ETH zürich

Current and future development of BASEMENT software

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6th BASEMENT Users Meeting

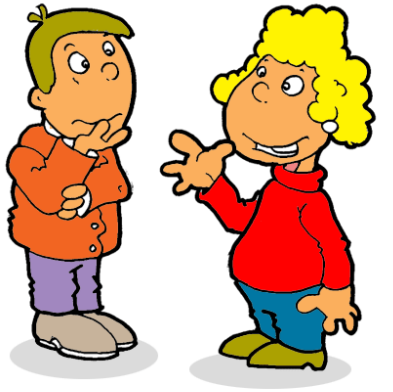
January 28, 2021, online via Zoom

VAW
Versuchsanstalt für Wasserbau, Hydrologie und Glaziologie

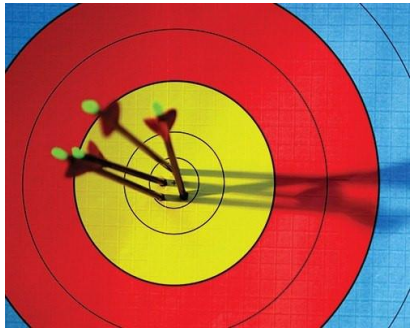
Contents

Objectives of the meeting

- Users are in the focus
  - exchange of experience
  - tell others about your success stories and pitfalls
  - participate to have a vivid discussion
  - networking -> at next COVID-free meeting



- Exchange between users and development team
  - share requirements and problems with us
  - modelling challenges in engineering practice
  - support focussed optimization of models



https://longbowevents.com

Recent Progress

Key tasks of current development phase (2018 - 2023)

Key Tasks Development *BASEMENT* 18-23			
concepts for engineering practice (A)	development & maintenance (B)		knowledge transfer (C)
	state-of-the-art models	new models	
40%	40%		20%

Recent Progress

(A) concepts for engineering practice

- objectives:
  - show scope and limits of model application
  - support correct model application, i.e. generation of meaningful results
  - best practice
- topics:
  - evaluated in collaboration with advisory group
  - many interesting inputs

Recent Progress

(A) concepts for engineering practice

- objectives:
  - show scope and limits of model application
  - support correct model application,

    i.e. generation of meaningful results
  - best practice
- topics:
  - evaluated in collaboration with advisory group
  - many interesting inputs

Priorität (1-4) höchste = 1; niedrigste = 4	gemittelte Priorität pro Themenblock	Themen	Schwerpunkte											
			Modellaufbau (Topografie, Querprofile, Netzerstellung und -optimierung)	Notwendige Randbedingungen / Grundlagen	Kalibrierung, Validierung	Bauwerke, Brücken, Durchlässe 1D und 2D Innere Randbedingungen	Einsatz 1D vs. 2D Modell	Makrorauheiten, Formverluste	fixierte / nicht fixierte Sohle	Modellauswertung, Interpretation der Resultate	Sensitivitätsanalyse	Umgang mit Unsicherheiten	Fallstricke, Fehlinterpretationen	Entwicklung
		Modellierung des Geschiebehaushaltes												
1		Geschiebetransportberechnung	X	X	X		X		X	X	X	X	X	
2	1.5	Umgang mit breiter Kornverteilung, Abpflästerung		X						X	X		X	X
		Morphodynamik bei Revitalisierungsprojekten												
3		Verzweigte Gerinne	X	X						X	X		X	
3		Alternierende Bänke		X	X						X		X	
2		Makrosohlenformen						X			X		X	
3	2.8	Flussaufweitungen, Versatzbildung	X	X			X			X		X		
		Kapazität und Gerinnestabilität												
1		Steile Gerinne und Bäche			X		X	X	X			X	X	
3		Berücksichtigung Verklausungsprozesse		X		X						X		
1		Berücksichtigung von Vegetation	X	X	X					X	X			X
4	*	Modellierung Ufererosion / Seitenerosionsprozesse	X	X							X	X		X
2	2.2	Wirkung von Buhnen und Längsverbau	X	X						X			X	
		Kraftwerke, Stauhaltungen, Querbauwerke												
1		Hydraulische Bauwerke, Querbauwerke	X	X		X						X		
4		Stauketten und Feststoffdurchgängigkeit	X	X		X								
4		Regulierung von Stauanlagen (Wehrreglement)	X	X		X								
2	2.8	Auswirkungen Schwall und Sunk		X			X						X	
		Gefahren- und Risikobeurteilung												
1		Überflutungsberechnung (2D)	X	X	X	X				X	X	X		
1		Abflusswirksamer Vorlandabfluss	X		X		X			X		X	X	
1		Abflussberechnung (HWS, Freibord)			X	X	X				X	X		
3	1.5	Hydraulik im urbanen Raum (Fokus: grosse Anzahl Quellen und Senken)	X		X						X	X	X	
4	4	**Schwebstofftransport**		X	X		X			X	X	X		

Recent Progress

(A) concepts for engineering practice

- key topics:
  - sediment transport and budget
  - morphodynamics in revitalisation projects
  - conveyance and stability of channels
  - hydraulic structures
  - hazard and risk assessment
  - suspended load

- ranking:
  1. **sediment transport and budget**
     hazard and risk assessment
  2. conveyance and stability of channels
  3. morphodynamics in revitalisation projects
     hydraulic structures
  4. suspended load

Recent Progress

(B) development & maintenance

- Roadmap 2020 (**main features only**)
  - Version 3.0.2
    - Windows version with GPU support ✓
    - scheduled Q1 2020 ✓
  - Version 3.1
    - passive tracer ✓
    - ~~turbulence models~~
    - + slope collapse, revision bed load
    - ~~scheduled Q1 2020~~ Q4 2020
- BASEmesh 2.0 ✓
  - ~~scheduled Q2 2020~~ Q4 2020
- ~~Version 3.2~~
  - ~~slope collapse~~
  - ~~suspended load~~
  - ~~mixed-size sediment transport~~
  - ~~scheduled Q2 2020~~
- ~~Version 3.3~~
  - ~~vegetation model~~
  - ~~scheduled Q4 2020~~

Recent Progress

(C) knowledge transfer

- instructions and application of BASEMENT software

  in gradate courses at ETH Zurich:

  - Experimental and Computer Laboratory I
  - River Morphodynamic Modelling

Future Development

Consolidation of versions 2 and 3: “2+3=4”

- reduce maintenance effort
- maintain valuable features of version 2
- provide efficient framework
- possible consolidation:
  - replace GUI of v2 by GUI from v3
  - modularize v2 to match workflow of v3
  - adjust output of v2

Approach:

- software technical evaluation
- proposal of possible strategies
- scheduled Q1 2021

Future Development

Tentative master plan for features

Feature	BASEMENT Version 2.8	3
1-D Model		
Hydrodynamics		
SWE (hydrostatic)	√	↗
BT (non-hydrostatic)	∞	↗
Morphodynamics		
bed load	√	↗
suspended load	√	↗
uniform sediment	√	↗
mixed size sediment	√	↗
2-D Model		
Hydrodynamics		
SWE (hydrostatic)	√	√
algebraic turbulence model	√	🌀
advanced turbulence models	∞	🌀
Morphodynamics		
bed load	√	√
suspended load	√	🌀
uniform sediment	√	√
mixed size sediment	√	🌀
lateral slope effect	√	√
curvature effect	√	√
slope collapse	√	√

Legend

√	available
🌀	implementation
↗	planned
∞	not scheduled for the time being

special features		
coupling 1D/2D models	√	∞
controller (1D and 2D)	√	∞
3D subsurface flow (2D)	√	∞
vegetation model (2D)	√	🌀
passive tracer	√	√
temperature	∞	🌀
backends		
Multicore CPU	√	√
GPU	∞	√

Future Development

BASEtools

- python tool box, open source (GPL)
- includes BASEmesh
- new/further developments:
  - BASEmesh: 1D channel generator
  - BASEprohaz: MC simulation
  - BASEviz (?)
  - BASEbreach (?)

```
        Returns
        -------
        Tuple[Mesh, Dict[str, List[int]]]
            The generated mesh, as well as a list of string definitions
            mapped to their respective node IDs.
        """
        # Generate input geometry
        triangle_nodes = [PSLGNode(*n.as_tuple_2d()) for n in self.nodes]
        triangle_segments = [
            PSLGSegment.from_points(*l.as_line(), nodes=triangle_nodes)
            for l in self.segments]
        # Run triangle
        mesh = quality_mesh(triangle_nodes, triangle_segments,
                            self.holes or [], self.regions,
                            min_angle=min_angle, max_area=max_area, **kwargs)

        # Process string definitions
        if self.string_defs is not None:
            # NOTE: The string defs are provided by the user as named lists of
            # nodes, but the parser expects point tuples.
            # This is converted here.
            sd_points = {name: tuple(n.as_tuple_2d() for n in line_string)
                         for name, line_string in self.string_defs.items()}
            string_defs = resolve_string_defs(sd_points, mesh, 1e-6)
        else:
            string_defs = {}

        # Interpolate mesh
        # NOTE: This works because the MeshFactory class itself supports the
        # ElevationSource ABC requried for interpolation
        interpolate_mesh(mesh, self, default=-999.0)
        return mesh, string_defs

    @abstractmethod
    def elevation_at(self, point: Point2D) -> float:
        """Return the elevation of the given point.

        This method must be overridden by the user.

        Parameters
        ----------
        point : Tuple[float, float]
            The point to interpolate

        Returns
        -------
        float
            The elevation at the given point
```

Roadmap 2021 (main features only)

- Version 3.2
  - vegetation model
  - longitudinal slope collapse 1D
  - scheduled Q1 2021
- Version 3.3
  - mixed-size sediment transport
  - scheduled Q2 2021
- Version 3.4
  - turbulence models
  - suspended load
  - scheduled Q3 2021
- BASEmesh 2.1
  - 1D channel generator
  - scheduled Q1 2021
- BASEtools 1.0
  - BASEmesh
  - BASEprohaz
  - scheduled Q4 2021

make your bets !!