Spatial tools for evaluating woody debris flooding hazard in gvSIG

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

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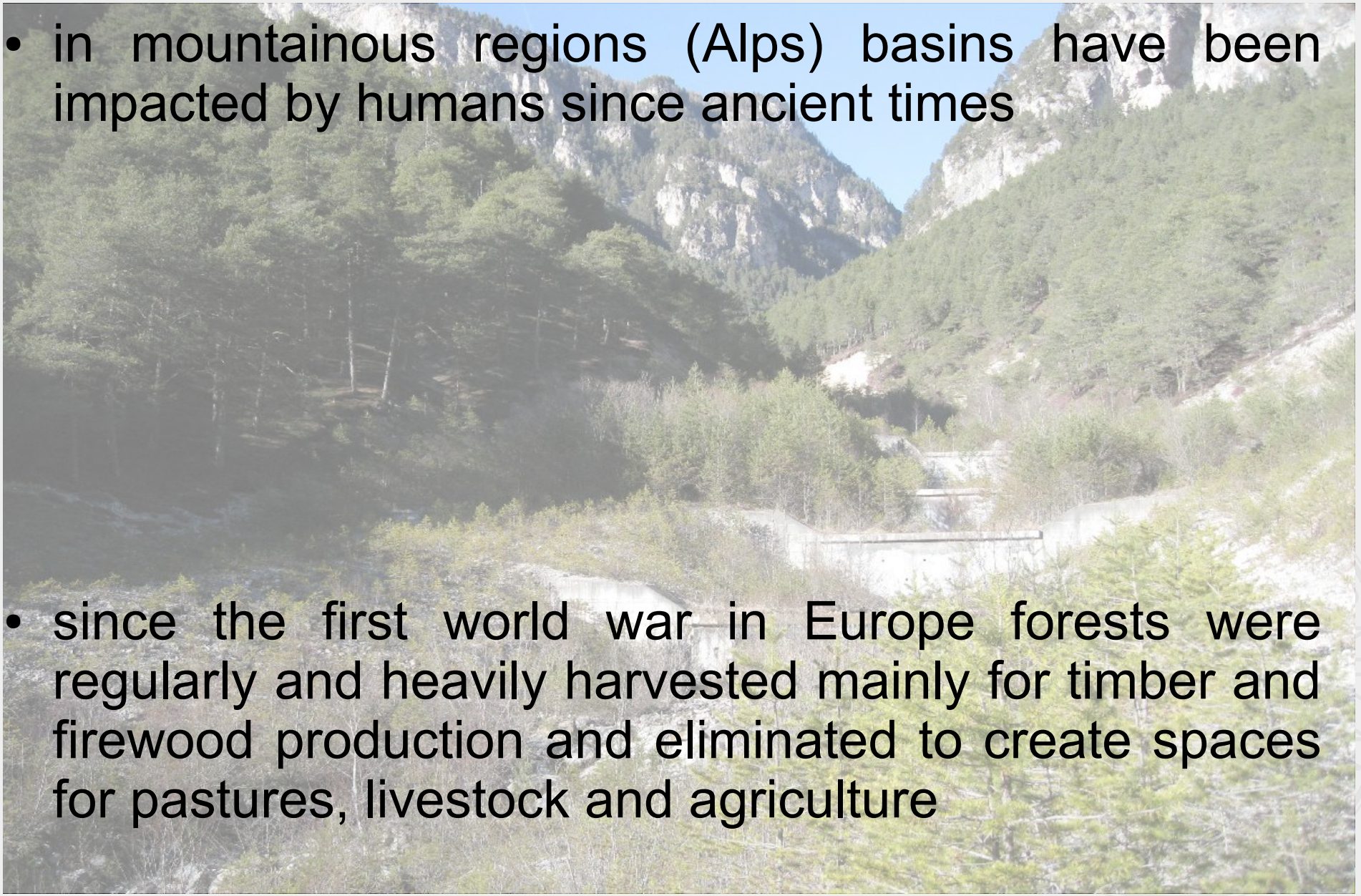
gvSIG festival – 23 May 2017

WHO AM I?

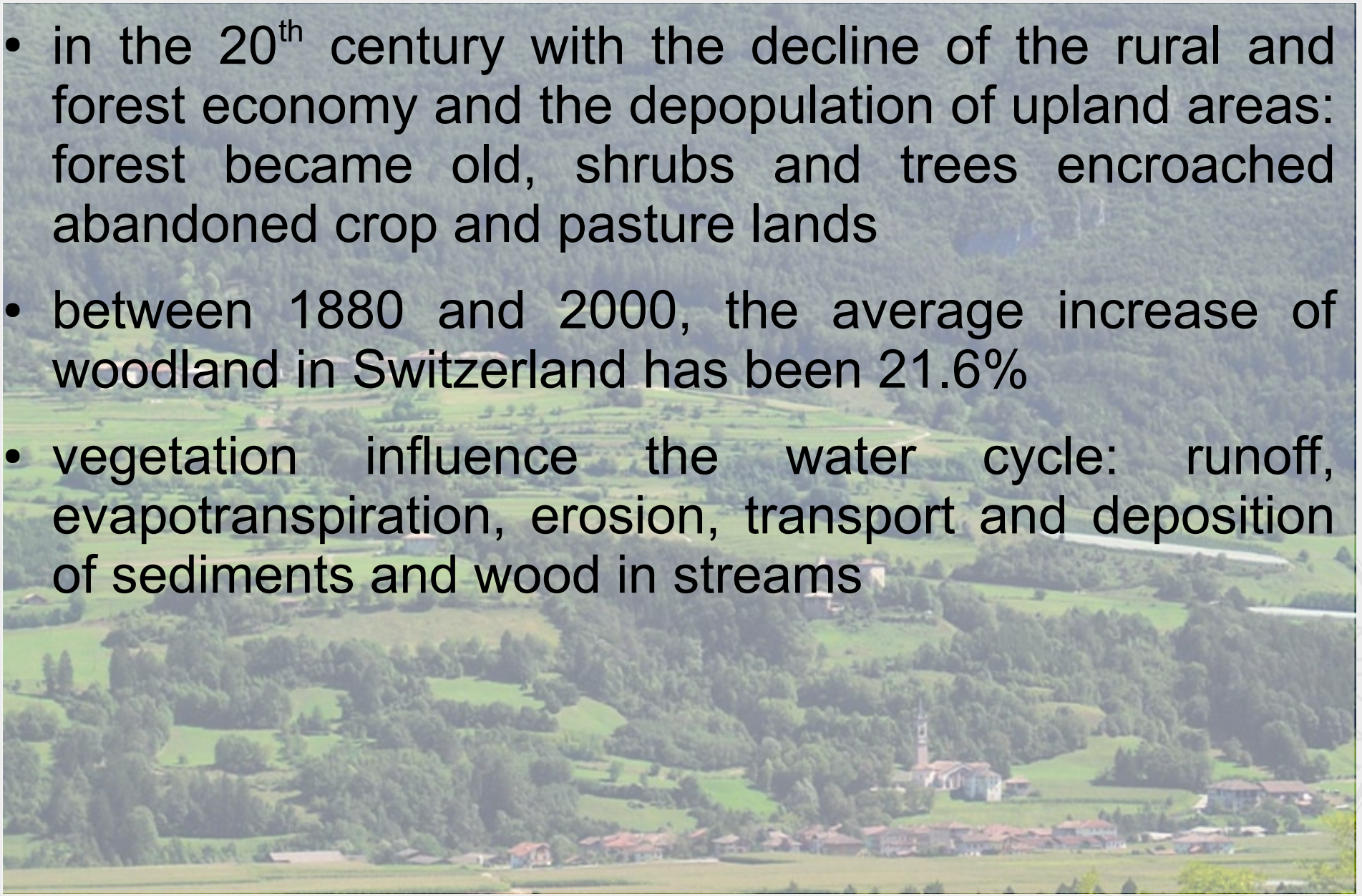
- environmental engineer specialized in hydrology, hydraulics and geomorphology
- co-founder of HydroloGIS member of gvSIG association
- developed scientific models contained in the JGrassTools library in the fields of: hydrology, hydraulics and forestry
- finishing PhD in Mountain Environment and Agriculture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

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 sediments and wood in streams

INTRODUCTION

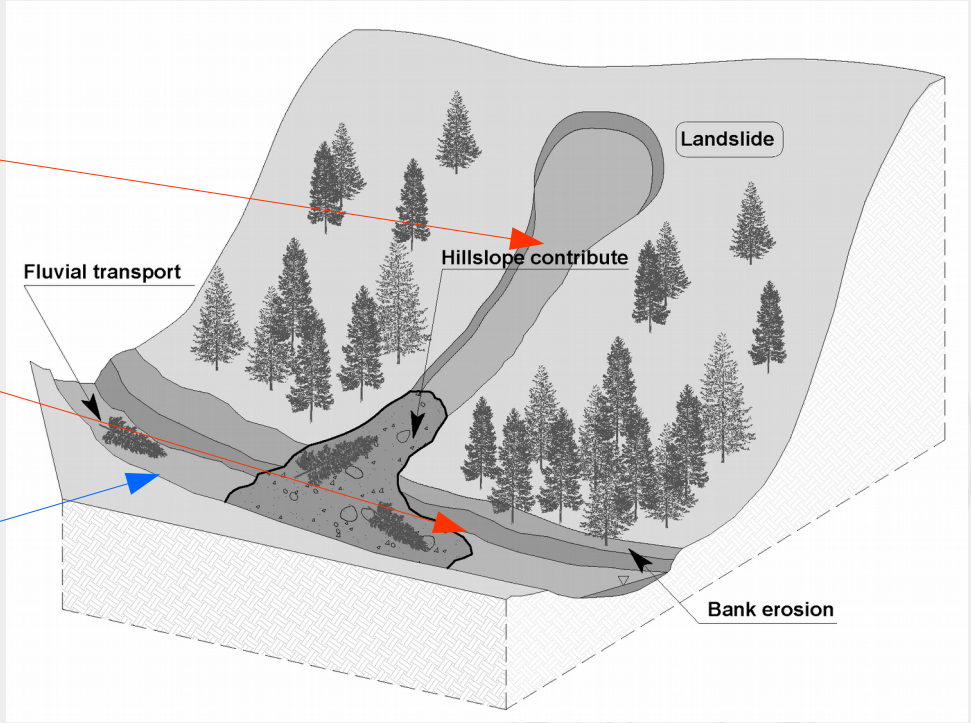
INTRODUCTION

management

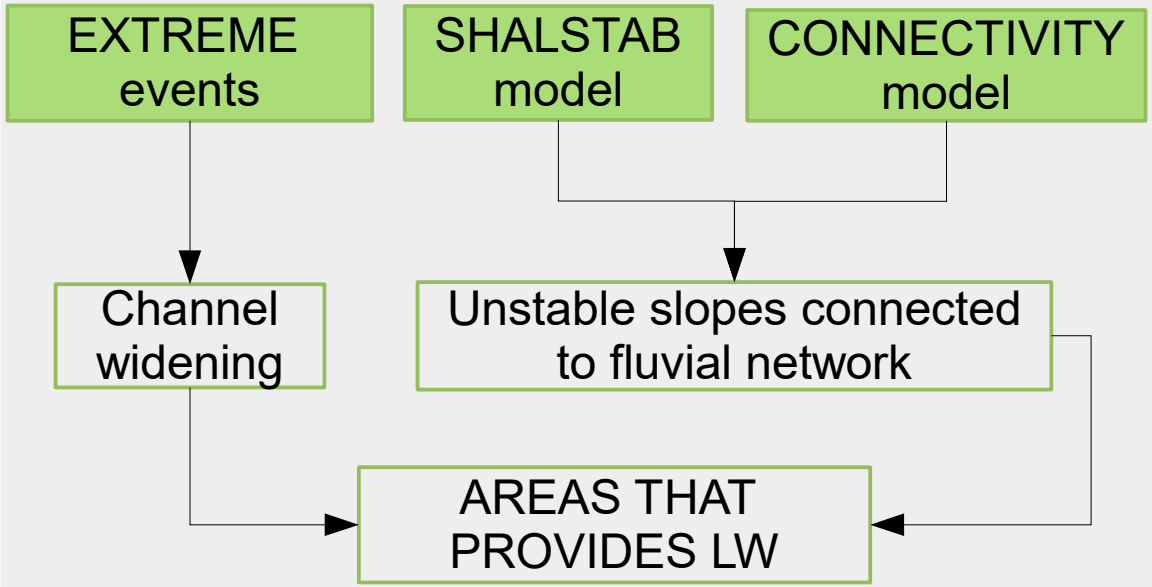
¡Tools for informed decisions are needed!

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



LEGEND | INPUTS AND PROCESSES | OUTPUTS

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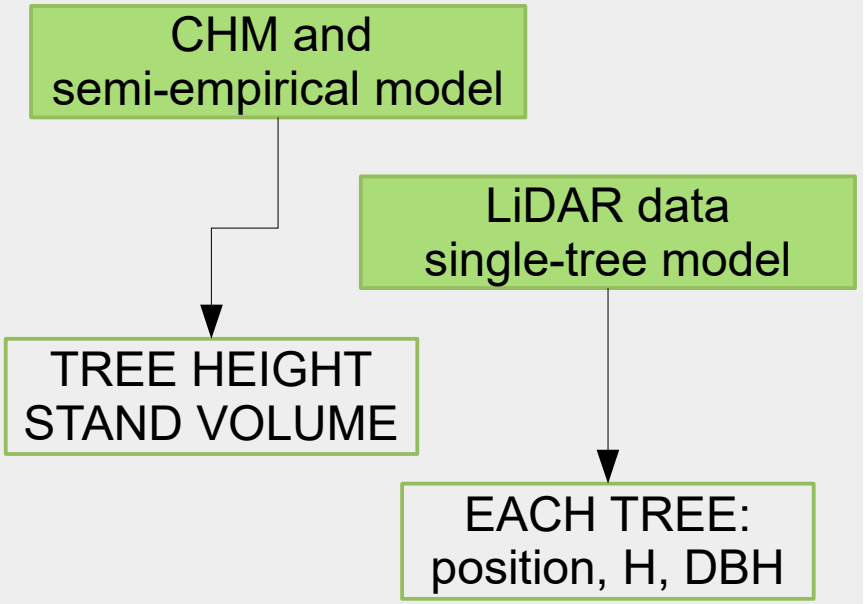

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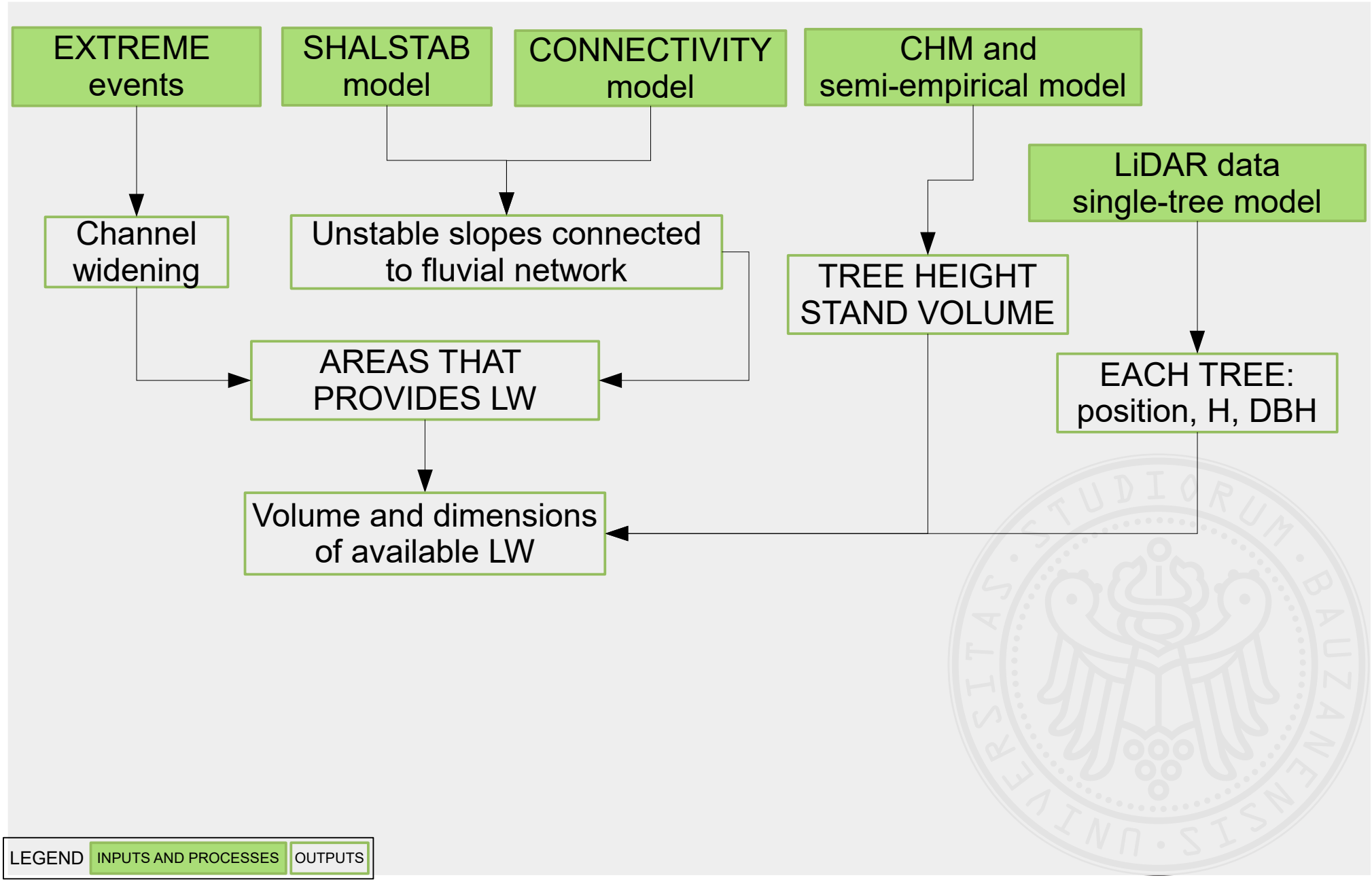
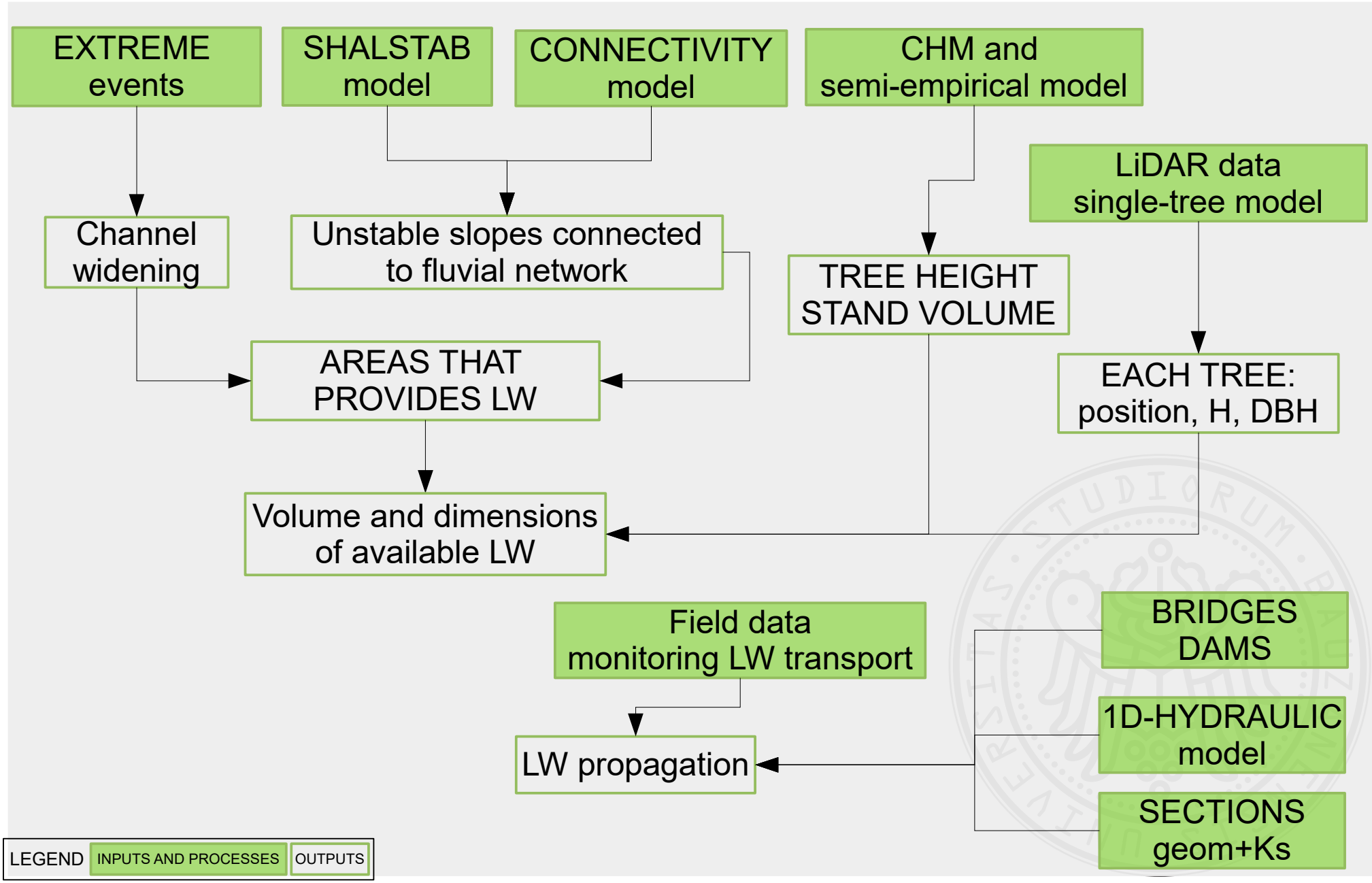
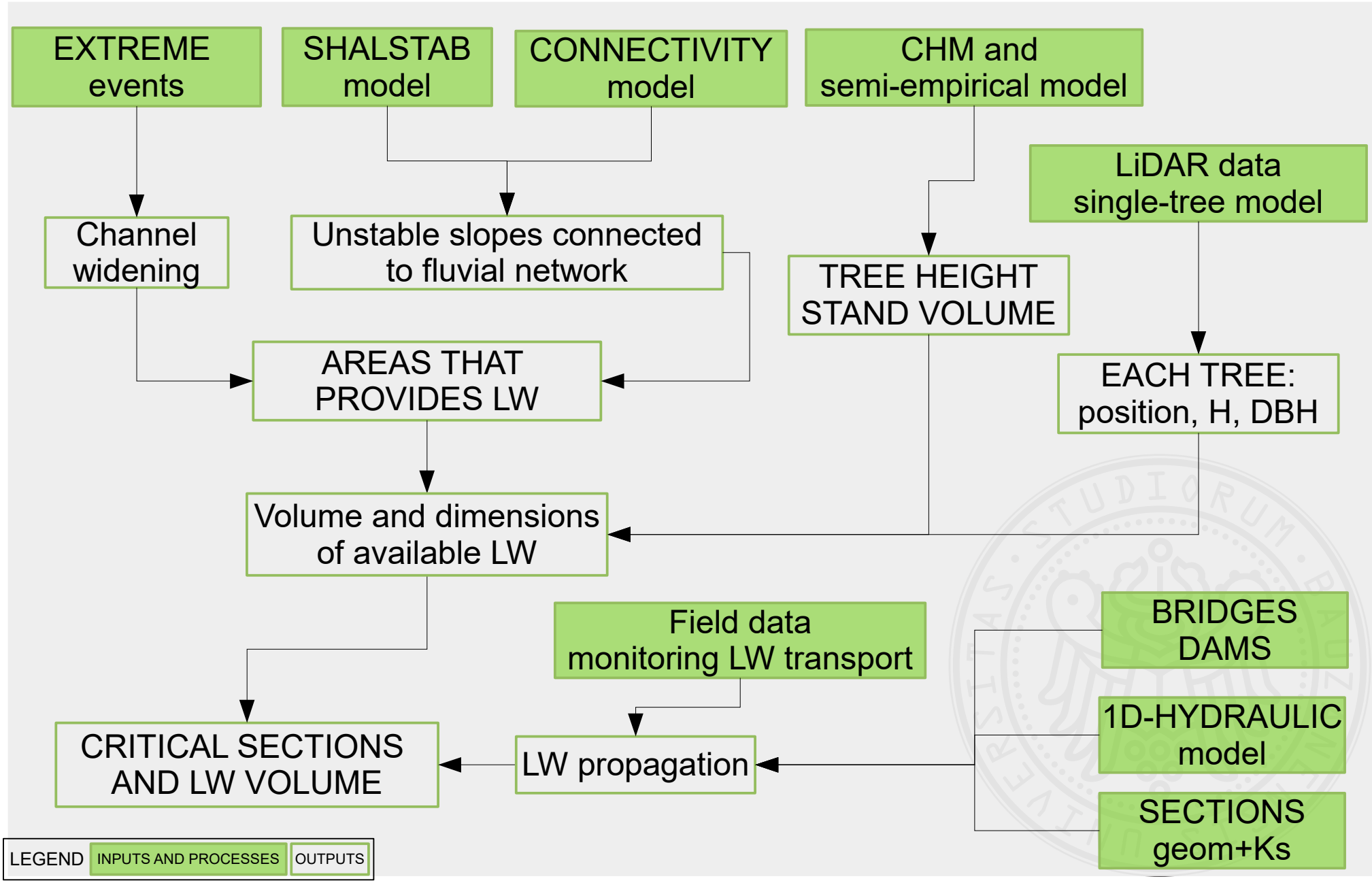


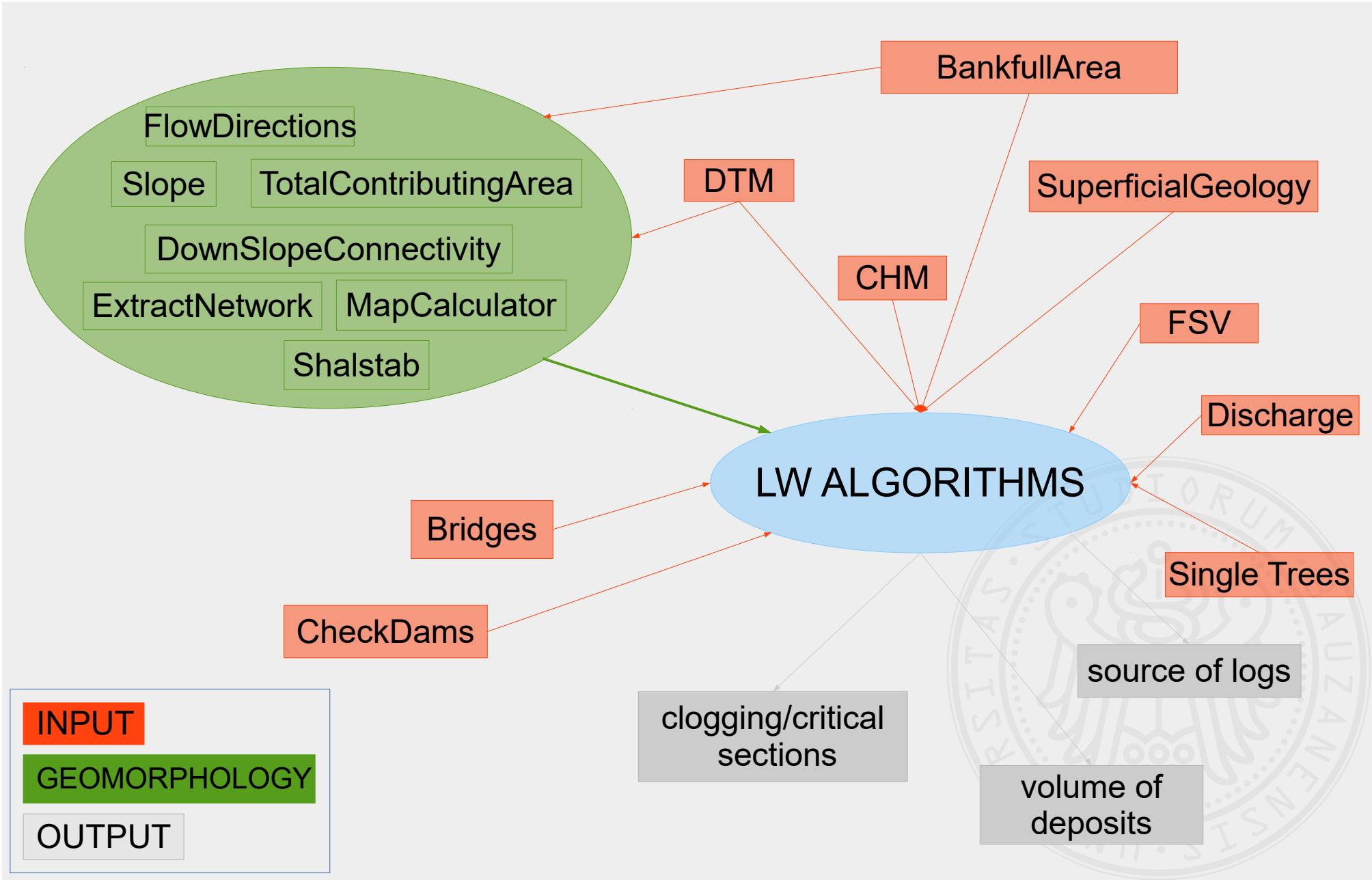
JGRASSTOOLS: LW PROPAGATION



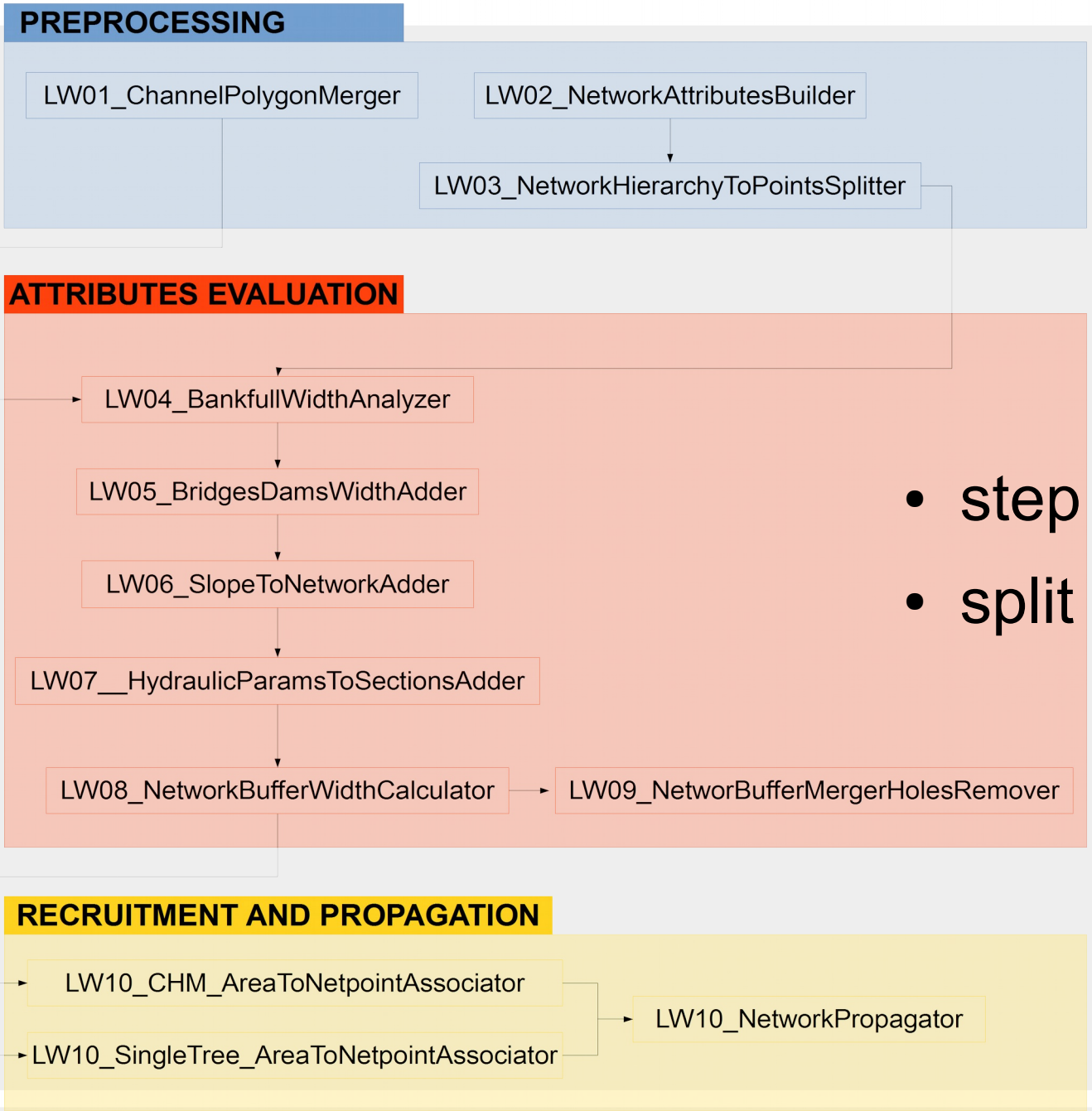
JGRASSTOOLS: PROPAGATION



JGRASSTOOLS: input & output



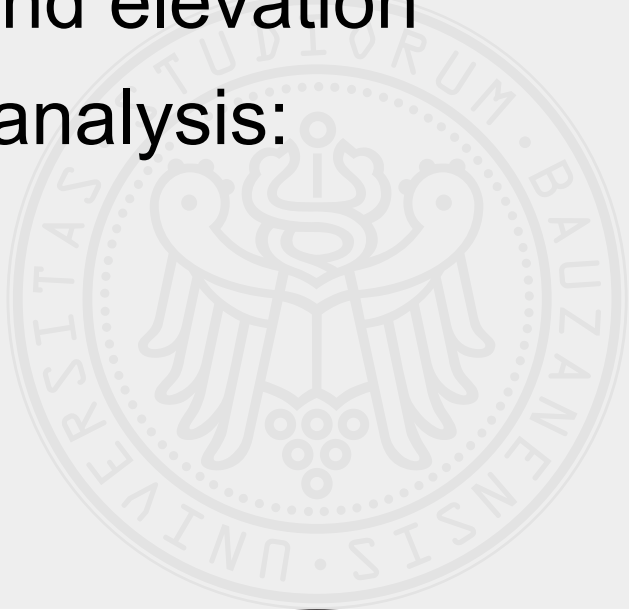
JGRASSTOOLS: workflow



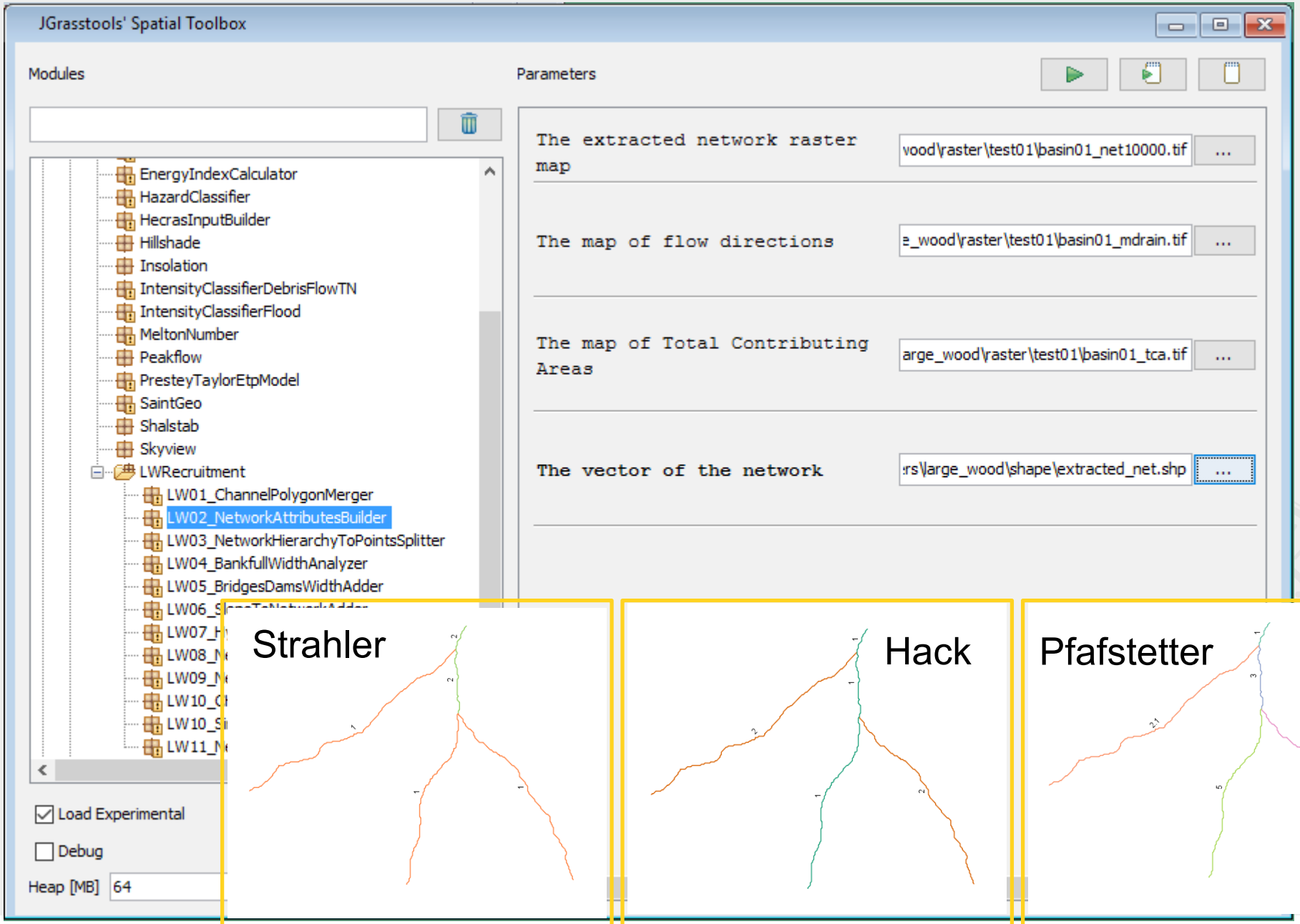
- step by step procedure
- split in submodules

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

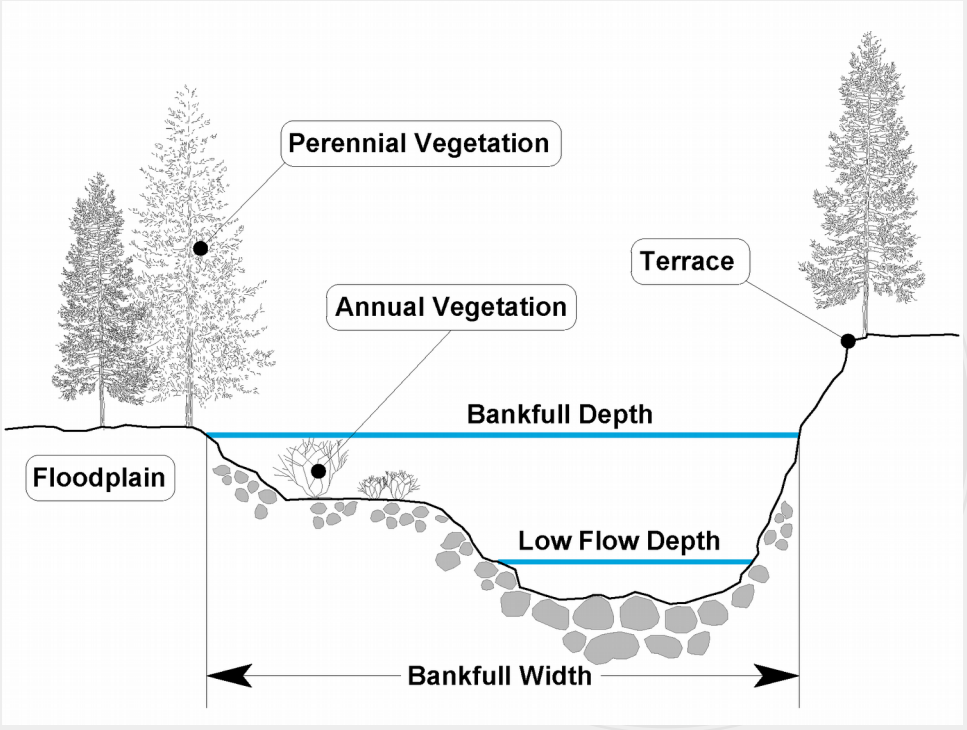


JGRASSTOOLS: network attributes



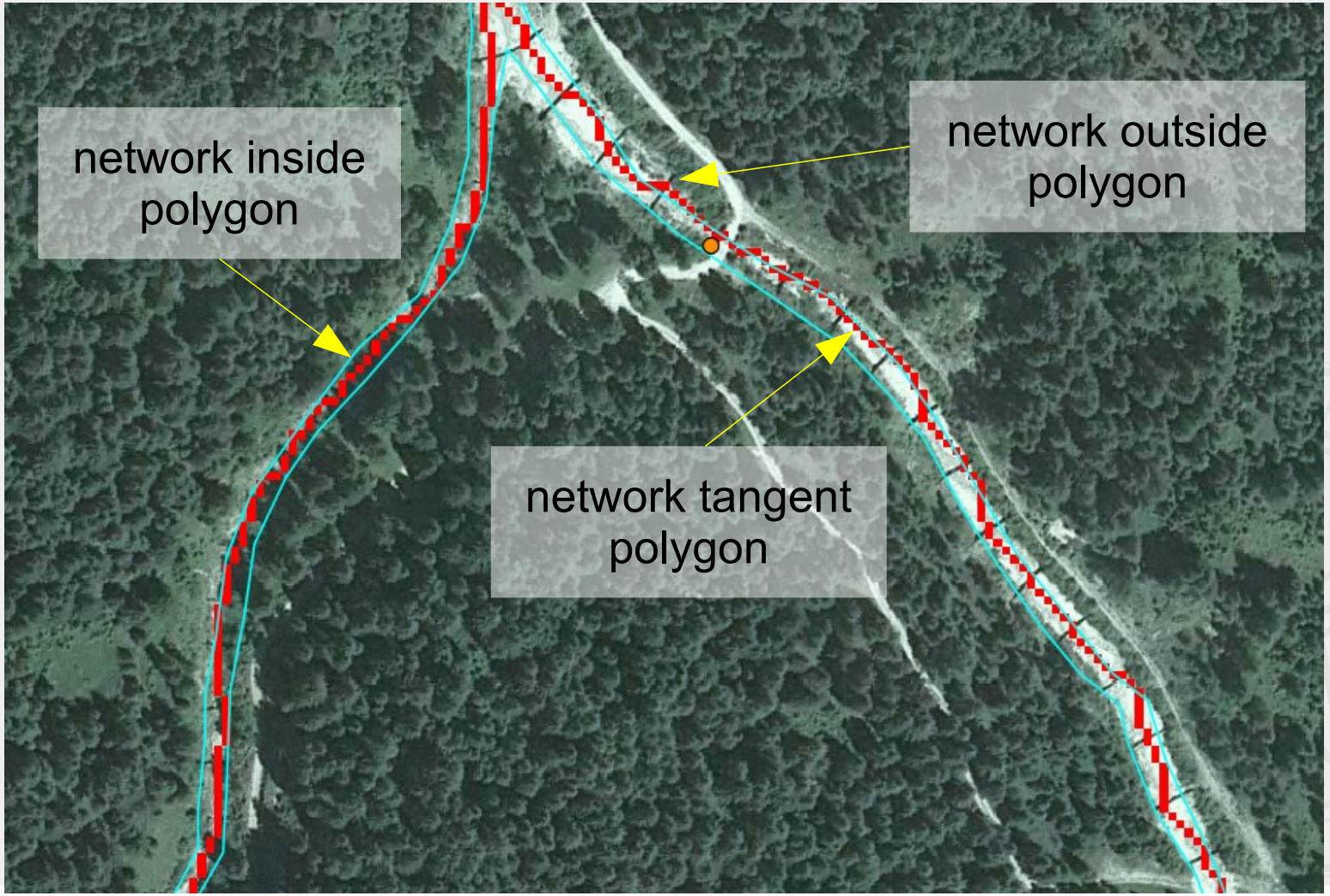
JGRASSTOOLS: bankfull width

- 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)



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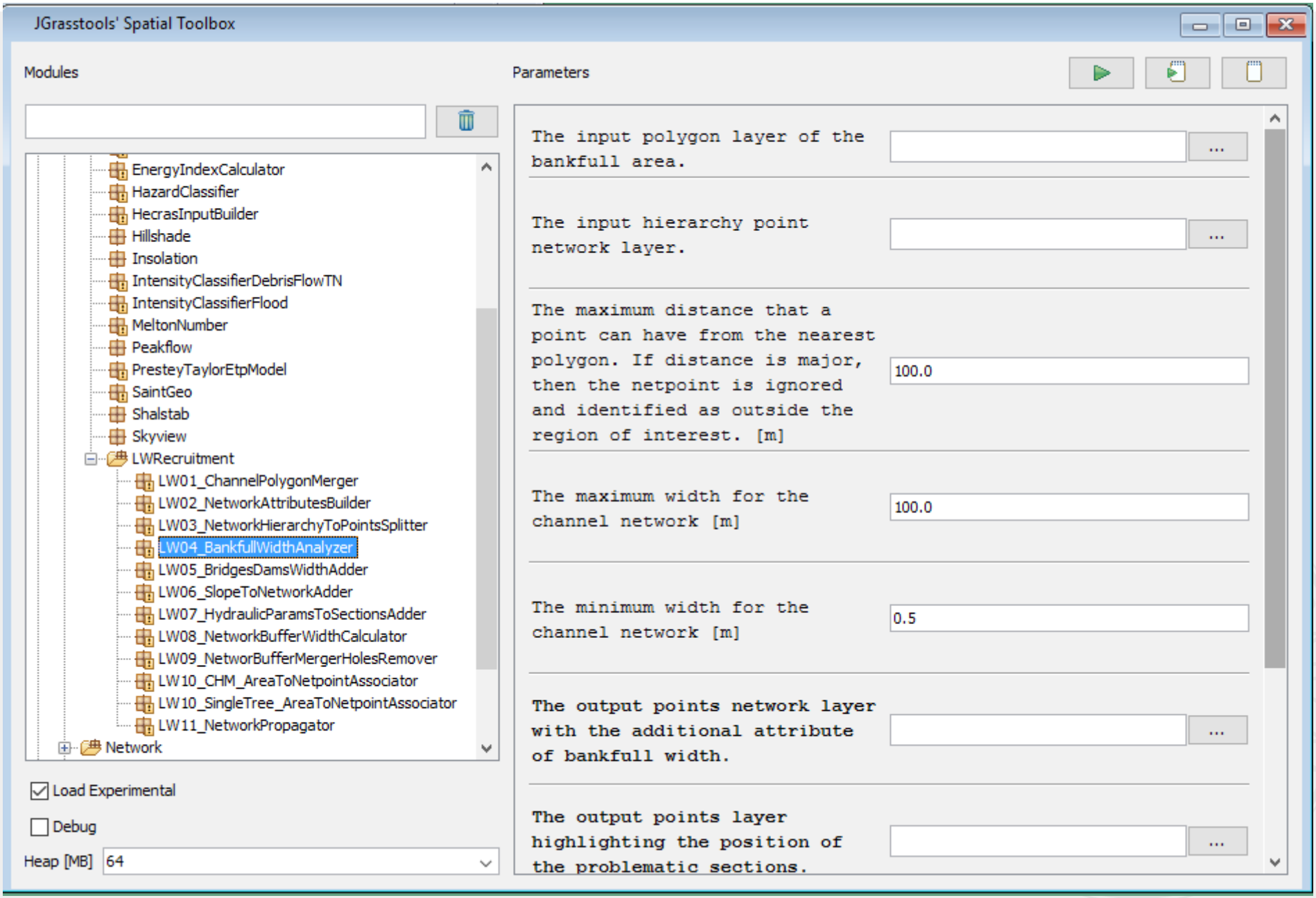

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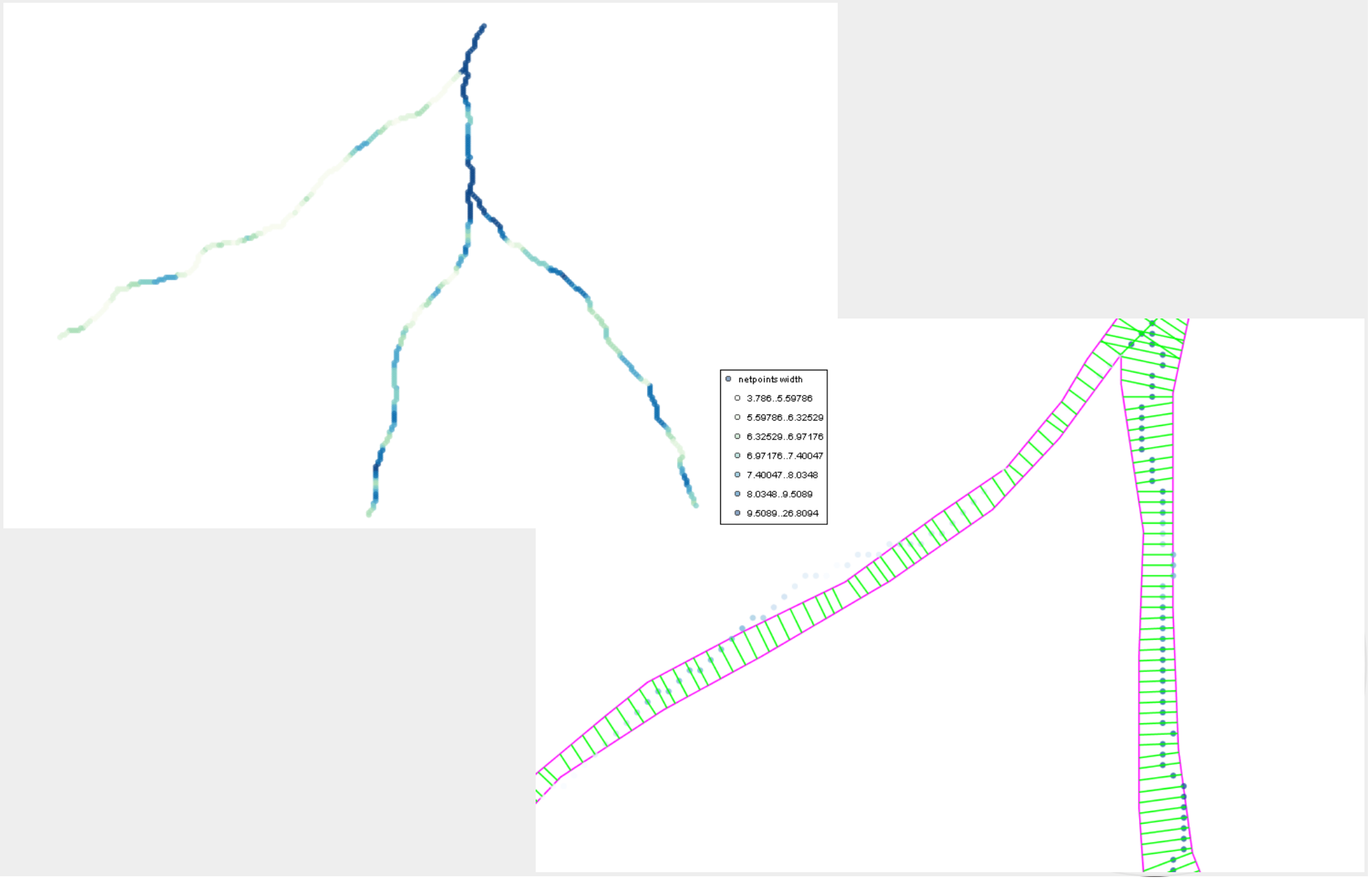


JGRASSTOOLS: bridges + dams width

- 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)

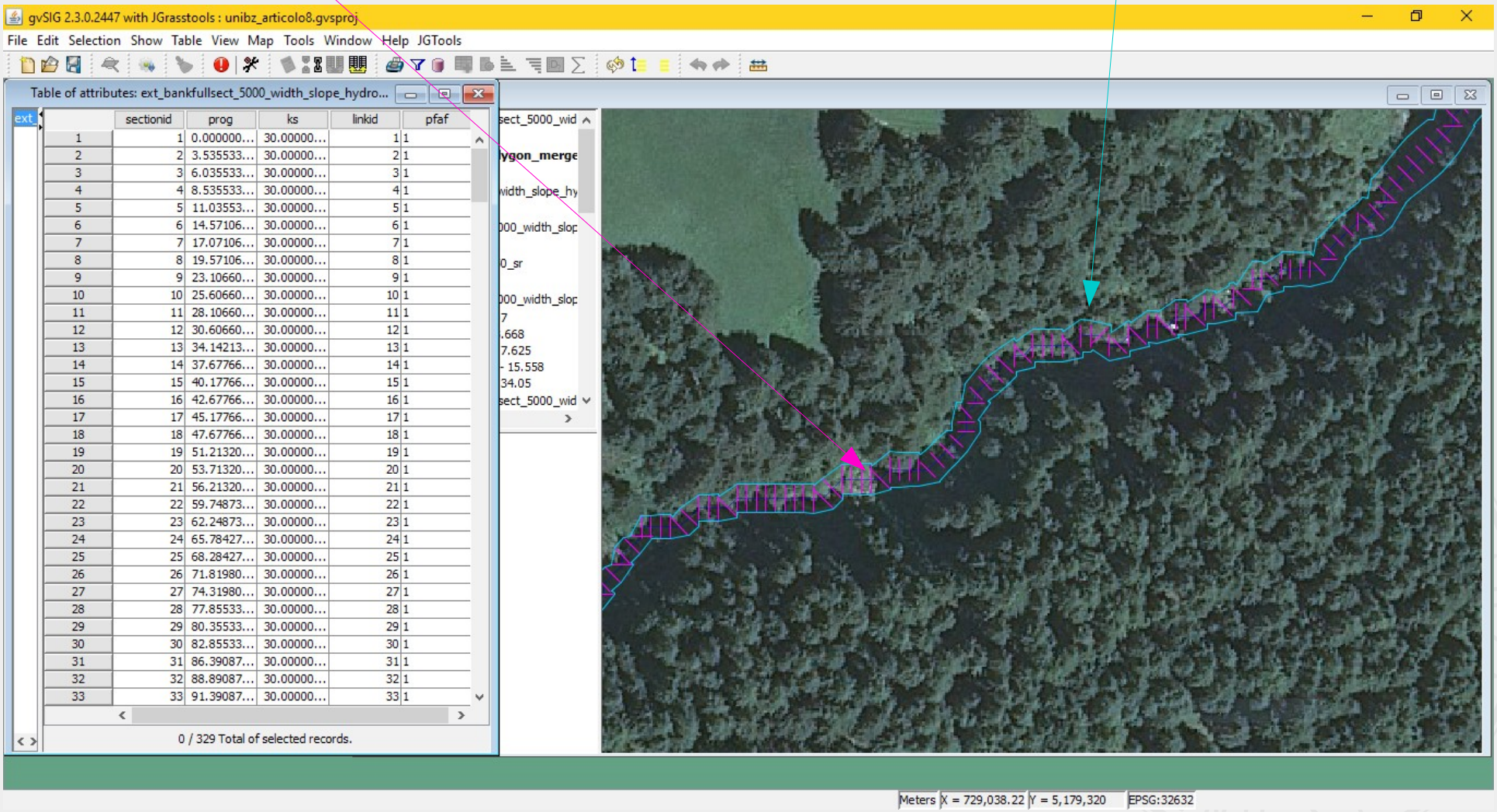
$$W_r = k \cdot \omega^n \qquad \omega = \frac{\gamma \cdot Q \cdot s}{width_{pre}}$$

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

JGRASSTOOLS: bank erosion

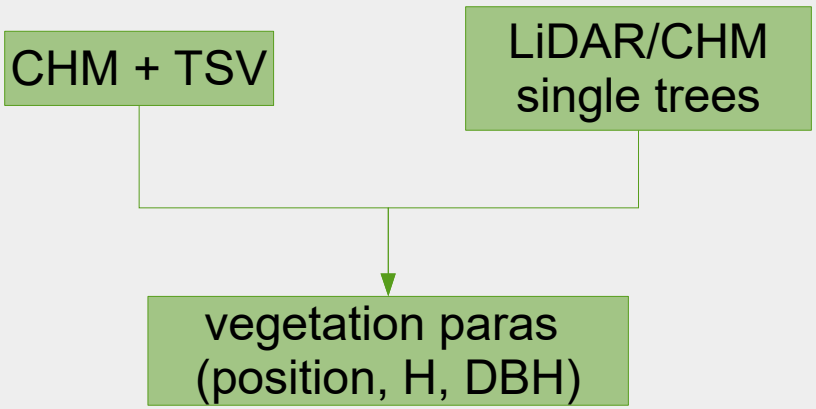
bankfull sections

event widening area



JGRASSTOOLS: LW from hillslopes

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



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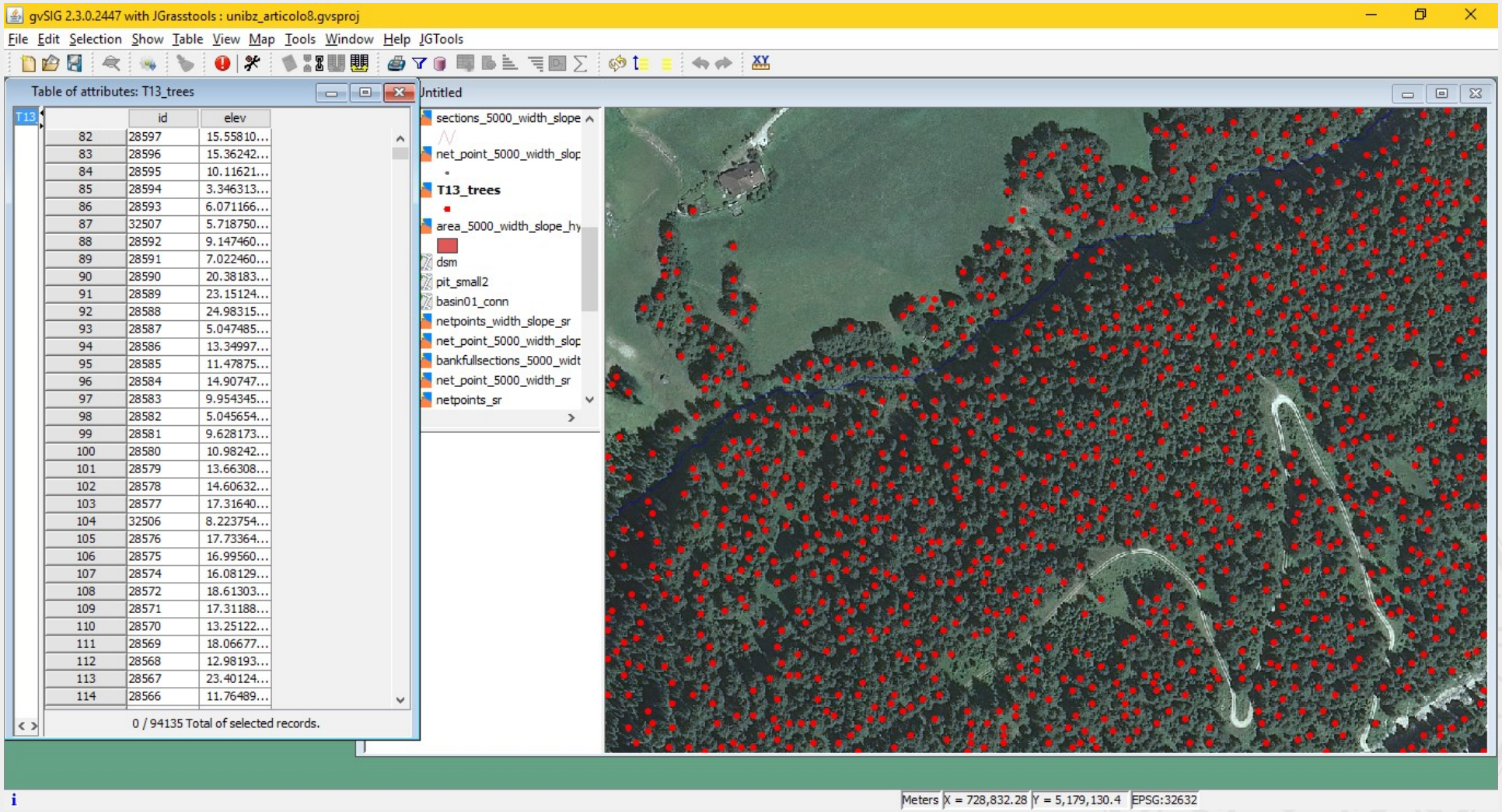
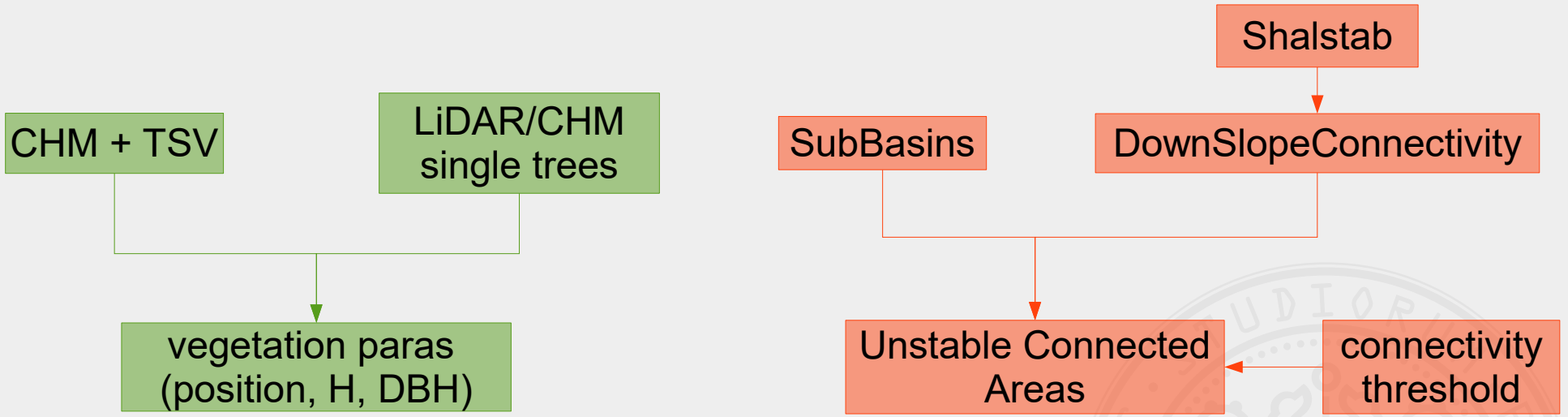


JGRASSTOOLS: LW from hillslopes

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



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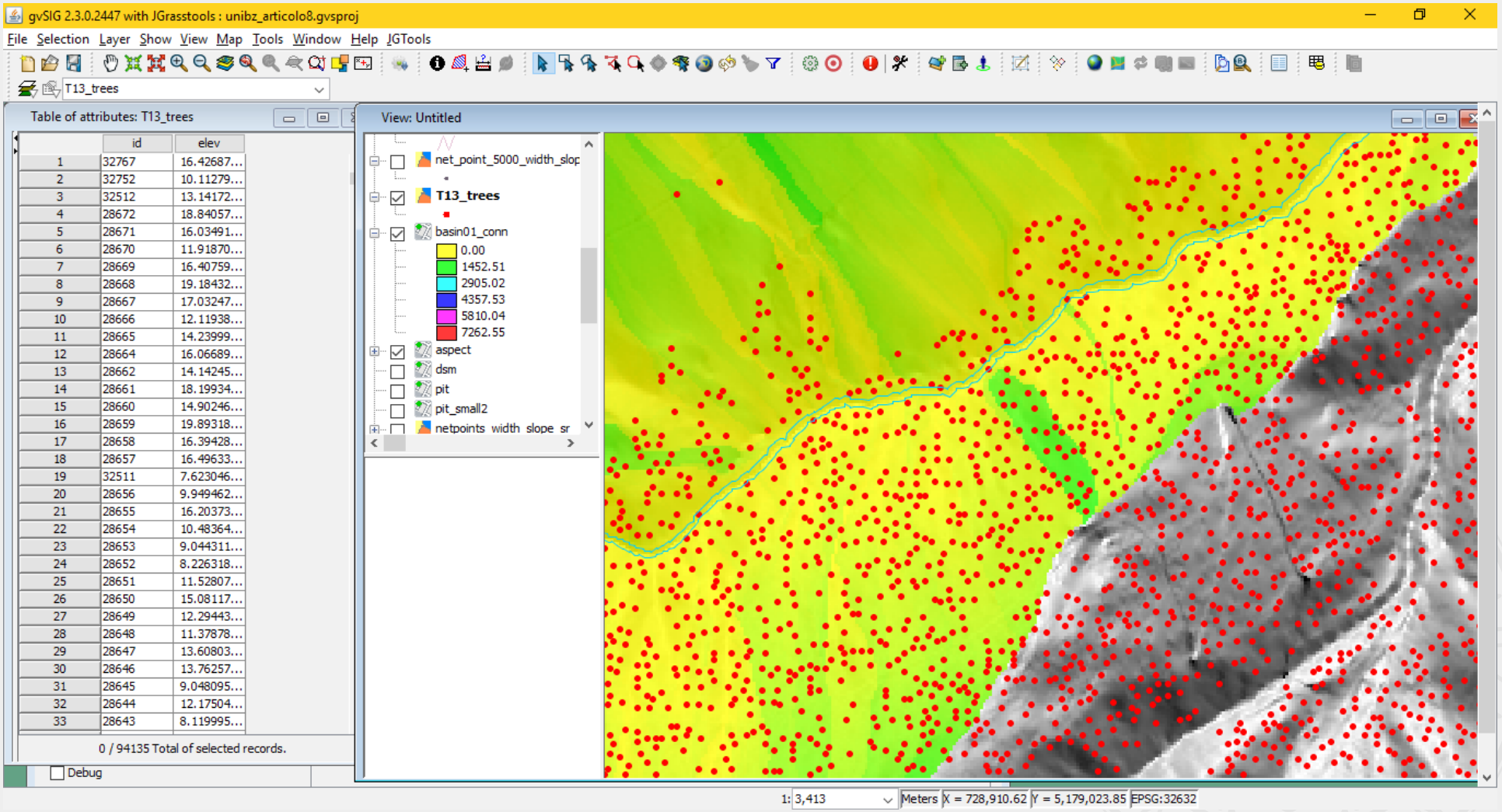

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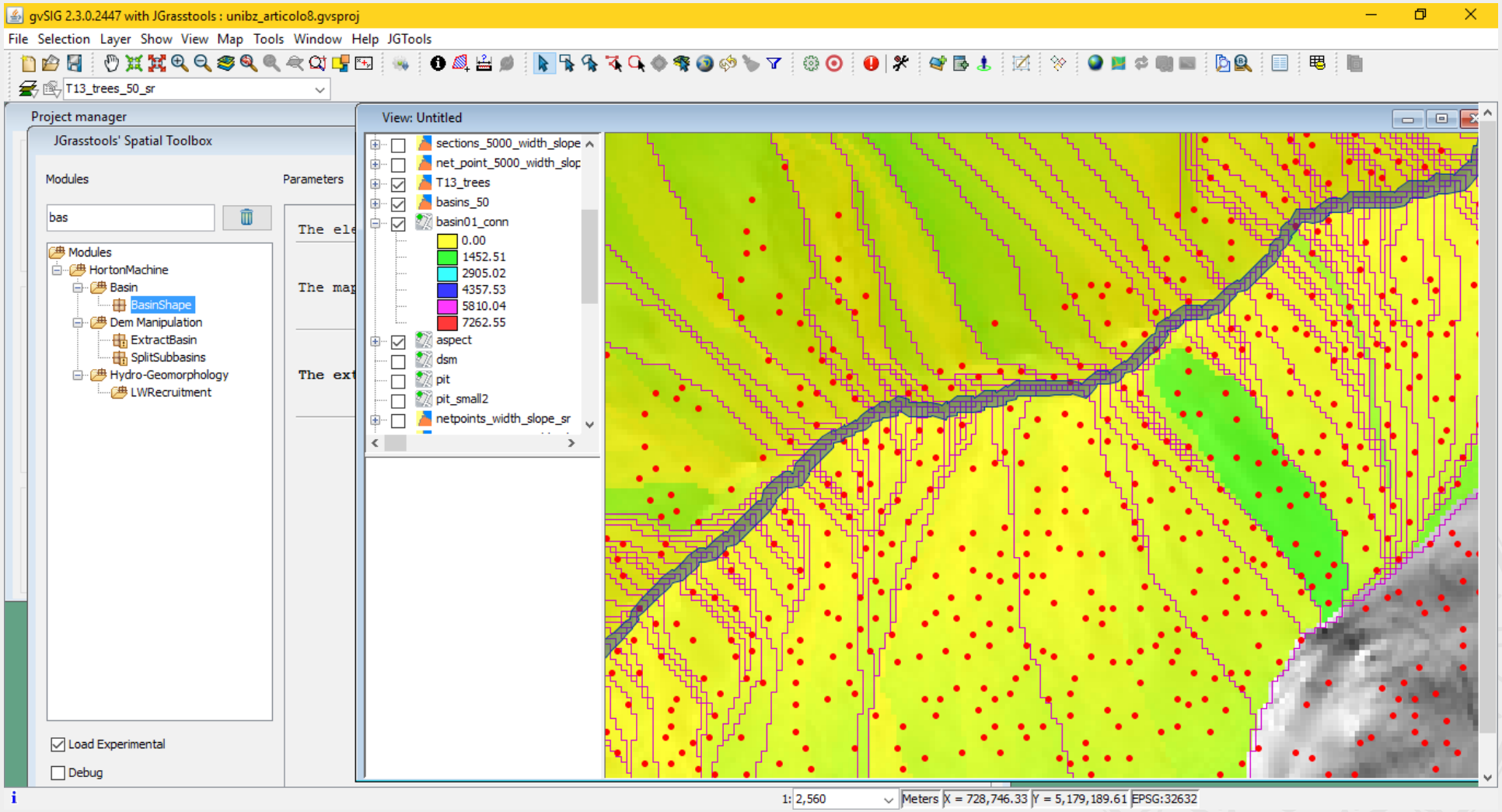

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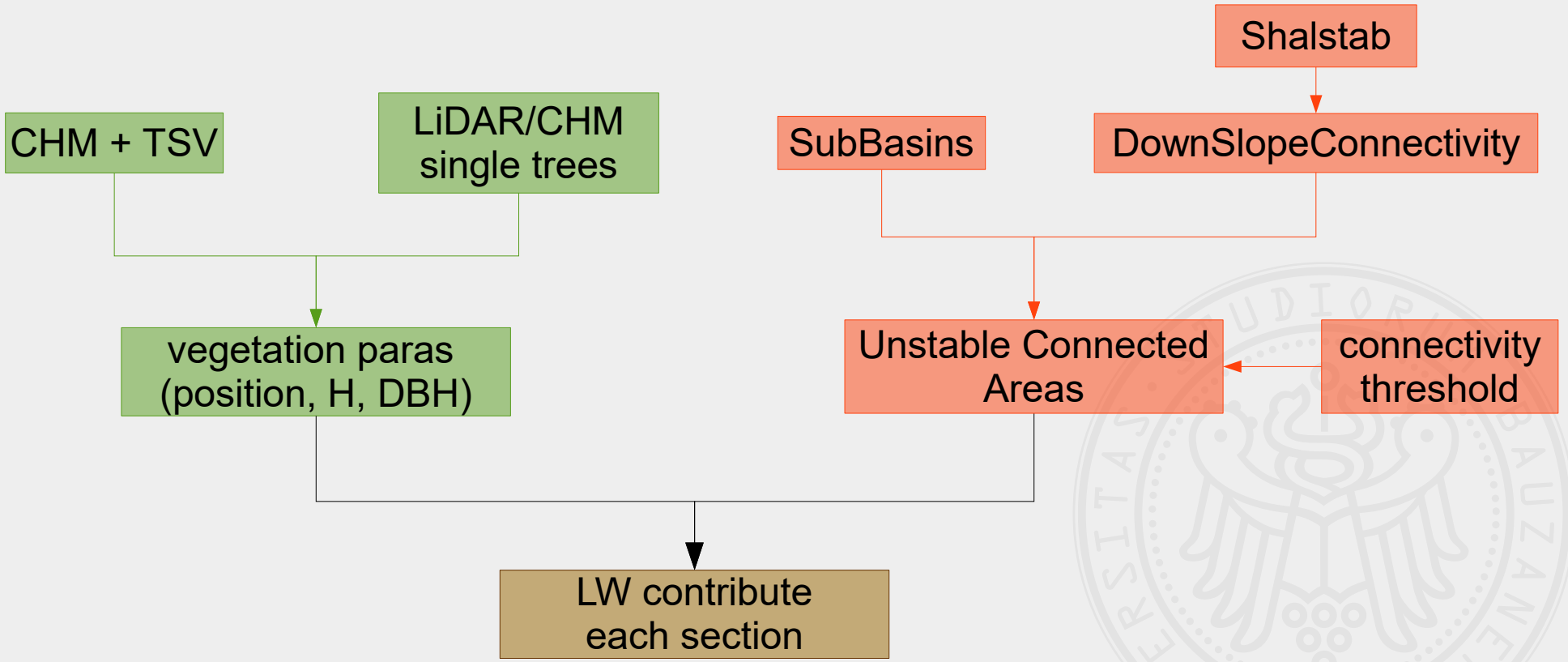

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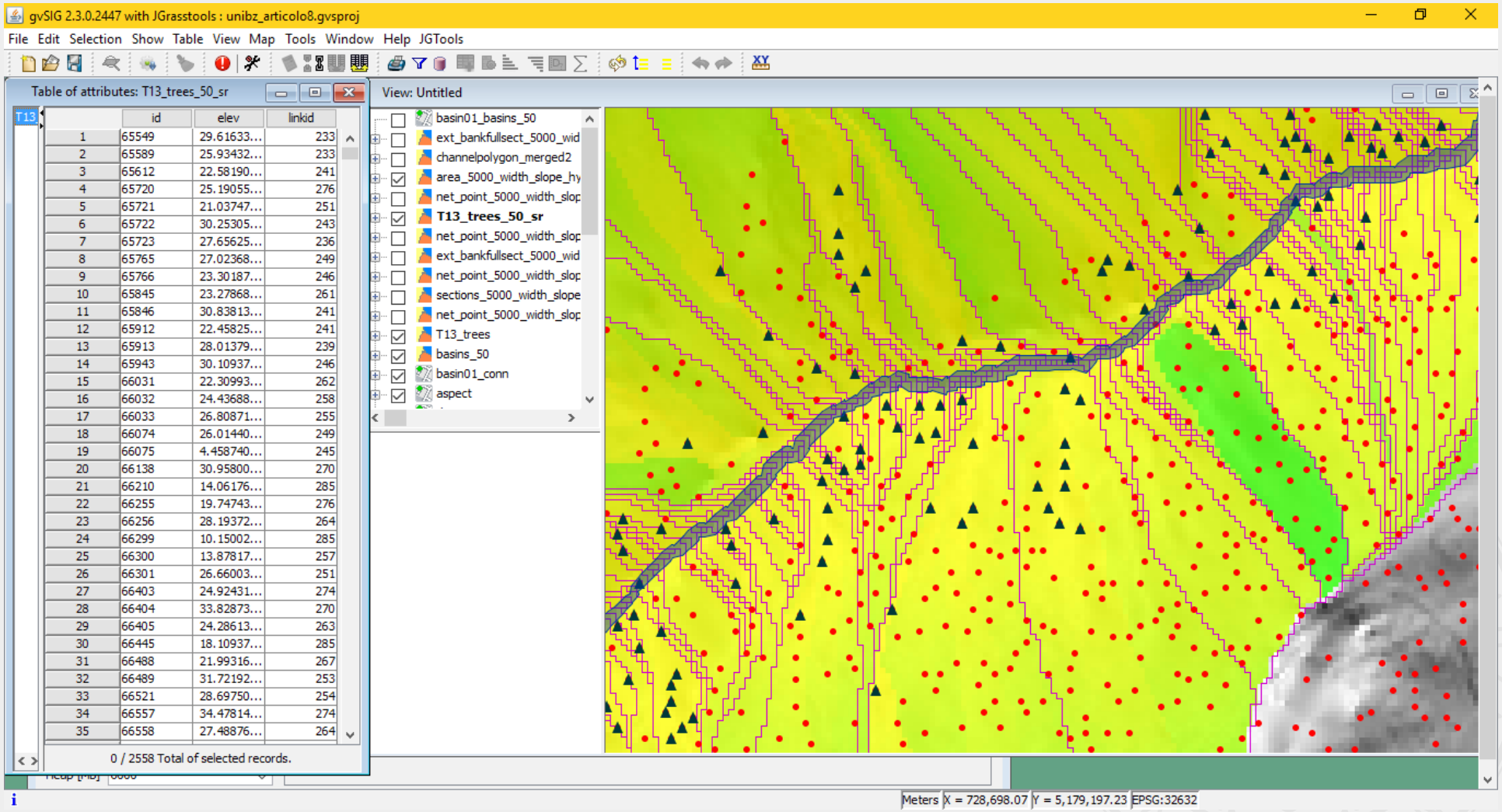

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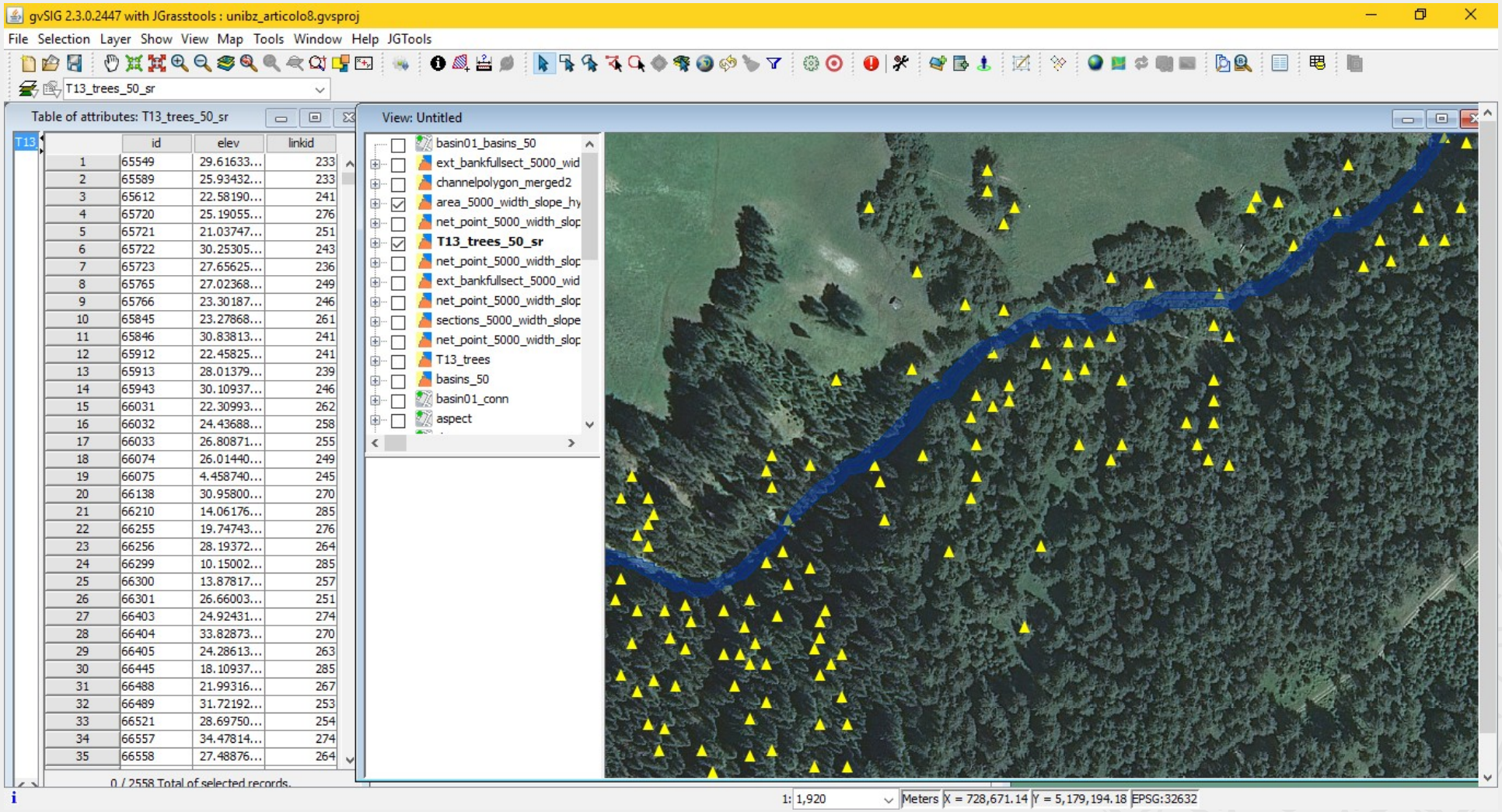
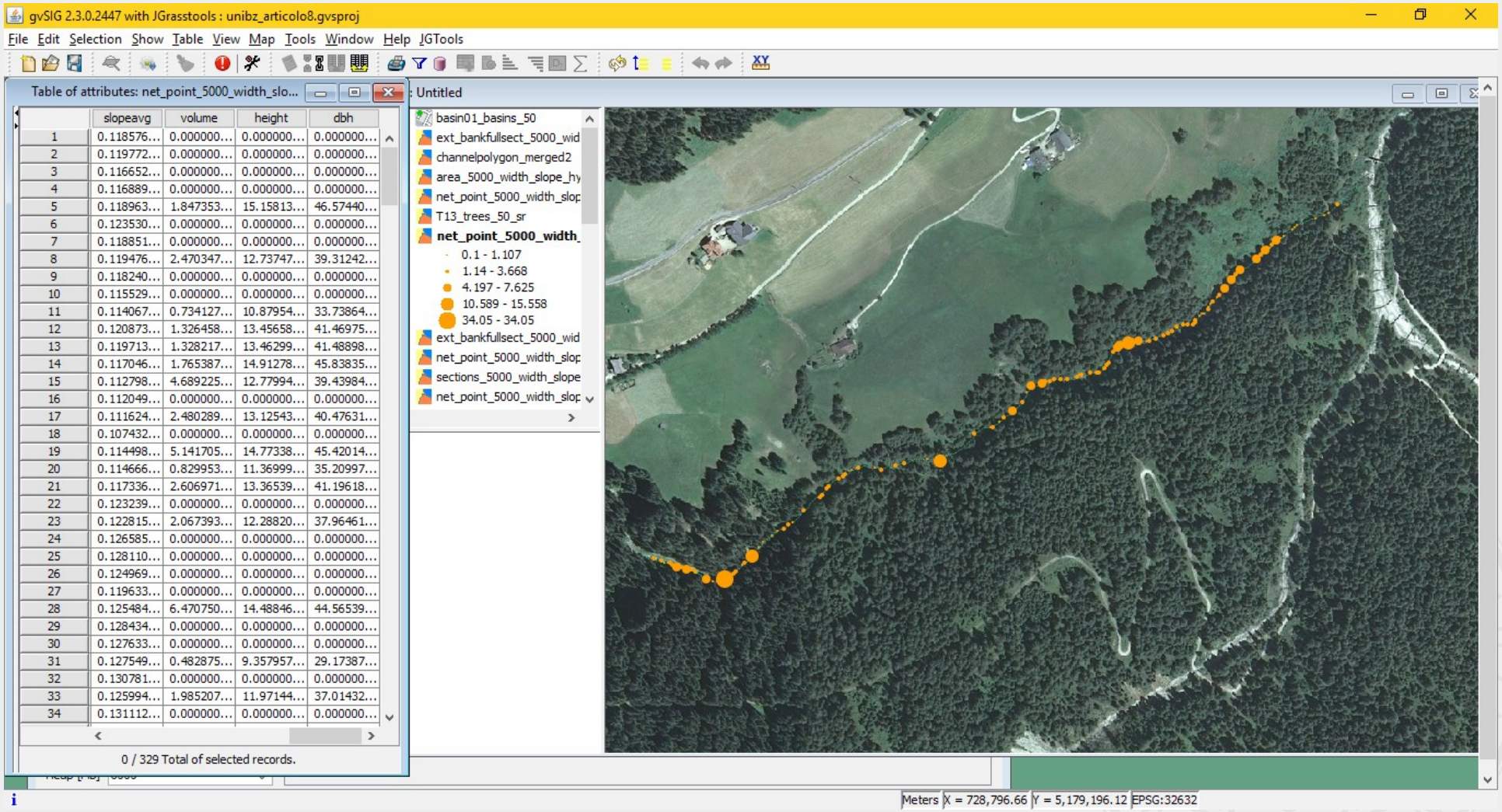


JGRASSTOOLS: LW recruitment

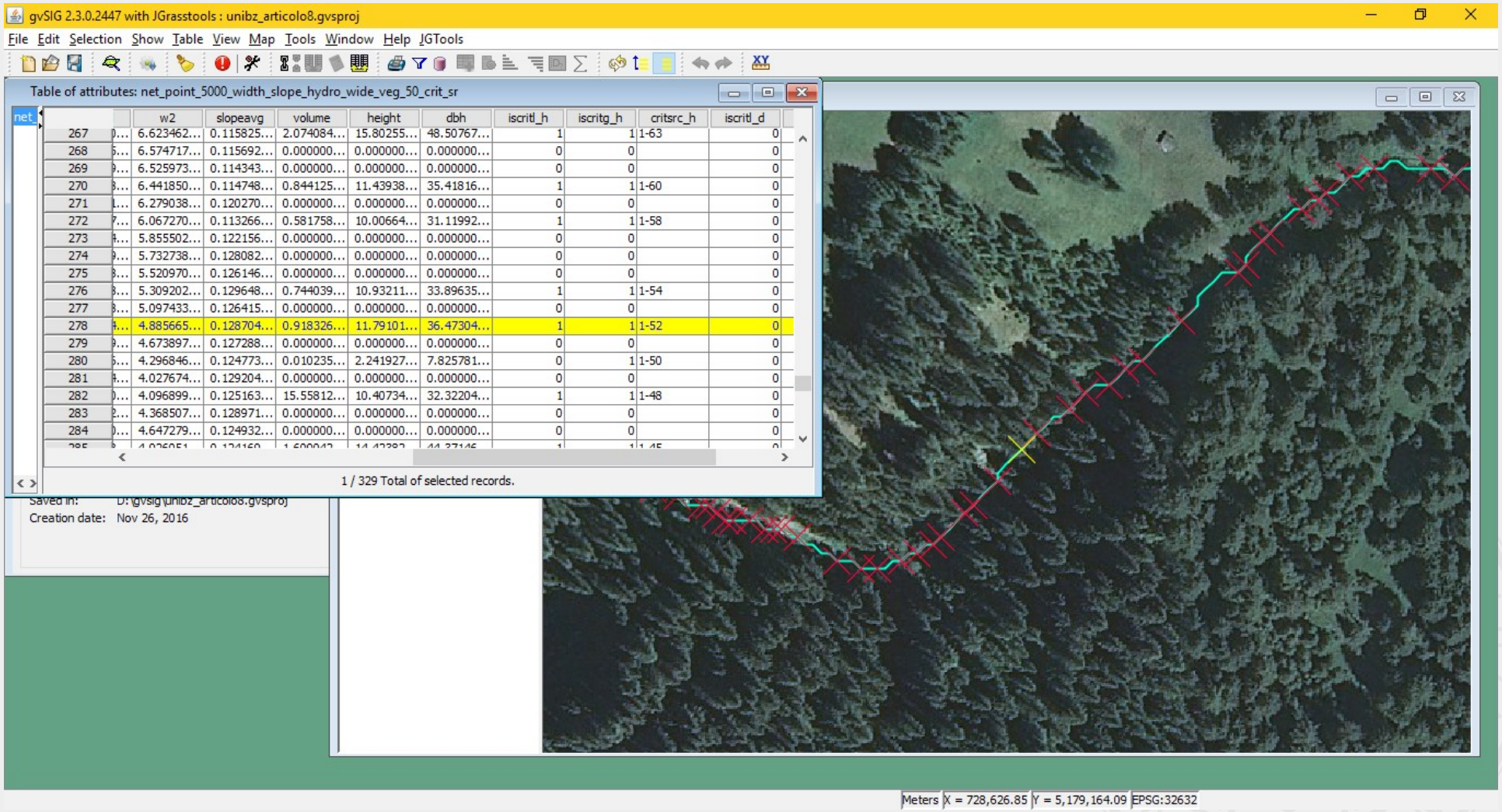


	slopeavg	volume	height	dbh
1	0.118576...	0.000000...	0.000000...	0.000000...
2	0.119772...	0.000000...	0.000000...	0.000000...
3	0.116652...	0.000000...	0.000000...	0.000000...
4	0.116889...	0.000000...	0.000000...	0.000000...
5	0.118963...	1.847353...	15.15813...	46.57440...
6	0.123530...	0.000000...	0.000000...	0.000000...
7	0.118851...	0.000000...	0.000000...	0.000000...
8	0.119476...	2.470347...	12.73747...	39.31242...
9	0.118240...	0.000000...	0.000000...	0.000000...
10	0.115529...	0.000000...	0.000000...	0.000000...
11	0.114067...	0.734127...	10.87954...	33.73864...
12	0.120873...	1.326458...	13.45658...	41.46975...
13	0.119713...	1.328217...	13.46299...	41.48898...
14	0.117046...	1.765387...	14.91278...	45.83835...
15	0.112798...	4.689225...	12.77994...	39.43984...
16	0.112049...	0.000000...	0.000000...	0.000000...
17	0.111624...	2.480289...	13.12543...	40.47631...
18	0.107432...	0.000000...	0.000000...	0.000000...
19	0.114498...	5.141705...	14.77338...	45.42014...
20	0.114666...	0.829953...	11.36999...	35.20997...
21	0.117336...	2.606971...	13.36539...	41.19618...
22	0.123239...	0.000000...	0.000000...	0.000000...
23	0.122815...	2.067393...	12.28820...	37.96461...
24	0.126585...	0.000000...	0.000000...	0.000000...
25	0.128110...	0.000000...	0.000000...	0.000000...
26	0.124969...	0.000000...	0.000000...	0.000000...
27	0.119633...	0.000000...	0.000000...	0.000000...
28	0.125484...	6.470750...	14.48846...	44.56539...
29	0.128434...	0.000000...	0.000000...	0.000000...
30	0.127633...	0.000000...	0.000000...	0.000000...
31	0.127549...	0.482875...	9.357957...	29.17387...
32	0.130781...	0.000000...	0.000000...	0.000000...
33	0.125994...	1.985207...	11.97144...	37.01432...
34	0.131112...	0.000000...	0.000000...	0.000000...

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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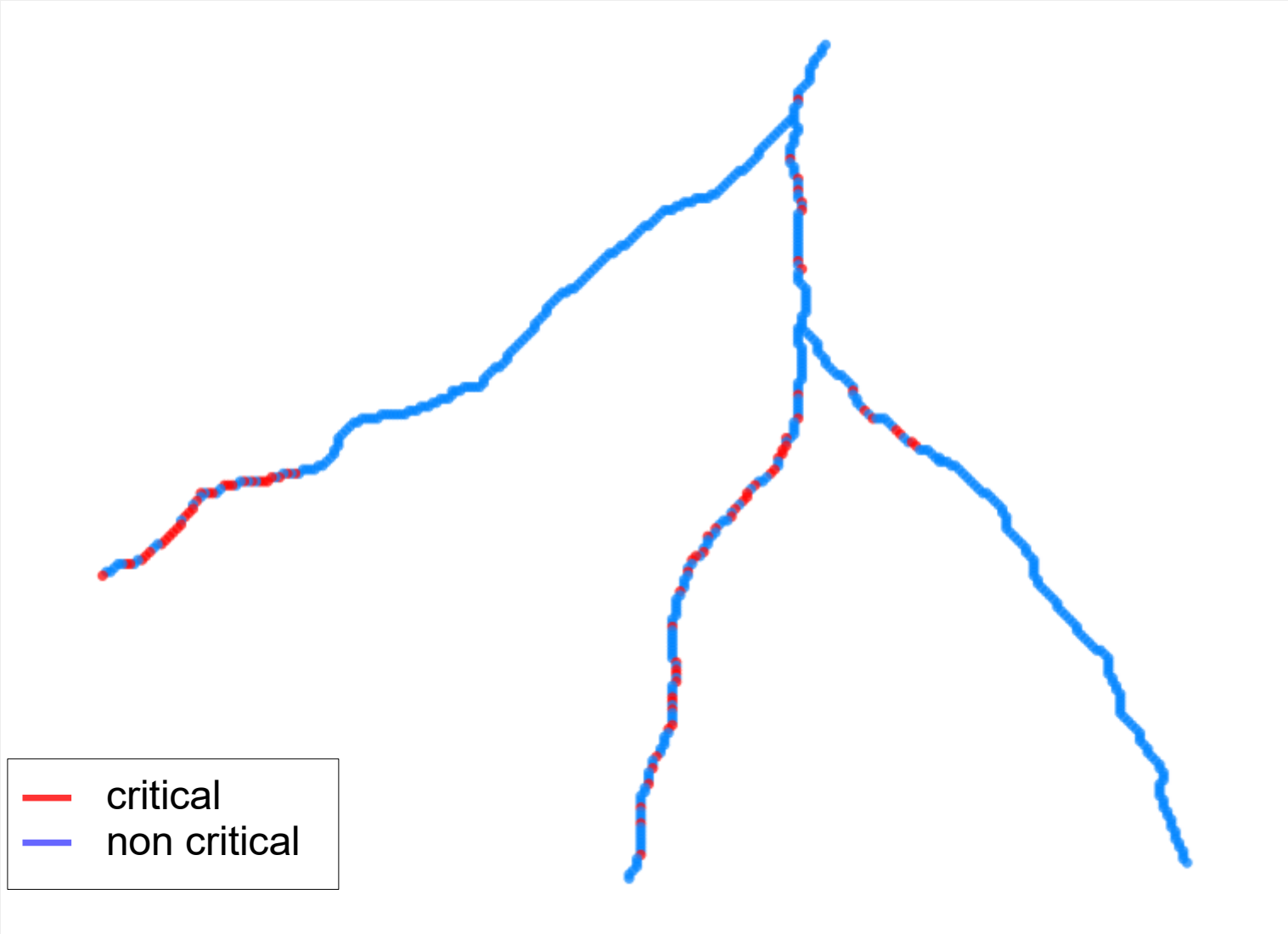

FUTURE PLANS

- 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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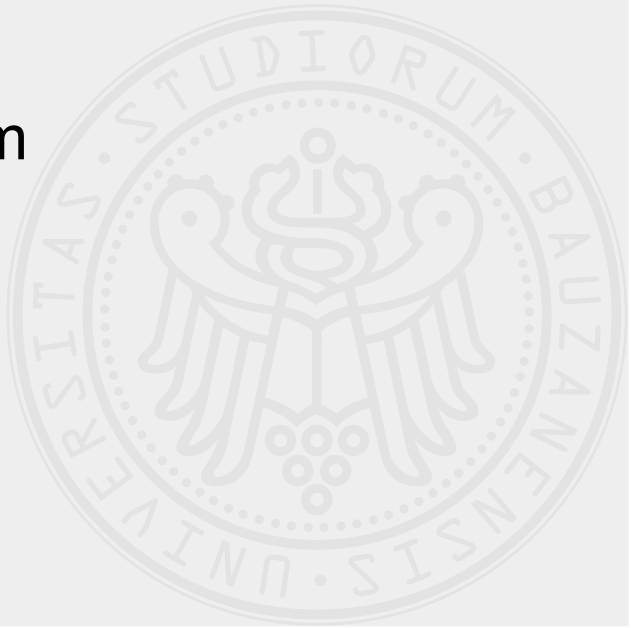

http://www.jgrasstools.org