

Web-based Interactive Landform Simulation Model – Grand Canyon (WILSIM–GC)

Wei Luo¹, Jon Pelletier², Kirk Duffin¹, Carol Ormand³, Weichen Hung¹,
Ellen Iverson³, David Shernoff¹, Xiaoming Zhai⁴, Anjana Chowdary¹

1. Northern Illinois University
2. University of Arizona
3. Carleton College
4. College of Lake County

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Outline

- Introduction
- Purposes of WILSIM
- WILSIM-CA (cellular automata)
- WILSIM-GC and initial results
- Ongoing and future work

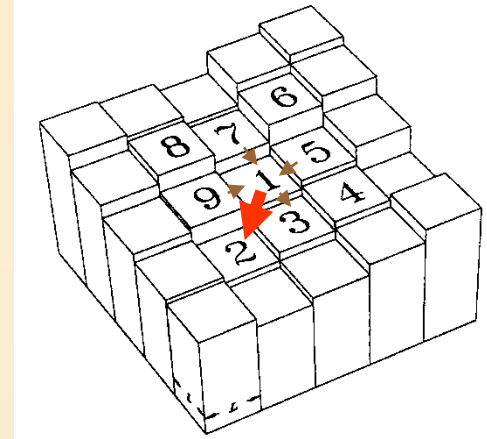
Introduction

- Landform evolution: an important aspect of geosciences
 - involves **multiple processes** over **long geologic time**
- Long-term landform evolution cannot be observed directly
- We need interactive tools to help students better understand how Earth systems work over geologic time scales
- Usually requires special programs or visualization software that is not easily accessible to students

Purpose of WILSIM

- To offer an easily accessible and **interactive environment** for students to engage in explorative scientific inquiry
- To enable and enhance students' **understanding of the processes** involved in landform evolution through meaningful manipulation of parameters/conditions

WILSIM CA



- First version of WILSIM
- Cellular Automata model (Chase, 1992)
 - Rule based (local rules > global pattern)
 - Simple
 - Captures first order features
- Implemented as Java Applet
- Accessible from anywhere with Internet
- <http://www.niu.edu/landform>

Short note

A web-based interactive landform simulation model (WILSIM)[☆]

Wei Luo^{a,*}, Kirk L. Duffin^b, Edit Peronja^b, Jay A. Stravers^c, George M. Henry^b

^a Department of Geography, Northern Illinois University, DeKalb, IL 60115, USA

^b Department of Computer Science, Northern Illinois University, DeKalb, IL 60115, USA

^c Department of Geology and Environmental Geosciences, Northern Illinois University, DeKalb, IL 60115, USA

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Short note

Incorporating nonlinear rules in a web-based interactive landform simulation model (WILSIM)

Wei Luo^{a,*}, Edit Peronja^{b,1}, Kirk Duffin^b, Jay A. Stravers^c

^a Northern Illinois University, DeKalb, IL 60115, USA

^b Northern Illinois University, DeKalb, IL 60115, USA

^c Geosciences, Northern Illinois University, DeKalb, IL 60115, USA

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Lessons Learned from Using a Web-based Interactive Landform Simulation Model (WILSIM) in a General Education Physical Geography Course

Wei Luo
Department of Geography, Northern Illinois University, DeKalb, IL 60115,
luo@geog.niu.edu

Jay A. Stravers
Department of Geology and Environmental Geosciences, Northern Illinois
University, DeKalb, IL 60115

Kirk L. Duffin
Department of Computer Science, Northern Illinois University, DeKalb, IL 60115

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New results from Using a Web-based Interactive Landform Simulation Model (WILSIM) in a General Education Physical Geography Course

Wei Luo
Department of Geography, Northern Illinois University, DeKalb, IL 60115

Michael Konen
Department of Geography, Northern Illinois University, DeKalb, IL 60115

WILSIM – CA (cont'd)

- WILSIM does improve students' learning
 - significant increase in average score from pre- to post-tests
- Shortcomings:
 - cannot easily relate model results to real world measurements quantitatively
 - Spatial scale (m, km)
 - Time scale (millions of years)

WILSIM - GC

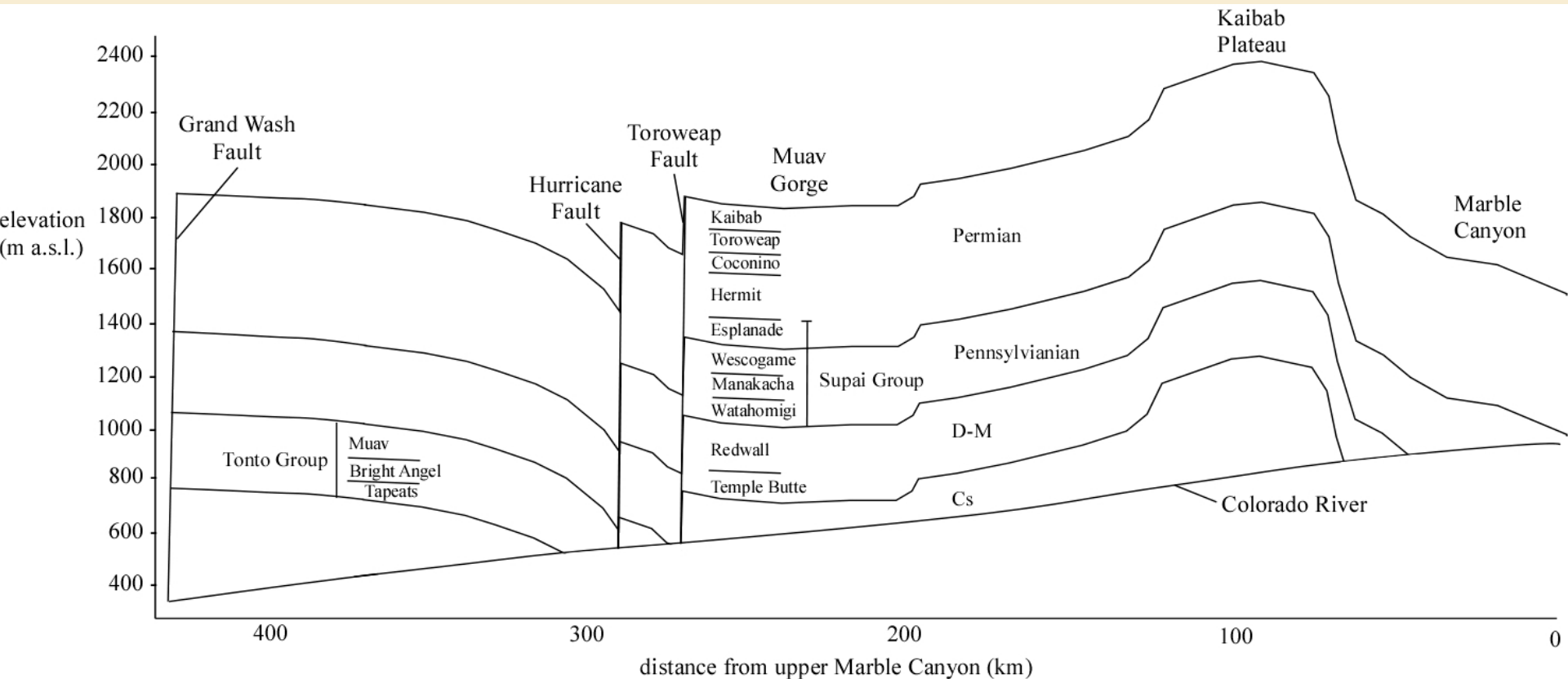
- Second version of WILSIM
- Grand Canyon
 - The most famous landform on Earth
- Physically based model (Pelletier, 2010)
 - Bedrock channel erosion
 - Cliff retreat
- Updated animation framework
 - Take advantage of latest advance in Java technology
- Enhanced curricular materials
 - Robustly tested, standards-based
 - Guided by educational psychology theory on engaged learning

WILSIM – GC (cont'd)

- Physically based model
 - Incision is driven by the histories of **key faults** (Grand Wash, Hurricane, Toroweap) as reconstructed from the geologic record
 - Rate of bedrock channel erosion is controlled by **drainage area** and **channel slope** (together these determine bed shear stress)
 - Weathering and failure of **cliffs** included based on geologic constraints
 - Realistic **stratigraphy** is included (hard and soft rocks)

WILSIM – GC (cont'd)

- Stratigraphic model



(Pelletier, 2010)

WILSIM – GC (cont'd)

- Java implementation (graphics)
 - Original WILSIM used customized rendering engine for increased general availability
 - Current implementation uses Java OpenGL (JOGL) for access to ubiquitous fast graphics hardware
 - Same graphics library used in many computer games

WILSIM – GC (cont'd)

- Java implementation (I/O)
 - Original WILSIM applet had no ability to write out intermediate results.
 - Current implementation uses Trusted Applet model which allows file output



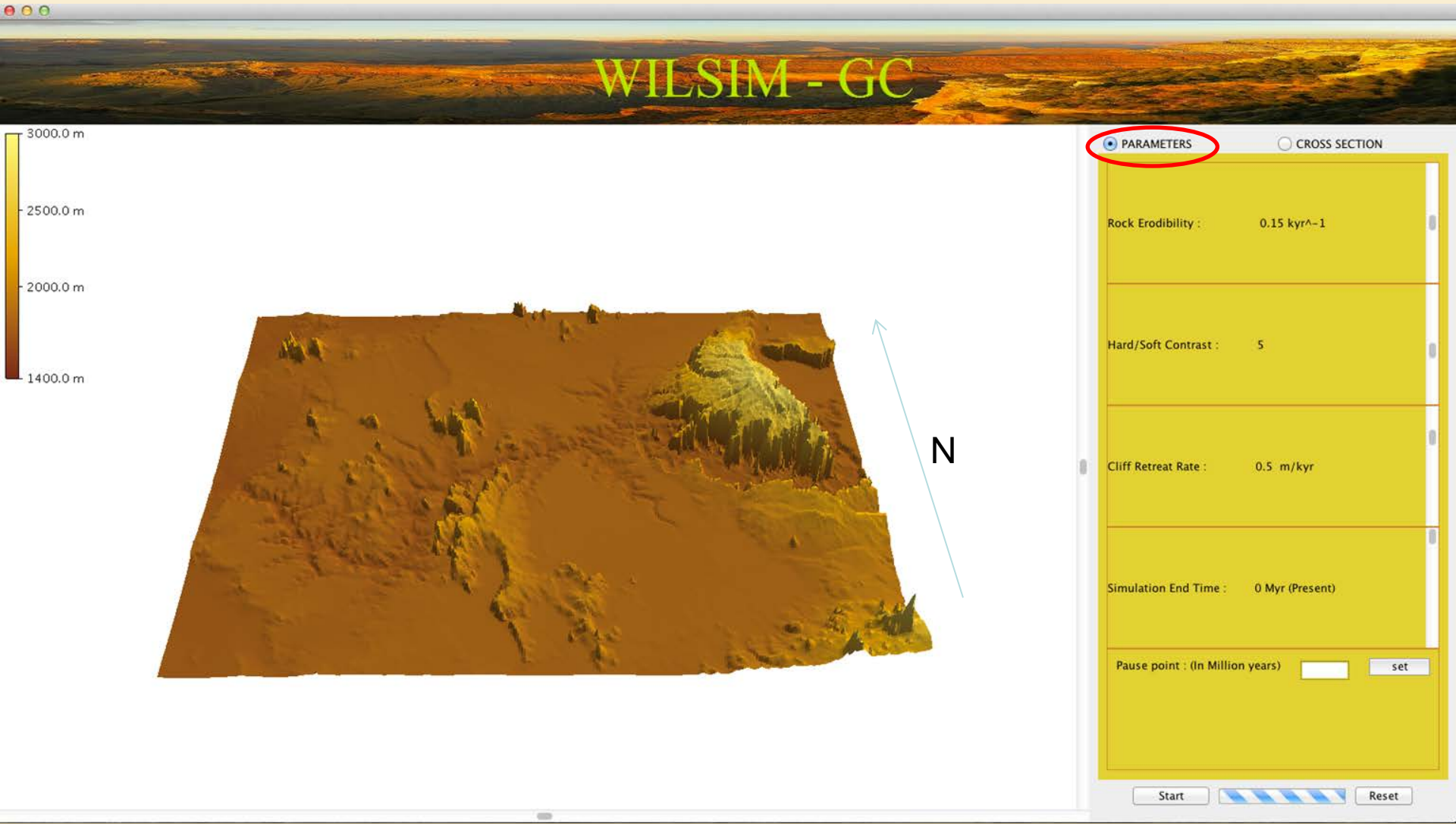
WILSIM GC (cont'd)

- Java implementation (Computation)
 - Original WILSIM was multithreaded to simplify code development
 - Current implementation maintains multithreaded ability which takes advantage of modern multi-core CPUs.
 - One thread for model computation.
 - One thread for visualization.
 - One thread for user interface.
 - Standard Model-View-Controller (MVC) design pattern

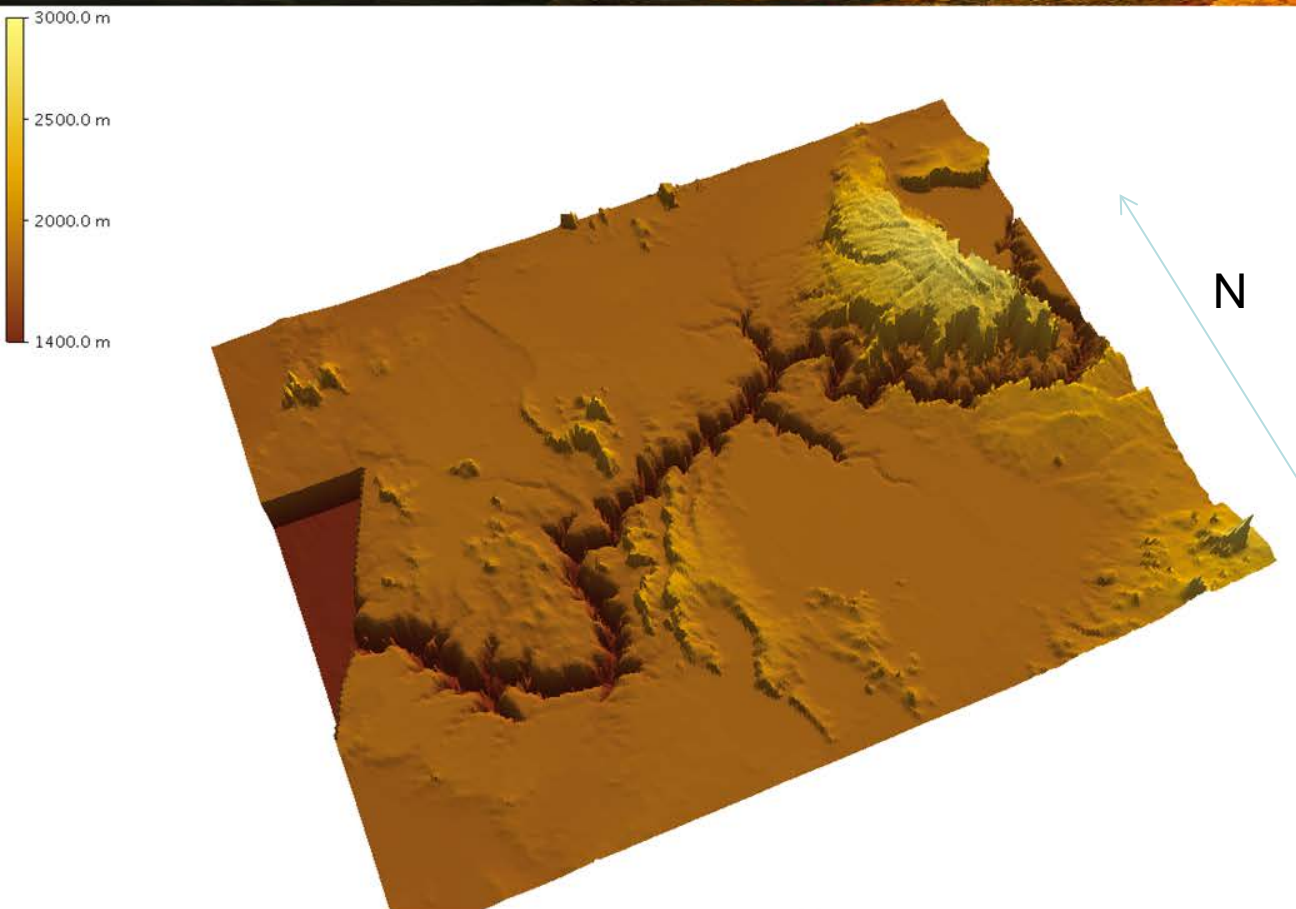
Preliminary Result

- Some model specifics:
 - Resolution of 720 m/pixel (runtime ~ 1 min at this resolution)
 - The initial topography – constructed from modern topography by backfilling the Canyon
 - Simulation starts 6 Ma to present (or to future)
 - Parameters: erodibility, soft/hard contrast, cliff retreat rate
 - Cut cross-section, save data

Interface and Parameters



WILSIM - GC



☒ PARAMETERS ☐ CROSS SECTION

Rock Erodibility : 0.15 kyr⁻¹

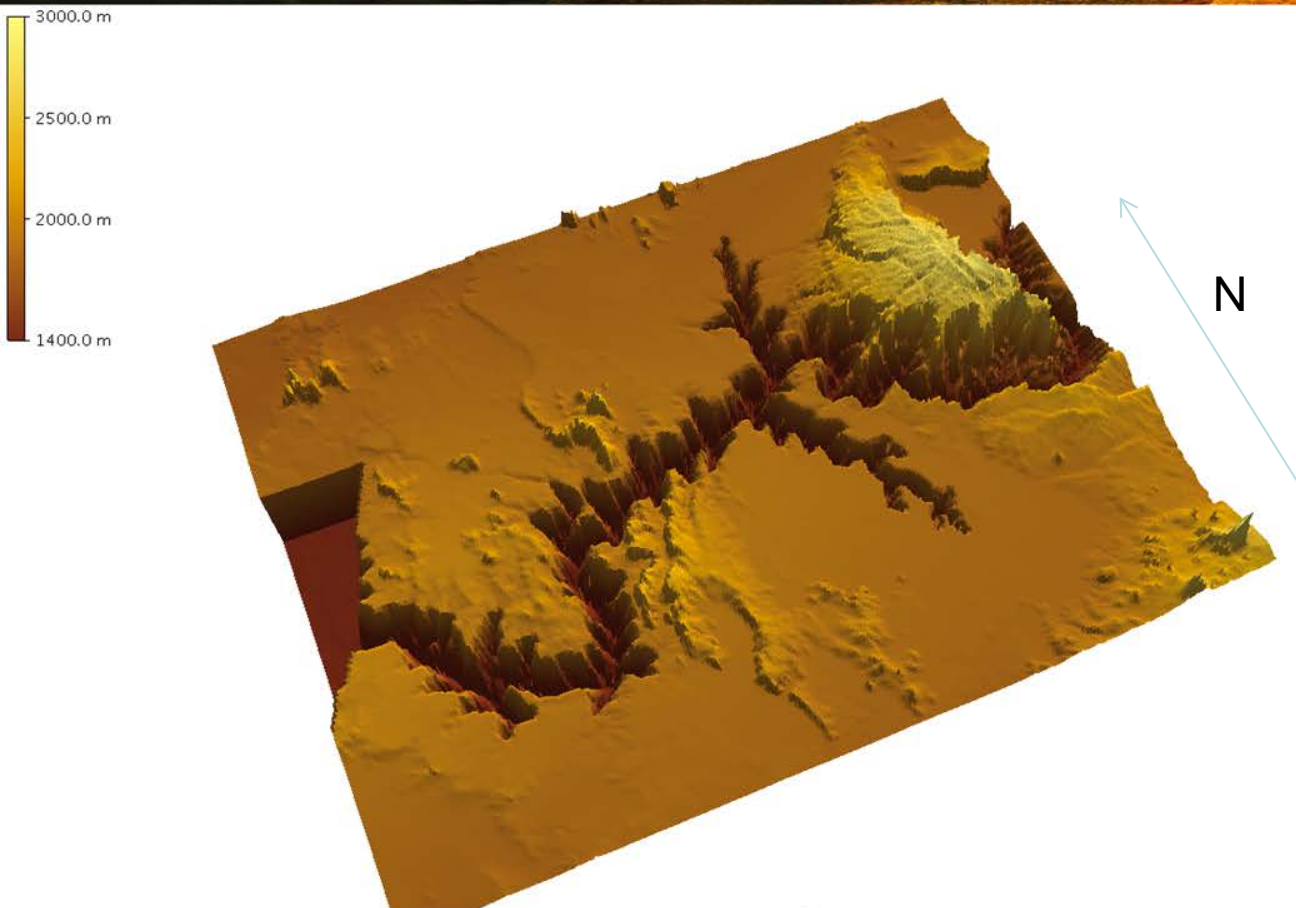
Hard/Soft Contrast : 5

Cliff Retreat Rate : 0.5 m/kyr

Simulation End Time : 0 Myr (Present)

Pause point : (In Million years)

WILSIM - GC



☒ PARAMETERS ☐ CROSS SECTION

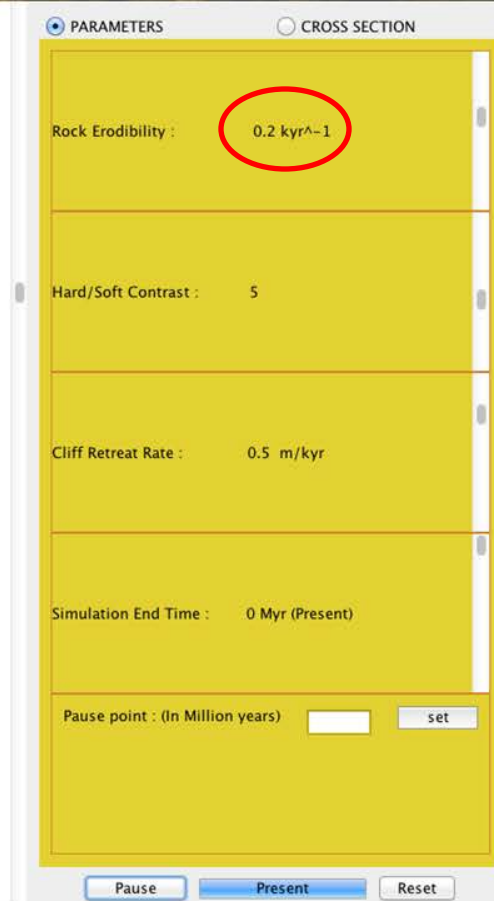
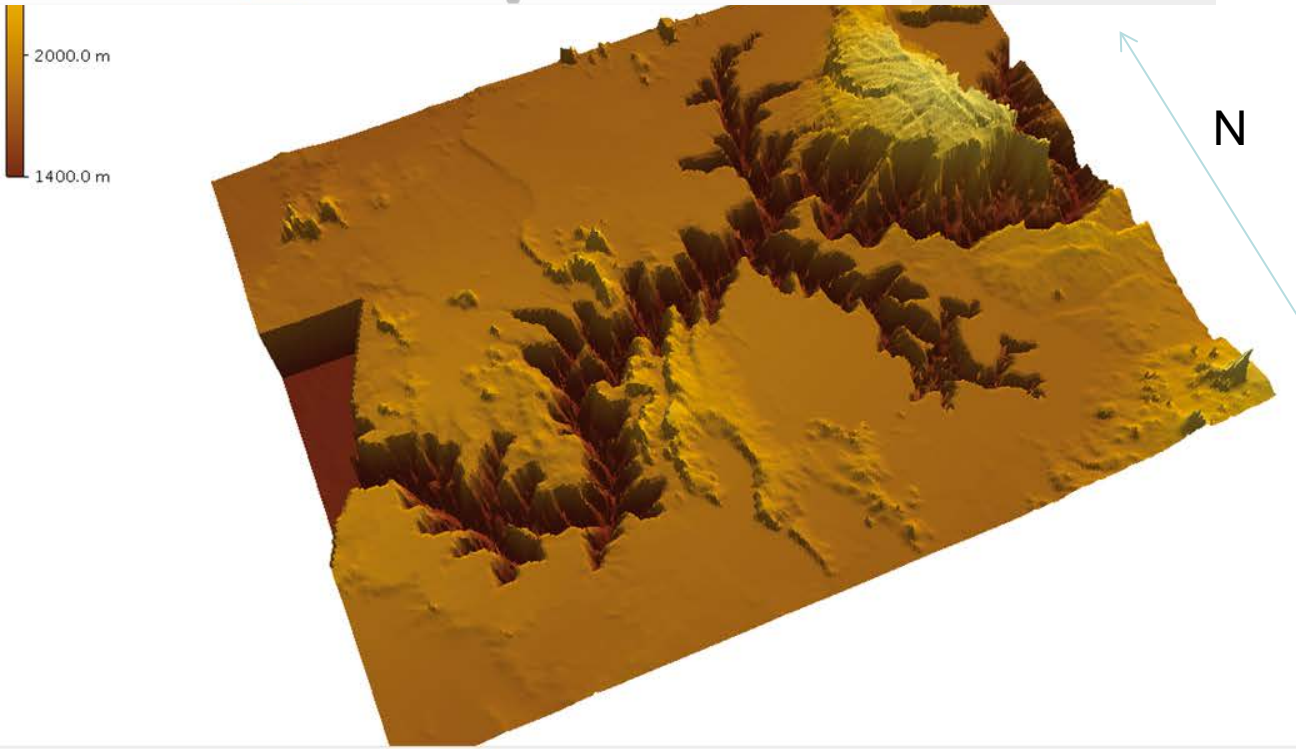
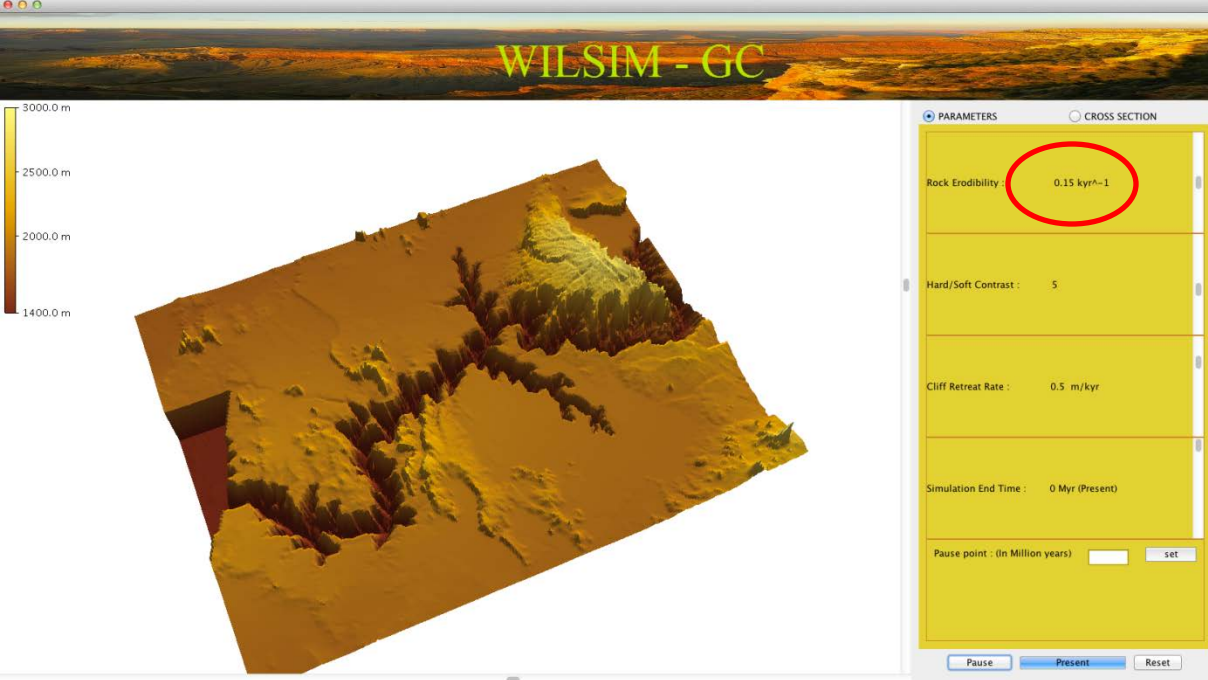
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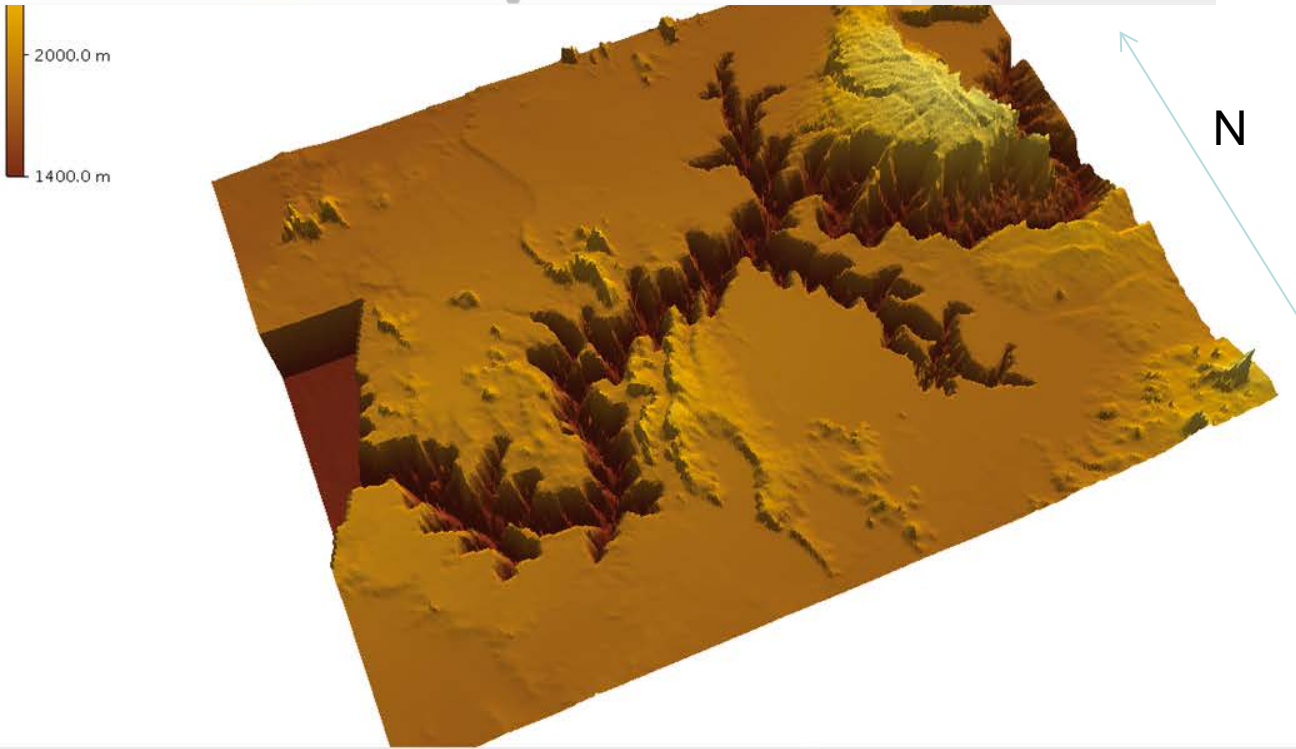
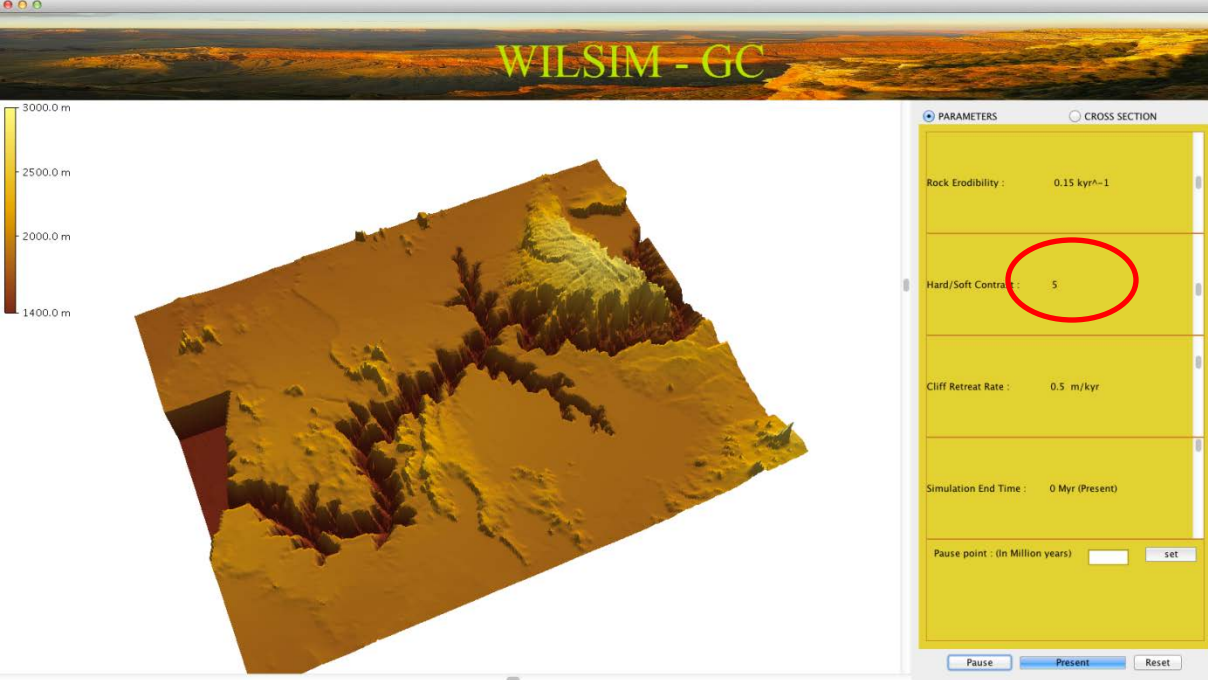
Hard/Soft Contrast : 5

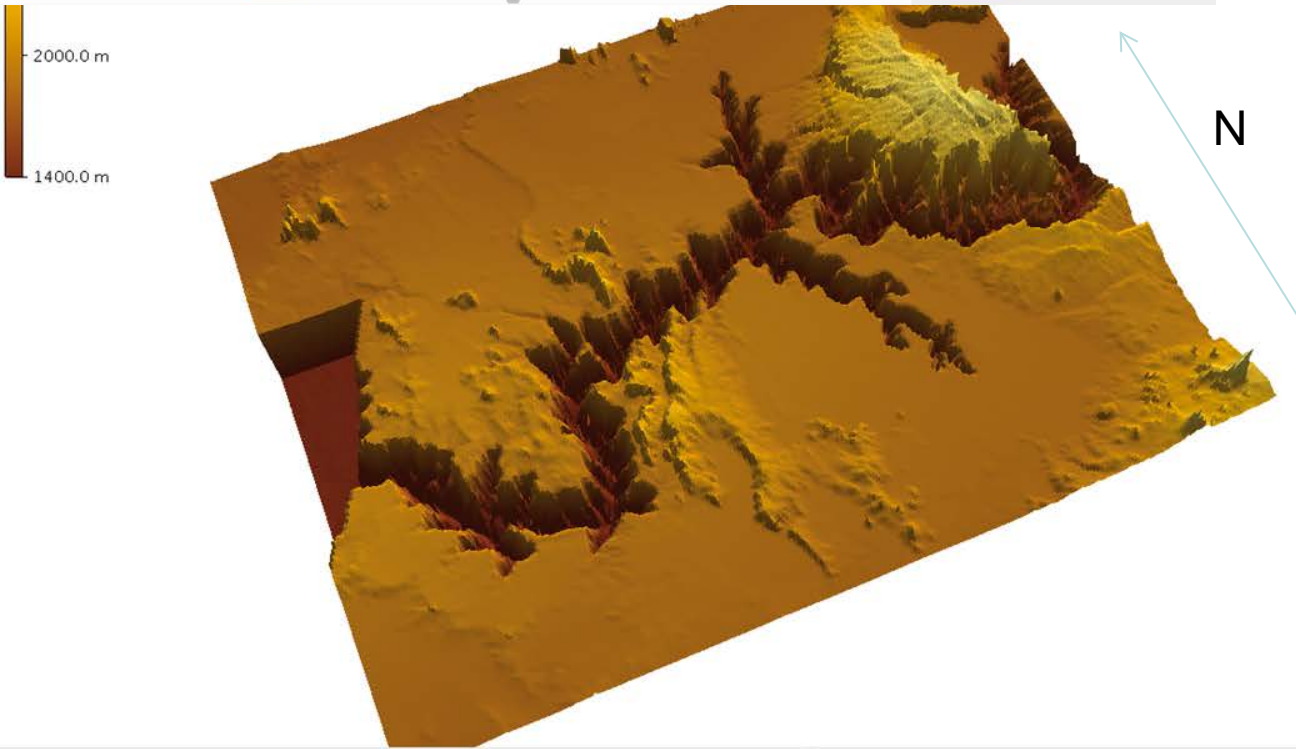
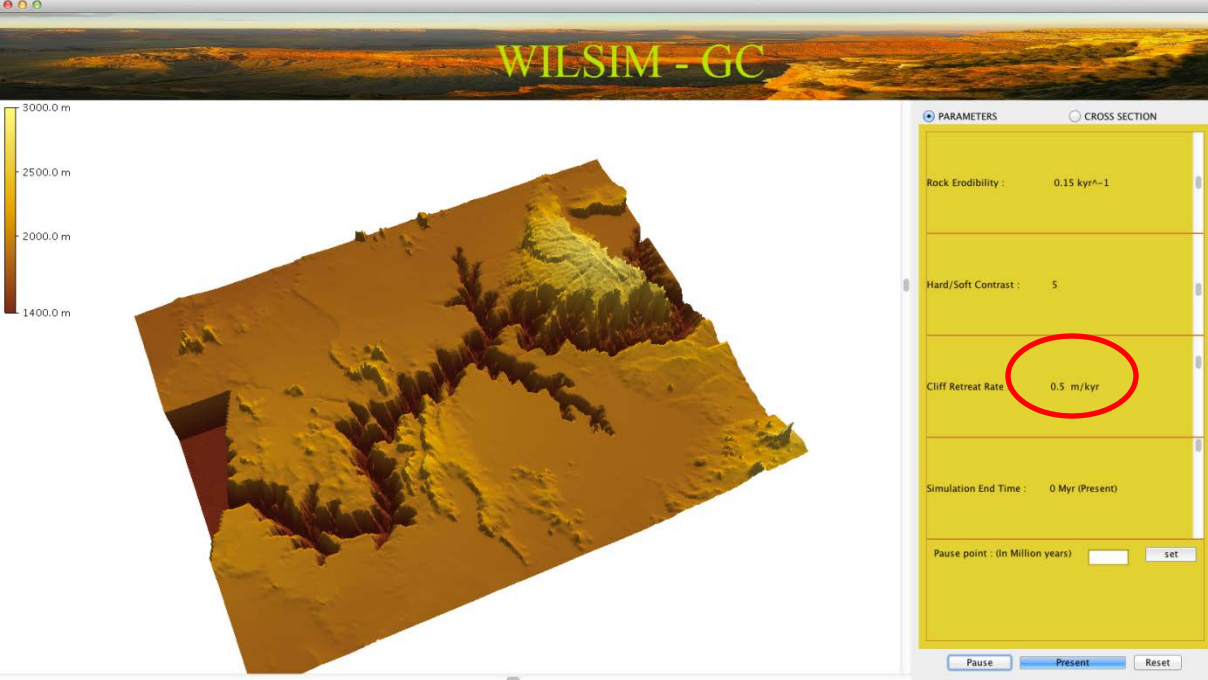
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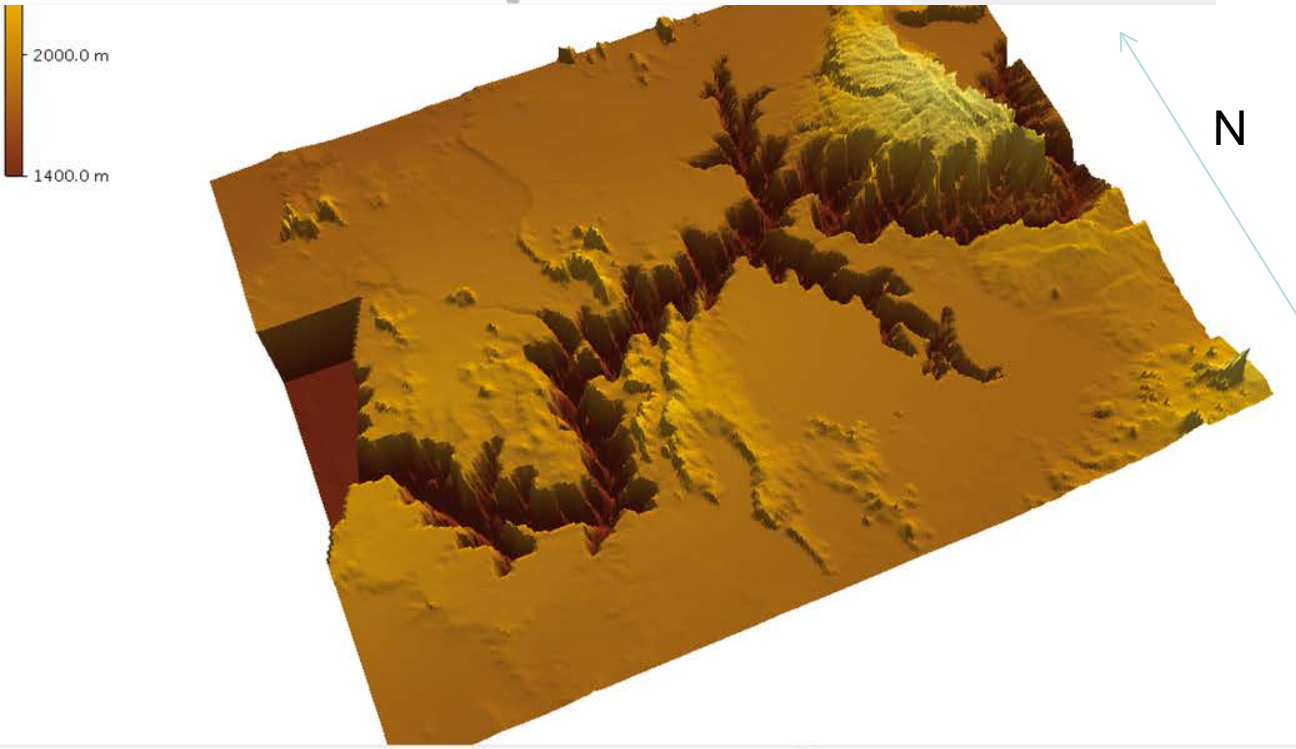
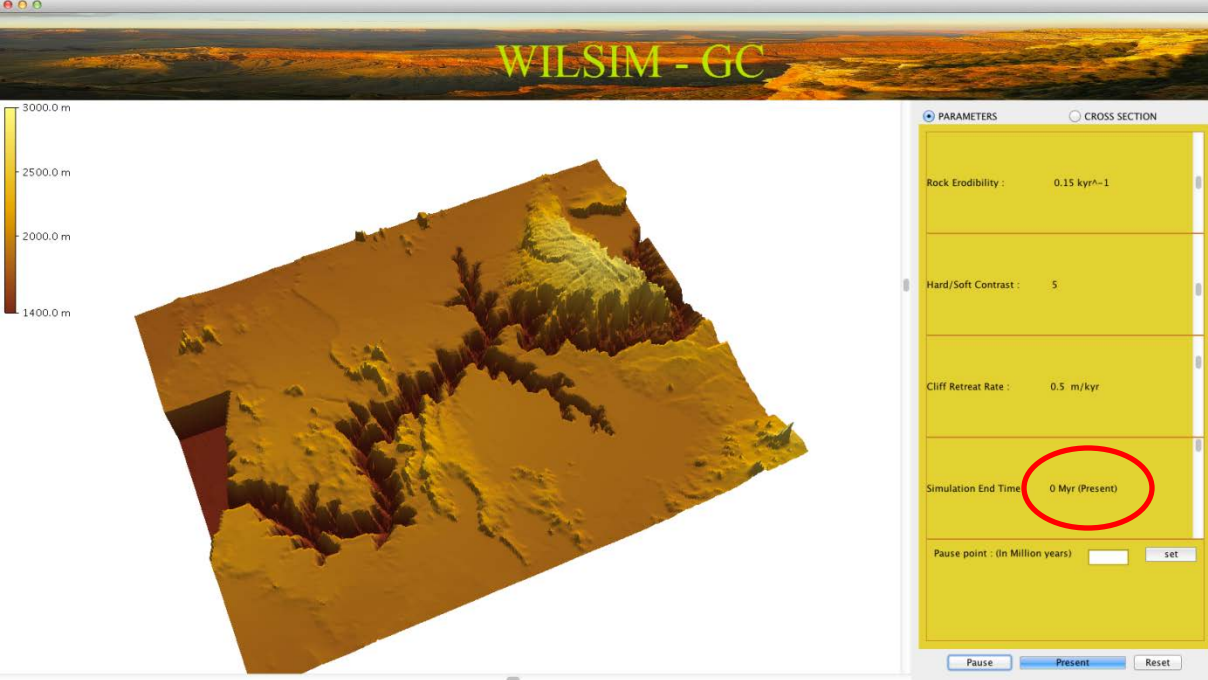
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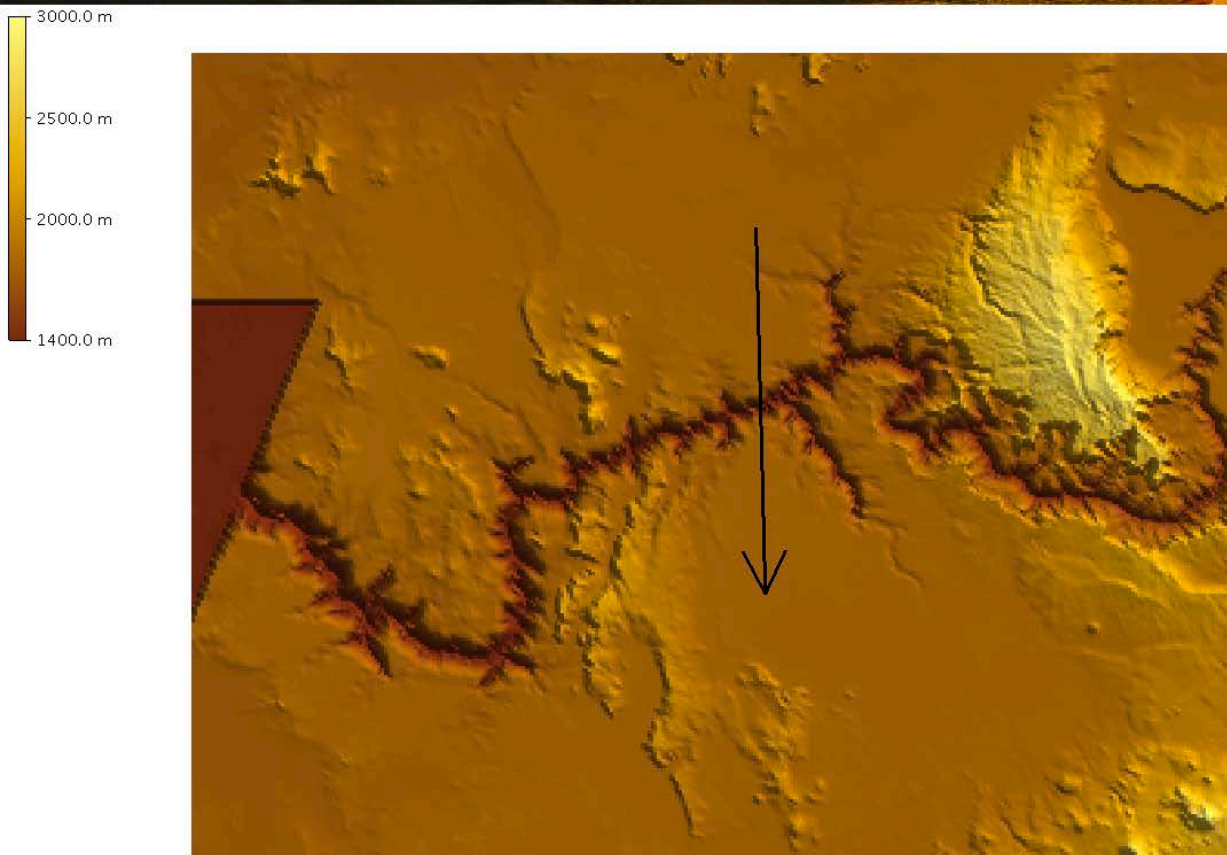








WILSIM - GC



☐ PARAMETERS

☒ CROSS SECTION

Setup

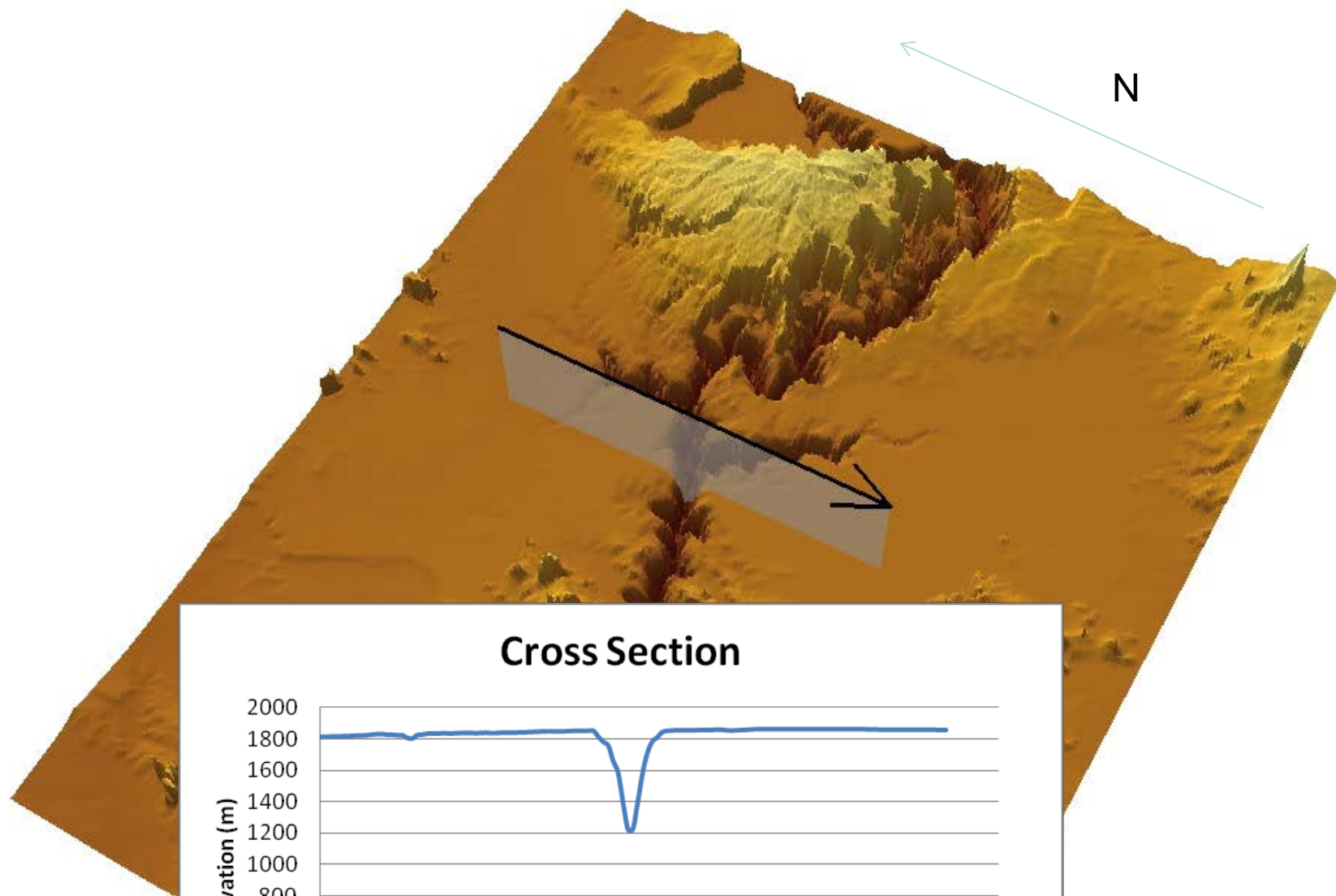
Clear

Save to Text File

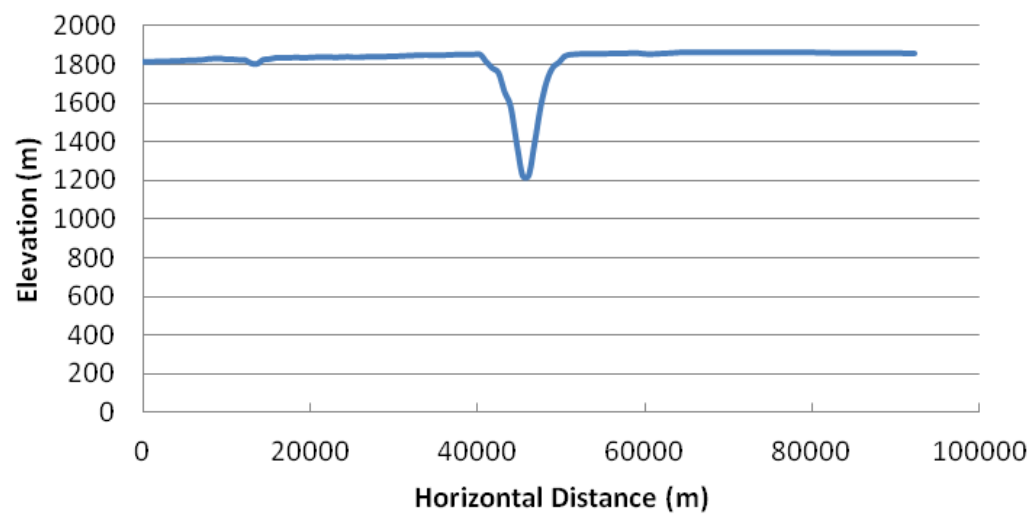
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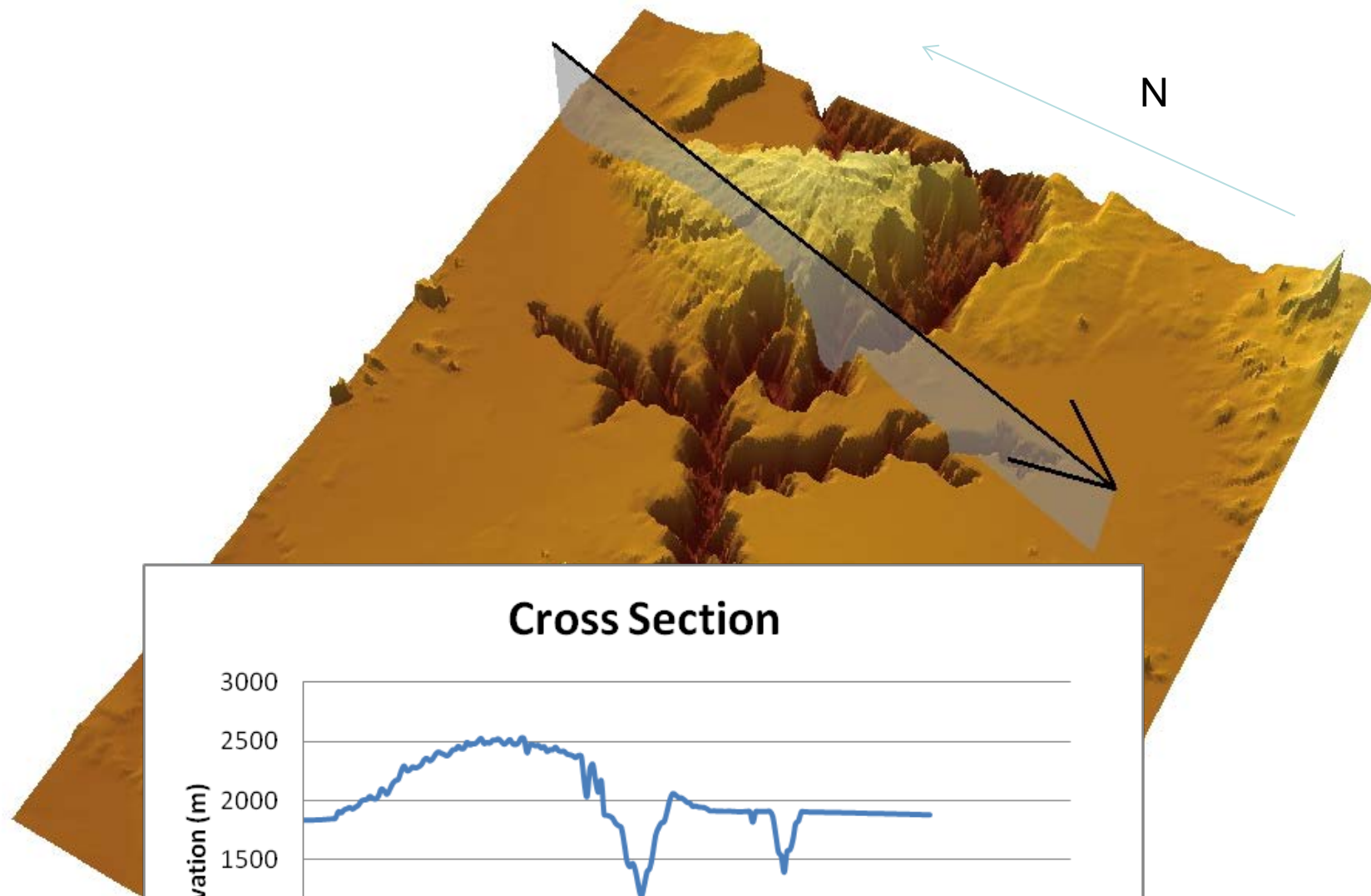
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Reset

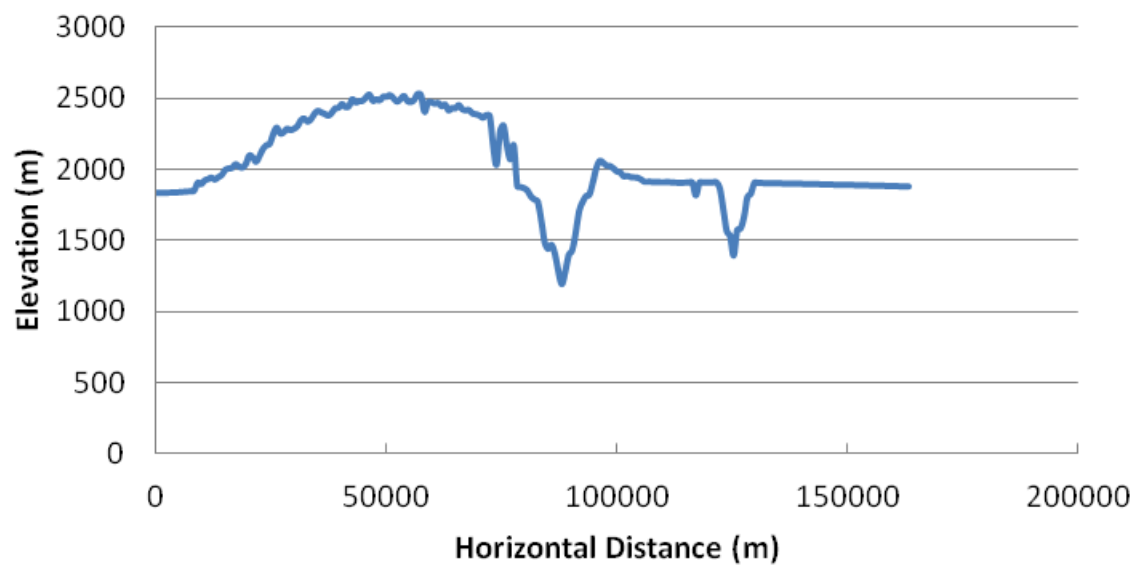


Cross Section





Cross Section

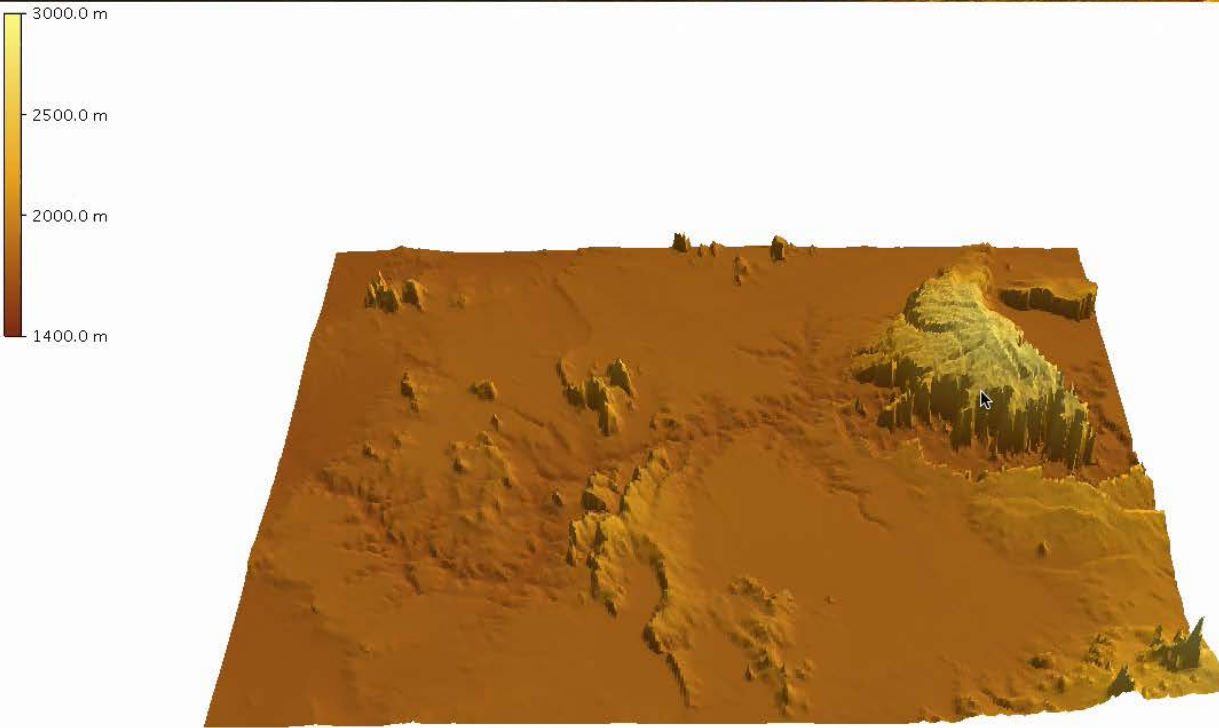


Ongoing and Future Work

- Tutorials and introduction material
- Curricular material
 - Knickpoint
 - Erodibility
 - Hard/soft contrast
 - Cliff retreat
- Test in classes
- Disseminate

Questions?

- Suggestions/ideas are welcome and appreciated.
- Website <http://serc.carleton.edu/landform>
- Join our email list
<http://serc.carleton.edu/mailman/listinfo/wilsim>



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 ☐ CROSS SECTION

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