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Ingenieurbüro André Burkard AG

REKONSTRUKTION EINES AUSSERORDENTLICHEN HOCHWASSER- UND GESCHIEBETRANSPORTEREIGNISSES AM GEBIRGSFLUSS SALTINA IN 1D UND 2D

BASEMENT Anwendertreffen, Rapperswil – 25.01.2017

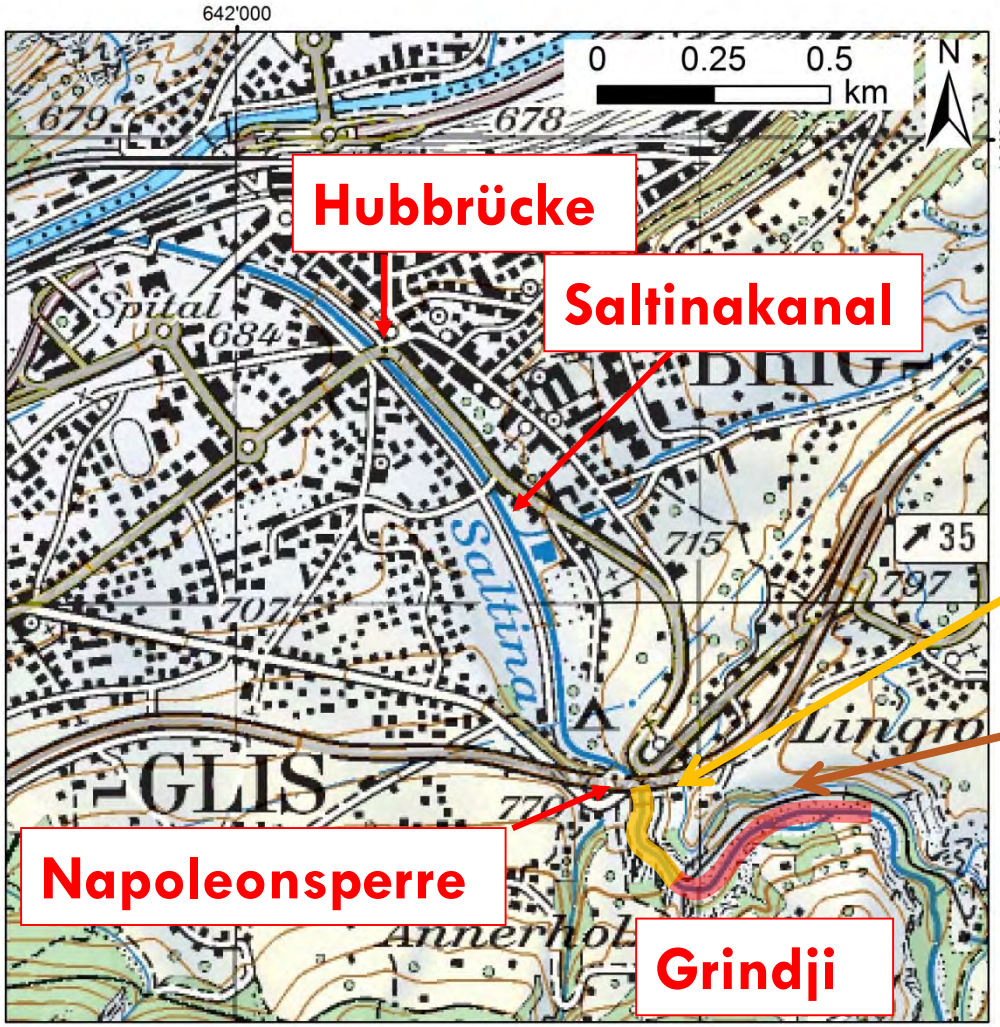
Inhalt

- Einführung - Saltina
- Grundlagen für die Simulation
- Modell & Resultate 1D (BASEchain)
- Modell & Resultate 2D (BASEplane)
- Diskussion

Saltina: früher

Brig / Saltina
1868

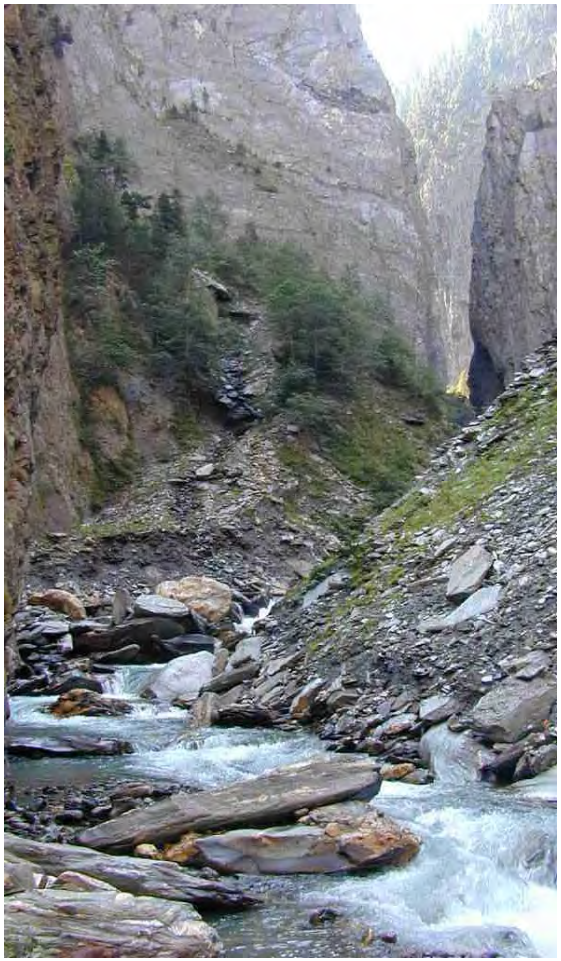
Saltina: heute

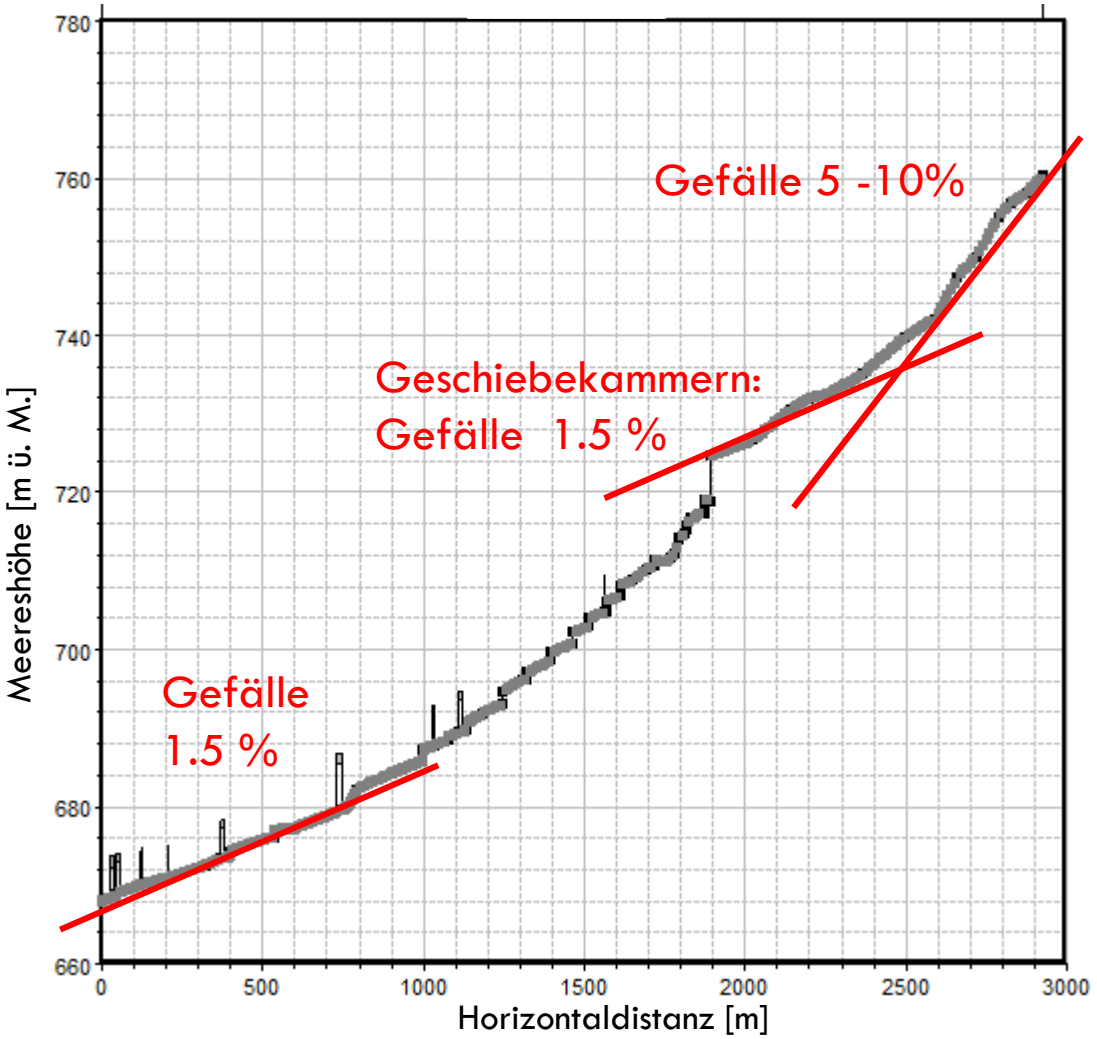


Untere Geschiebekammer

Obere Geschiebekammer

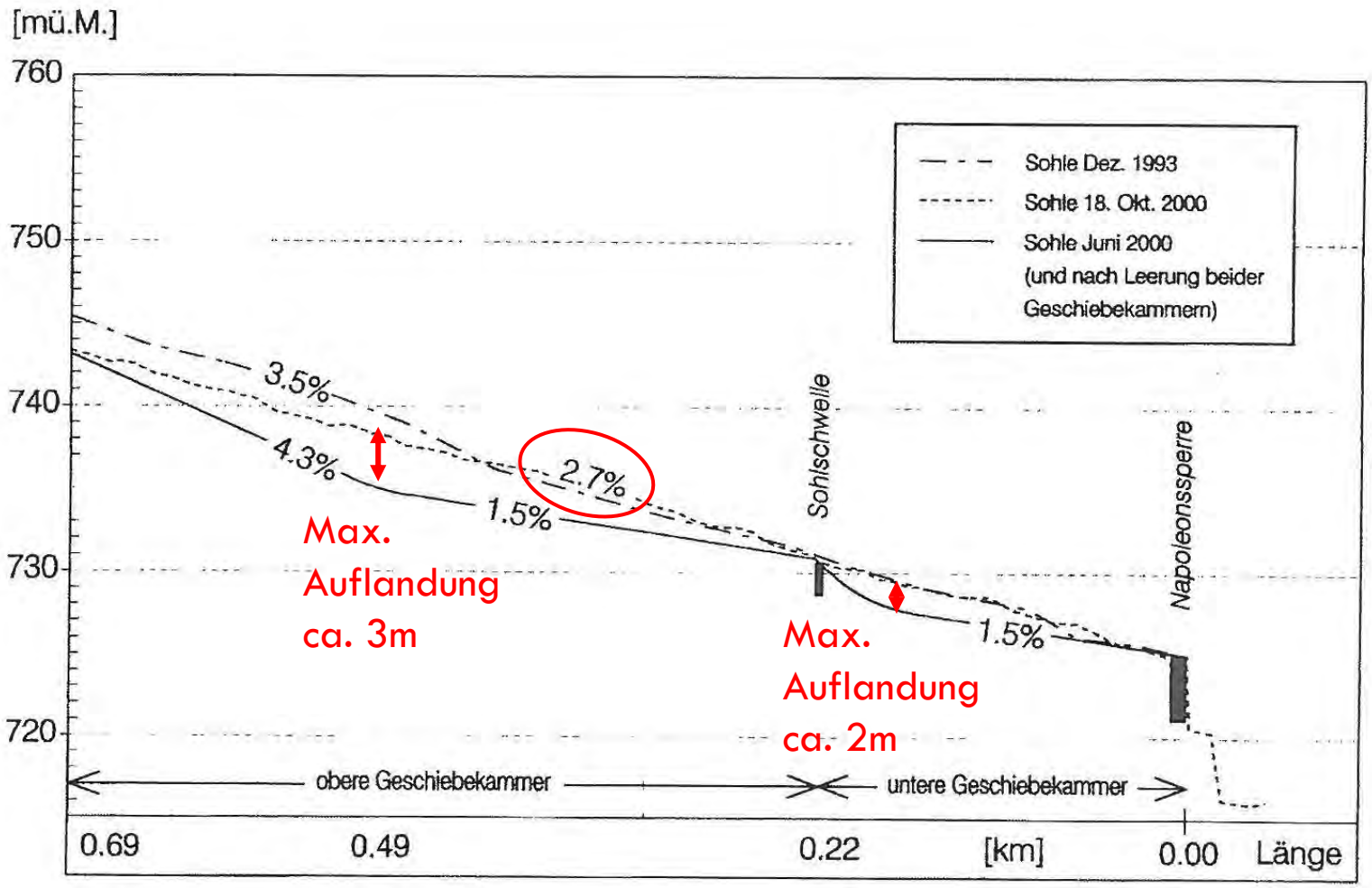
Saltina: heute





Grindji, Geschiebekammer / Okt 2000

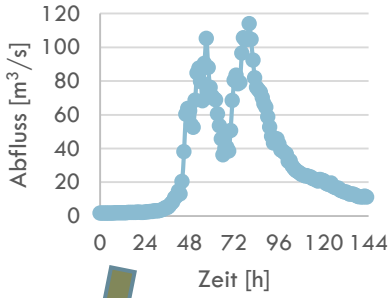
Rekonstruktion Ereignis Okt. 2000



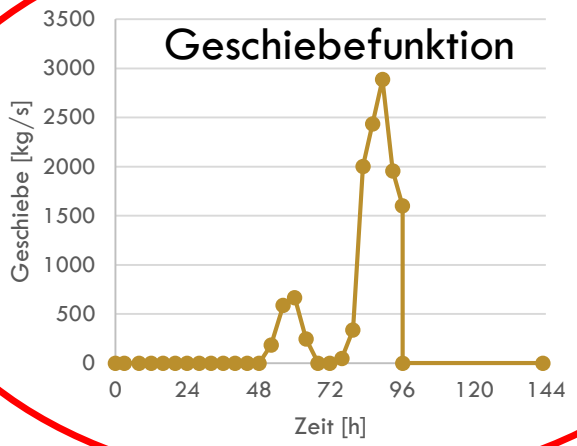
Quelle: Burkard & Jäggi, Wasser Energie Luft, 93/ 2003

Rekonstruktion Ereignis Okt. 2000

Hochwassergangline

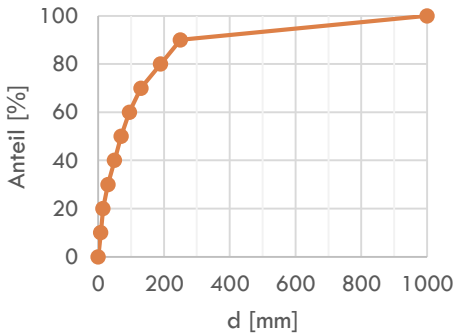


Geschiebefunktion



Beobachtungen während Ereignis

Beobachtungen nach Ereignis



Kornverteilung

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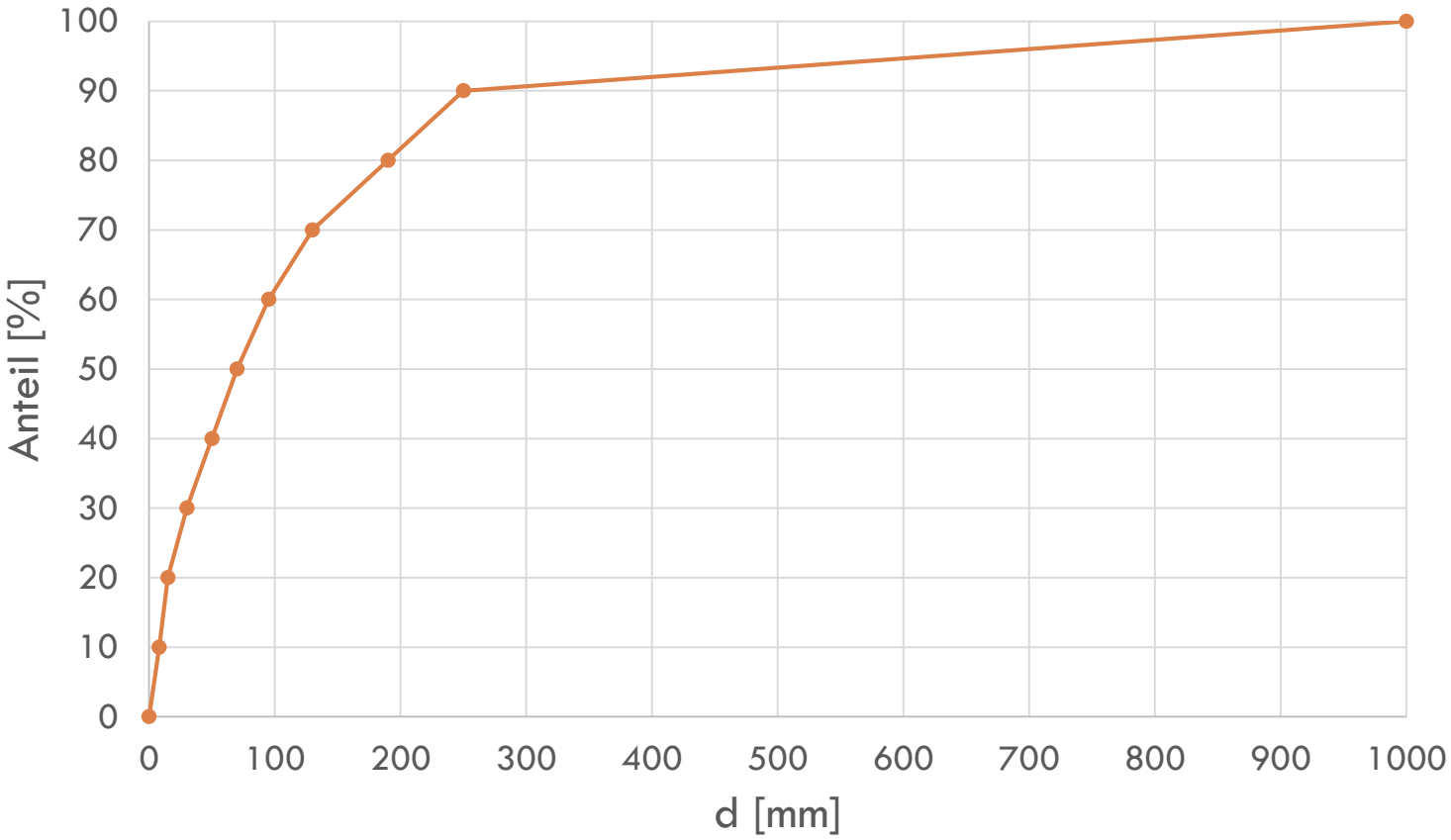
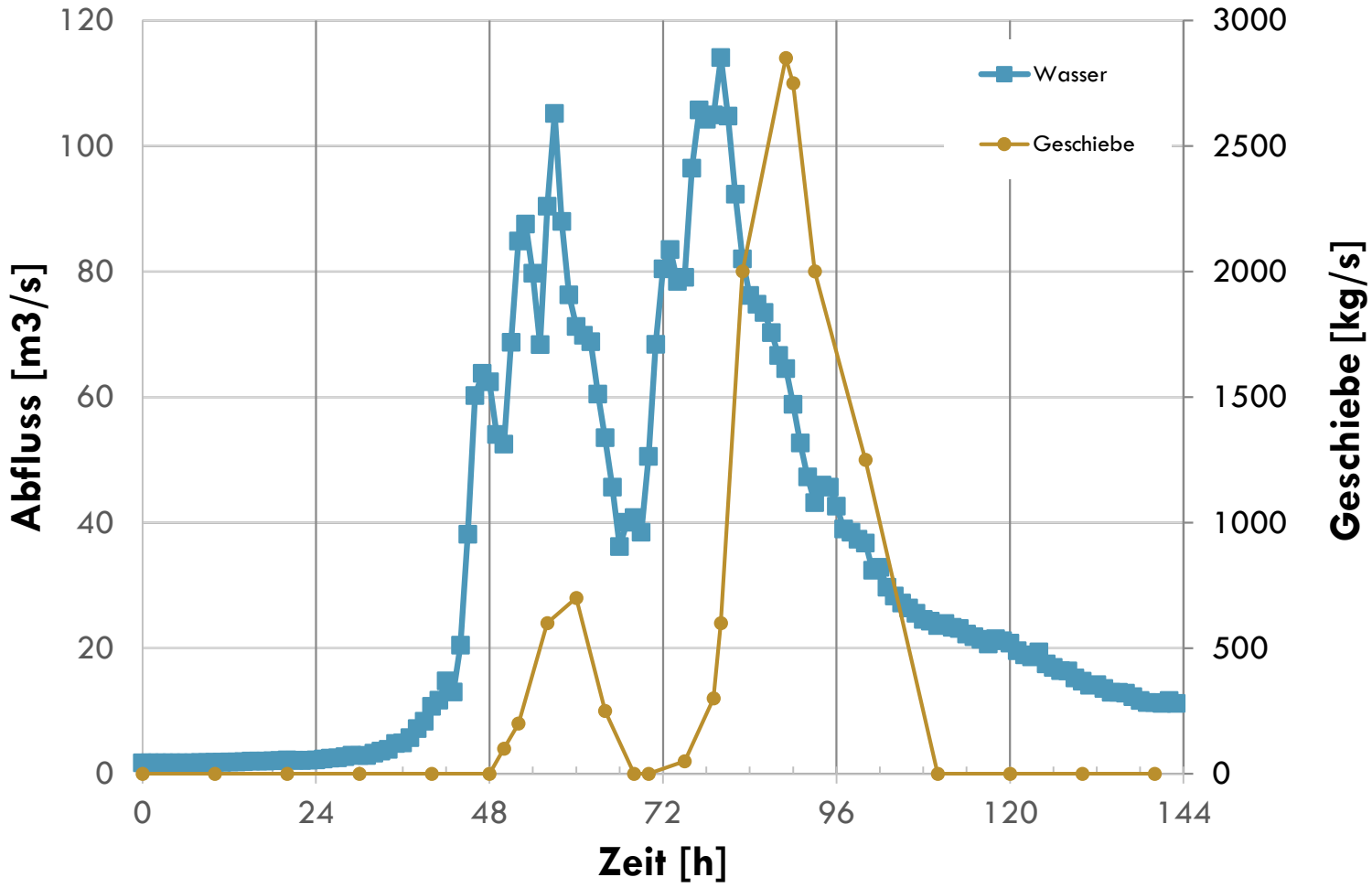
Kornverteilungskurve

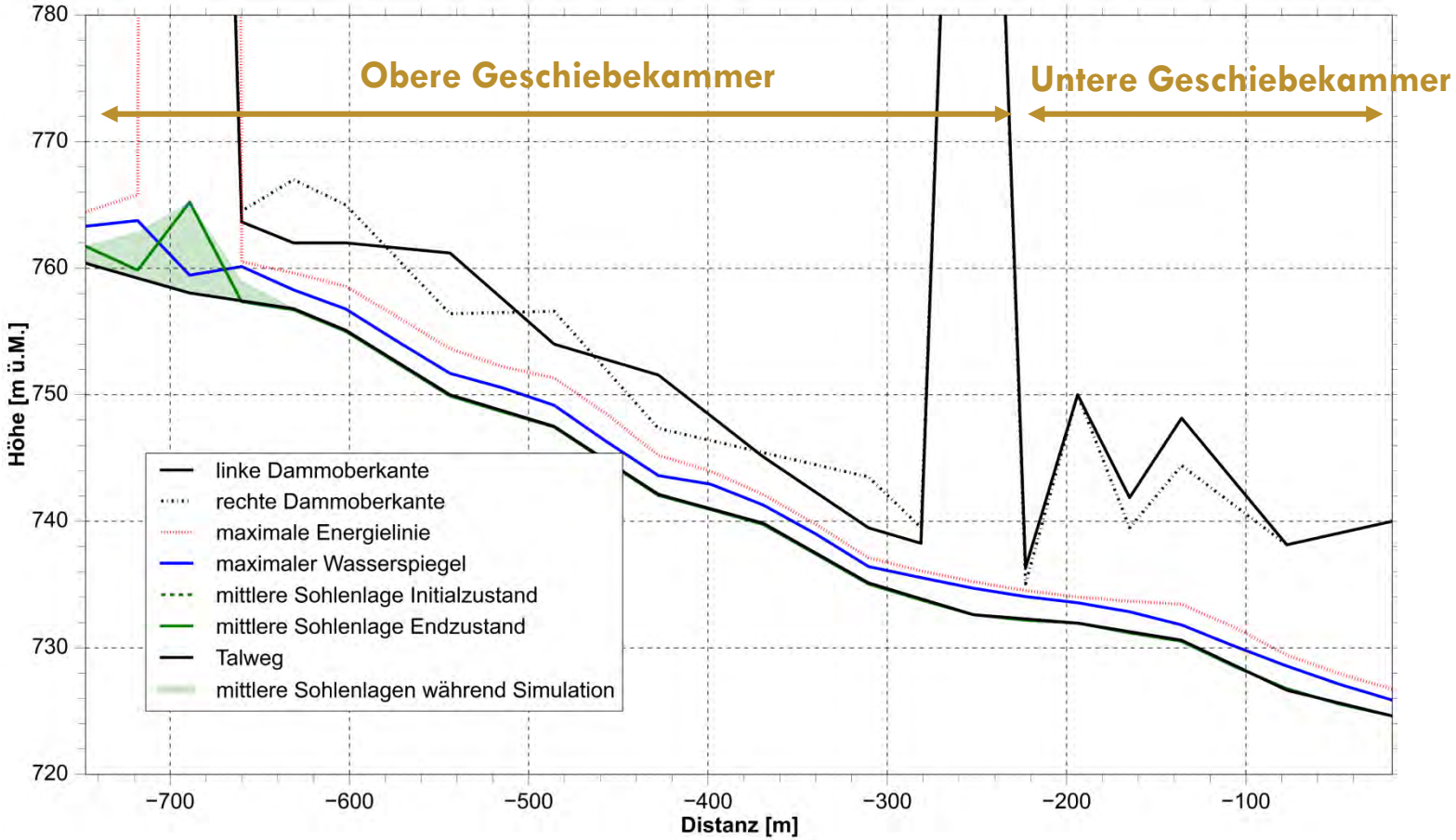


Hochwasser- und Geschiebeganglinie



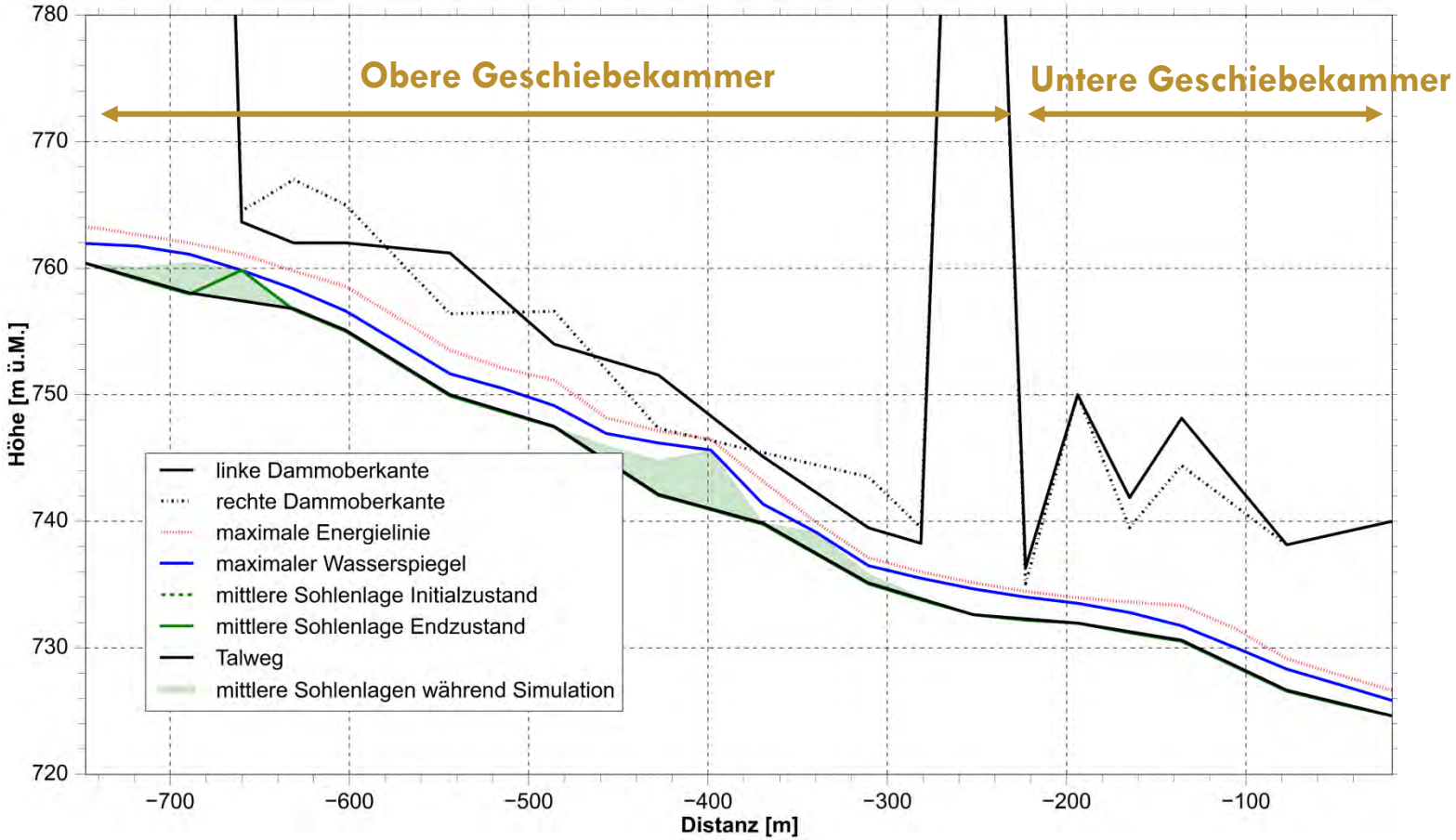
BASEchain - Resultate

Rickenmann, Einkorn (d_{30} = 30mm, d_{90} = 250 mm)



BASEchain - Resultate

Smart-Jäggi, Einkorn (d_{30} = 30mm, d_{90} = 250 mm)



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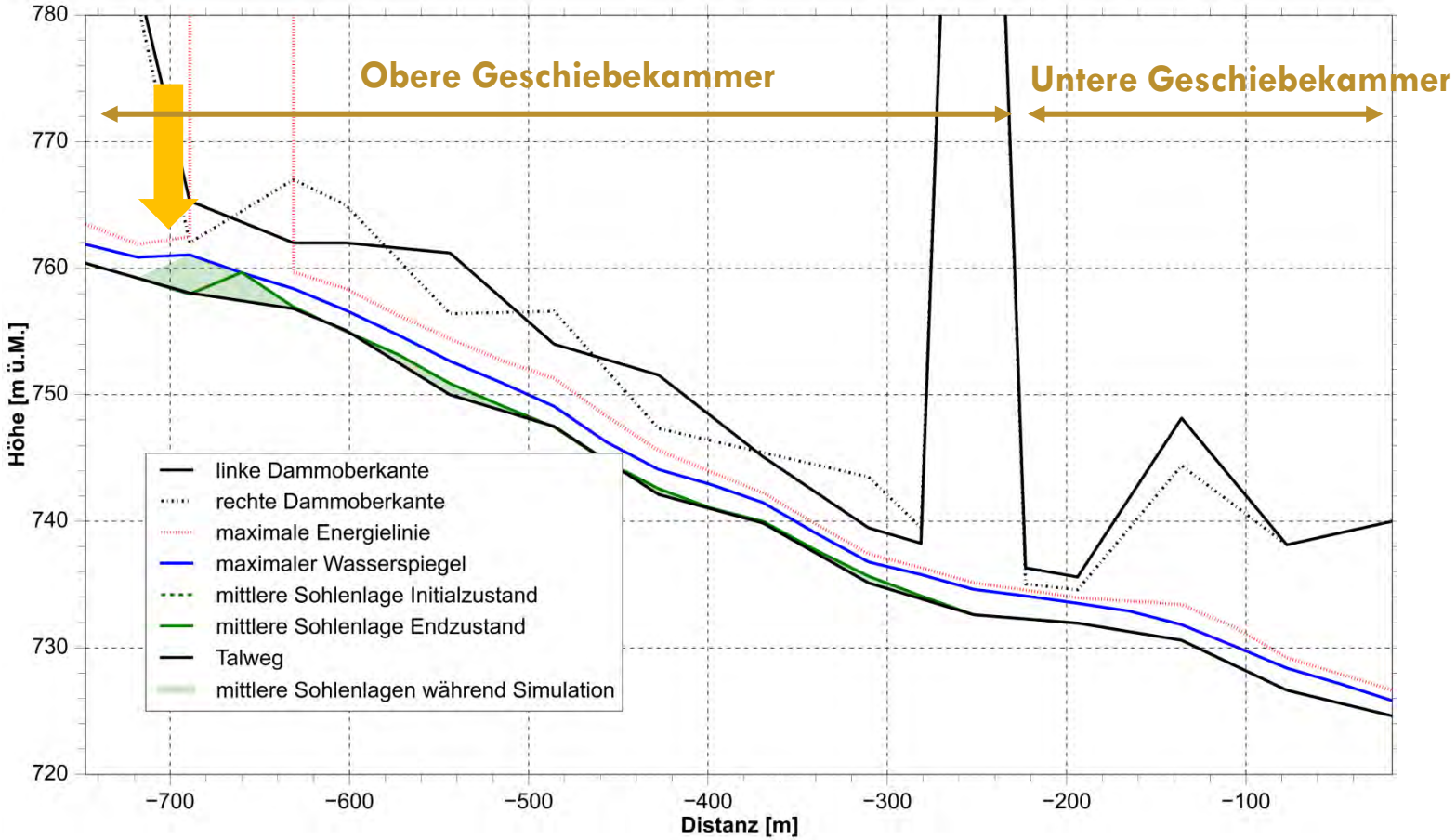
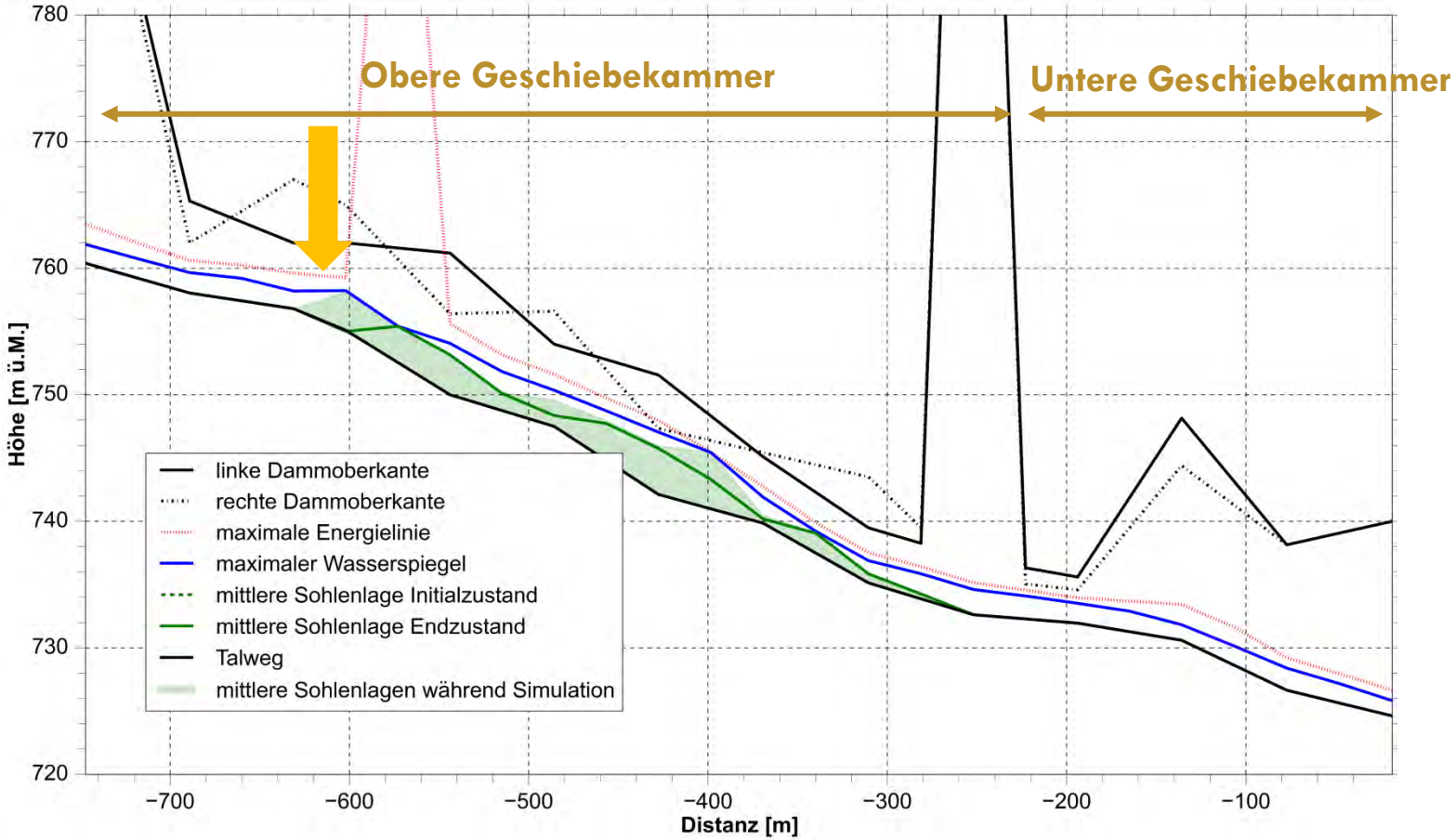
BASEchain - Resultate

Smart-Jäggi, Mehrkorn (5 Klassen)



BASEchain - Resultate

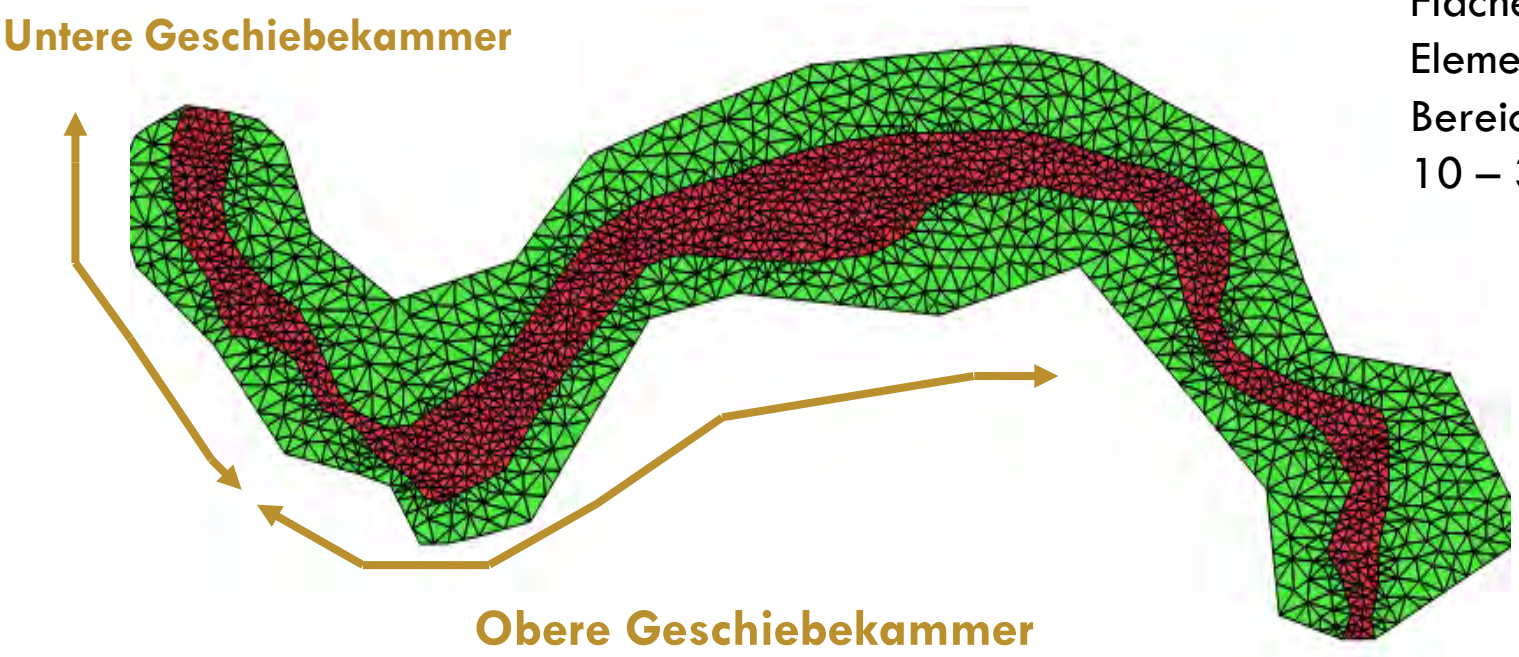
Smart-Jäggi, Mehrkorn (5 Klassen)



BASEchain - Rechenzeit

- Nur Grindji (700 m): ok (wenige Minuten)
- Grindji (700 m) mit Kanal (1.5 km) direkt angehängt: Stunden bis Tage
- Grindji mit Kanal via Inner Boundary gekoppelt: Tage bis Wochen!
- Coupling mit Rhone → ???

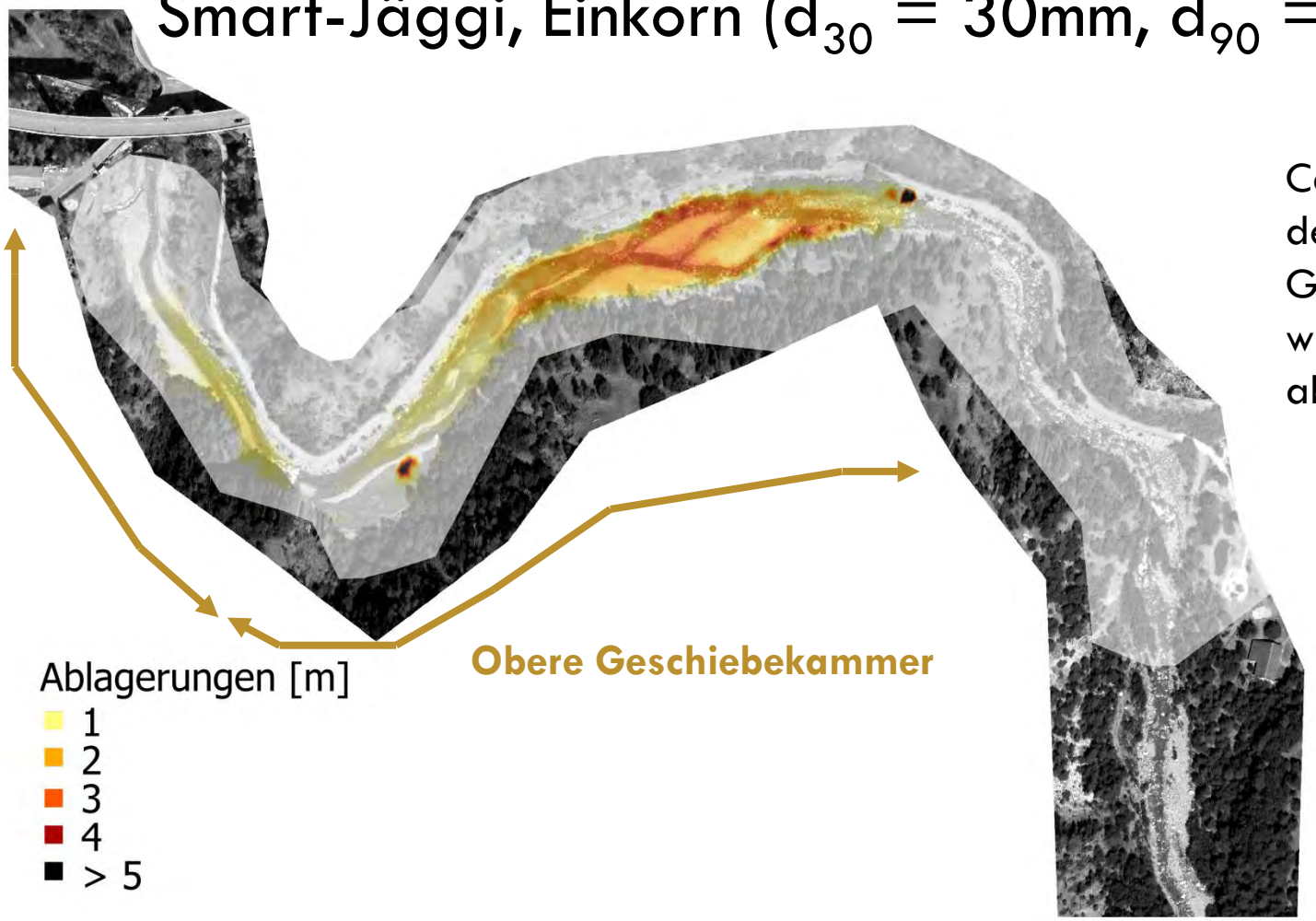
BASEplane - Geometrie



Fläche Mesh-Elemente im Bereich Flussbett: 10 – 30 m^2

BASEplane - Resultate

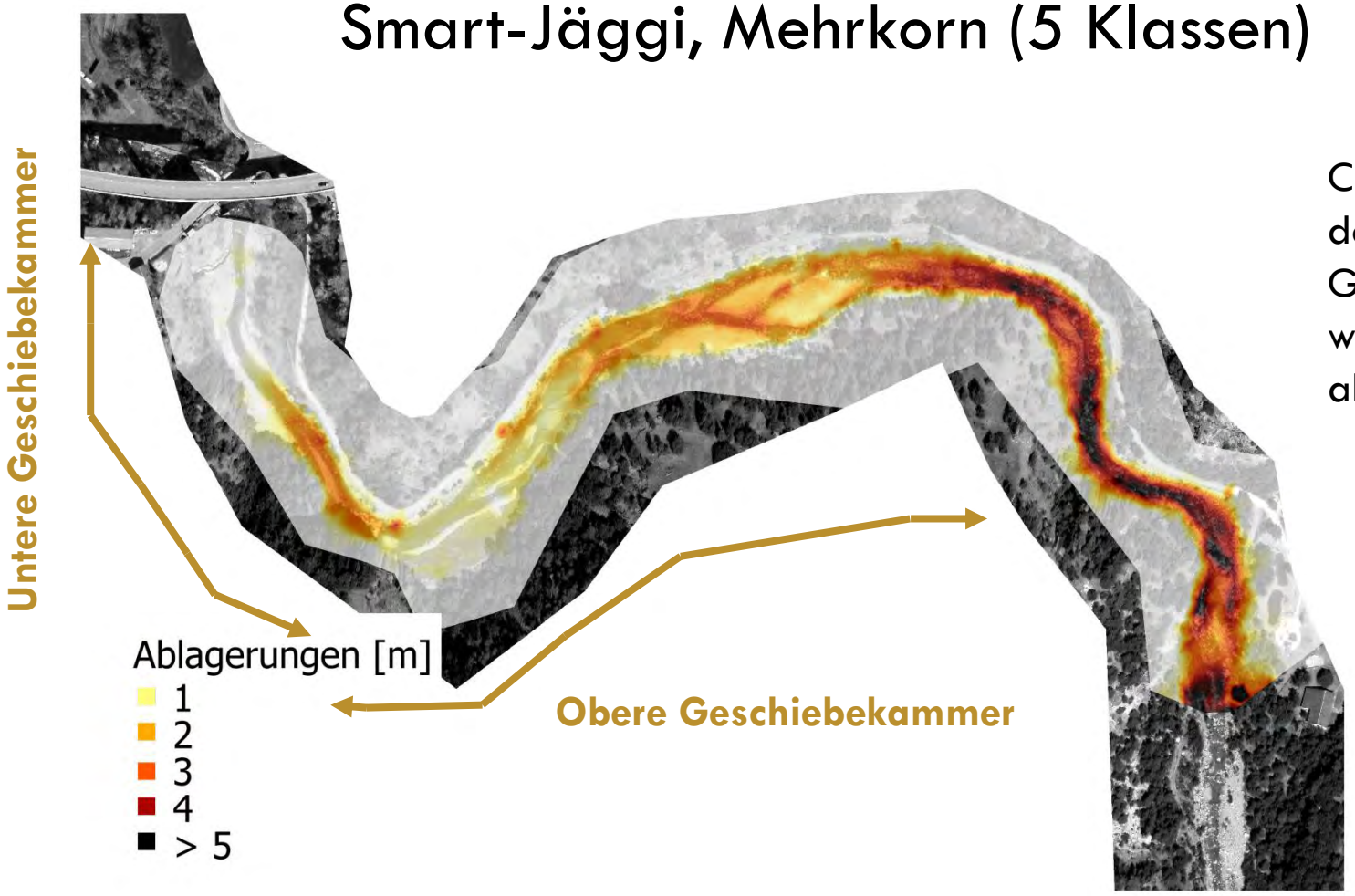
Smart-Jäggi, Einkorn (d_{30} = 30mm, d_{90} = 250 mm)



Ca. 25 % des Geschiebes wird abgelagert

BASEplane - Resultate

Smart-Jäggi, Mehrkorn (5 Klassen)



Ca. 80% des Geschiebes wird abgelagert

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Diskussion und Fragen

- Verbesserungsvorschläge für die Simulationen / Parameter für Kalibration
- Geschiebetransportformeln, Formrauigkeit etc.
- Grenzen von BASEMENT: (a) für Gebirgsflüsse, (b) für Extremereignisse
- 1D: Rechenzeit, Coupling?

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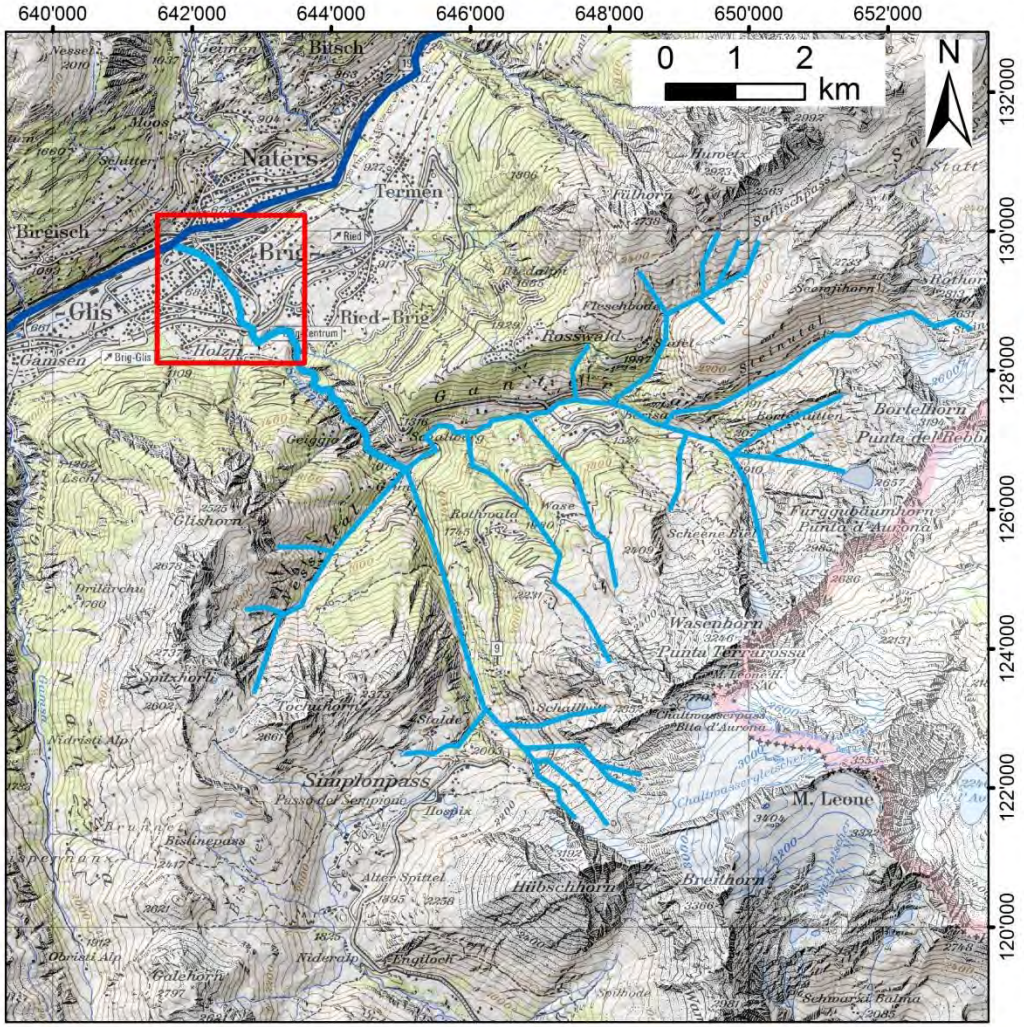
Anhang

- Übersichtskarten
- Setup & Auszug .bmc, 1D (beispielhaft)
- Froude-Zahlen, Sohlschubspannungen 1D (beispielhaft)
- Setup & Auszug .bmc, 2D (beispielhaft)

Saltina



- Geographische Lage: Wallis – Simplongebiet
- Grösse Einzugsgebiet: 78 km^2
- Höchster Punkt: ca. 3250 m ü. M.
  tiefster Punkt: ca. 680 m ü. M.
- Lage der Stadt Brig-Glis: auf dem Schwemmkegel

Saltina

- Geographische Lage: Wallis – Simplongebiet
- Grösse Einzugsgebiet: ca. 80 km^2
- Höchster Punkt: ca. 3250 m ü. M.
  tiefster Punkt: ca. 680 m ü. M.
- Lage der Stadt Brig-Glis: auf dem Schwemmkegel

BASEMENT 1D - Setup

- Soil: Layer -0.1 m im Sohlbereich / fixed im Uferbereich
- Transport Einkorn: Rickenmann & Smart-Jäggi, $d_{30} = 30$, $d_{90} = 250$
- Transport Mehrkorn:: smartjaeggi_multi mit 5 Klassen
- Geschiebeeingabe ca. 50 m unterhalb hydraulischem Modellrand

Modell BASEchain


```
DOMAIN {
        BASECHAIN_1D {
                region_name = Saltina
                GEOMETRY {
                        type              = basement
                        file              = g12_grindji_soil.bmg
                        dump_crosssections  = no
                        cross_section_order = (....) }
         TIMESTEP {
                        CFL               = 0.9
                        maximum_time_step = 3600
                        total_run_time    = 514800
                        start_time        = -1.0   }
```


Modell BASEchain


```
HYDRAULICS {
        PARAMETER {
            riemann_solver      = upwind
            simulation_scheme   = explicit
            minimum_water_depth = 0.01
            SECTION_COMPUTATION {
                type      = iteration
                precision = 0.1 } }
        FRICTION {
            type             = manning
            default_friction = 0.05  }
```


Modell BASEchain


```
INITIAL {  type     = backwater
           q_out    = 1.75
           WSE_out = 669 }
BOUNDARY {
           string             = upstream
           type               = hydrograph
           slope              = 100
           file               = inflow2000.txt
           precision          = 0.0001
           number_of_iterations = 250  }
BOUNDARY {
           string = downstream
           type   = zero_gradient  }
```

Modell BASEchain


```
MORPHOLOGY {
                    PARAMETER {
                            porosity     = 30
                            density      = 2650
                            max_dz_table = 0.1  }
                    INITIAL {
                            type = initial_mesh  }
```

Modell BASEchain


```
BEDMATERIAL {     GRAIN_CLASS { diameters = (8 33 73 143 595 1000) }
                  MIXTURE {   name            = mix1
                              volume_fraction = (20 20 20 20 20 0) }
                  SOIL_ASSIGNMENT {           index = (1 2)
                                              soil  = (mobile fixed)
                                              type  = index_table }
                  MIXTURE {                   name            = soil1
                              volume_fraction = (0 0 0 0 0 100)  }
                  SOIL_DEF {                  name = mobile
                              LAYER {   mixture         = soil1
                                        bottom_elevation = -0.1  }}
                  SOIL_DEF {                  name = fixed   } }
```

Modell BASEchain

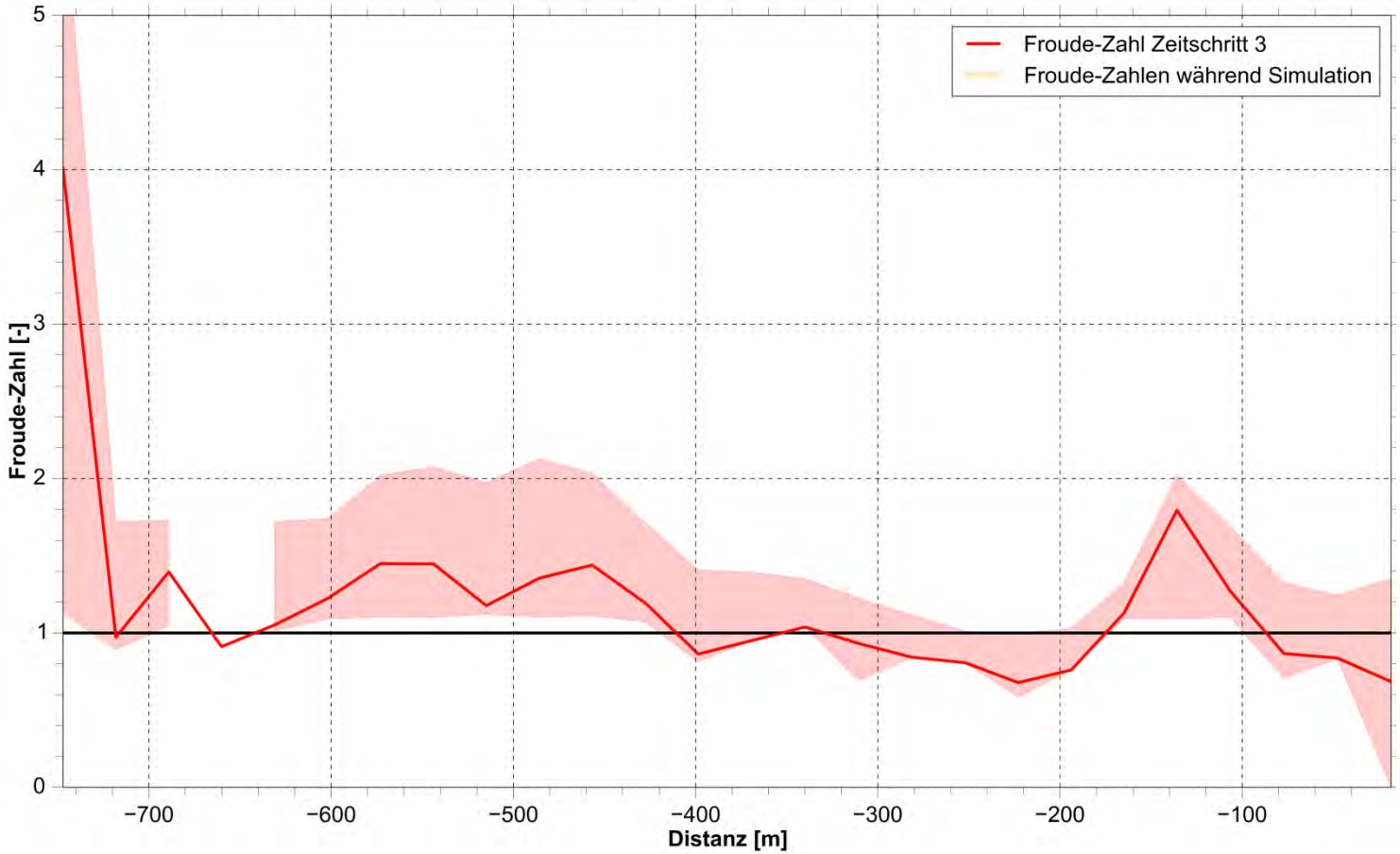

```
BEDLOAD {       PARAMETER {     upwind       = 1
                                velocity_area = general  }
                FORMULA {       bedload_formula = smartjaeggi_multi }
                BOUNDARY {      type   = IOUp
                                string = upstream  }
                BOUNDARY {      string = downstream
                                type   = IODown  } }
SOURCE {
                EXTERNAL_SOURCE {
                                type         = sediment_discharge
                                file         = geschiebe2000.txt
                                mixture      = mix1
                                cross_section = 2819.60  }}
```

Modell BASEchain


```
OUTPUT {
                output_time_step  = 10000
                console_time_step = 10000
                        SPECIAL_OUTPUT {
                                Q               = (time)
                                output_time_step = 10000
                                type            = monitor
                                cross_sections  = (2819.60 )
                                energy_line     = (time)
                                Qb              = (time)  }}
        PARALLEL {
                number_threads = 3 }
```


BASEMENT 1D - Resultate

Smart-Jäggi, Mehrkorn (5 Klassen): Froude-Zahl



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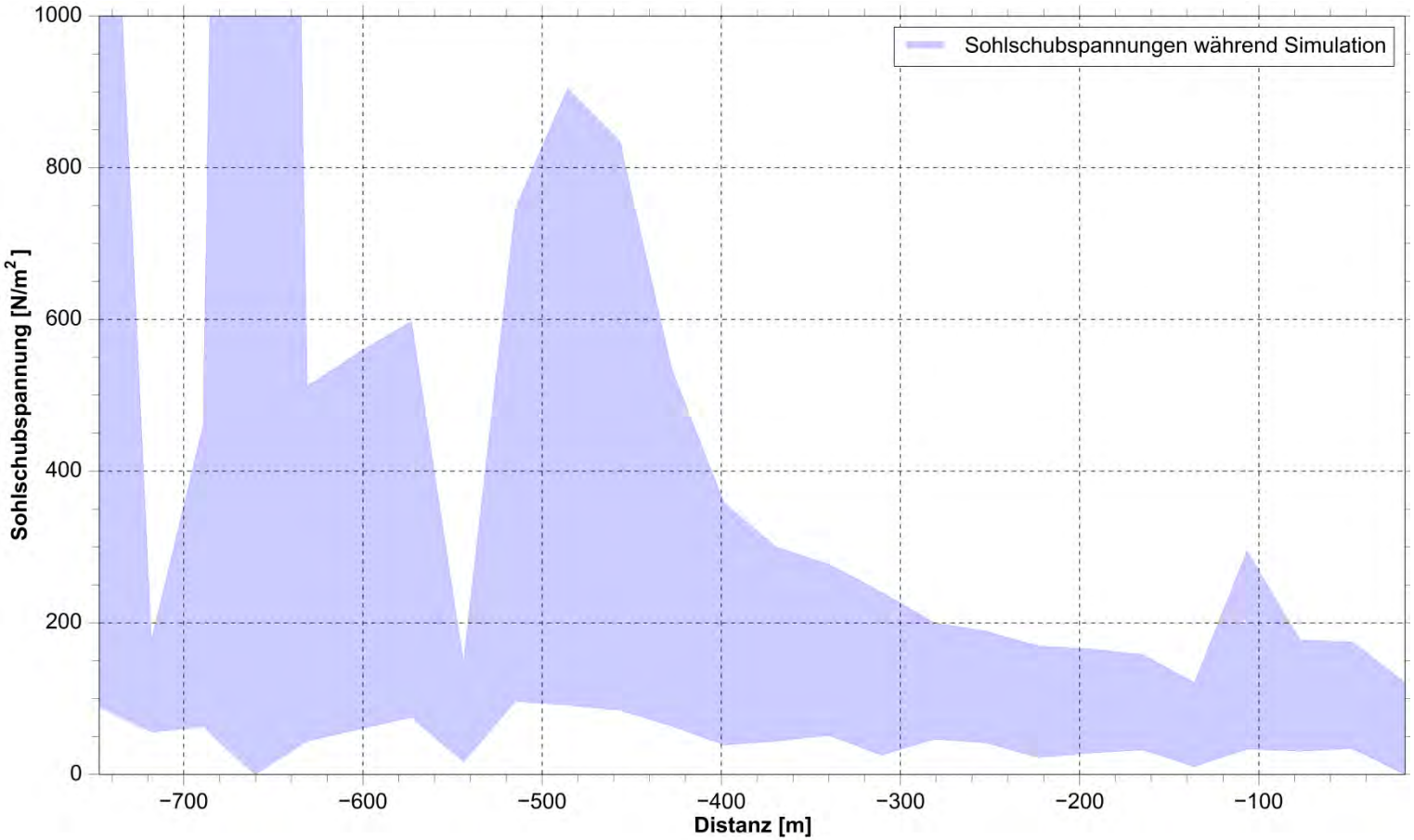
BASEMENT 1D - Resultate

Smart-Jäggi, Mehrkorn (5 Klassen): Sohlschubspannungen



BASEMENT 2D - Setup

- Soil: Layer -0.1 m im Sohlbereich / fixed im Uferbereich
- Transport Einkorn: Rickenmann & Smart-Jäggi, d_{30} = 30 mm, d_{90} = 250 mm (Rickenmann: ähnliche Resultate)
- Transport Mehrkorn:: smartjaeggi_multi & mpm_multi mit 5 Klassen (mpm_multi: ähnliche Resultate)
- Geschiebeeingabe am hydraulischen Modellrand (sonst schlechtere Resultate)

Modell BASEplane


```
DOMAIN {
        multiregion = saltina
        PARALLEL {  number_threads = 3  }
        PHYSICAL_PROPERTIES {
                gravity    = 9.81
                viscosity = 0.000001
                rho_fluid = 1000  }
        TIMESTEP {
                CFL              = 0.95
                total_run_time    = 514800
                minimum_time_step = 0.0001
                start_time        = 0.0  }
```


Modell BASEplane


```
BASEPLANE_2D {  region_name = Saltina
        GEOMETRY {      type = 2dm
                        file = saltina.2dm
                STRINGDEF {     name            = Inflow
                                node_ids        = (1582 1573)
                                upstream_direction = right }
                STRINGDEF {     name            = Inflow_sed
                                node_ids        = (1534 1519 1527)
                                upstream_direction = right }
                STRINGDEF {     name            = Outflow
                                node_ids        = (39 394 372 378 1)
                                upstream_direction = left  } }
```

Modell BASEplane


```
HYDRAULICS {
                    PARAMETER {
                            simulation_scheme   = exp
                            riemann_solver      = exact
                            minimum_water_depth = 0.05 }
        FRICTION {
                            type            = strickler
                            default_friction = 25
                            input_type      = index_table
                            index           = (1  2)
                            friction        = (25  25)
                            wall_friction   = off  }
```


Modell BASEplane


```
BOUNDARY {
                    type          = hydrograph
                    string_name   = Inflow
                    file          = inflow2000.txt
                    slope         = 50.0
                    weighting_type = area  }
BOUNDARY {
                    type        = hqrelation
                    string_name = Outflow
                    slope       = 2.0  }
INITIAL {
                    type = dry
                }
```


Modell BASEplane


```
MORPHOLOGY {
        PARAMETER {
                porosity              = 40
                density               = 2650
                control_volume_type       = constant
                control_volume_thickness = 0.15  }
        INITIAL {
                type = initial_mesh
            }
```


Modell BASEplane


```
BEDMATERIAL {
GRAIN_CLASS {    diameters = (8 33 73 143 595 1000) }
                 MIXTURE { name            = mixture_inflow
                           volume_fraction = (20 20 20 20 20 0) }
                 MIXTURE { name            = mixture_soil
                           volume_fraction = (0 0 0 0 0 100)  }
                 SOIL_DEF {  name = soil_everywhere
                           LAYER {  bottom_elevation = -0.01
                                    mixture          = mixture_soil  } }
                 SOIL_ASSIGNMENT {
                           type  = index_table
                           index = ( 1  2)
                           soil  = (soil_everywhere soil_everywhere)}
```

Modell BASEplane


```
BEDLOAD {
        PARAMETER {     limit_bedload_wetted          = off
                        use_cell_averaged_bedload_flux = off  }
        BOUNDARY {      type        = sediment_discharge
                        string_name = Inflow
                        mixture     = mixture_inflow
                        file        = geschiebe2000.txt  }
        BOUNDARY {      type        = IODown
                        string_name = Outflow }
        FORMULA {       bedload_formula = smartjaeggi_multi
                        bedload_factor  = 1   }
        DIRECTION {     lateral_transport_type = lateral_bed_slope
                        lateral_index          = (1 2)}
```

Modell BASEplane


```
GRAVITATIONAL_TRANSPORT {
        index                       = (1 2)
        angle_failure_dry           = (30 30)
        angle_failure_wetted        = (15 15)
        angle_failure_deposited     = (10 10)
        gravity_transport_on_cells = partially wetted
        angle_wetted_criterion      = partially_wetted  }
```

Modell BASEplane


```
OUTPUT {              console_time_step = 1000
                      restart_time_step = 1E32
                      reference_time    = 12-10-2000-00-00-00
SPECIAL_OUTPUT { type             = balance
                      balance_values    = ( sediment timestep )
                      output_time_step = 100 }
SPECIAL_OUTPUT { type             = boundary_history
                      output_time_step = 1000
                      boundary_values  = (Q Qsed)
                      history_one_file = yes  }
SPECIAL_OUTPUT { type             = node_centered
                      values           = (depth deltaz tau velocity)
                      format           = sms
                      output_time_step = 1800}}
```