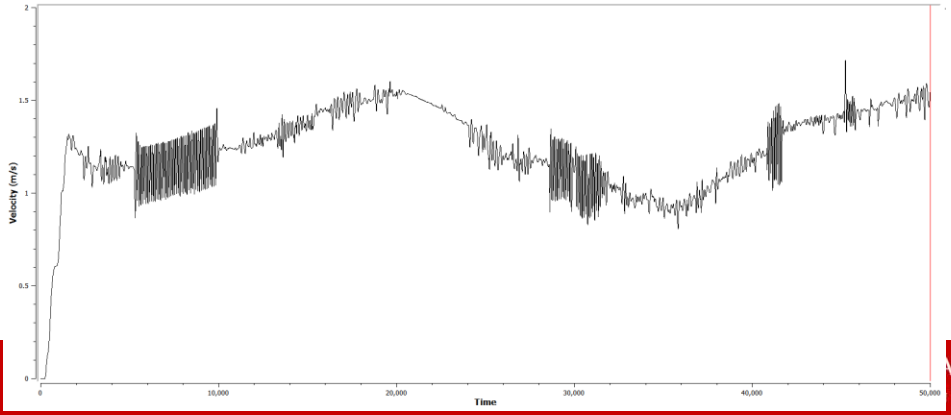


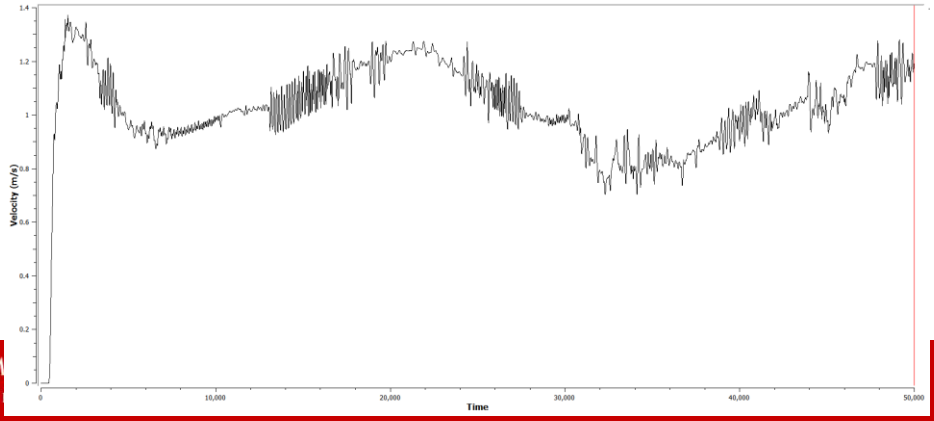
elevation change





mean velocity





Conclusions and future research

Preliminary applications show that:
- iRIC suite is a powerful tool in multi-scale analyses;
- 2D solvers can be applied to produce boundary conditions for 3D simulations;
- hydro-morphodynamics are quite well represented, regardless the low-quality input data;
- flow velocities of around 1 m/s and bed erosion of 5-10 cm/y are plausible (e.g. Lamberti & Schippa, 1994; Guerrero et al., JofH 2013; Lanzoni et al., AWR 2015).

Future research is necessary on:
- **modelling approach**, changing the simulation parameters (grid dimension, time step) and the forcing terms (initial and boundary conditions, spatially-varying bed roughness, etc.)
- **input data**, measuring local quantities with traditional and innovative techniques (remote imagery, hADCP, etc.)

Thank you for your attention

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