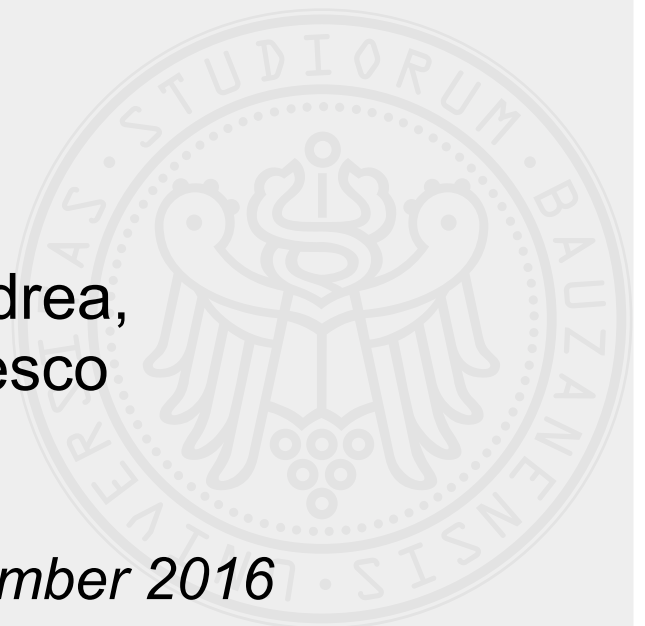


Spatial tools for evaluating woody debris flooding hazard in gvSIG

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

Franceschi Silvia, Antonello Andrea,
Giustino Tonon, Comiti Francesco

gvSIG conference – Valencia, 01 December 2016



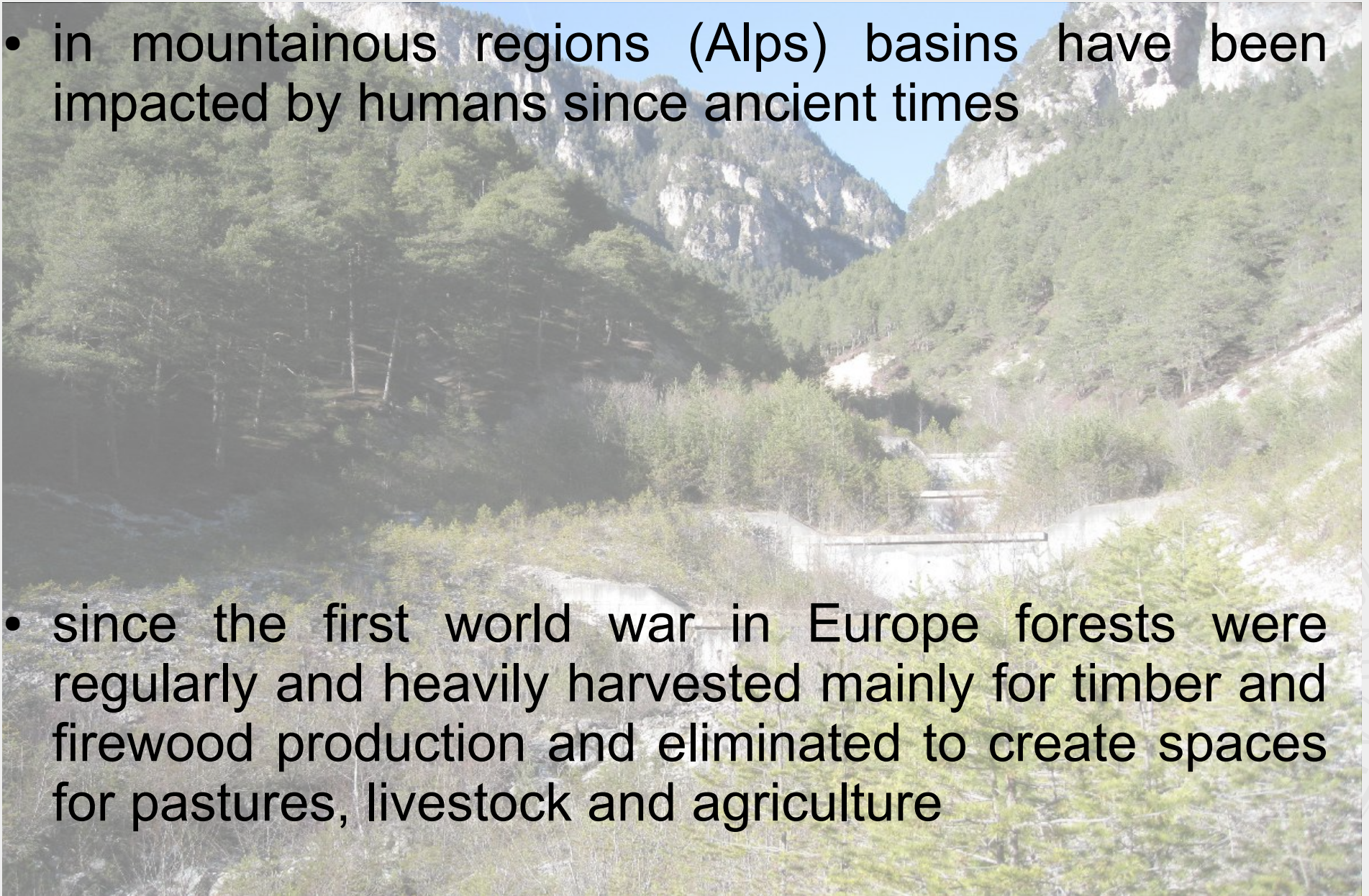
WHO AM I?

- 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
 - forestry
- PhD student of Science and Technology at the Free University of Bolzano (Italy)
- OSGeo Charter Member



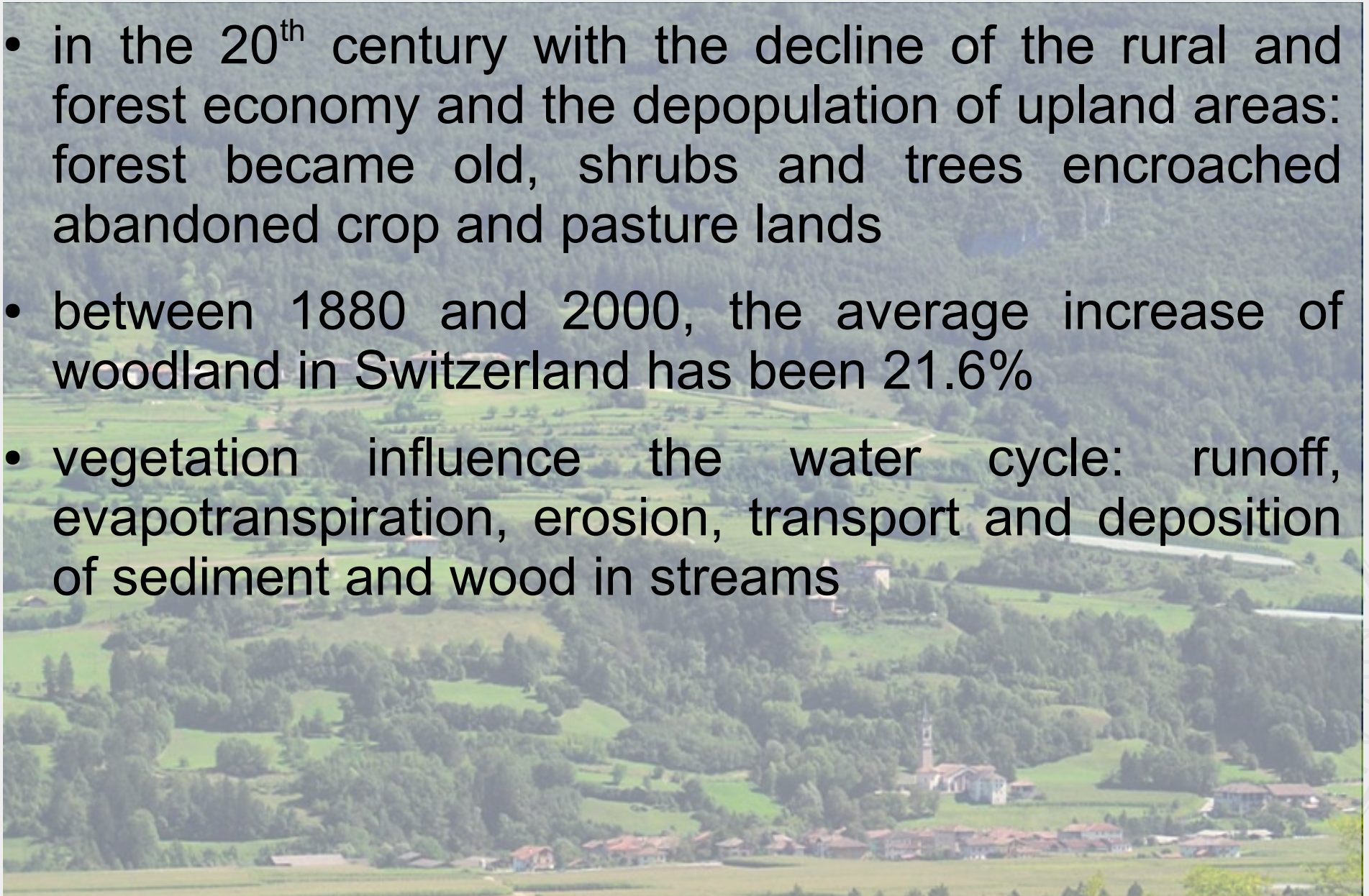
INTRODUCTION

- 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



INTRODUCTION

- 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 sediment and wood in streams



INTRODUCTION



INTRODUCTION

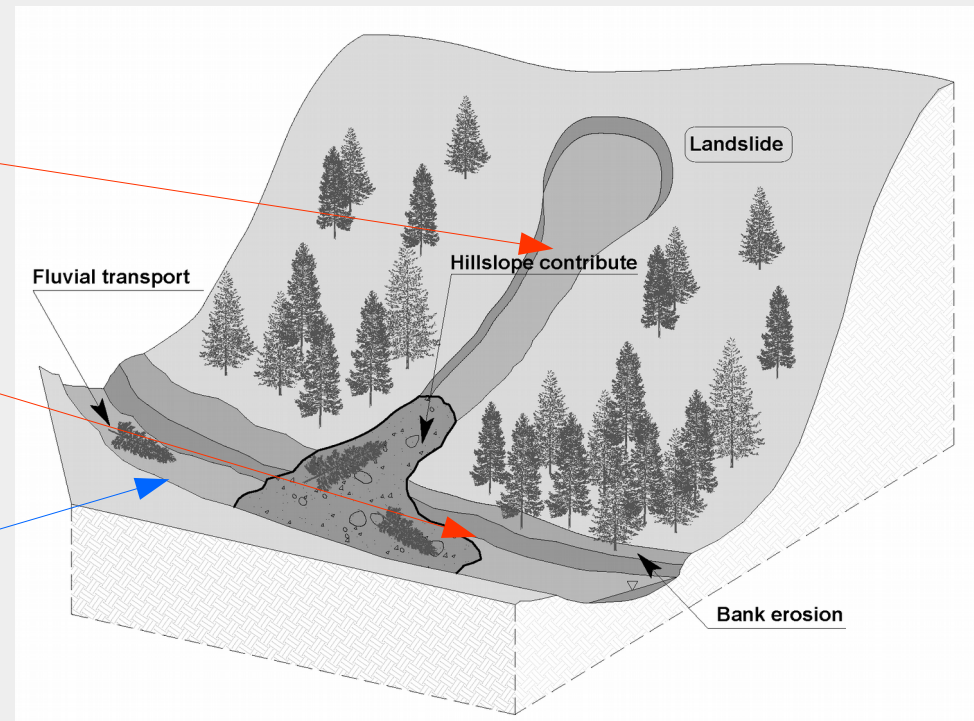


Tools for informed decisions are needed!

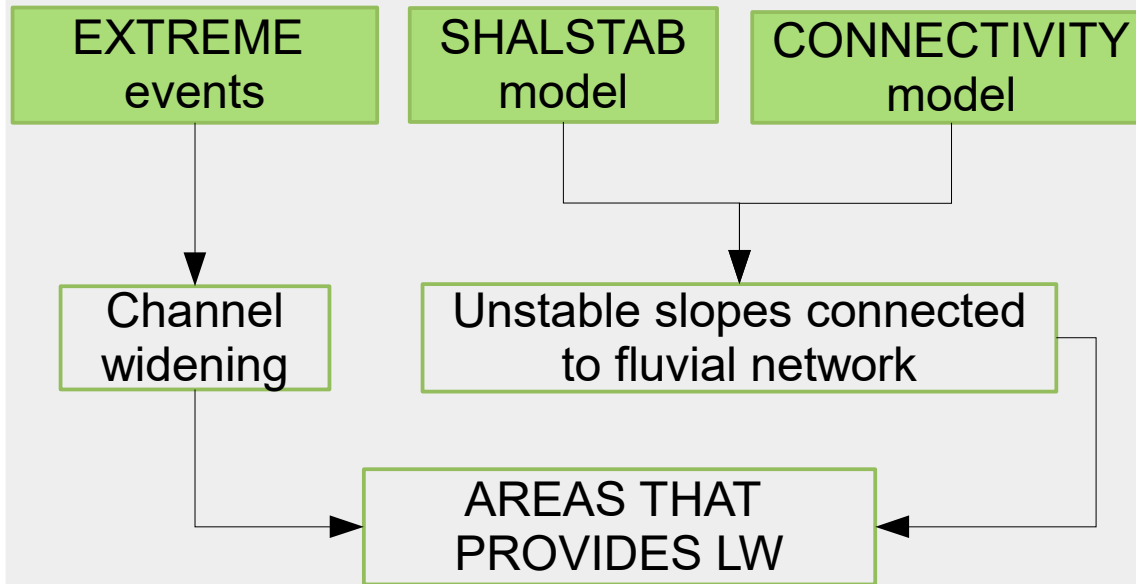


INTRODUCTION

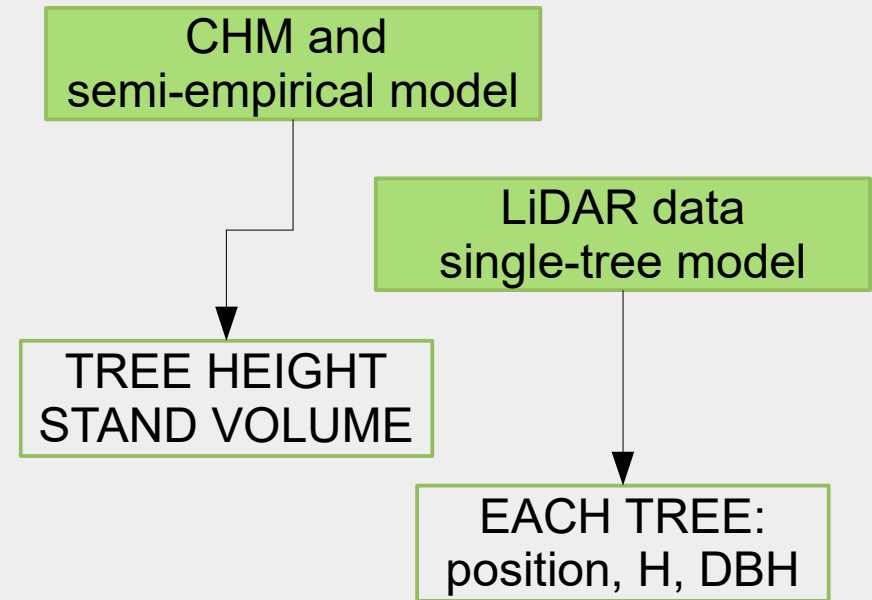
- **GIS-based** tool for predicting the magnitude of **LW** transport during flood events at any given **section** within a river basin
- two main processes related to woody debris:
 - **LW recruitment**
 - from hillslopes
 - from bank erosion (geology)
 - **LW transport/propagation** along the network



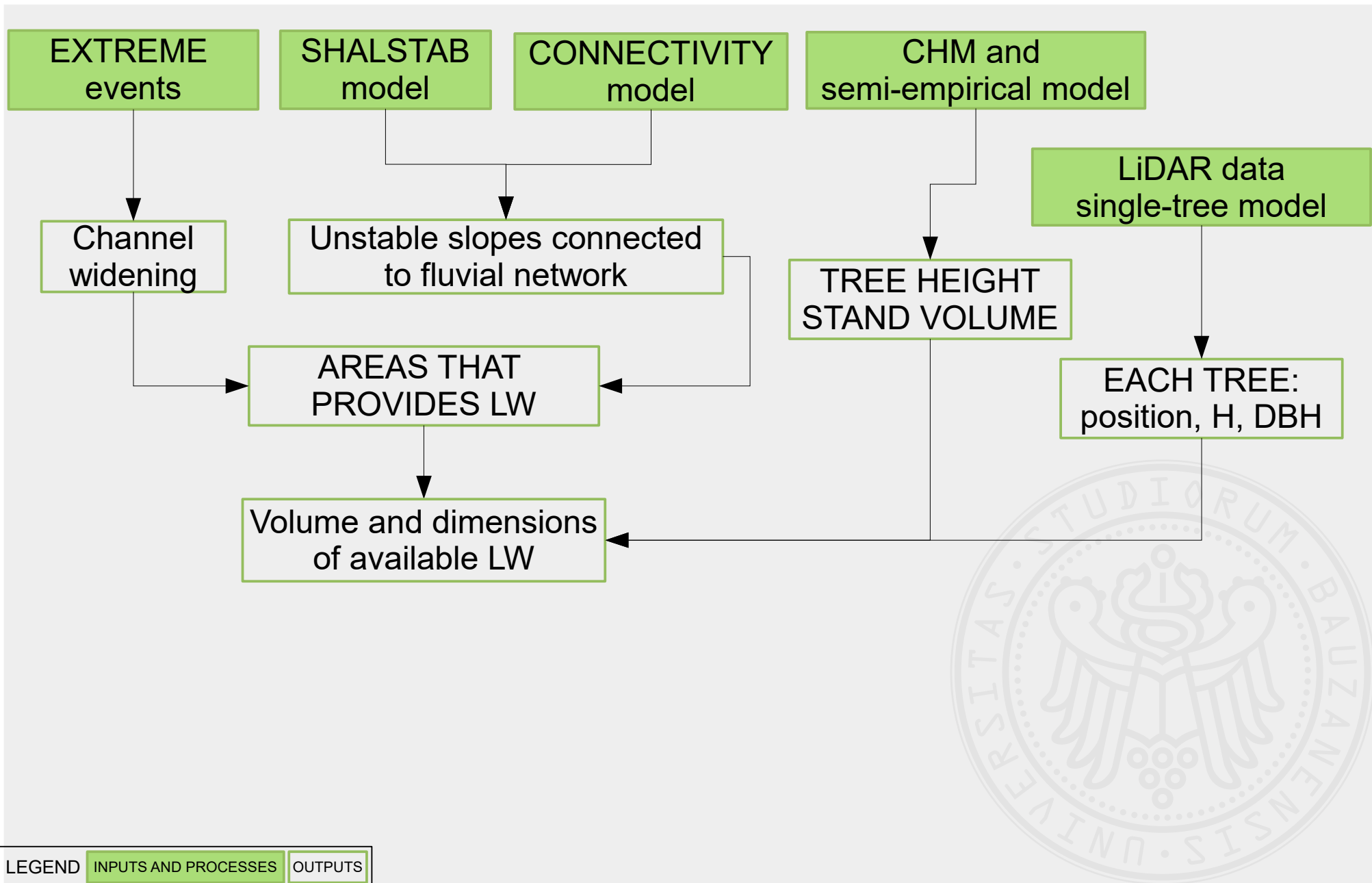
JGRASSTOOLS: LW RECRUITMENT



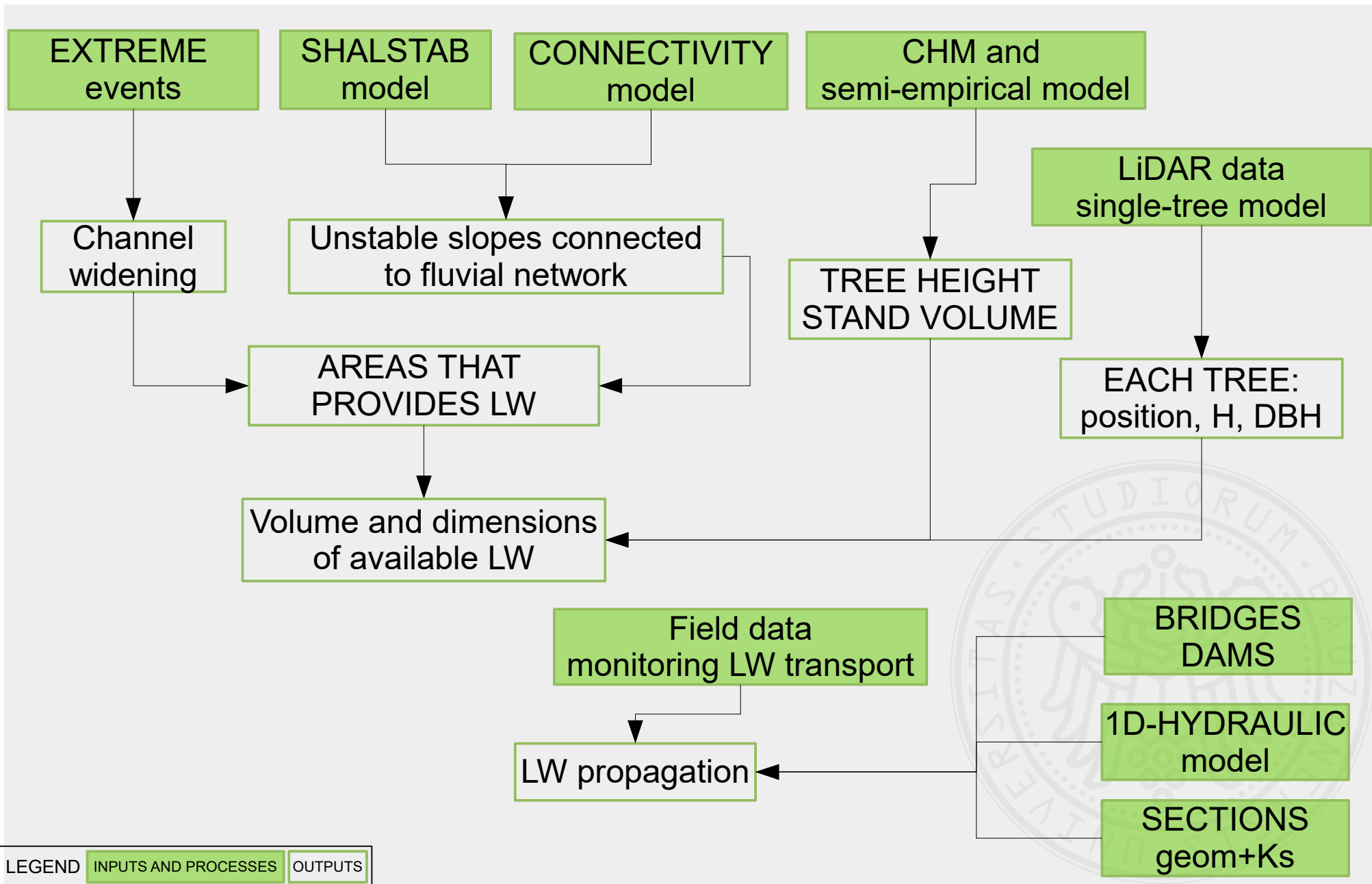
JGRASSTOOLS: LW RECRUITMENT



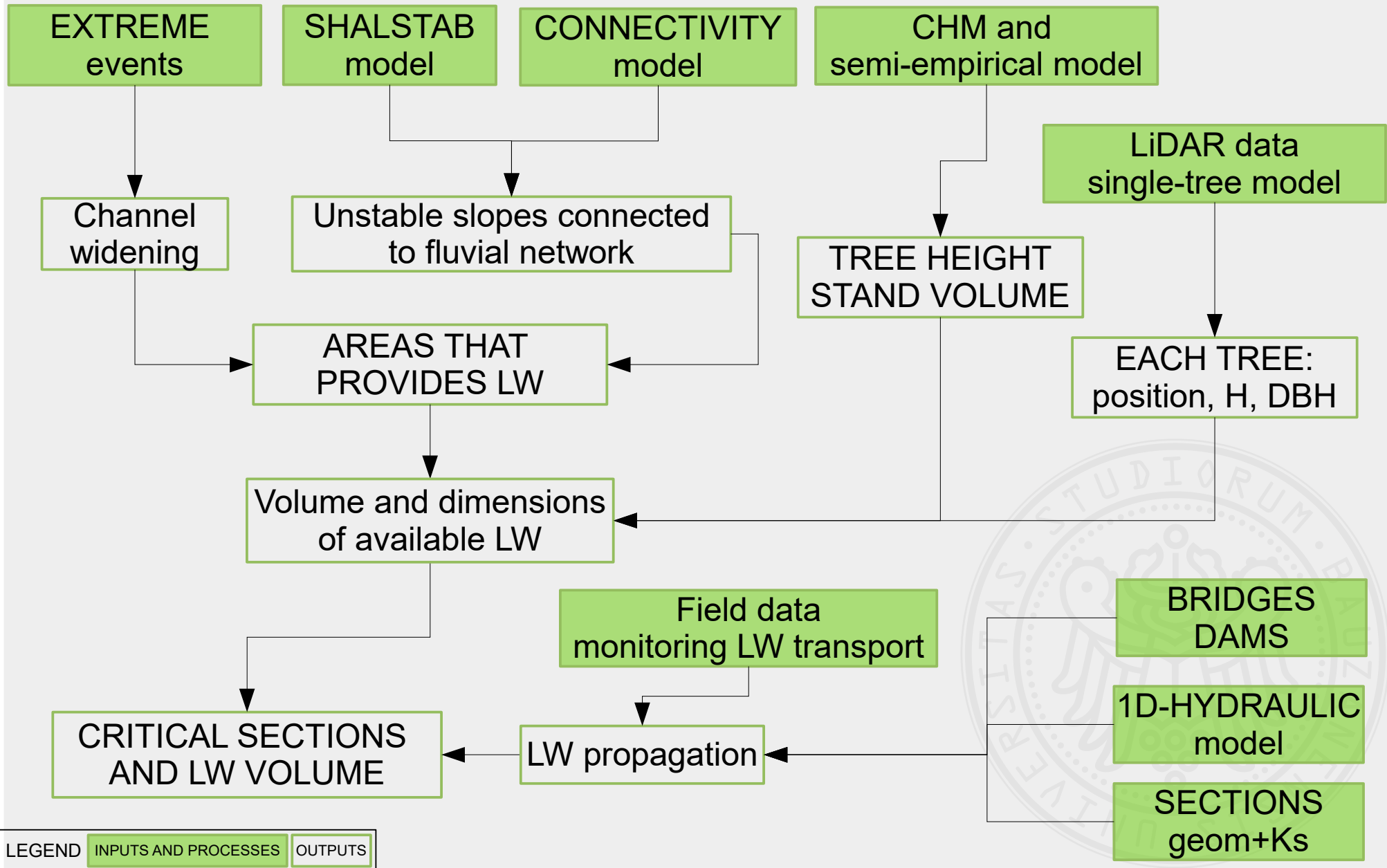
JGRASSTOOLS: LW RECRUITMENT



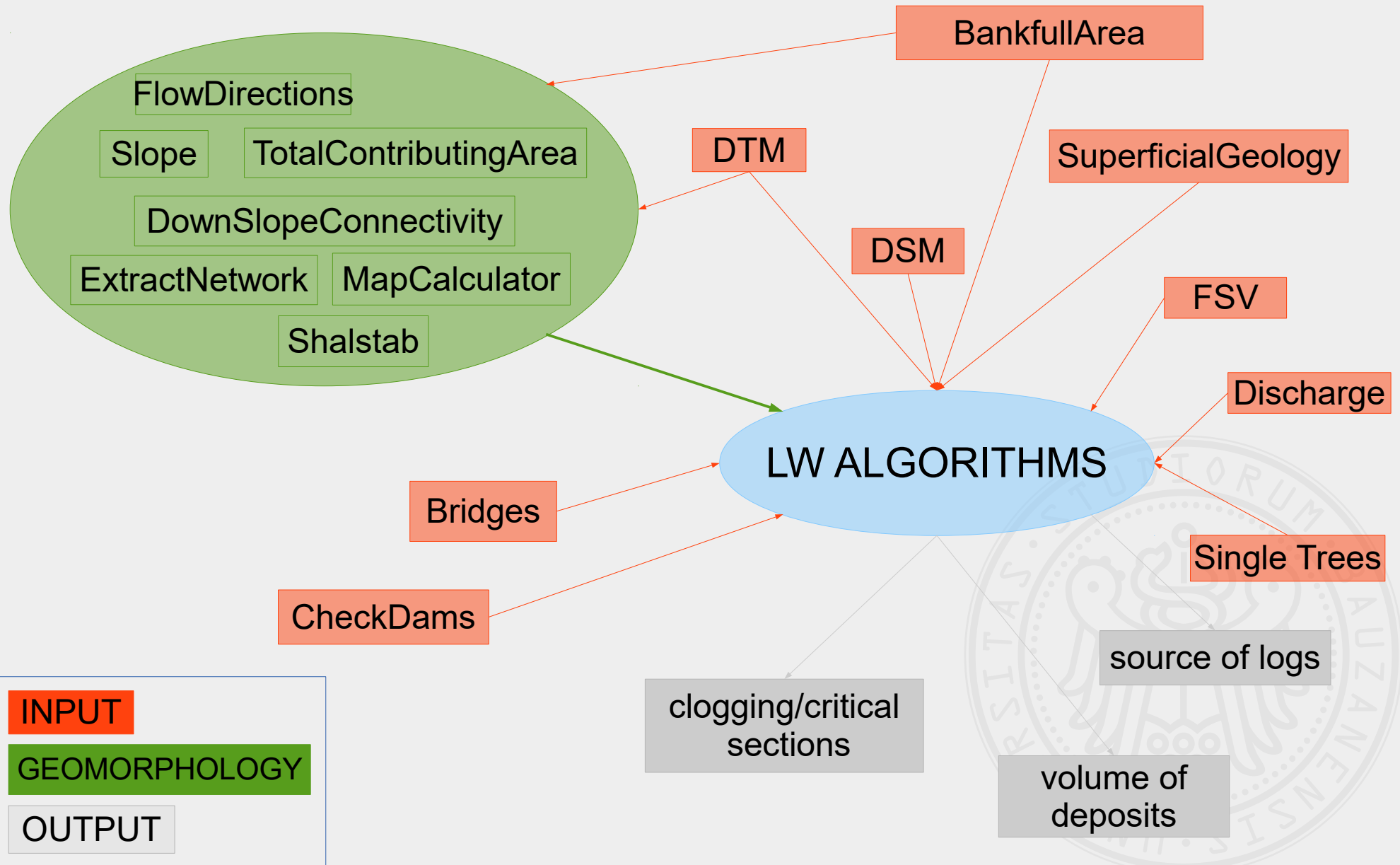
JGRASSTOOLS: LW PROPAGATION



JGRASSTOOLS: PROPAGATION



JGRASSTOOLS: input & output



JGRASSTOOLS: workflow

PREPROCESSING

LW01_ChannelPolygonMerger

LW02_NetworkAttributesBuilder

LW03_NetworkHierarchyToPointsSplitter

ATTRIBUTES EVALUATION

LW04_BankfullWidthAnalyzer

LW05_BridgesDamsWidthAdder

LW06_SlopeToNetworkAdder

LW07_HydraulicParamsToSectionsAdder

LW08_NetworkBufferWidthCalculator

LW09_NetworkBufferMergerHolesRemover

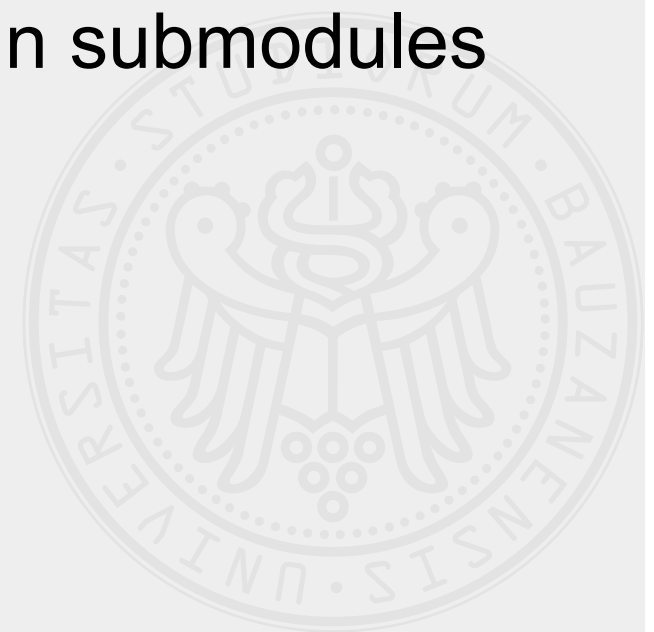
- step by step procedure
- split in submodules

RECRUITMENT AND PROPAGATION

LW10_CHM_AreaToNetpointAssociator

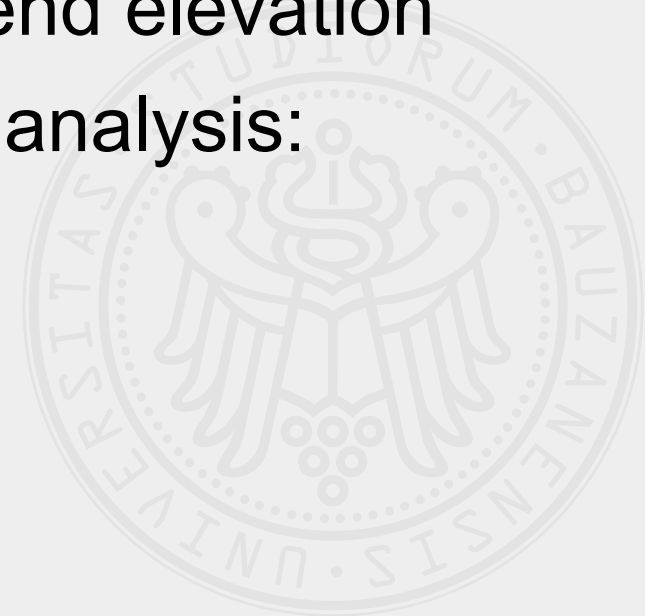
LW10_SingleTree_AreaToNetpointAssociator

LW10_NetworkPropagator



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

Modules

- EnergyIndexCalculator
- HazardClassifier
- HecrasInputBuilder
- Hillshade
- Insolation
- IntensityClassifierDebrisFlowTN
- IntensityClassifierFlood
- MeltonNumber
- Peakflow
- PresteyTaylorEtpModel
- SaintGeo
- Shalstab
- Skyview
- LWRecruitment
 - LW01_ChannelPolygonMerger
 - LW02_NetworkAttributesBuilder**
 - LW03_NetworkHierarchyToPointsSplitter
 - LW04_BankfullWidthAnalyzer
 - LW05_BridgesDamsWidthAdder
 - LW06_SlopeToNetworkAdder
 - LW07_H
 - LW08_N
 - LW09_N
 - LW10_C
 - LW10_Si
 - LW11_N

Parameters

The extracted network raster map: wood\raster\test01\basin01_net10000.tif


The map of flow directions: e_wood\raster\test01\basin01_mdain.tif

The map of Total Contributing Areas: arge_wood\raster\test01\basin01_tca.tif


The vector of the network: rs\arge_wood\shape\extracted_net.shp

☒ Load Experimental
☐ Debug
Heap [MB] 64

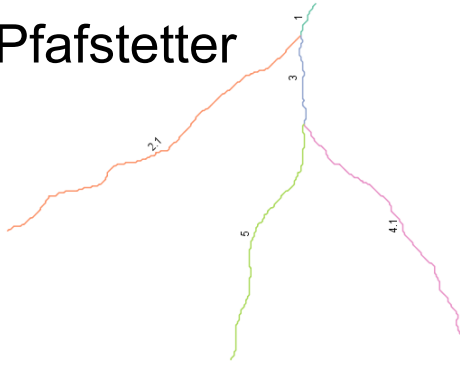
Strahler



Hack

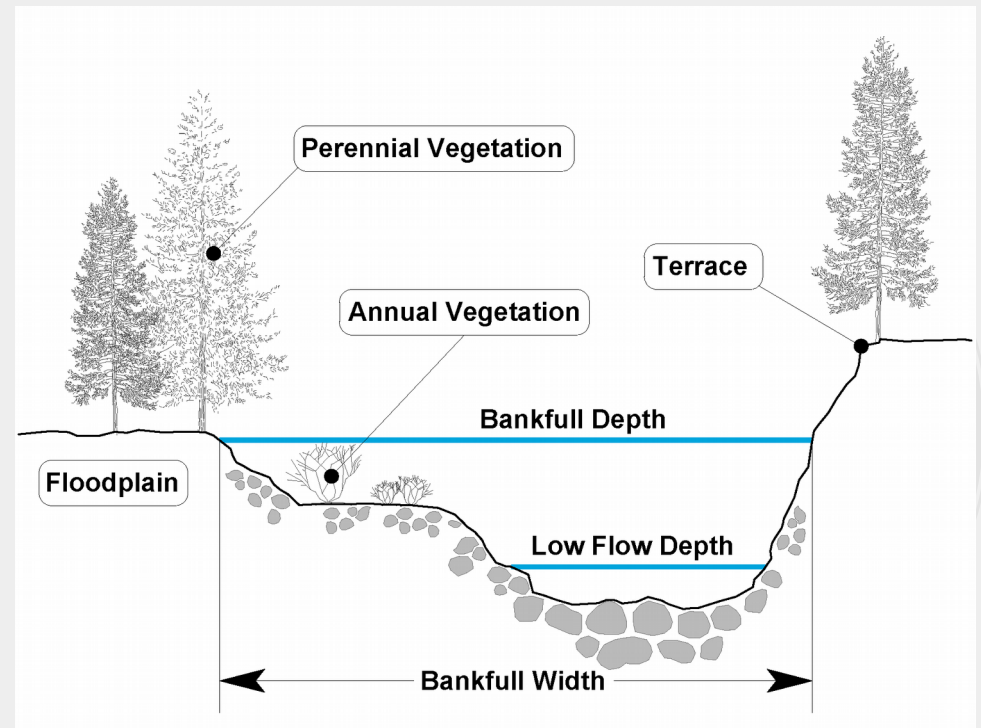


Pfafstetter



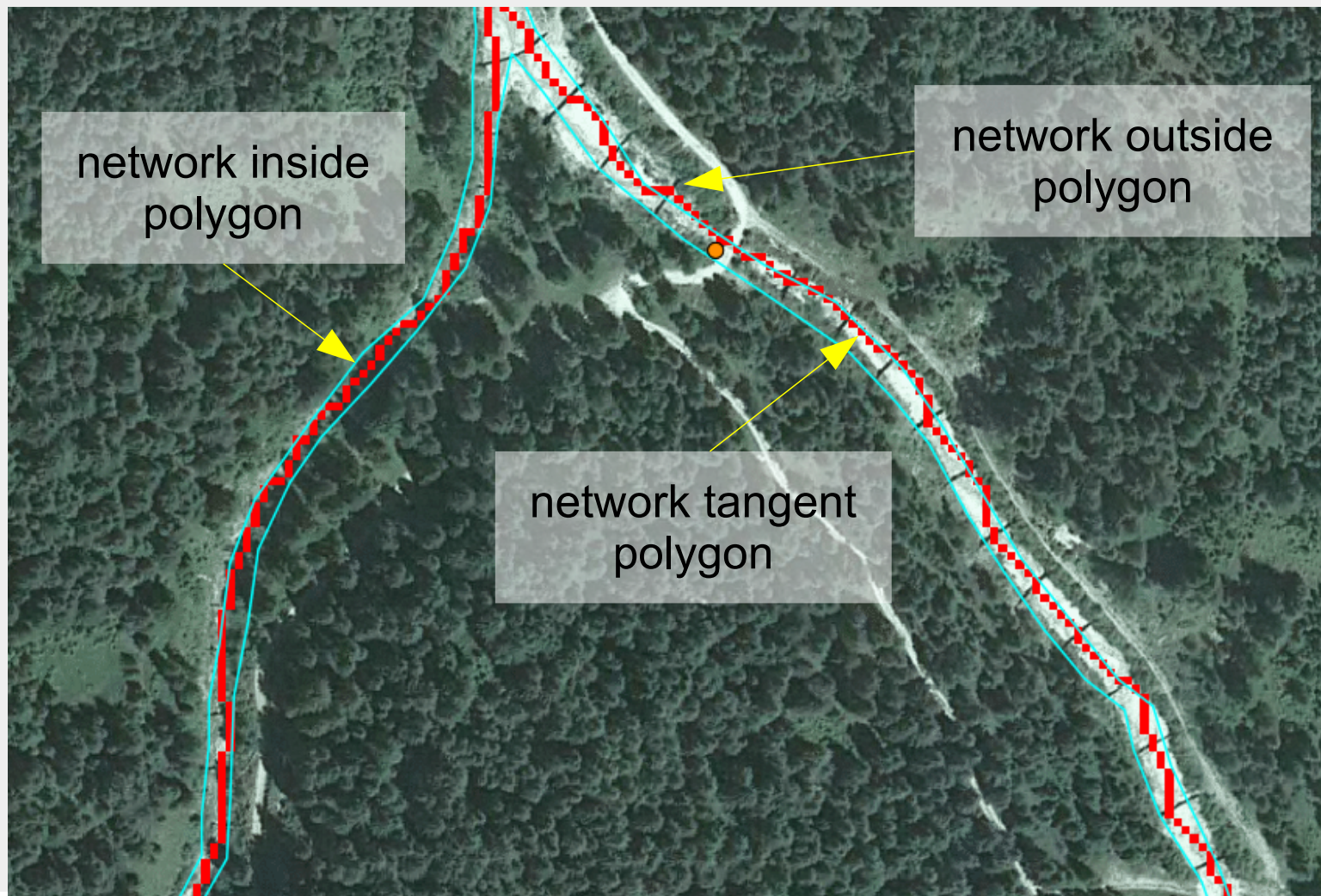
JGRASSTOOLS: bankfull width

- 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

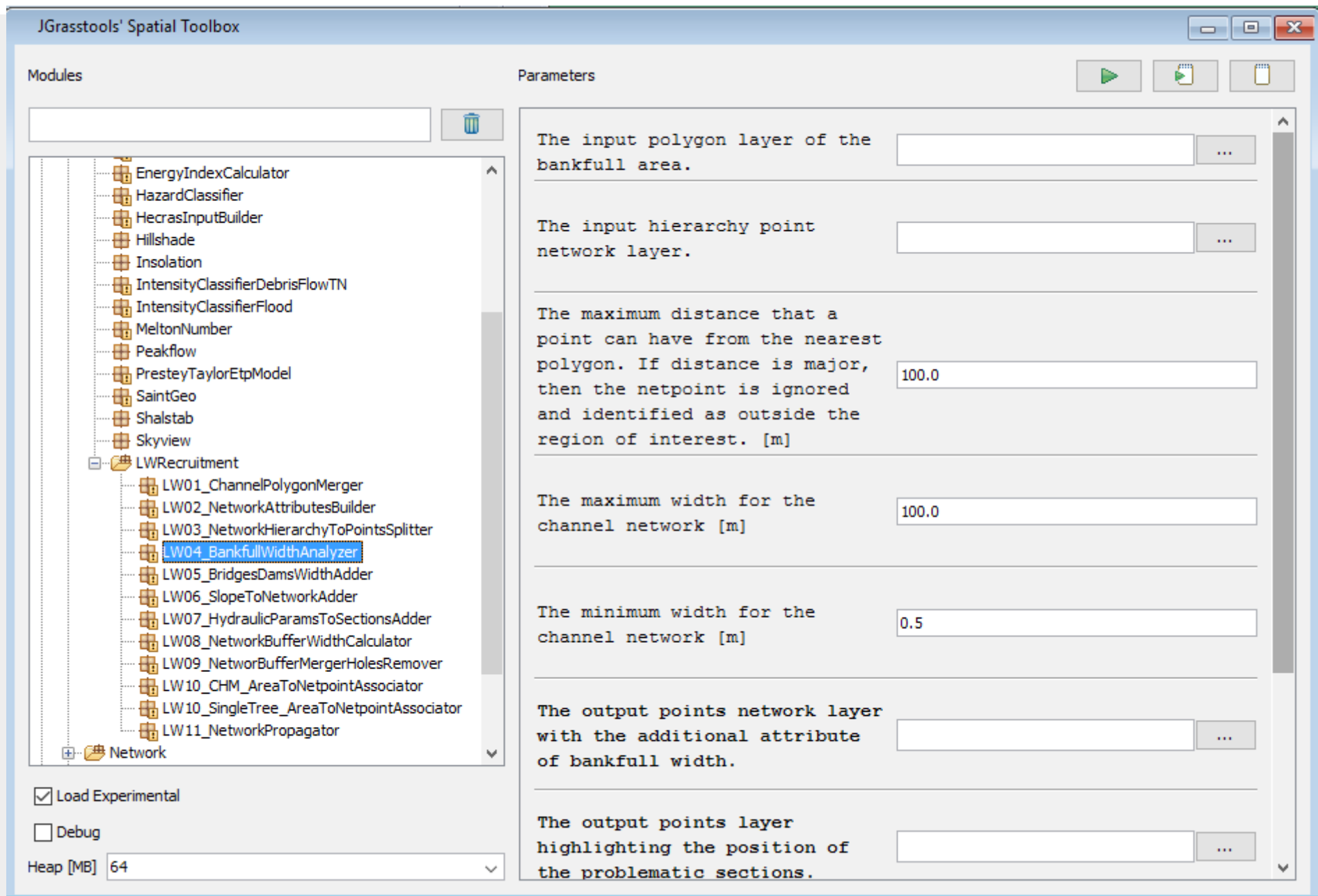


JGRASSTOOLS: bankfull width

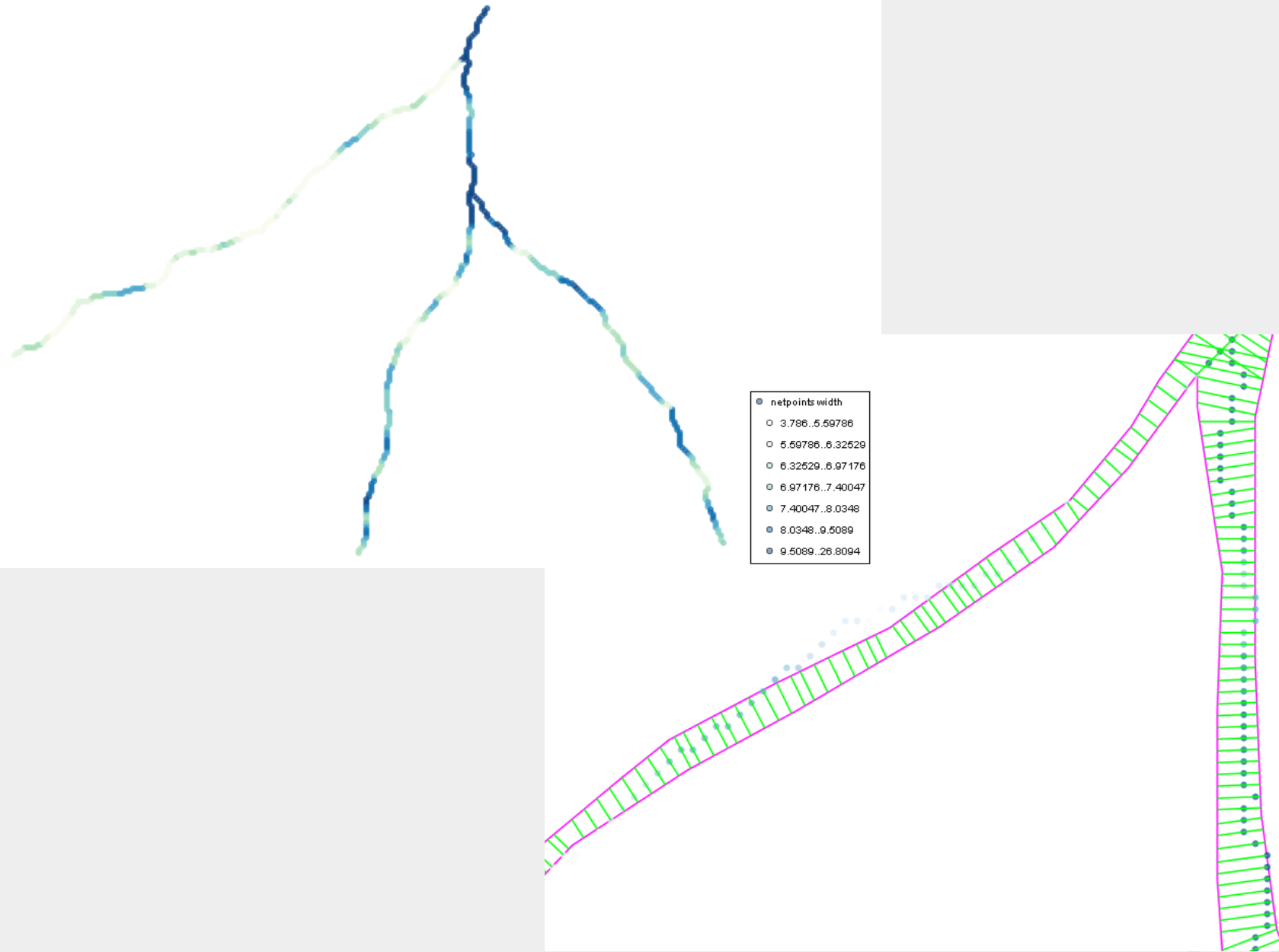
- different origin of input data (DTM derived network, delineation of the bankfull from ortophoto or field)



JGRASSTOOLS: bankfull width

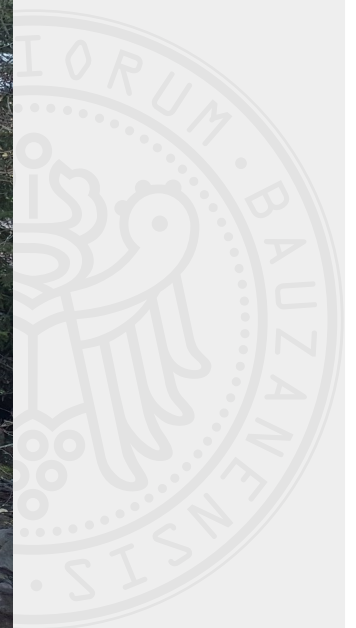


JGRASSTOOLS: bankful width



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

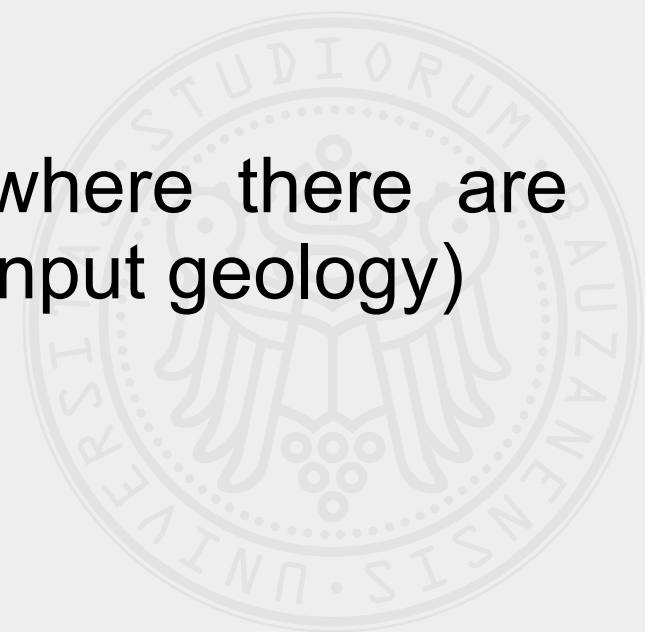


JGRASSTOOLS: bank erosion

- 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)

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

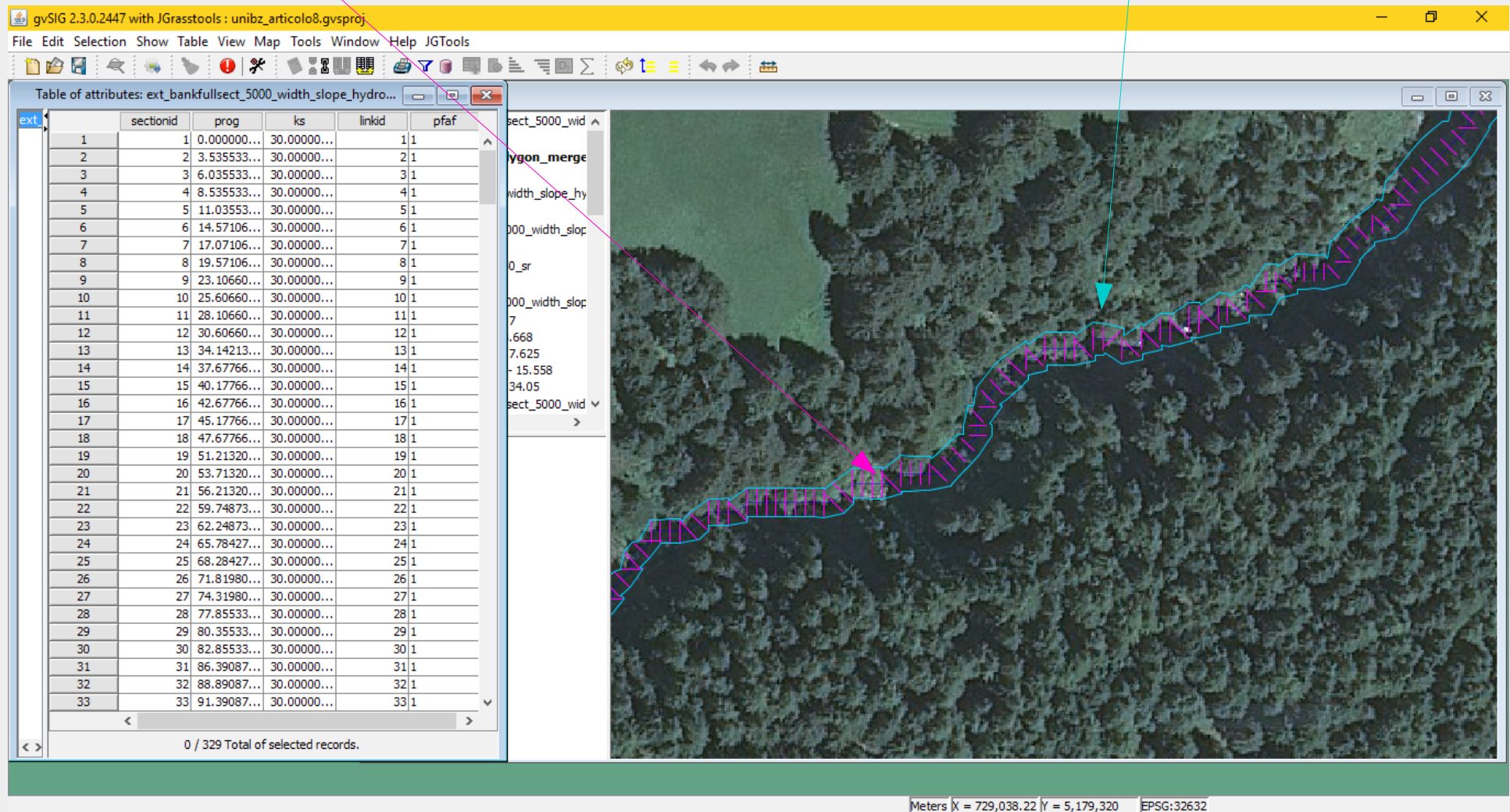
- widening is avoided for sections where there are structures and where there is rock (input geology)



JGRASSTOOLS: bank erosion

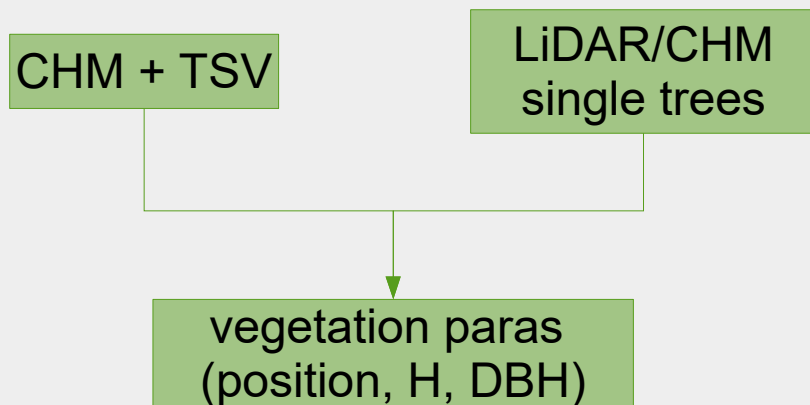
bankfull sections

event widening area

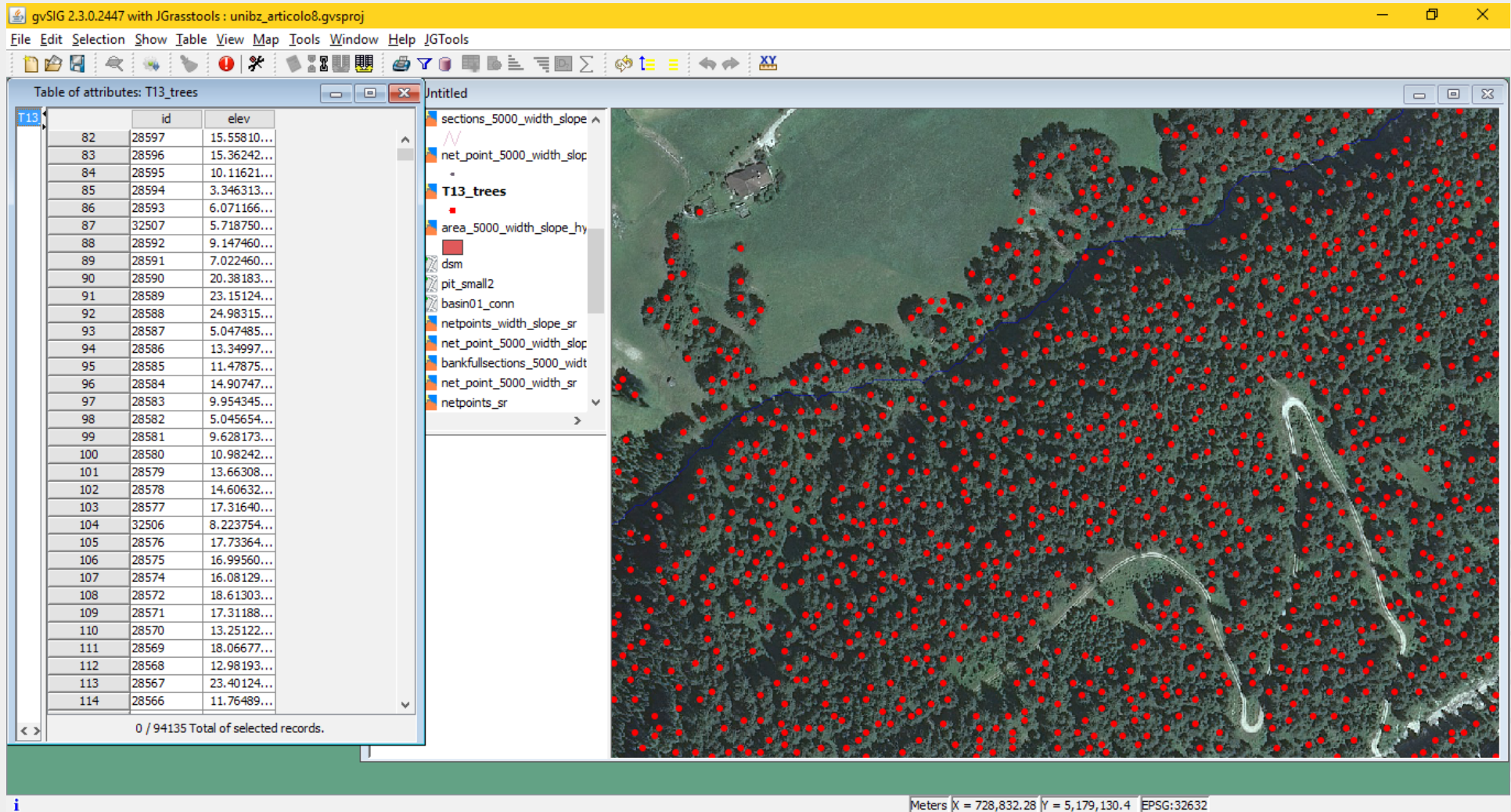


JGRASSTOOLS: LW from hillslopes

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

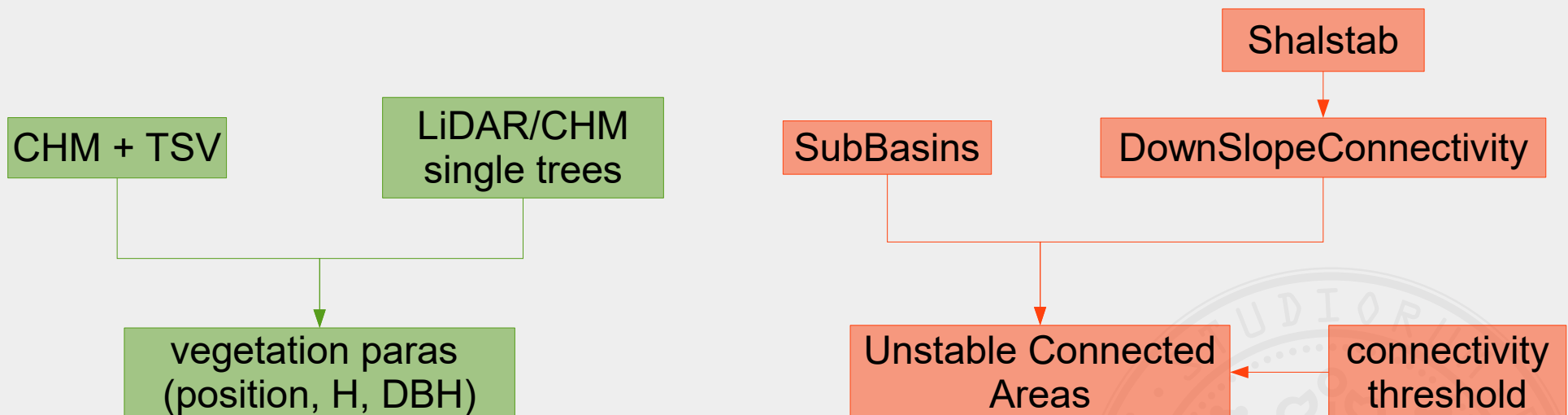


JGRASSTOOLS: LW from hillslopes

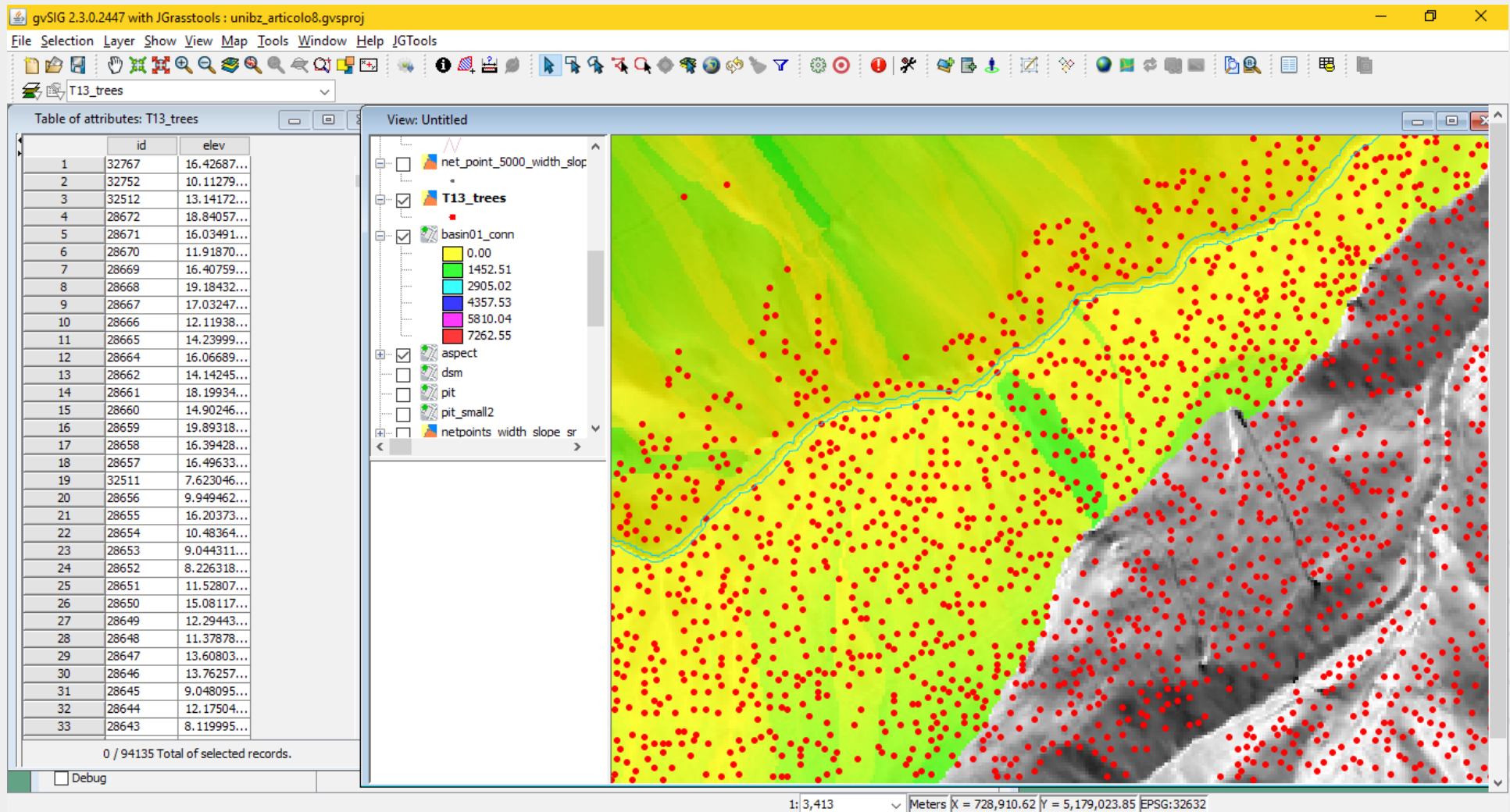


JGRASSTOOLS: LW from hillslopes

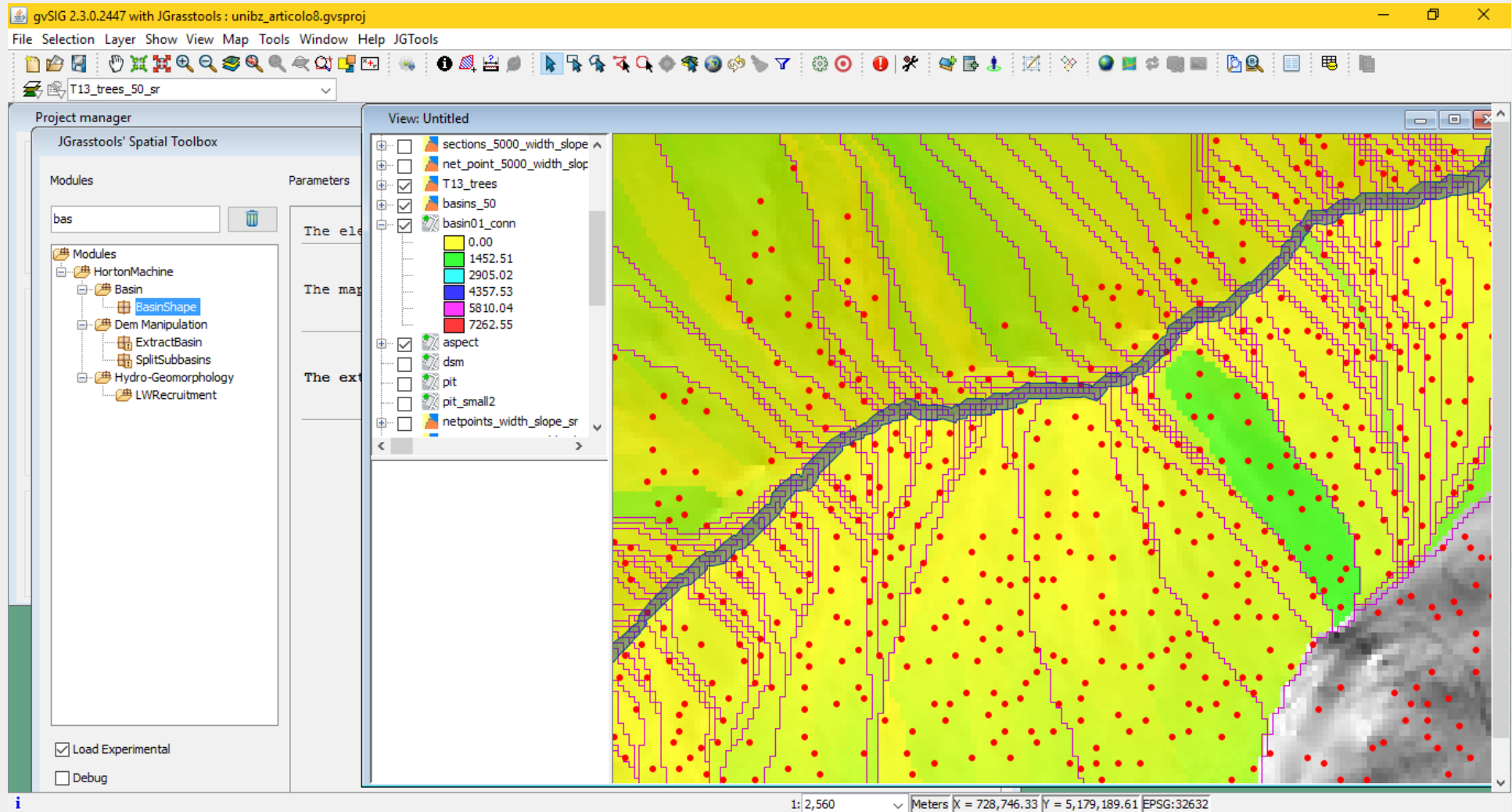
- shallow landslides on connected hillslopes deliver logs to the channels → amount of wood on the unstable and connected areas



JGRASSTOOLS: LW from hillslopes

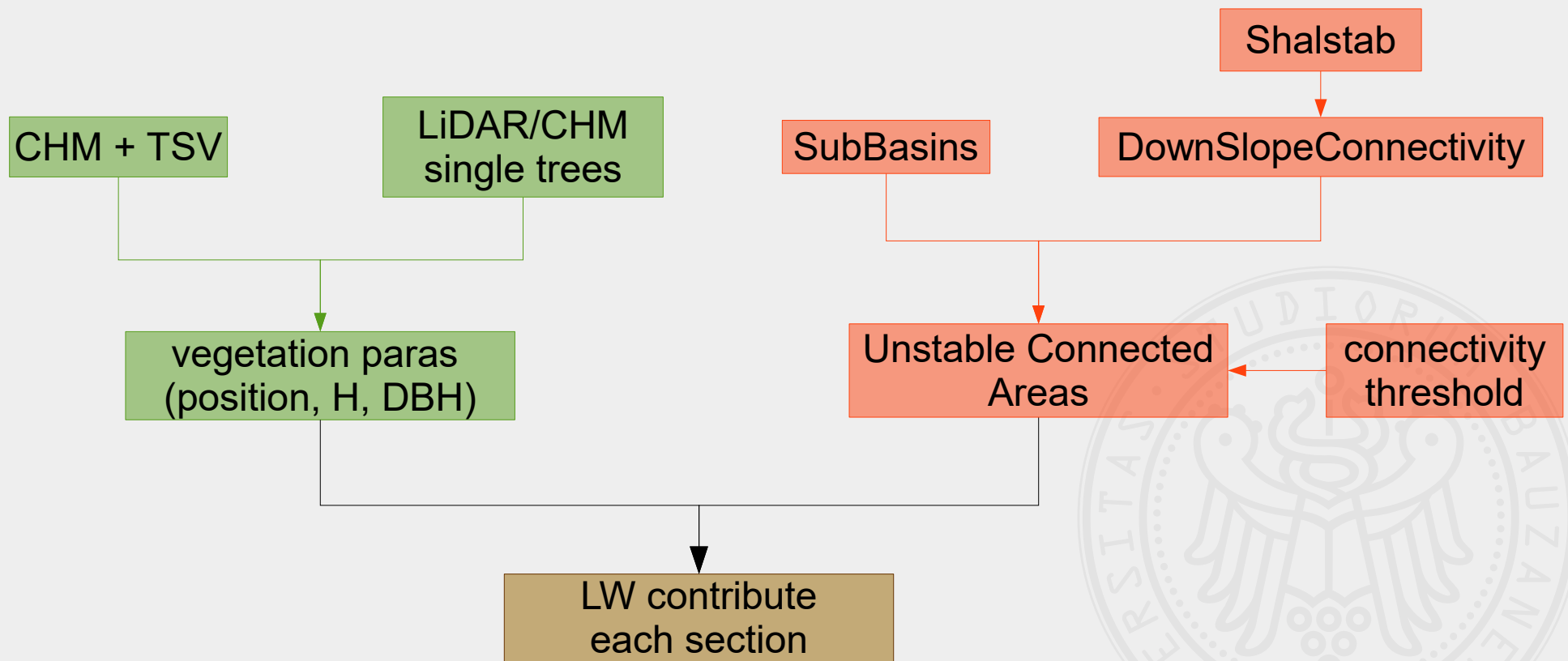


JGRASSTOOLS: LW from hillslopes

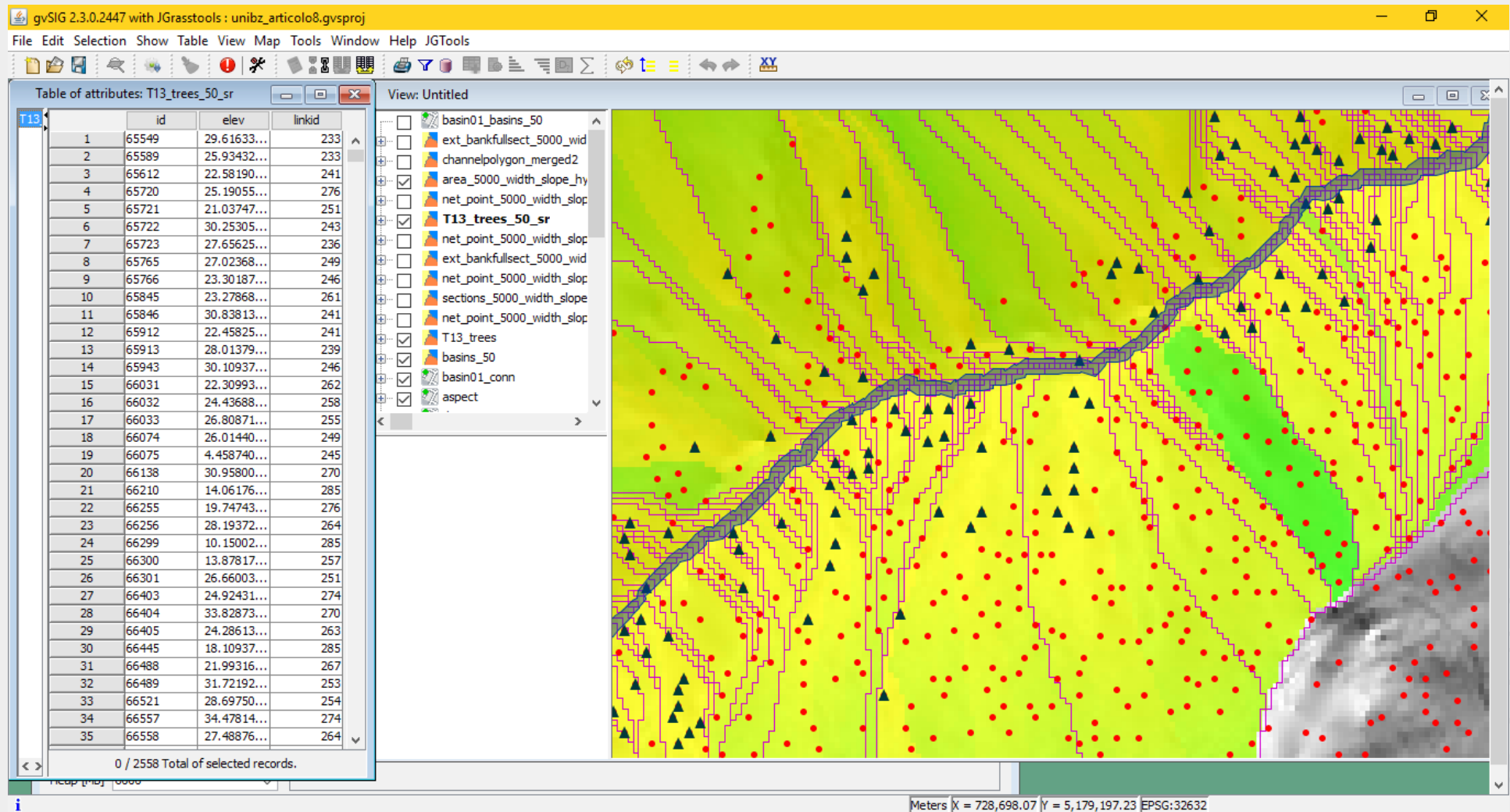


JGRASSTOOLS: LW from hillslopes

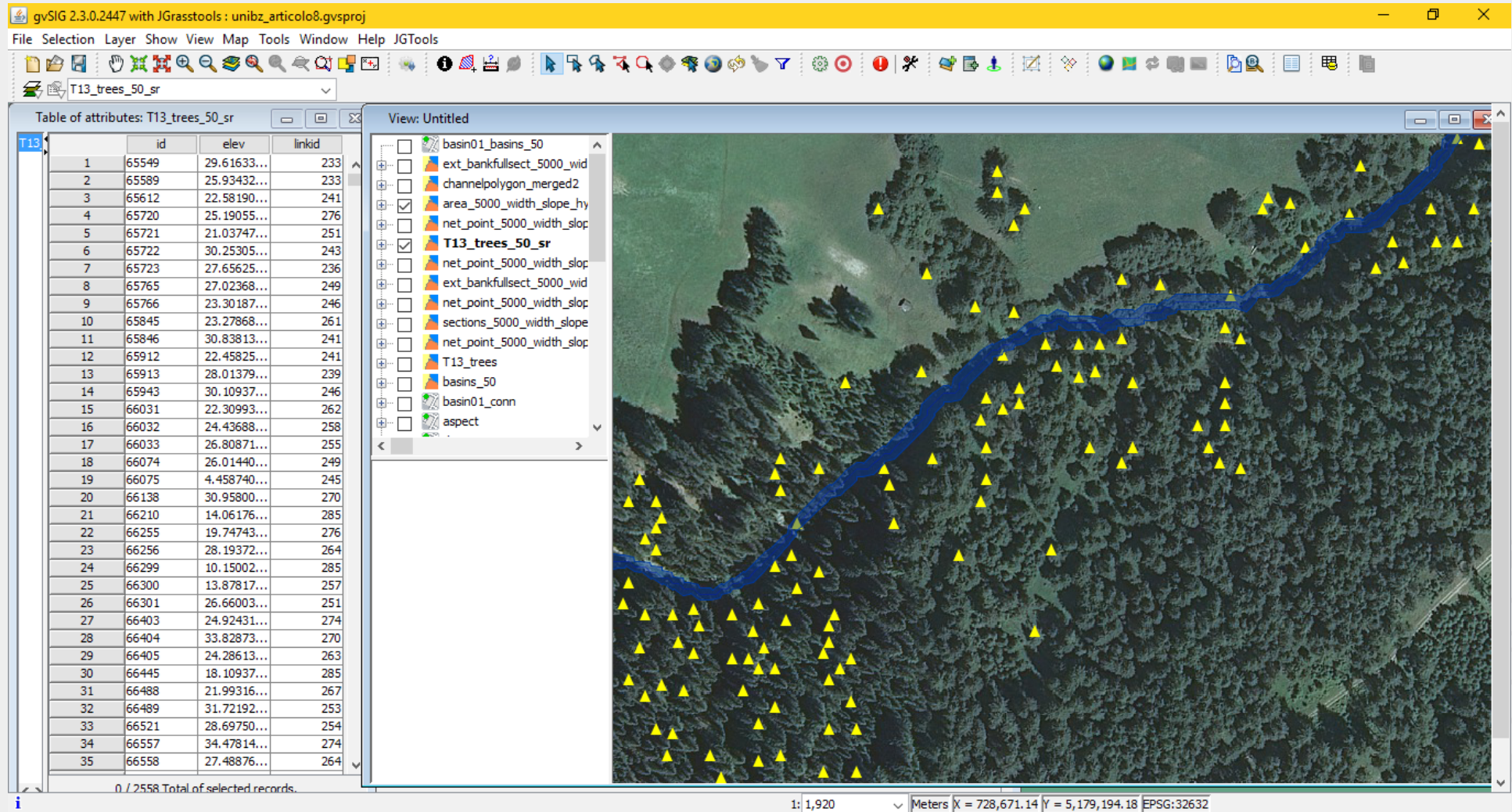
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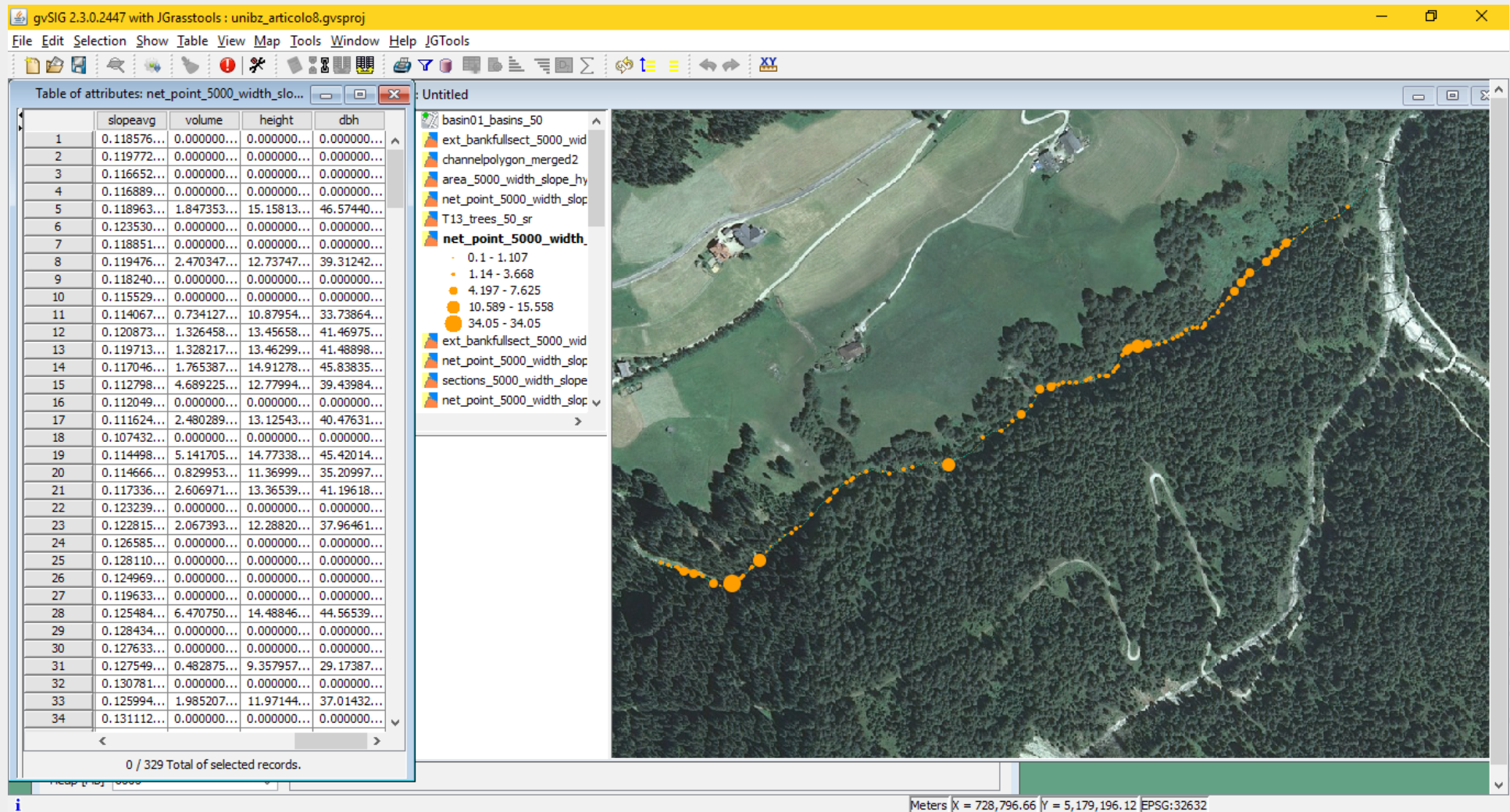
JGRASSTOOLS: LW from hillslopes



JGRASSTOOLS: LW from hillslopes



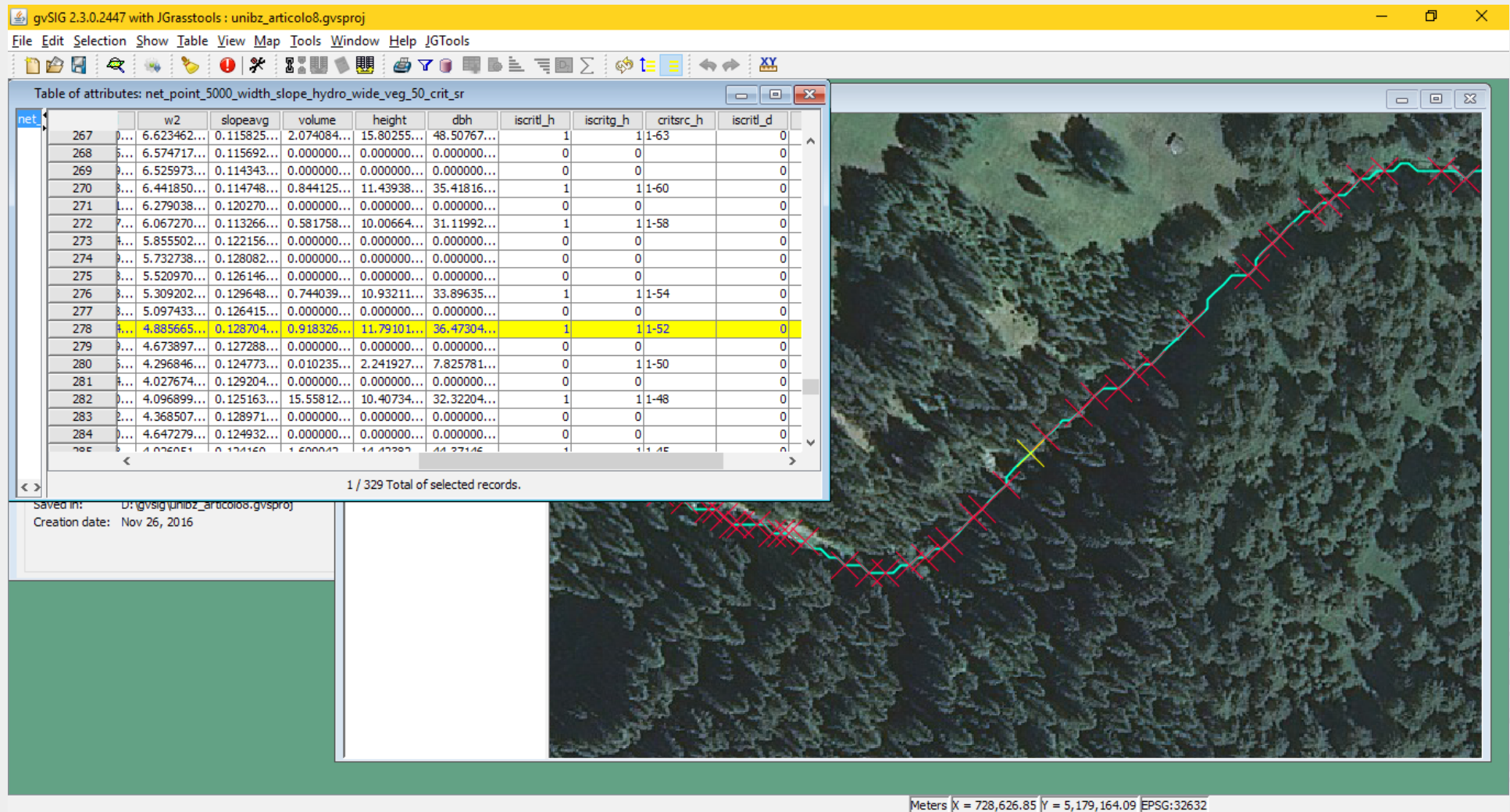
JGRASSTOOLS: LW recruitment



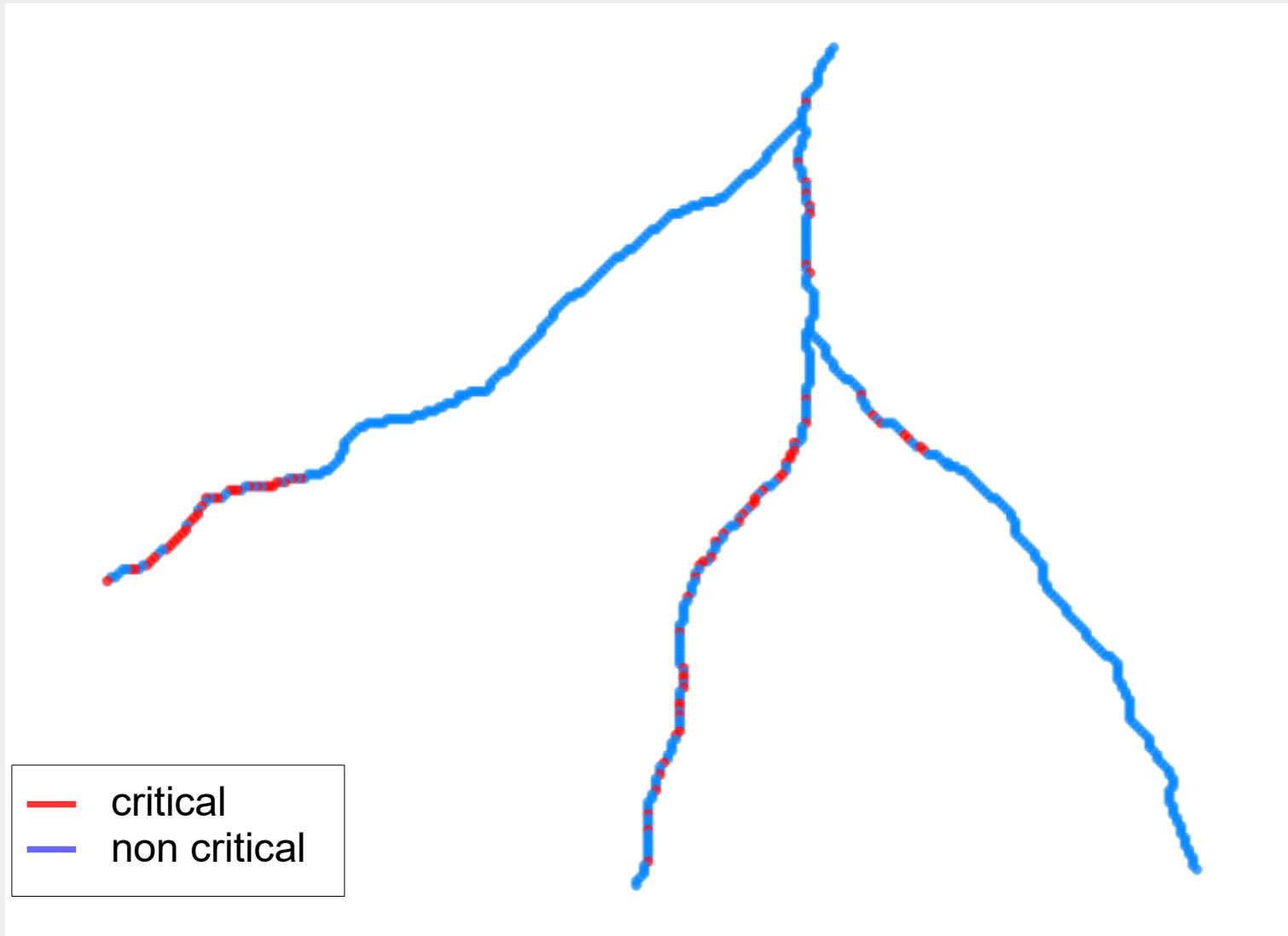
JGRASSTOOLS: propagation

- 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 section for the transit of LW in the given stream network

JGRASSTOOLS: propagation



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!

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<http://www.jgrasstools.org>

