Spatial tools for evaluating woody debris flooding hazard in gvSIG

Herramientas para evaluar el peligro de inundación con transporte de madera en gvSIG

Franceschi Silvia, Antonello Andrea, Giustino Tonon, Comiti Francesco

gvSIG festival – 23 May 2017

WHO AM I?

- environmental engineer specialized in hydrology, hydraulics and geomorphology
- co-founder of HydroloGIS member of gvSIG association
- developed scientific models contained in the JGrassTools library in the fields of: hydrology, hydraulics and forestry
- finishing PhD in Mountain Environment and Agriculture at the Free University of Bolzano (Italy)
- OSGeo Charter Member

in mountainous regions (Alps) basins have been impacted by humans since ancient times

since the first world war in Europe forests were regularly and heavily harvested mainly for timber and firewood production and eliminated to create spaces for pastures, livestock and agriculture

in the 20th century with the decline of the rural and forest economy and the depopulation of upland areas: forest became old, shrubs and trees encroached abandoned crop and pasture lands

between 1880 and 2000, the average increase of woodland in Switzerland has been 21.6%

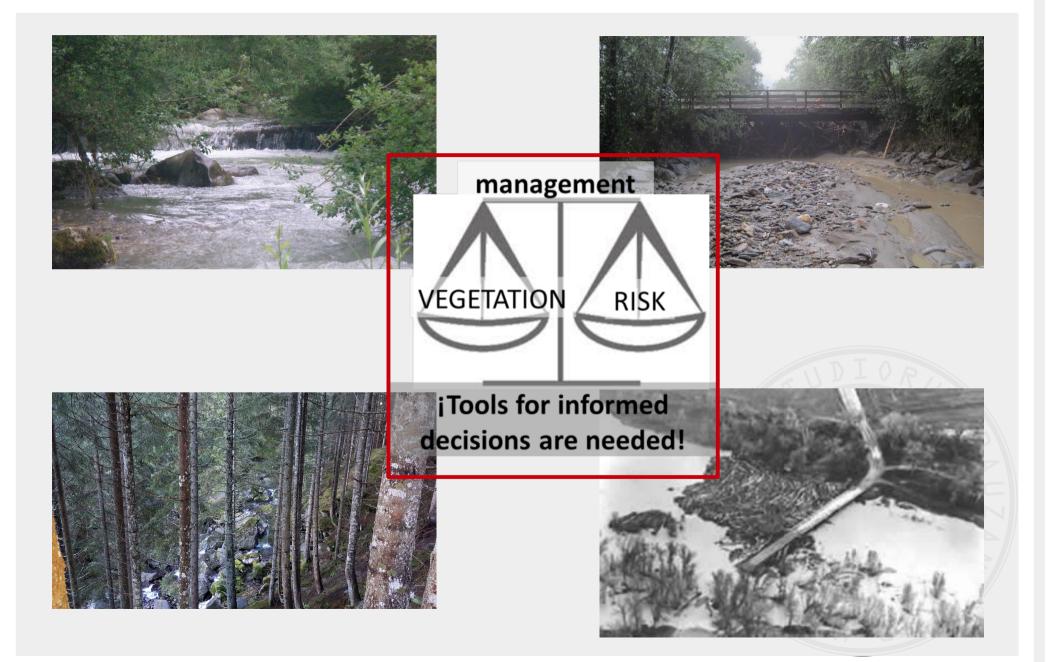
 vegetation influence the water cycle: runoff, evapotranspiration, erosion, transport and deposition of sediments and wood in streams









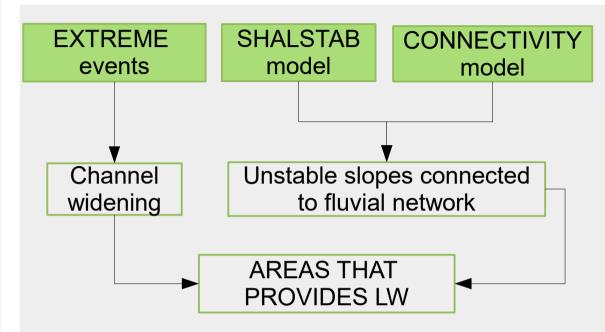


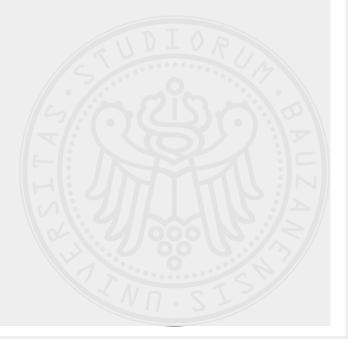
- **GIS-based** tool for predicting the magnitude of **LW** transport during flood events at any given **section** within a river basin
- two main processes related to woody debris:
 - LW recruitment

 from hillslopes
 from bank erosion (geology)

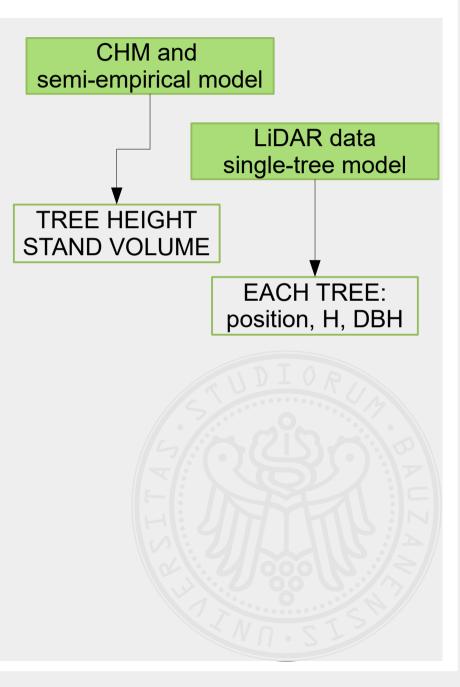
 LW transport/propagation along the network

JGRASSTOOLS: LW RECRUITMENT

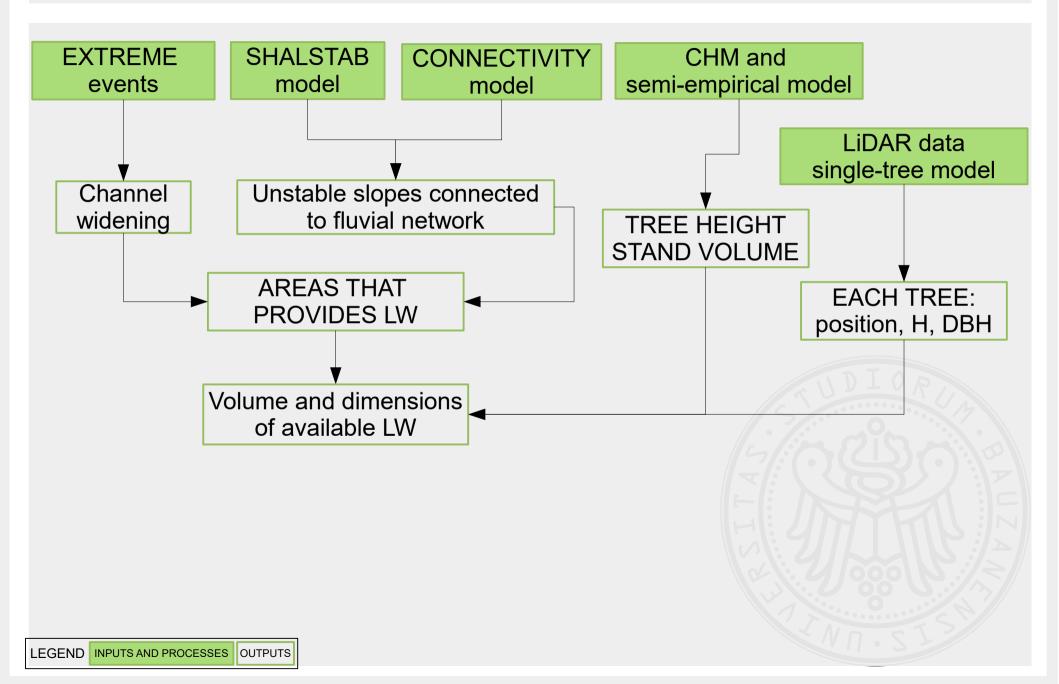




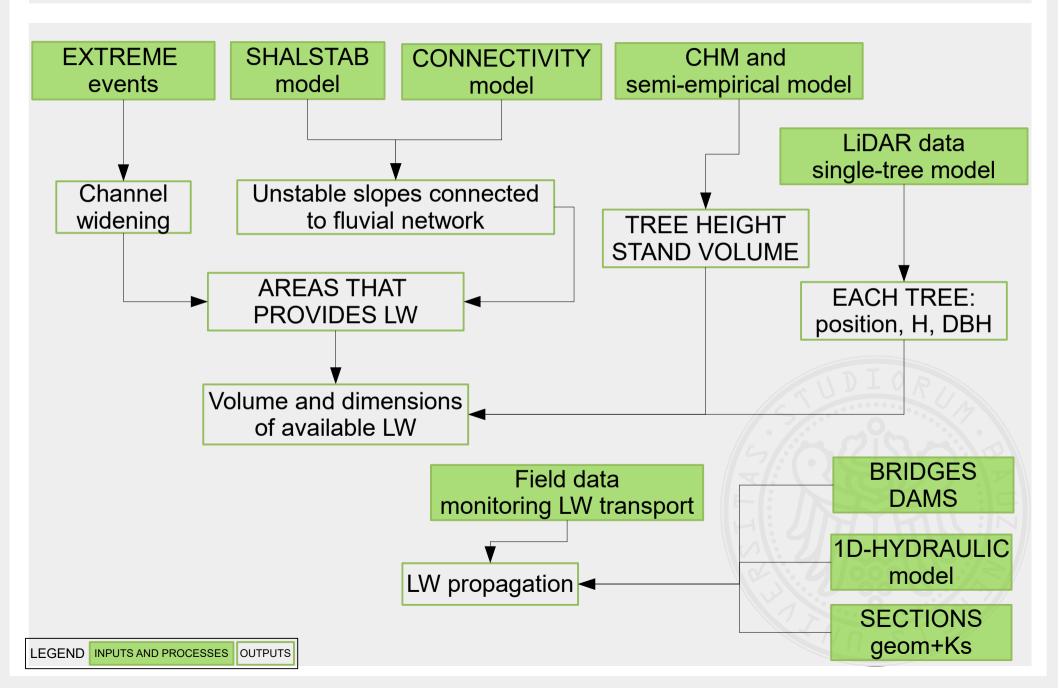
JGRASSTOOLS: LW RECRUITMENT



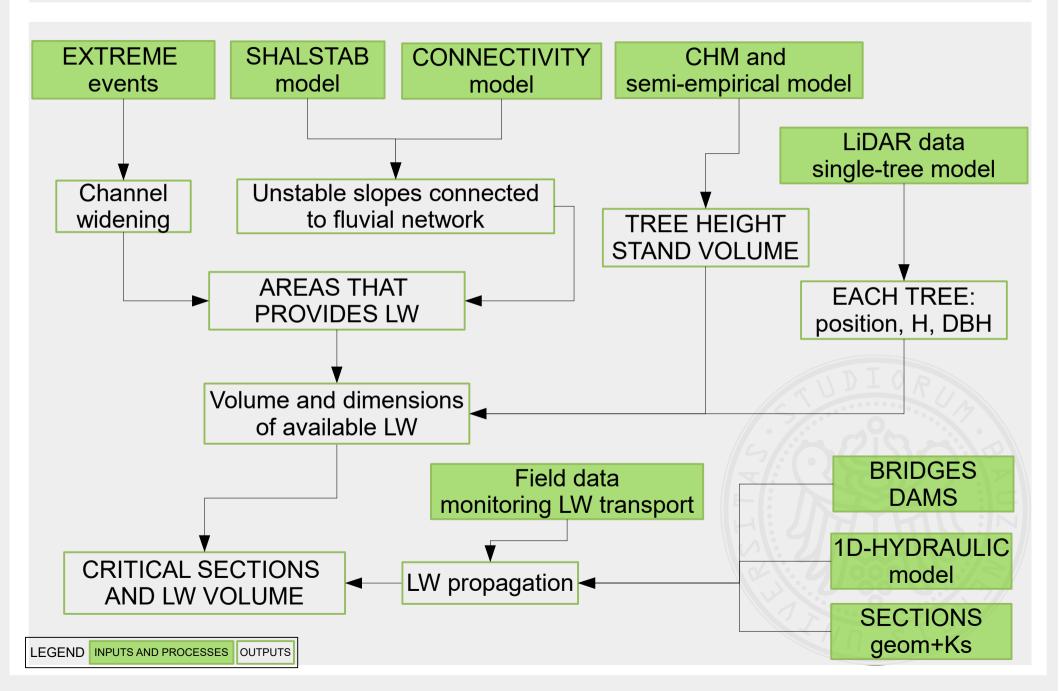
JGRASSTOOLS: LW RECRUITMENT



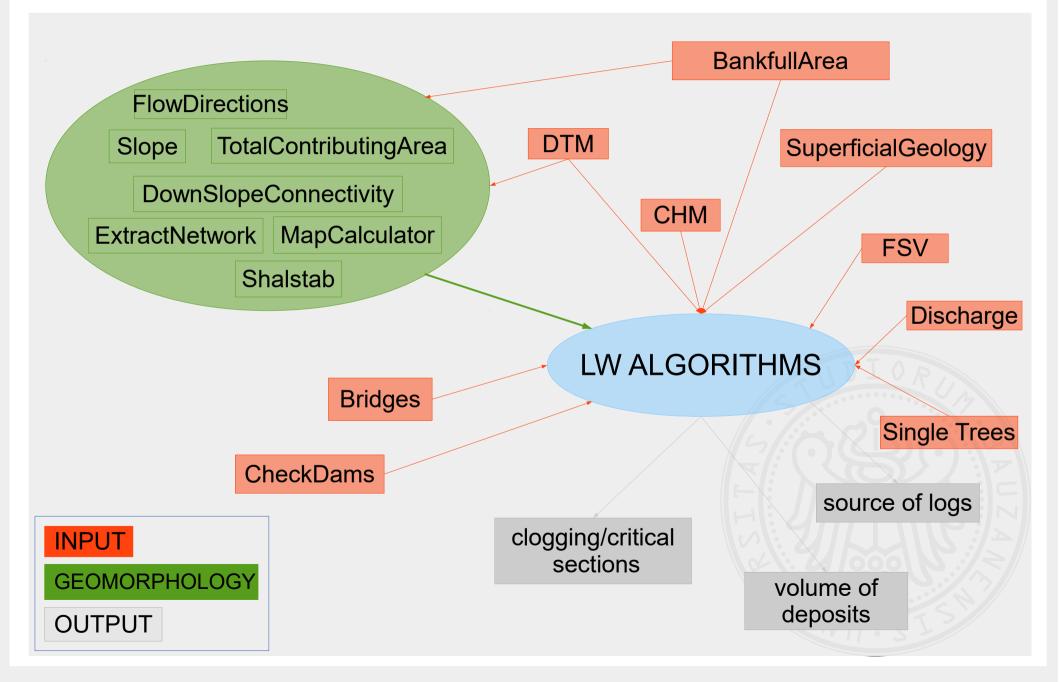
JGRASSTOOLS: LW PROPAGATION



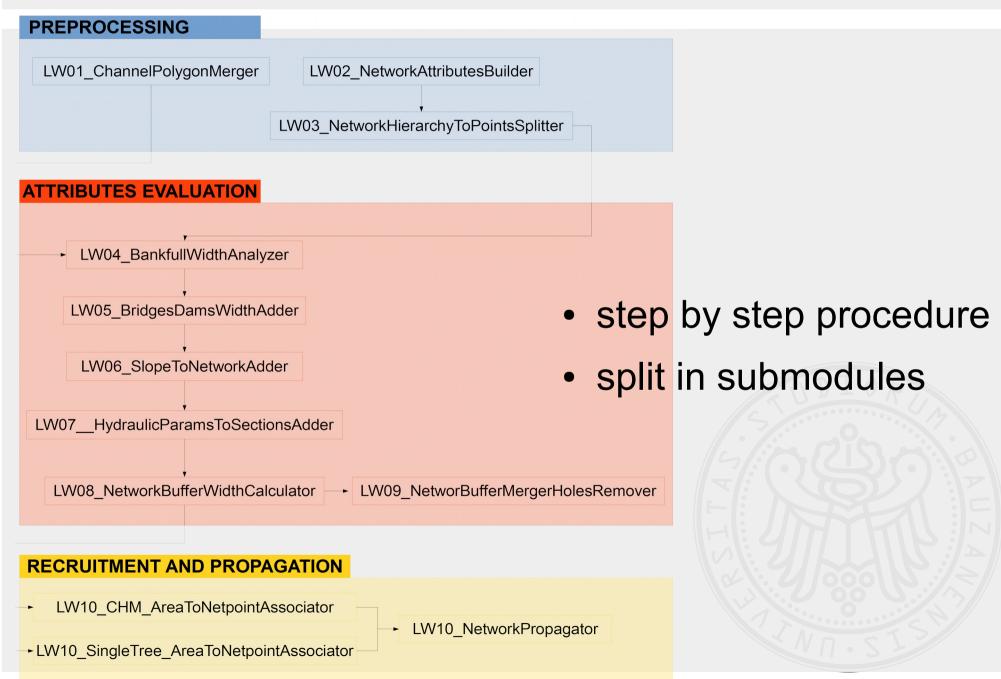
JGRASSTOOLS: PROPAGATION



JGRASSTOOLS: input & output



JGRASSTOOLS: workflow



JGRASSTOOLS: network attributes

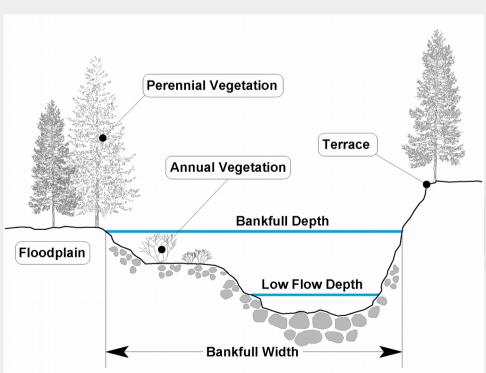
- vector of the network:
 - split at each confluence
 - digitized from upstream to downstream
 - hierarchical attributes: enumeration following Strahler, Hack and Pfafstetter
 - elevation attributes: starting and end elevation
- input from geomorphological (DTM) analysis:
 - network raster layer
 - map of flow directions
 - map of TCA

JGRASSTOOLS: network attributes

JGrasstools' Spatial Toolbox					
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Debug Heap [MB] 64					

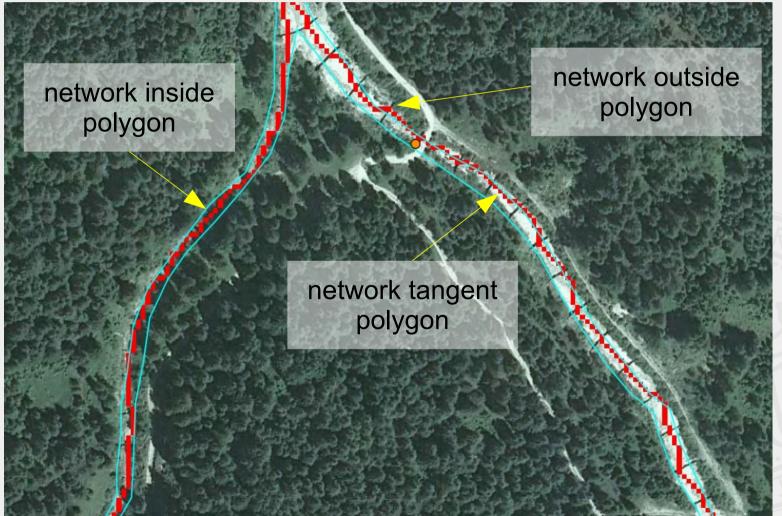
JGRASSTOOLS: bankfull width

- bankfull width corresponds to the stage at which the water overflows the natural banks and begins to inundate the upland (flow event that recurs every 1.5 year)
- polygon with the extension of the bankfull area (field survey or remote sensing imagery)
- extract the bankfull width for each section of the stream



JGRASSTOOLS: bankfull width

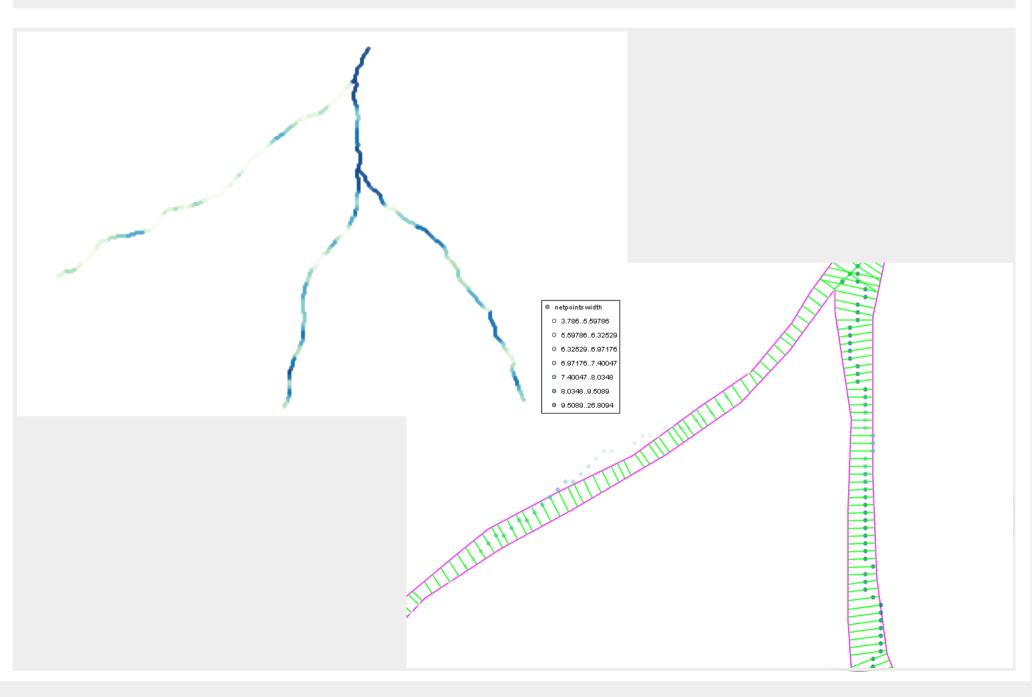
• different origin of input data (DTM derived network, delineation of the bankfull from ortophoto or field)



JGRASSTOOLS: bankful width

JGrasstools' Spatial Toolbox		- • •
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IntensityClassifierFlood	The maximum distance that a point can have from the nearest	
PresteyTaylorEtpModel	polygon. If distance is major, then the netpoint is ignored and identified as outside the region of interest. [m]	100.0
UWRecruitment LW01_ChannelPolygonMerger LW02_NetworkAttributesBuilder LW03_NetworkHierarchyToPointsSplitter LW04_BankfullWidthAnalyzer	The maximum width for the channel network [m]	100.0
LW05_BridgesDamsWidthAdder LW06_SlopeToNetworkAdder LW07_HydraulicParamsToSectionsAdder LW08_NetworkBufferWidthCalculator LW09_NetworBufferMergerHolesRemover	The minimum width for the channel network [m]	0.5
LW 10_CHM_AreaToNetpointAssociator	The output points network layer with the additional attribute of bankfull width.	
Load Experimental Debug Heap [MB] 64 V	The output points layer highlighting the position of the problematic sections.	

JGRASSTOOLS: bankful width



JGRASSTOOLS: bridges + dams width

- width where there is a structure is maintained fixed during the flooding events: no widening is allowed
- correct the bankfull width where a bridge or a check dam is located with the real width of the structure



JGRASSTOOLS: bank erosion

 the width ratio (between after and before event) is calculated following a power law of the unit stream power (pre-event conditions), parameters of the power law should be derived from field observations (input parameters)

$$W_r = k \cdot \omega^n \qquad \omega = \frac{\gamma \cdot Q \cdot s}{width_{pre}}$$

 widening is avoided for sections where there are structures and where there is rock (input geology)

JGRASSTOOLS: bank erosion

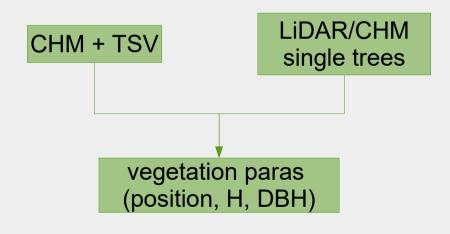
bankfull sections

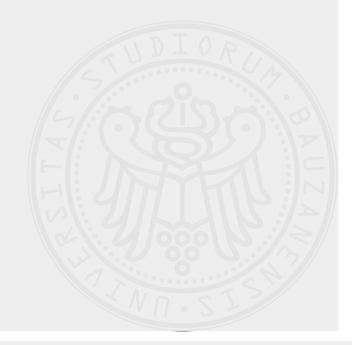
event widening area

			 			
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 shallow landslides on connected areas deliver logs to the channels → amount of wood on the unstable and connected areas



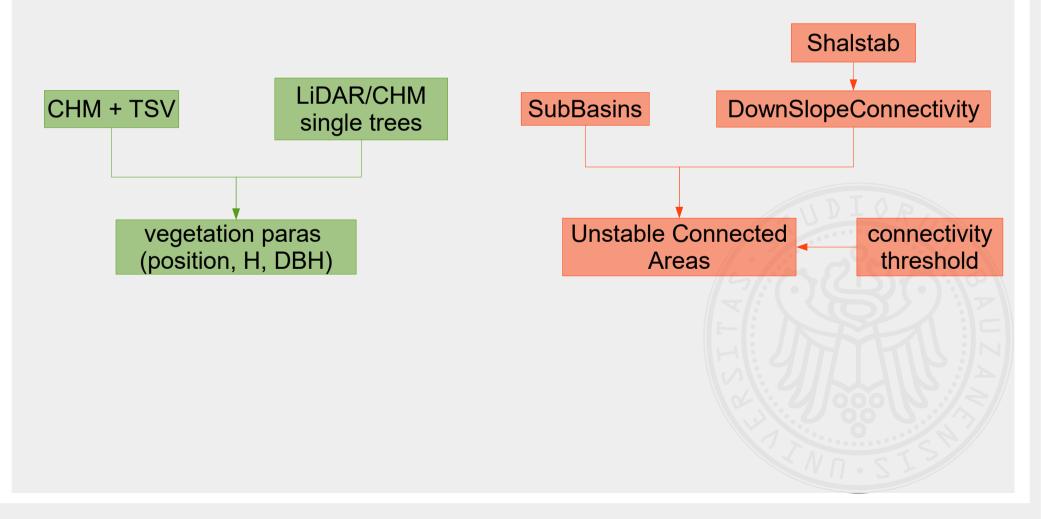


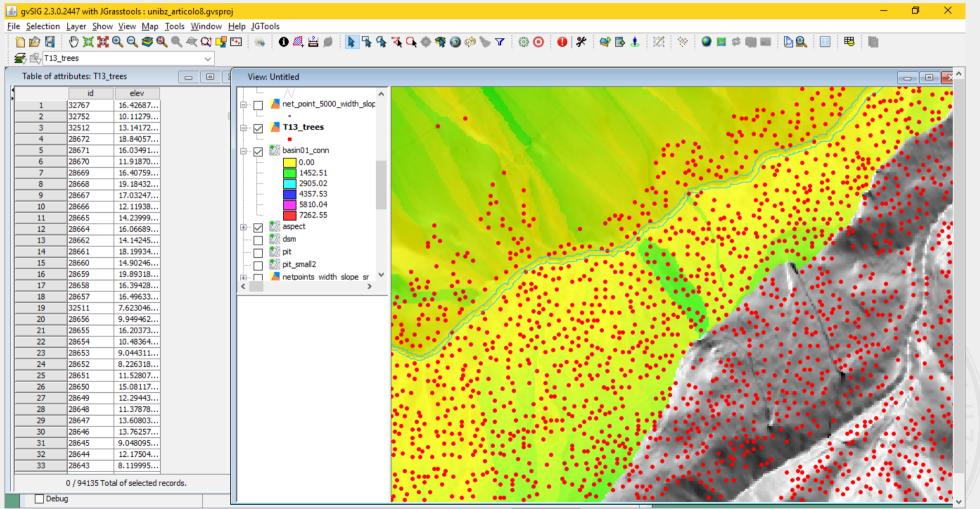
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Meters X = 728,832.28 Y = 5,179,130.4 EPSG:32632

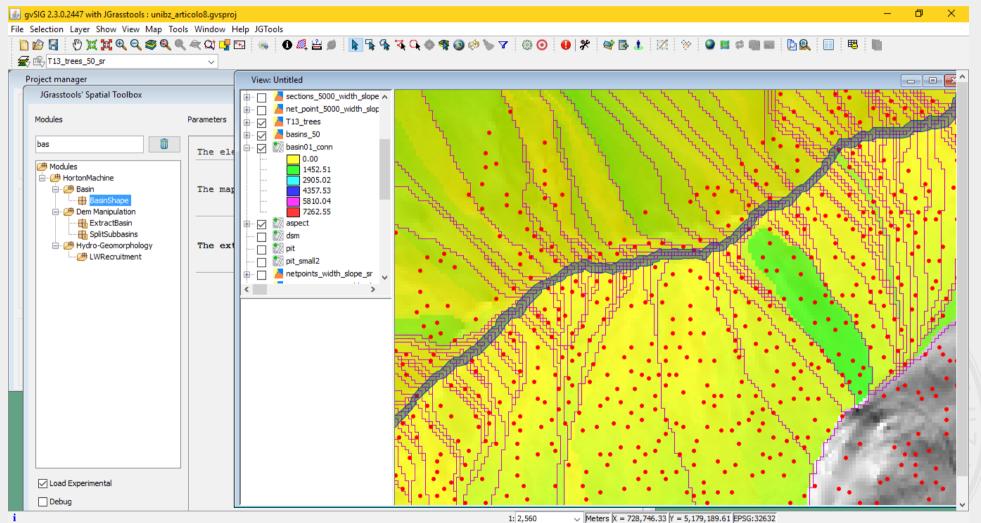
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 shallow landslides on connected hillslopes deliver logs to the channels → amount of wood on the unstable and connected areas

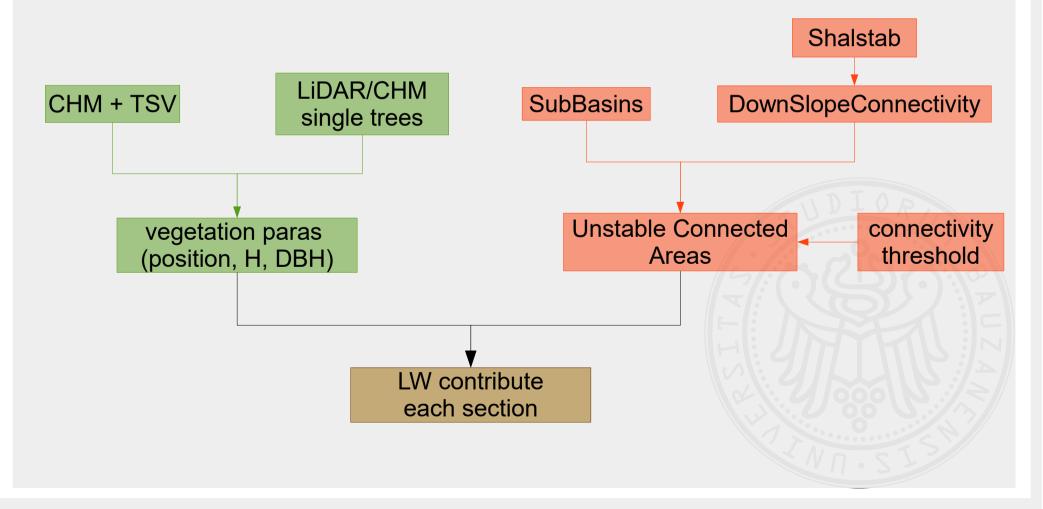




1: 3,413 V Meters X = 728,910.62 Y = 5,179,023.85 EPSG:32632



 shallow landslides on connected hillslopes deliver logs to the channels → amount of wood on the unstable and connected areas



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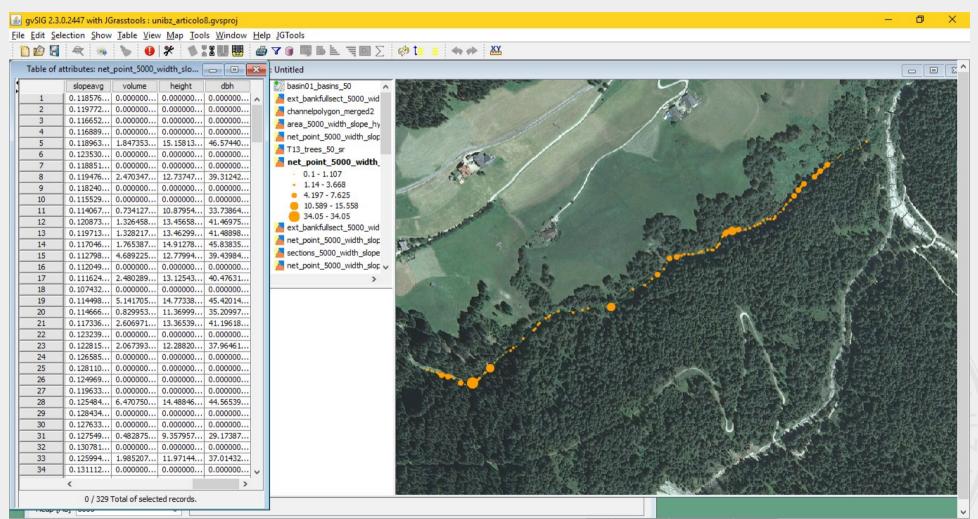
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JGRASSTOOLS: LW recruitment



Meters X = 728,796.66 Y = 5,179,196.12 EPSG:32632

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JGRASSTOOLS: propagation

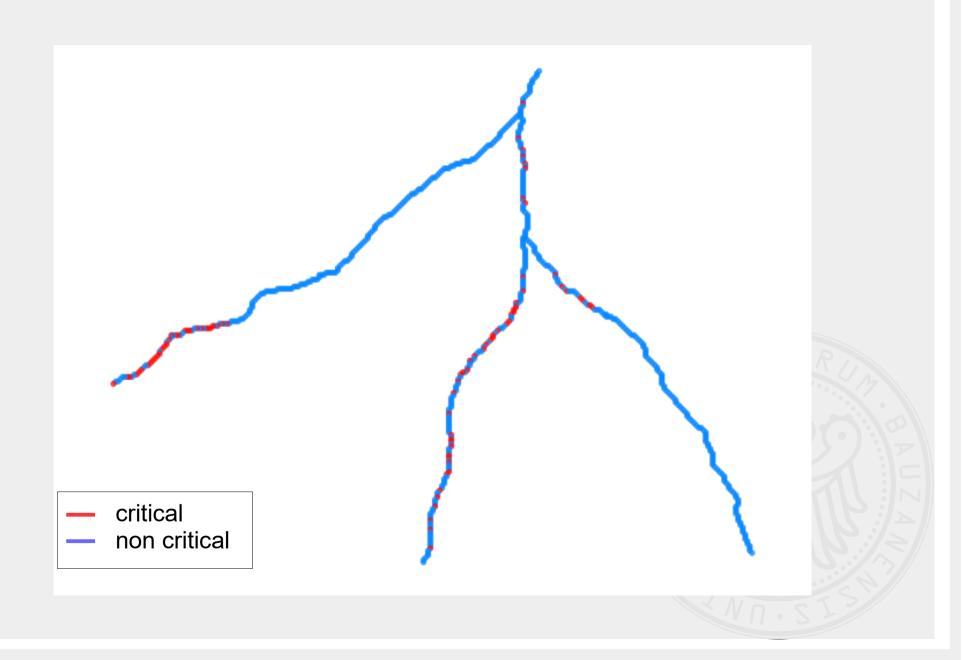
- LW is routed downstream using simple Boolean transport conditions based on:
 - ratio between the length of the logs and the width of the sections (input parameter)
 - ratio between the diameter of the logs and the water depth (input parameter)
- post-event channel width + water depth are calculated through the 1D hydraulic model using the peak discharge
- identifies the critical sections for the transit of LW in the given stream network

JGRASSTOOLS: propagation

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Meters X = 728,626.85 Y = 5,179,164.09 EPSG:32632

JGRASSTOOLS: propagation



FUTURE PLANS

- consider river sections from field surveys and not only extracted from DTM
- run the model automatically on a whole basin connecting the runs on multiple streams using the Pfafstetter enumeration to proceed downstream



THANKS FOR THE ATTENTION!

Franceschi Silvia silvia.franceschi@gmail.com

http://www.jgrasstools.org