MIKE
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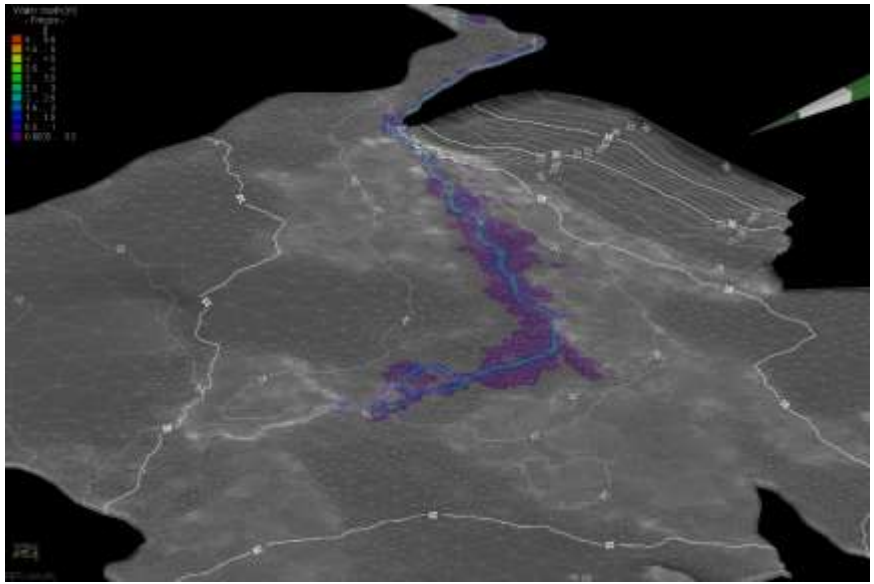
COUPLING OF FEFLOW AND MIKE 21 FLOW MODEL FM

Empowering the full meshing flexibility and solution efficiency



Surface and subsurface flow systems are unified continua that need to **operate together** in order to analyze and simulate

- rainfall - runoff phenomena
- river - aquifer interactions
- surface water and groundwater flooding events
- do integrated watershed modelling studies
- assess irrigation/fertigation measures
- or carry out climate change impacts on inland waters scenarios

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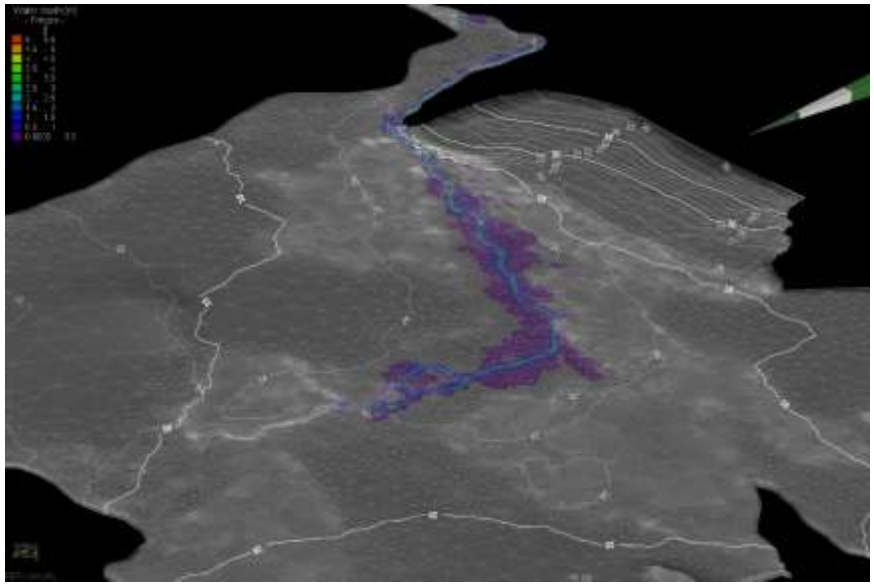

- This new coupling integrates the two state-of-the-art Ground Water model FEFLOW 7.1 and Surface Water model MIKE 21 Flow Model FM (MIKE21FM) into a single, dynamically coupled modelling system.
- The coupling engine handles a 4-way coupling:
  - 3-way coupling between MIKE21FM, the river models MIKE11/MIKE1D and the Urban model
  - Coupling between MIKE21FM and FEFLOW

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TYPICAL APPLICATIONS

- Rainfall, surface runoff, infiltration of ponded water phenomena
- Surface flooding events, storm events
- Groundwater flooding events
- River / aquifer interactions at fine resolution / local scale
- River / aquifer interactions in coastal settings
- Mine water / groundwater interactions
- Industrial porous media applications (diaper swelling)

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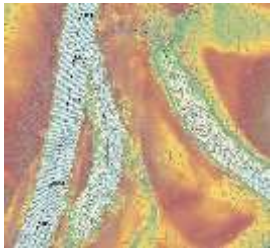
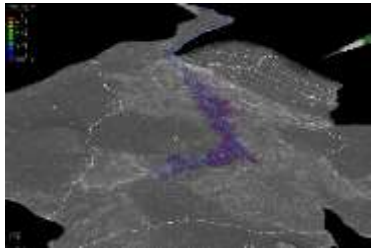
FEATURES

- Ability to model
  - Coupled variably-saturated / phreatic subsurface and overland flows
  - Coupled heat transfer
  - Coupled salinity transport





MAIN CHARACTERISTICS

- Flexible meshes for the two continua
- Non-conforming surface and subsurface meshes
- Sub-timing with independent dynamical stepsize control
- 1st-order relationship controlled exchanges
- Integrated monitoring of exchange quantities
- Graphical rendering in FEFLOW of surface and subsurface quantities [exchange fluxes, water depth, pressure, temperature, salinity]

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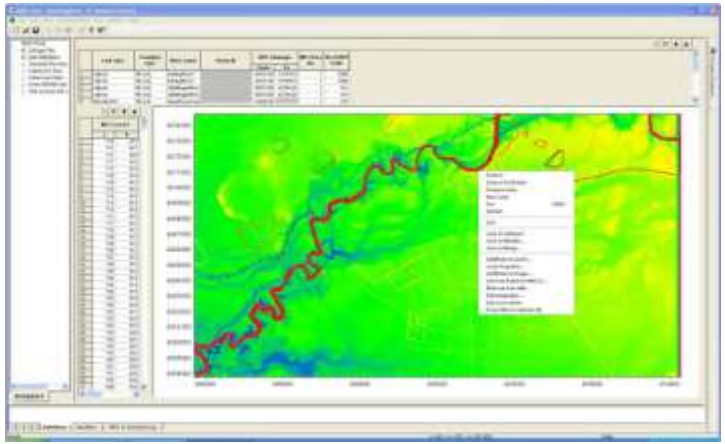
BENEFITS

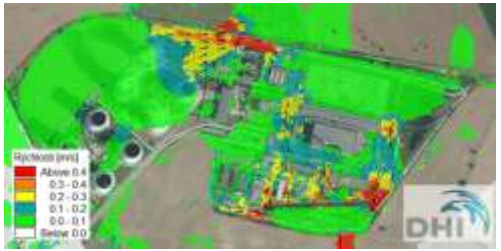
- Easy workflows through integration in FEFLOW
- Results visualization in 2D and 3D exploiting advanced FEFLOW graphics
- Take advantage of the state-of-the-art capabilities and computational power of MIKE21FM
- Couple 2D overland flow with 3D groundwater flow, heat and salinity transport processes
- Use together process-tuned optimal meshes resolution through area-weighted interpolation
- Automatic time-stepping and continua dynamics coupling
- Optimal parallelization models with hybrid OpenMP, MPI, and Multi-GPU

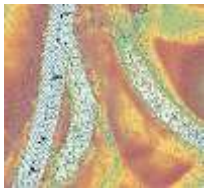
COUPLING OF FEFLOW AND MIKE 21 FLOW MODEL FM

- Setup your MIKE21FM Model
  - THINK GROUND WATER ▶▷▶ Design your 2D mesh with optimal discretization supporting both surface constraints and subsurface mesh features



MIKE21FM overall model



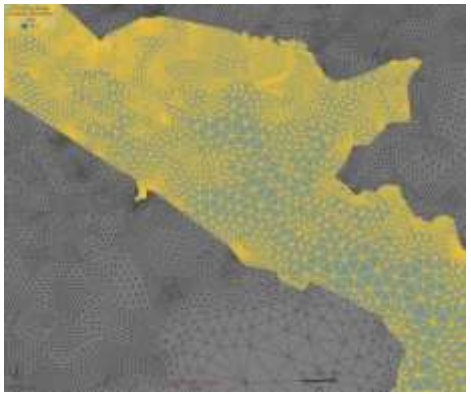


MIKE21FM detailed abandoned river

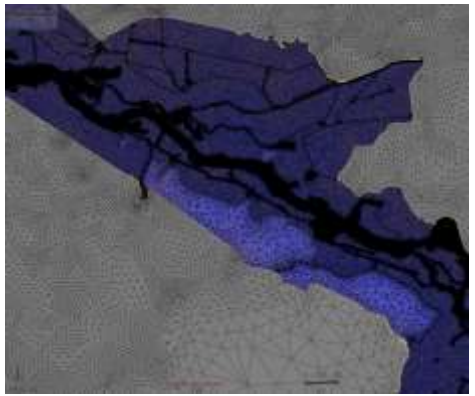
COUPLING OF FEFLOW AND MIKE 21 FLOW MODEL FM

- Setup your FEFLOW Model
  - THINK SURFACE WATER ▶▷▶ Design your 3D mesh with optimal discretization at recharge horizons

Coupled domains/meshes



Exchange surface definition in FEFLOW



MIKE21FM surface mesh

COUPLING OF FEFLOW AND MIKE 21 FLOW MODEL FM

- Use FEFLOW UI to generate a PFS coupling file

```
[FEFLOWM21_Coupling_Parameters]
  MIKE21_Path = |.\MIKE21FM\borden_2d.m21fm|
  FEFLOW_Path = |.\FEFLOW\Borden.fem|
  FEFLOW_version = '7.1'

  [FEFLOW_MODULE]
    [TIME]
      time_specification = 1
      start_time = 2004, 1, 1, 0, 0, 0
    EndSect  // TIME

    [DOMAIN]
      projection_specification = 1
      coordinate_type = 'NON-UTM'
      DIM_unit_XY = 1000
      DIM_unit_Z = 1000
      X_offset = 0
      Y_offset = 0
      write_mesh = 1
      file_name = |.\FEFLOW\Mesh\Borden.mesh|
    EndSect  // DOMAIN

    [OUTPUT]
      write_output = 1
      file_name = |.\FEFLOW\Results\Borden.dac|
    EndSect  // OUTPUT
  EndSect  // FEFLOW_MODULE
EndSect  // FEFLOWM21_Coupling_Parameters
```

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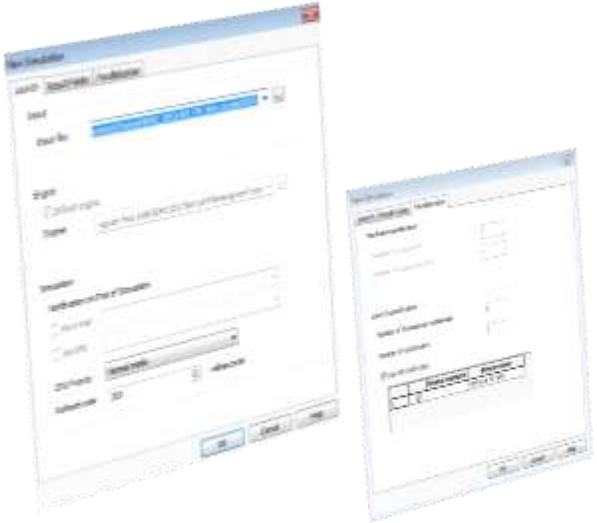
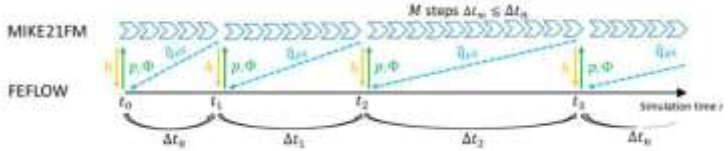
- Launch the coupled simulations with MZLaunch or in batch mode





Exchange of quantities events

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- Use FEFLOW and MIKE Zero to view and post-process results