Investigation of landslide tsunami using BASEMENT (version 2.8)

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Outlines

- >Why I choose BASEMENT to study my project (Landslide tsunami)?
- Modelling an experimental landslide tsunami (Sue's experiment)
- Investigate an physical experiment of landslide tsunami (Monai Experiment)
- **>**Future work

>Why I choose BASEMENT to study my project (Landslide tsunami)?

- I. Friendly interface , powerful function
- **II.** OpenMP multi-threads parallelisation
- **III.** Built-in visualization(BASEvis)
- **IV. Output files within multiple formats**

> Modelling an experimental landslide tsunami (Sue's experiment)



Figure 1 Experimental set-up for submarine landslideinduced tsunami(Sue,2006)

> Modelling an experimental landslide tsunami (Sue's experiment)



Figure 2 Slide view of the experiment (Sue, 2006)

> Modelling an experimental landslide tsunami (Sue's experiment)



Figure 3 Experimental results of water levels at t=0.6,1.6,2.6s(Sue, 2006)

> Modelling an experimental landslide tsunami (Sue's experiment)



Figure 4 experimental result of water levels at t=3.6,4.6,5.6s(Sue,2006)

- > Modelling an experimental landslide tsunami (Sue's experiment)
 - Tsunami wave propagation process reproduced by BASEMENT:
 - I. Domain discretized by BASEmesh
 - **II.** Initial simulation with input waves by **BASEMENT**
 - III. Event-driven water levels were created by CGNSview tool
 - **IV. Compare the simulated results with measured results**

CGNSview : SUE3_restart.cgns File Config Tree Tools Utilities Help Node Tree Node Description Parent Node //base/zone unstructured/FlowEle 0.600000 <u>|</u>/ GINSLibraryVersion Node Name Depth 占 🧰 base Node Label DataArrav t E- i zone_unstructured Link Description GridCoordinates Link File Browse 🕀 🚞 Elem Browse 🖶 🚞 ZoneIterativeData Link Node FlowEle 0.600000 Data Description 🗄 🧰 Depth Data Type 🗄 🚞 VelocityX 8511 Dimensions ±- velocit Bytes 🗄 🚞 FlowEle 1.600000 🕂 🗀 FlowEle 2.600000 🕂 🚞 FlowEle 3.600000 modify read clear delete 🕂 🗀 FlowEle 4.600000 Node Data 🗄 🚞 FlowEle 5.600000 0.434794 -0.0014291 -0.00140244 0.435027 0.434989 -0.00140871 0.435137 -0.00140252 -0.00140249 0.374946 🗄 🧰 FlowEle 6 000000 🗄 🚞 FlowEle -0.00140244 0.434894 0.434995 -0.00142092 0.222228 -0.00140864 -0.00140865 0.435028 0.435048 -0.00142095 7.000000 🗄 🚞 FlowEle 8 000000 0.435093 -0.00142094 -0.00142093 0.435028 -0.00142095 0.156957 -0.00140246 0.43484 0.435095 -0.00142095 SimulationType 0.105691 -0.00142095 0.0918319 0.022871 0.280876 0.245962 0.428831 0.434988 0.18505 0.374947 DataClass 0.323662 0.195121 0.434988 0.397544 0.435007 0.434793 0.435203 0.435024 0.434988 0.434988 DimensionalUnits 0 435047 0 434987 0 435003 0 435169 0 435008 0 435026 0 43496 0 435238 0 43502 0 434922 + TimeIterValues 0.43497 -0.0014086 -0.00142095 0.435152 0.397539 -0.00140862 0.0387683 -0.00142095 -0.00142095 0.105714 -0.00142095.0.435025.0.357646.-0.00142095.0.435014.0.435069.-0.00141475.0.435141.0.434991.-0.00140248 0.435055 -0.00140252 -0.00140249 0.435108 -0.00140195 0.435001 -0.0014086 0.195127 0.0291553 -0.00140858 0 106054 0 106475 0 010807 0 0918688 0 23815 0 157093 0 272174 0 32284 0 415734 0 435241 0.43508 0.246493 0.435001 0.435029 0.435026 0.43504 0.435012 0.435008 0.435208 0.435141 0.434991.0.435059.0.435004.0.435009.0.435007.0.435025.0.434793.0.428588.0.434795.0.43507 **Observational** 0.434932 0.43479 0.434921 0.434963 0.435022 0.434996 0.435096 0.434975 0.435146 0.434643 **5** snapshots of 0 435122 0 434755 0 434946 0 435117 0 434757 0 435072 0 434797 0 434841 0 434873 0 435005 43497 0.434974 0.434956 0.434955 0.434991 0.434845 0.434859 0.434935 0.435046 0 434928 0 434785 0 434935 0 435118 0 435114 0 434932 0 434887 0 434919 0 434932 0 435063 0.434984 0.434929 0.435014 0.434935 0.434935 0.434991 0.434932 0.435012 0.435026 0.434928 tsunami wave simulated water level 0.434928 0.434989 0.434937 0.415721 0.435199 0.434934 0.435051 0.434935 0.435125 0.434935 0.435136 0.434932 0.434951 0.435069 0.434925 0.434941 0.435119 0.435104 0.43501 0.435129 0.434759.0.435094.0.435023.0.434984.0.434993.0.434895.0.434883.0.434792.0.435011.0.435002 0.434989 0.434989 0.43497 0.434981 0.434992 0.43485 0.434858 0.435032 0.434882 water level 0.43492 0.271334 0.434875 0.107325 0.194959 0.434912 0.434928 0.322872 0.434937 0.43503 corrected with Sue's 0.434935 0.0212841 0.434937 0.434937 0.435085 0.434934 0.434986 0.43492 0.434907 0.434893 0.435002 0.434964 0.434746 0.435079 0.434871 0.434851 0.434912 0.435028 0.434937 0.434935 -0.00140256 0.322779 0.435018 0.435002 0.435014 0.43489 0.435007 0.4348 0.434852 0.435005 0.43496 0.434949 0.435071 0.435027 0.435005 0.435022 0.43509 0.428599 0.374907 data observational data 0.29691 0.137802 0.221986 0.435093 0.435058 0.434927 0.434991 0.434994 0.434729 0.435019 0.435021 0.434716 0.435147 0.435025 0.435031 0.246249 0.245717 0.434992 0.434985 0.43497 0.434982 0.43497 0.434845 0.435131 0.43514 0.271541 0.271302 0.0397712 0.040462 0.415794 0.397598 0.435013 0.435002 0.434991 0.434975 0.435048 0.435023 0.434647 0.434748 0.435012 0.435003 0.434991 0.434968 0.435092 0.435027 0.435027 0.428645 0.424745 0.124728 -0.00140243 0.435025 0.435195 0.43513 0.435105 0.435123 0.434875 0.43486 0.434935 0.434931 0.435043 0.435113 0.43509 0.435091 0.434863 0.434921 0.434863 0.434863 0.434979 0.435006 0.434998

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Values/Line 10

CGNSview window

(1)

Line 1

Modelling an experimental landslide tsunami (Sue's experiment)



Figure 5 The comparison between measured and corrected results at t=1.6s,2.6s,3.6s

> Modelling an experimental landslide tsunami (Sue's experiment)



Figure 6 The comparison between measured and corrected simulated results at t=4.6s, 5.6s.

> Modelling an experimental landslide tsunami (Sue's experiment)

Preliminary results:

I. The landslide process plays an significant role in the whole landslide tsunami waves.

II. It's hard to simulate the real wave propagation process by the pure hydrodynamic code for landslip events.

III. Coupled simulation between geomechanic and hydrodynamic models could be more suitable to reproduce the real process especially at the starting stages

Investigate an physical experiment of landslide tsunami (Monai Experiment)



单位:毫米

Figure 7 The physical setup of Monai experiment(NOAA)

>Investigate Monai experiment on landslide tsunami



Figure 8 Configuration of Monai simulation(NOAA)

>Investigate Monai experiment on landslide tsunami



Figure 9 Comparison between measured and simulated water levels at 3 positions for model validation

>Investigate Monai experiment on landslide tsunami



Figure 10 Influence of different friction coefficients on water levels

>Investigate Monai experiment on landslide tsunami

Based on the initial simulation, Sediment transport is introduced

to discuss the effect of topography change and water level

Added type	Porosity	Grain size	Inlet Suspended sediment concentration
Bed load	40%	0.5/1/1.5mm	0
	40%/45%50	0.5	0
	40%	0.5	1e-5/5e-5/1e-4 m ³ /s
Suspended load	40%	0.5	5e-5 m³/s

>Investigate Monai experiment on landslide tsunami



Figure 10 Effect of sediment porosity on the topography evolution at 2 exact positions

>Investigate Monai experiment on landslide tsunami



Figure 11 The different porosity on seafloor topography changes

>Investigate Monai experiment on landslide tsunami



Figure 11 Influence of different grain size on water levels at 2 exact positions

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>Investigate Monai experiment on landslide tsunami



Figure 13 Influence of different sediment discharge on water levels at 2 exact positions

Investigate Monai experiment on landslide tsunami 5 高程变化(米) $1e-5m^{3}/s$ 0 006 5e-5m³/s 0.0055 高程变化(米) 0.005 0.032 0.0045 0.03 0.004 0.028 0.0035 0.026 0.003 0.024 0.0025 3 0.022 3 Y(米) Y(米) 0.002 0.02 0.0015 0.018 0.001 0.016 0.0005 0.014 2 0 2 0.012 -0.0005 0.01 0.008 0.006 0.004 1 0.002 0 00 00 3 X(米) 4 5 2 3 4 5 6 2 X(米) 5 $1e-4m^{3}/s$ 高程变化(米) 0.06 0.055 0.05 0.045 X(米) 3 0.04 0.035 0.03 0.025 2 0.02 0.015 0.01 0.005 Figure 14 Influence of different sediment discharge on seafloor topography changes



Figure 15 The snap shot of concentration distribution



Figure 2 The snap shot of searfloor topography changes

>Investigate Monai experiment on landslide tsunami

Preliminary results:

I. The parameters such as porosity, grain size and sediment concentration play an significant role both in water level and seafloor topography.

II. Tsunami-induced sediment transport results in sea floor topography changes that's the archive of geological event.

Future work

I. Multi-grain components for sediment transport simulation will be considered, especially for the in-situ situation.

II. More accurate event-driven simulations will be adopted for landslide induced tsunami.

III. GPU parallelized computation (BASEMENT version 3.x) should be conducted.

Thank you for listening !