

# **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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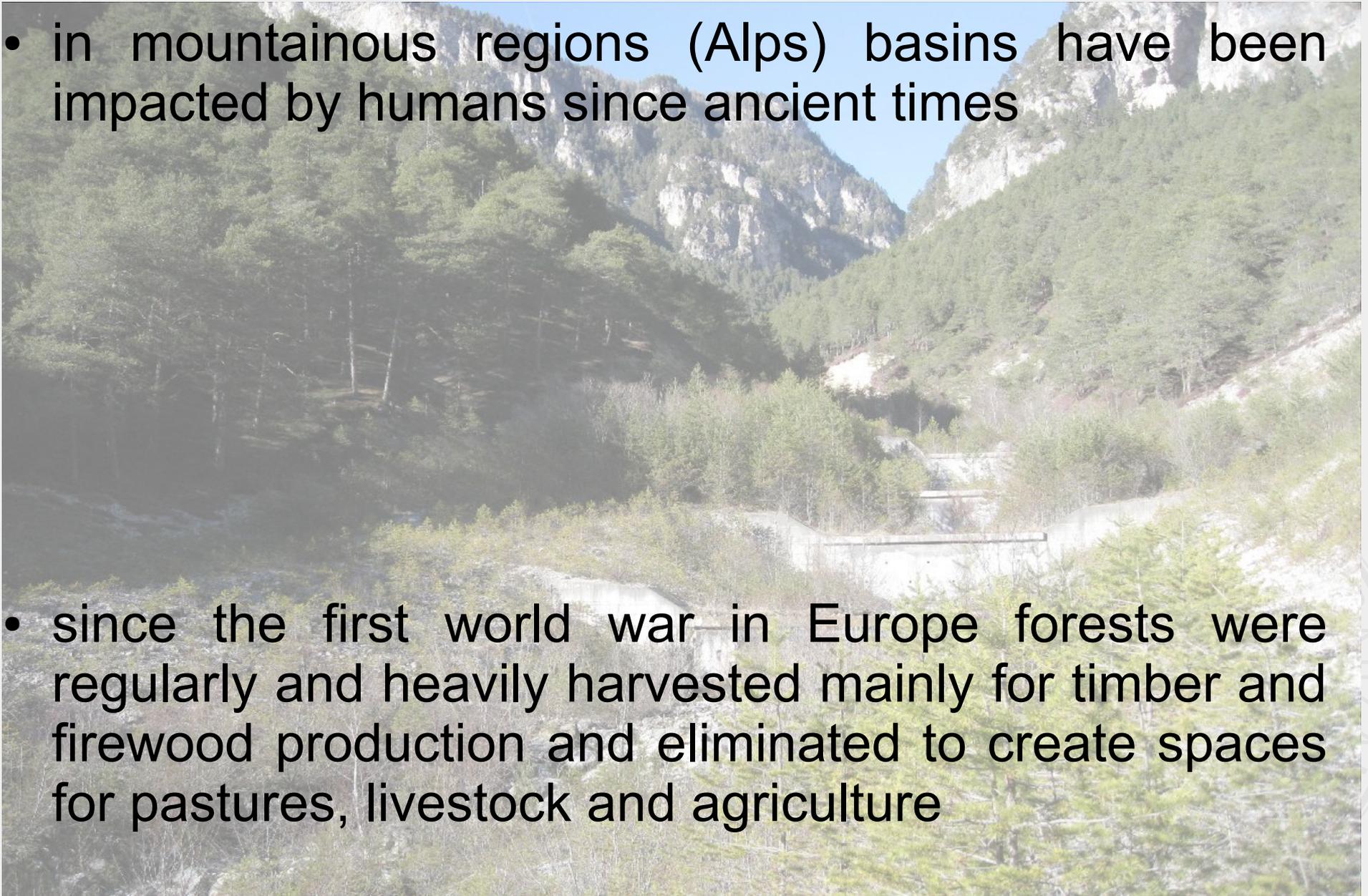
# WHO AM I?

- 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



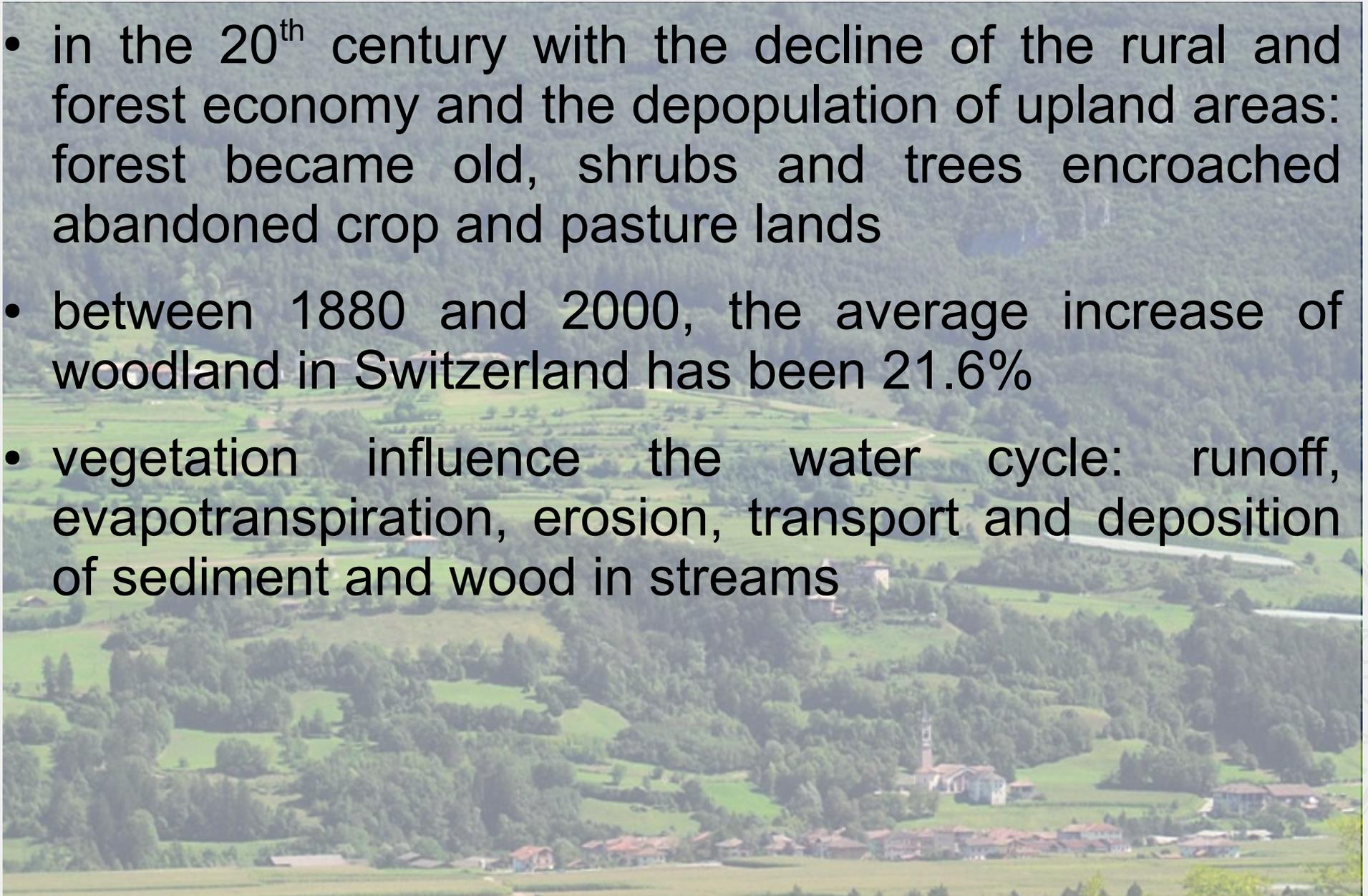
# INTRODUCTION

- 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 20<sup>th</sup> 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

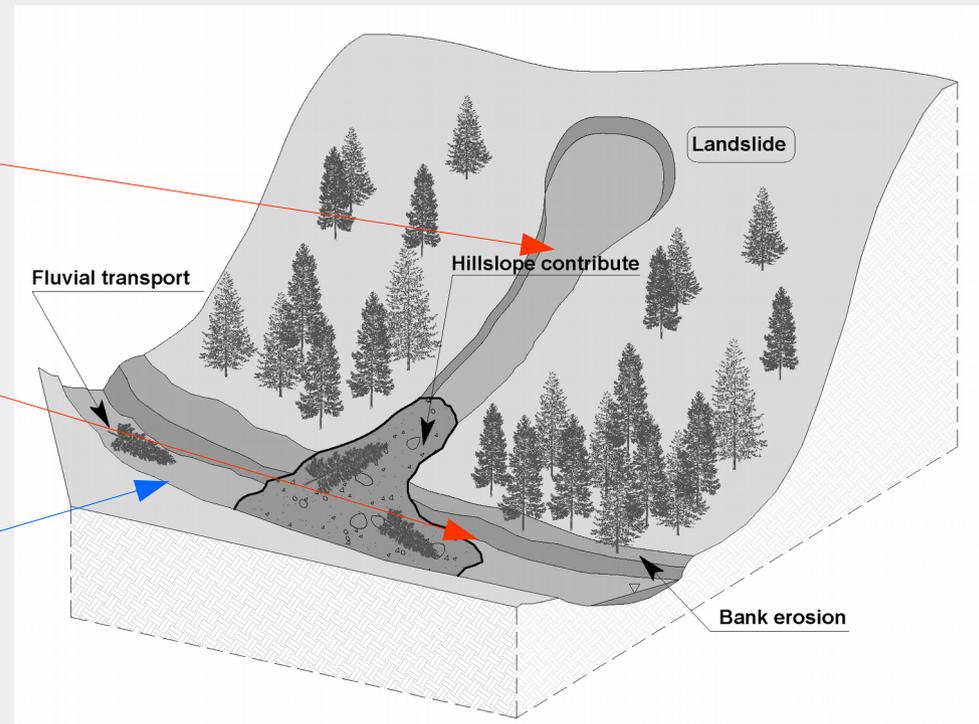


# INTRODUCTION

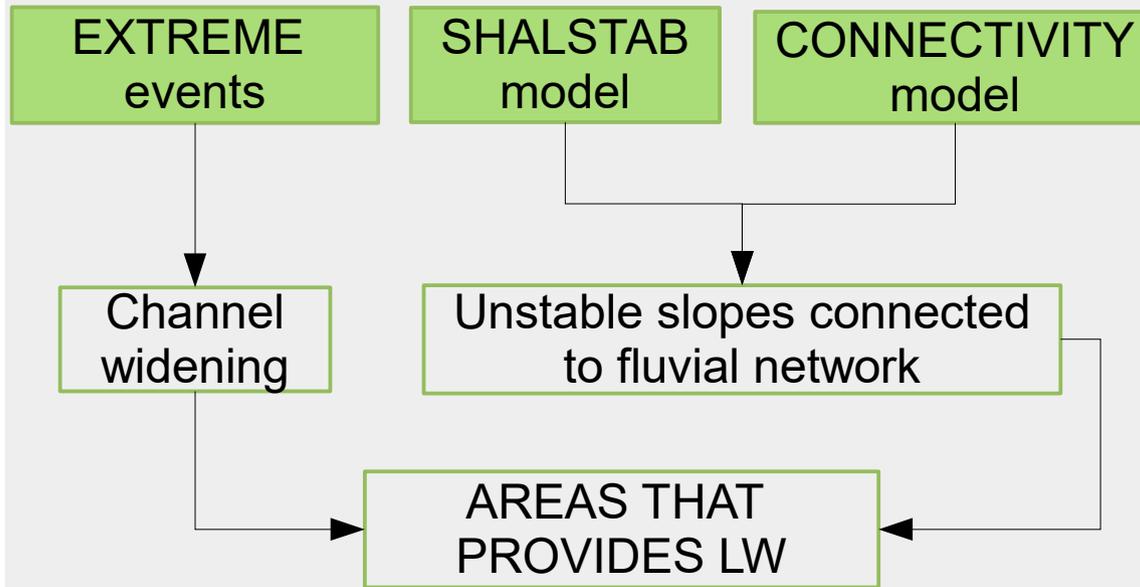


# INTRODUCTION

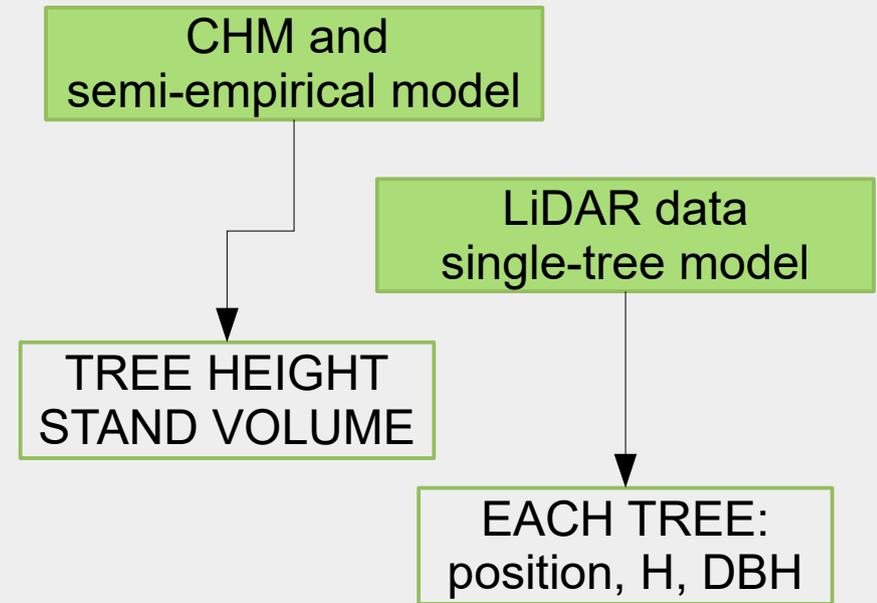
- **GIS-based** tool for predicting the magnitude of **LW** transport during flood events at any given **section** within a river basin
- two main processes related to woody debris:
  - **LW recruitment**
    - from hillslopes
    - from bank erosion (geology)
  - **LW transport/propagation** along the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



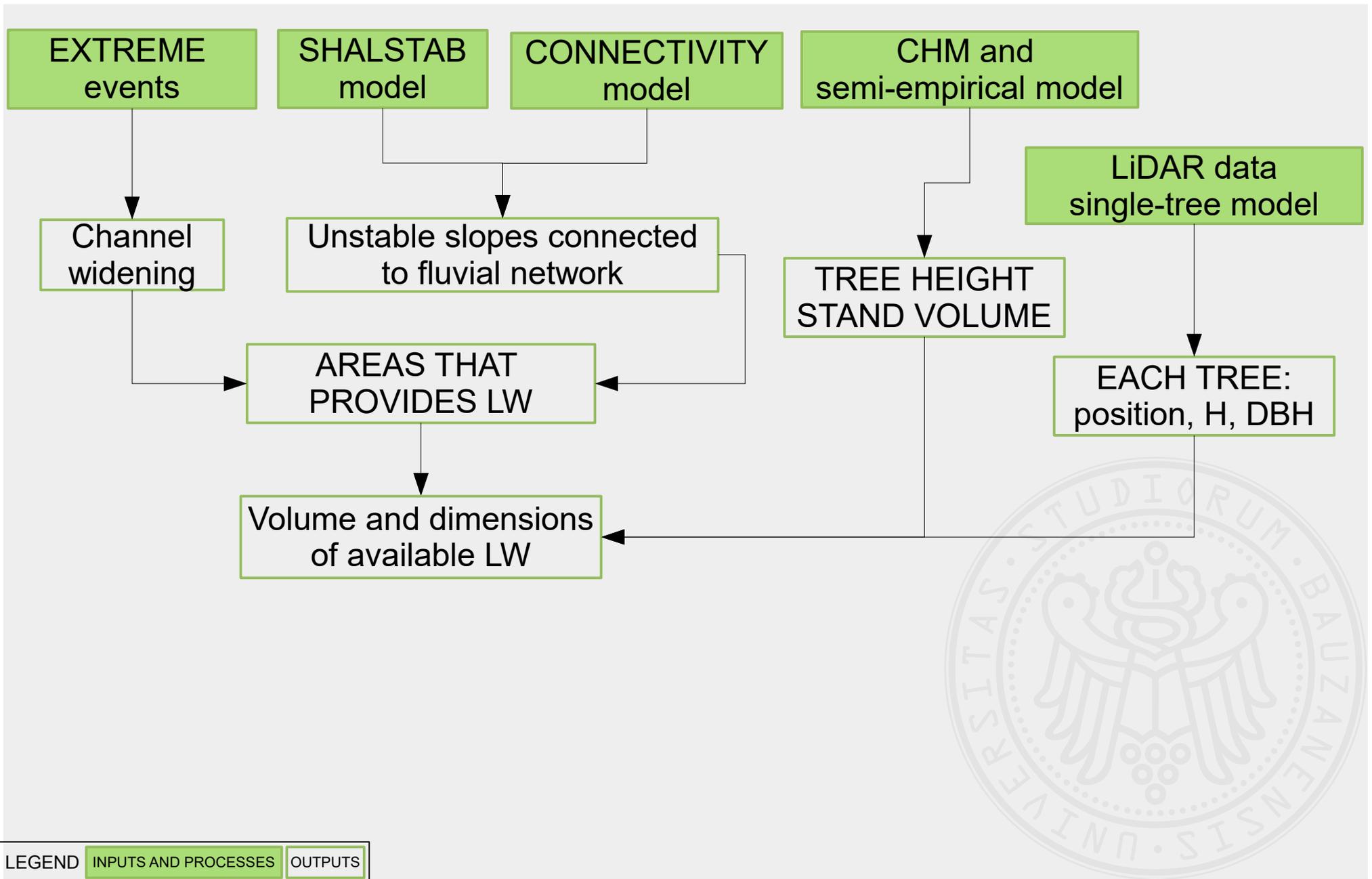
# JGRASSTOOLS: LW RECRUITMENT



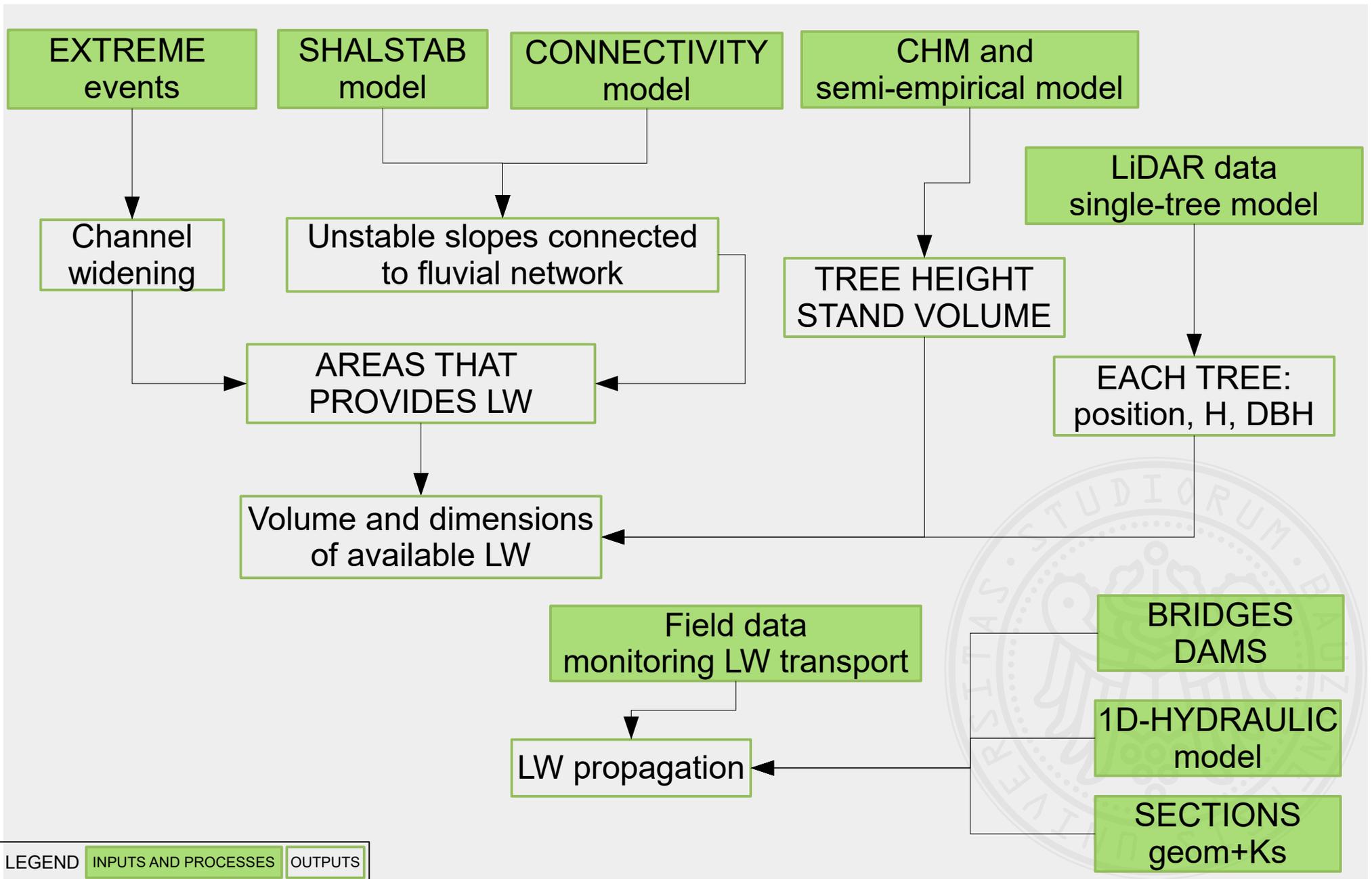
# JGRASSTOOLS: LW RECRUITMENT



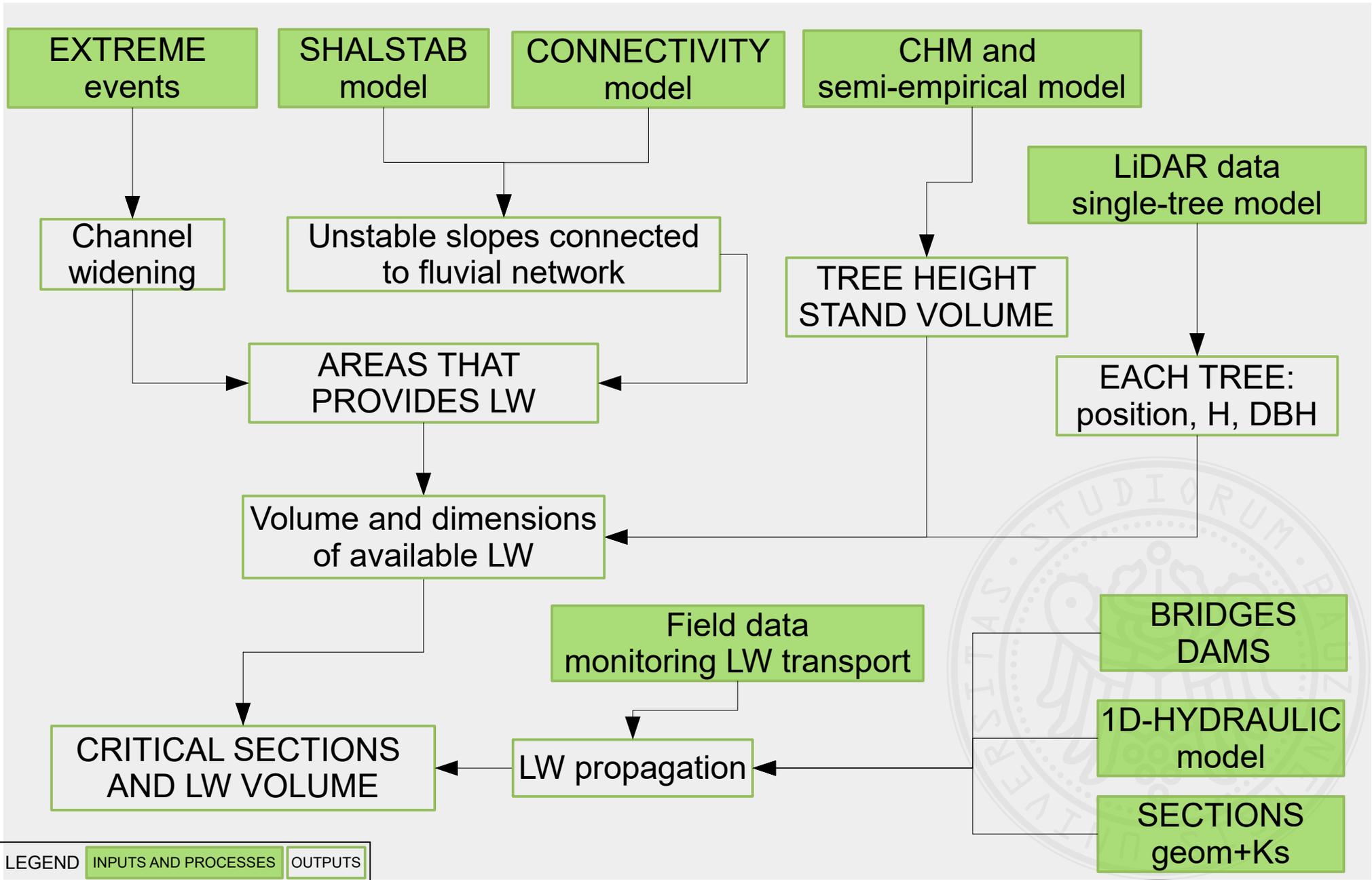
# JGRASSTOOLS: LW RECRUITMENT



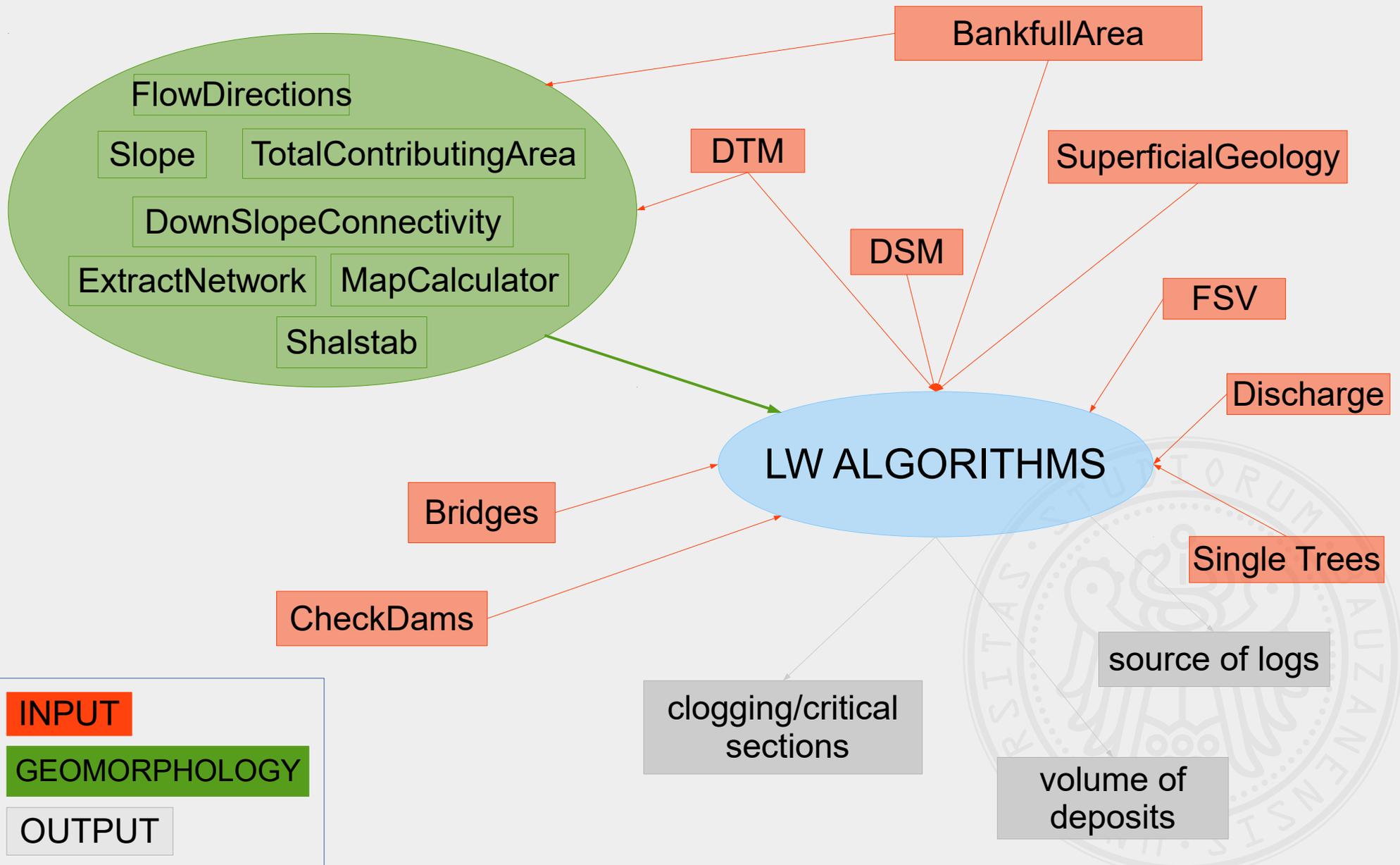
# JGRASSTOOLS: LW PROPAGATION



# 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

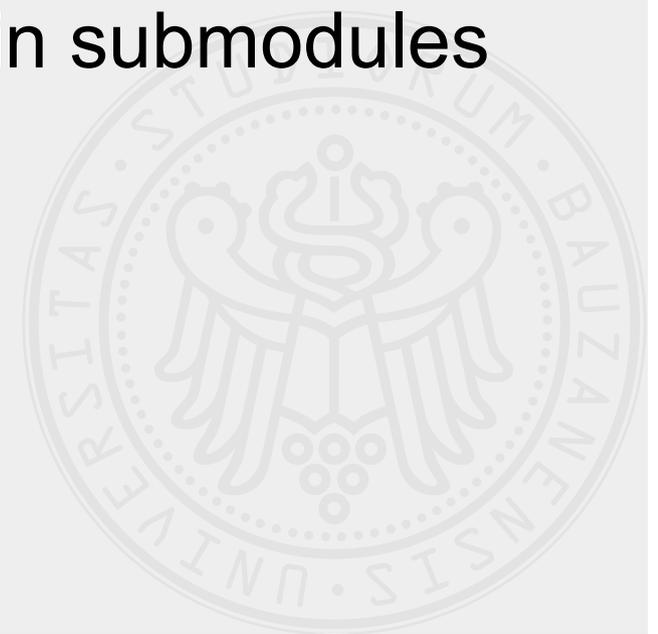
- step by step procedure
- split in submodules

## RECRUITMENT AND PROPAGATION

LW10\_CHM\_AreaToNetpointAssociator

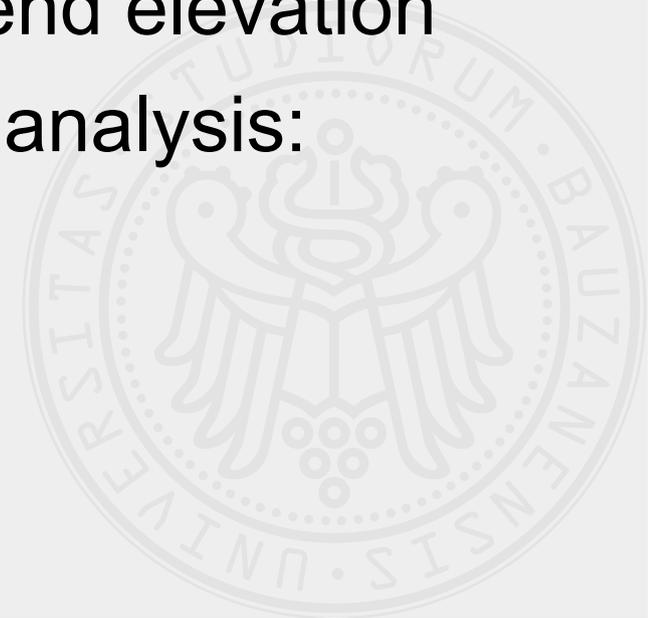
LW10\_SingleTree\_AreaToNetpointAssociator

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\_S
  - LW11\_N

Parameters

The extracted network raster map: wood\yaster\test01\basin01\_net10000.tif

The map of flow directions: e\_wood\yaster\test01\basin01\_mdtrain.tif

The map of Total Contributing Areas: arge\_wood\yaster\test01\basin01\_tca.tif

The vector of the network: :rs\arge\_wood\shape\extracted\_net.shp

Load Experimental  
 Debug  
Heap [MB] 64

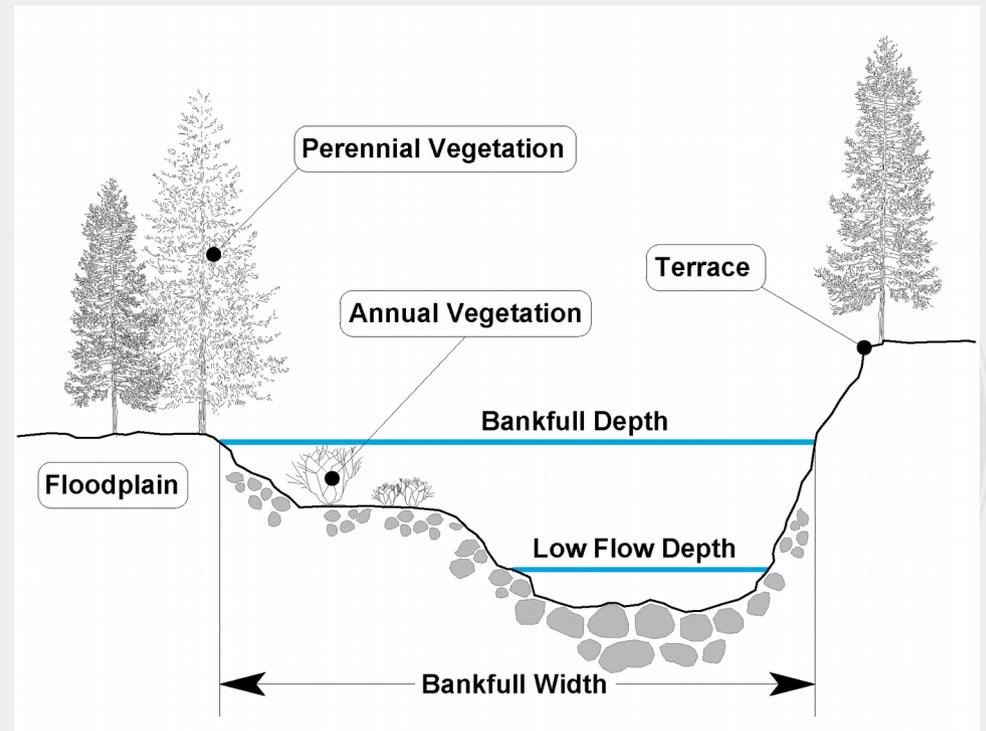
**Strahler**

**Hack**

**Pfafstetter**

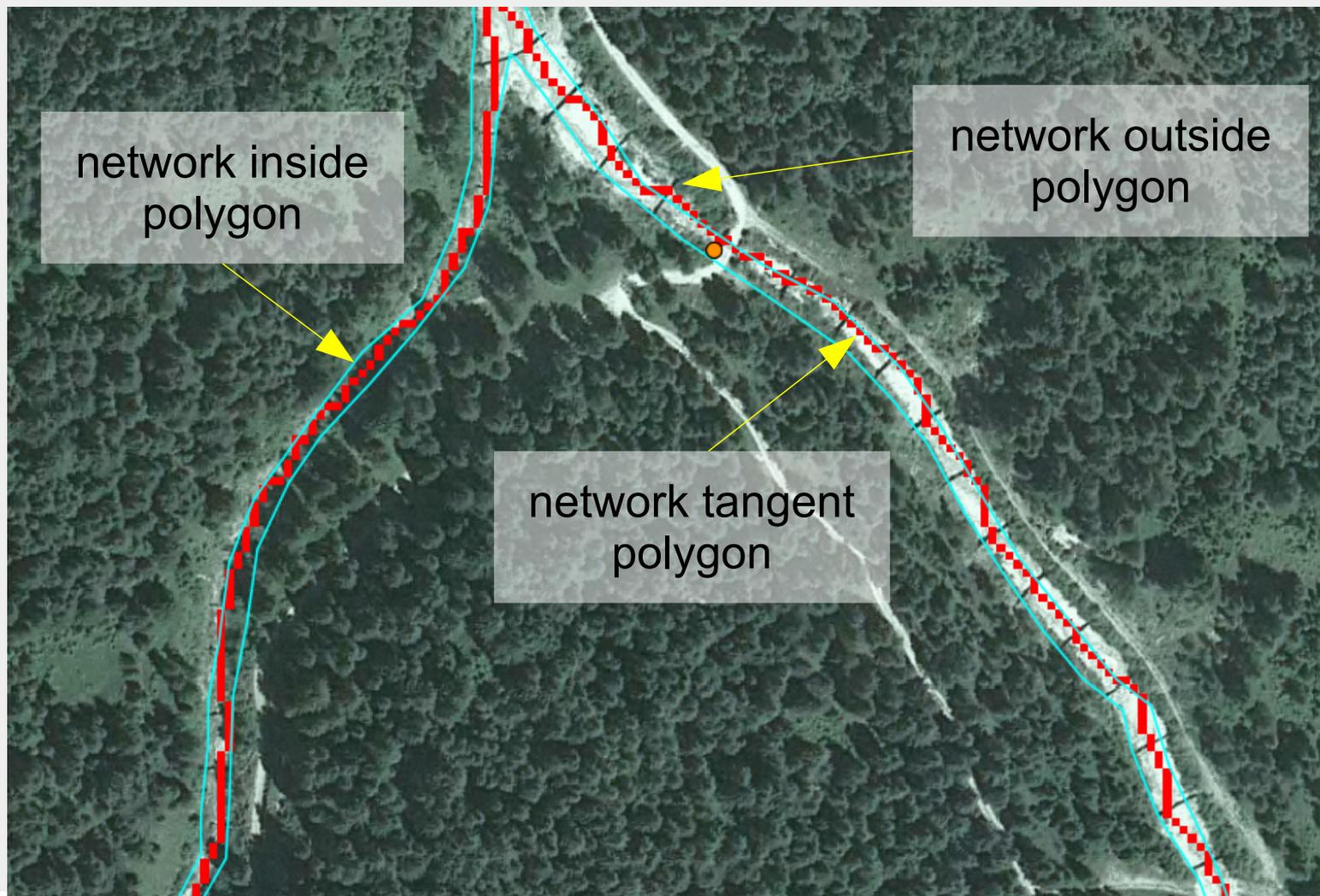
# JGRASSTOOLS: bankfull width

- 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)

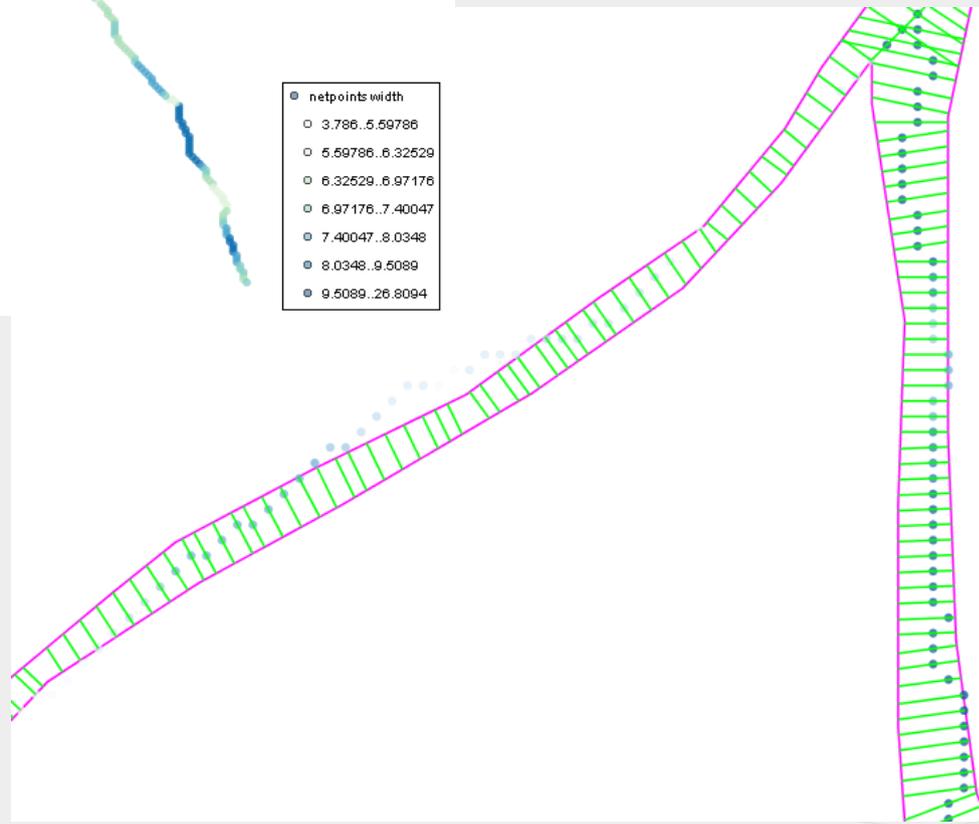
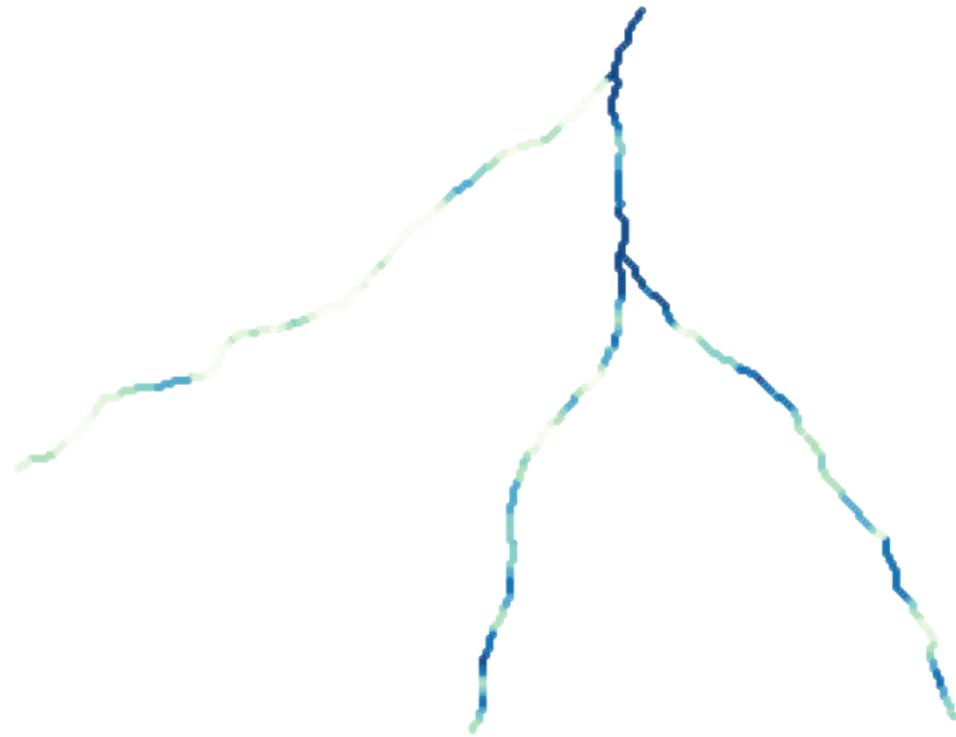


# JGRASSTOOLS: bankfull width

The screenshot displays the JGrasTools Spatial Toolbox interface. On the left, the 'Modules' panel shows a tree view of tools, with 'LW04\_BankfullWidthAnalyzer' selected. Below the tree are checkboxes for 'Load Experimental' (checked) and 'Debug' (unchecked), and a 'Heap [MB]' dropdown set to '64'. On the right, the 'Parameters' panel shows the configuration for the selected tool. It includes a 'Play' button and three icons (a green play button, a document with a play button, and a document with a list icon). The parameters are:

- The input polygon layer of the bankfull area. (Empty text box with a browse button)
- The input hierarchy point network layer. (Empty text box with a browse button)
- The maximum distance that a point can have from the nearest polygon. If distance is major, then the netpoint is ignored and identified as outside the region of interest. [m] (Text box containing '100.0')
- The maximum width for the channel network [m] (Text box containing '100.0')
- The minimum width for the channel network [m] (Text box containing '0.5')
- The output points network layer with the additional attribute of bankfull width. (Empty text box with a browse button)
- The output points layer highlighting the position of the problematic sections. (Empty text box with a browse button)

# 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

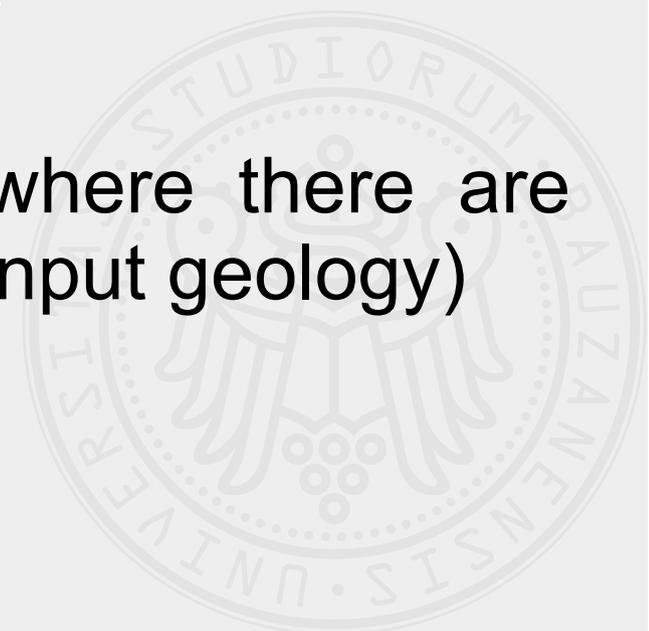


# JGRASSTOOLS: bank erosion

- 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)

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

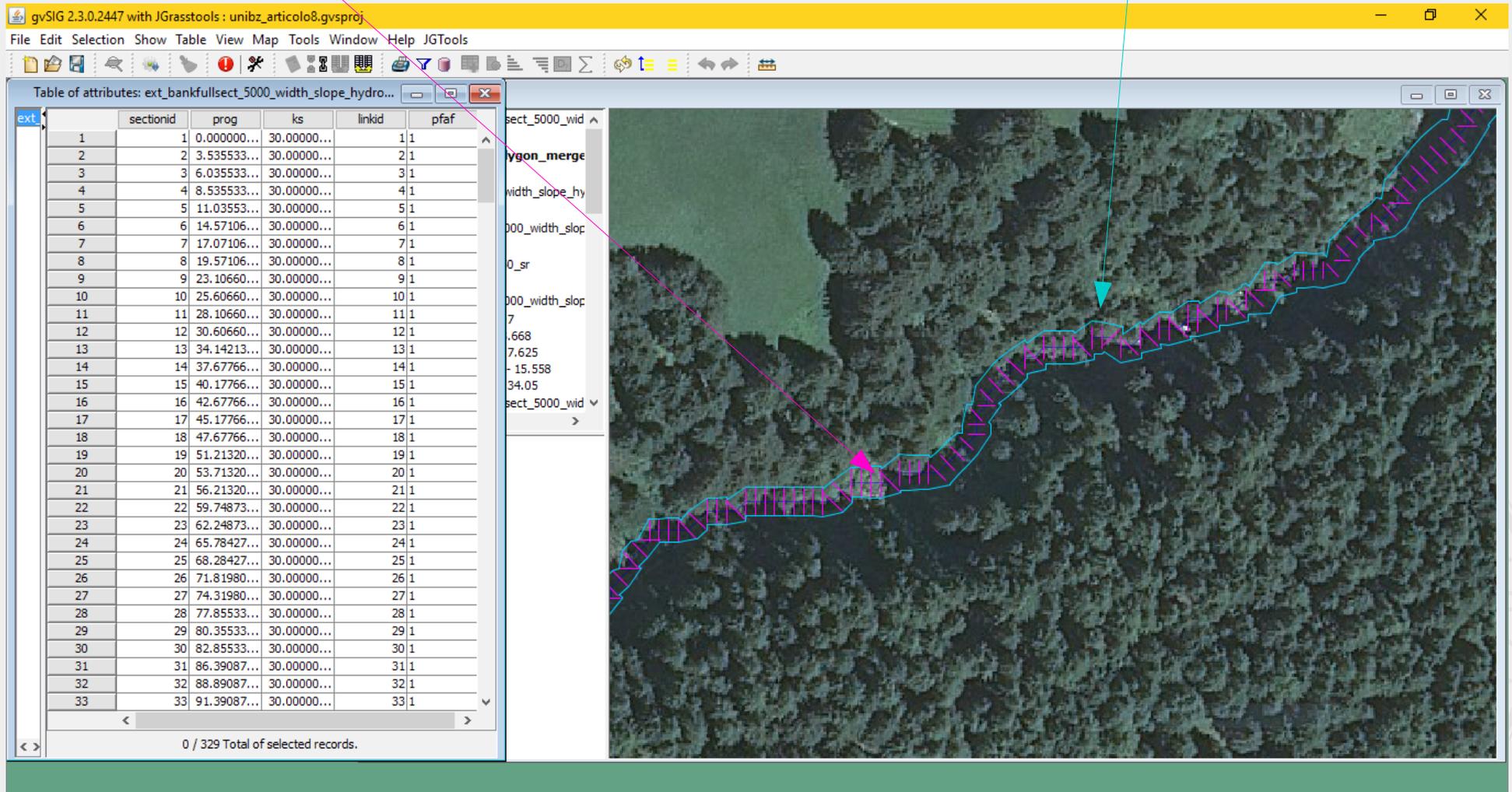
- widening is avoided for sections where there are structures and where there is rock (input geology)



# JGRASSTOOLS: bank erosion

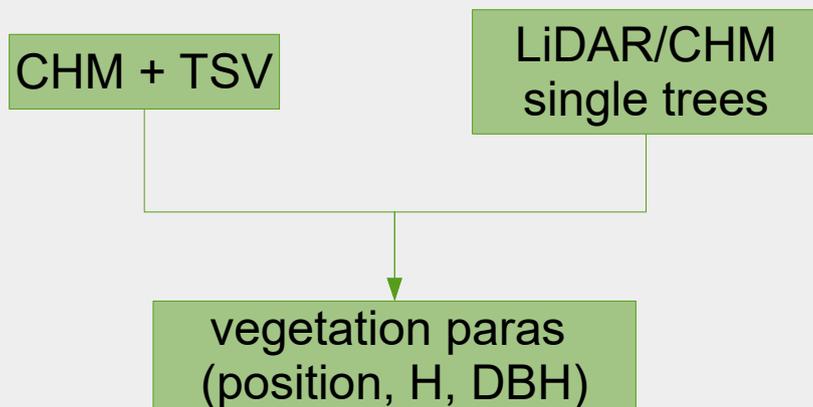
bankfull sections

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

gvSIG 2.3.0.2447 with JGrasstools : unibz\_articolo8.gvsproj

File Edit Selection Show Table View Map Tools Window Help JGTools

Table of attributes: T13\_trees

	id	elev
82	28597	15.55810...
83	28596	15.36242...
84	28595	10.11621...
85	28594	3.346313...
86	28593	6.071166...
87	32507	5.718750...
88	28592	9.147460...
89	28591	7.022460...
90	28590	20.38183...
91	28589	23.15124...
92	28588	24.98315...
93	28587	5.047485...
94	28586	13.34997...
95	28585	11.47875...
96	28584	14.90747...
97	28583	9.954345...
98	28582	5.045654...
99	28581	9.628173...
100	28580	10.98242...
101	28579	13.66308...
102	28578	14.60632...
103	28577	17.31640...
104	32506	8.223754...
105	28576	17.73364...
106	28575	16.99560...
107	28574	16.08129...
108	28572	18.61303...
109	28571	17.31188...
110	28570	13.25122...
111	28569	18.06677...
112	28568	12.98193...
113	28567	23.40124...
114	28566	11.76489...

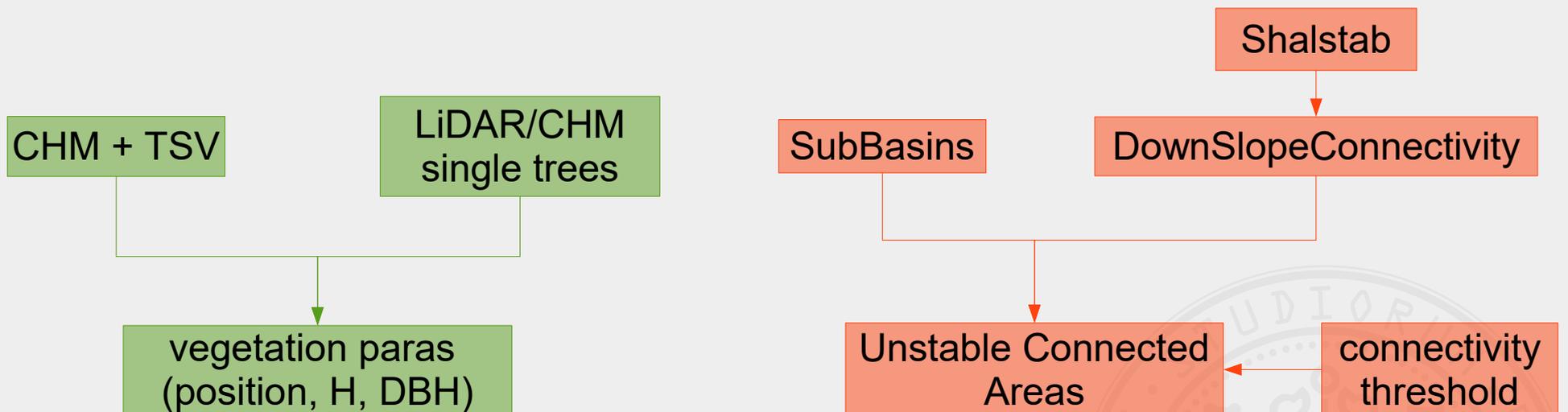
0 / 94135 Total of selected records.

Layers: sections\_5000\_width\_slope, net\_point\_5000\_width\_slop, T13\_trees, area\_5000\_width\_slope\_hy, dsm, pit\_small2, basin01\_conn, netpoints\_width\_slope\_sr, net\_point\_5000\_width\_slop, bankfullsections\_5000\_wid, net\_point\_5000\_width\_sr, netpoints\_sr

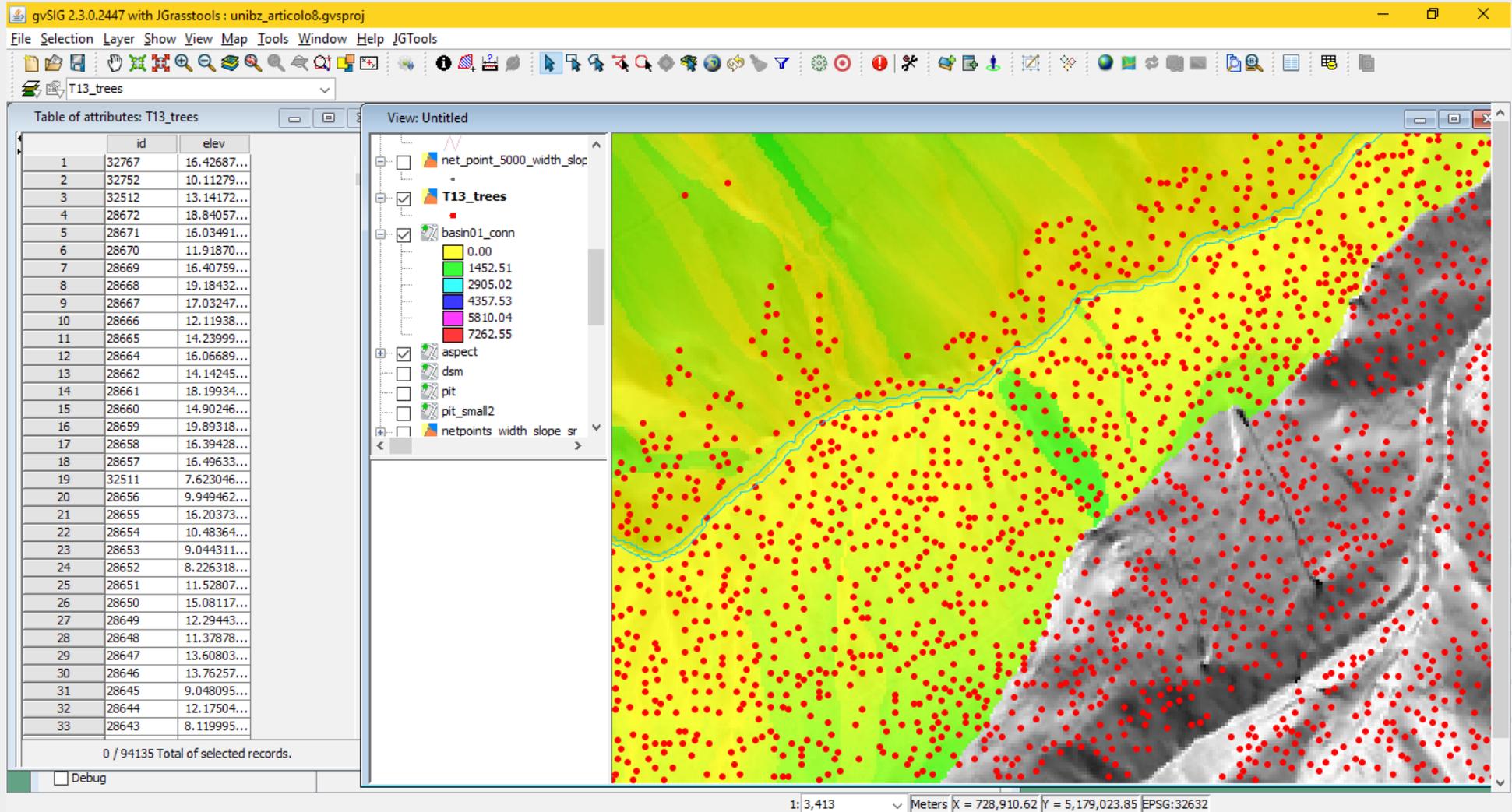
Meters | x = 728,832.28 | y = 5,179,130.4 | EPSG:32632

# JGRASSTOOLS: LW from hillslopes

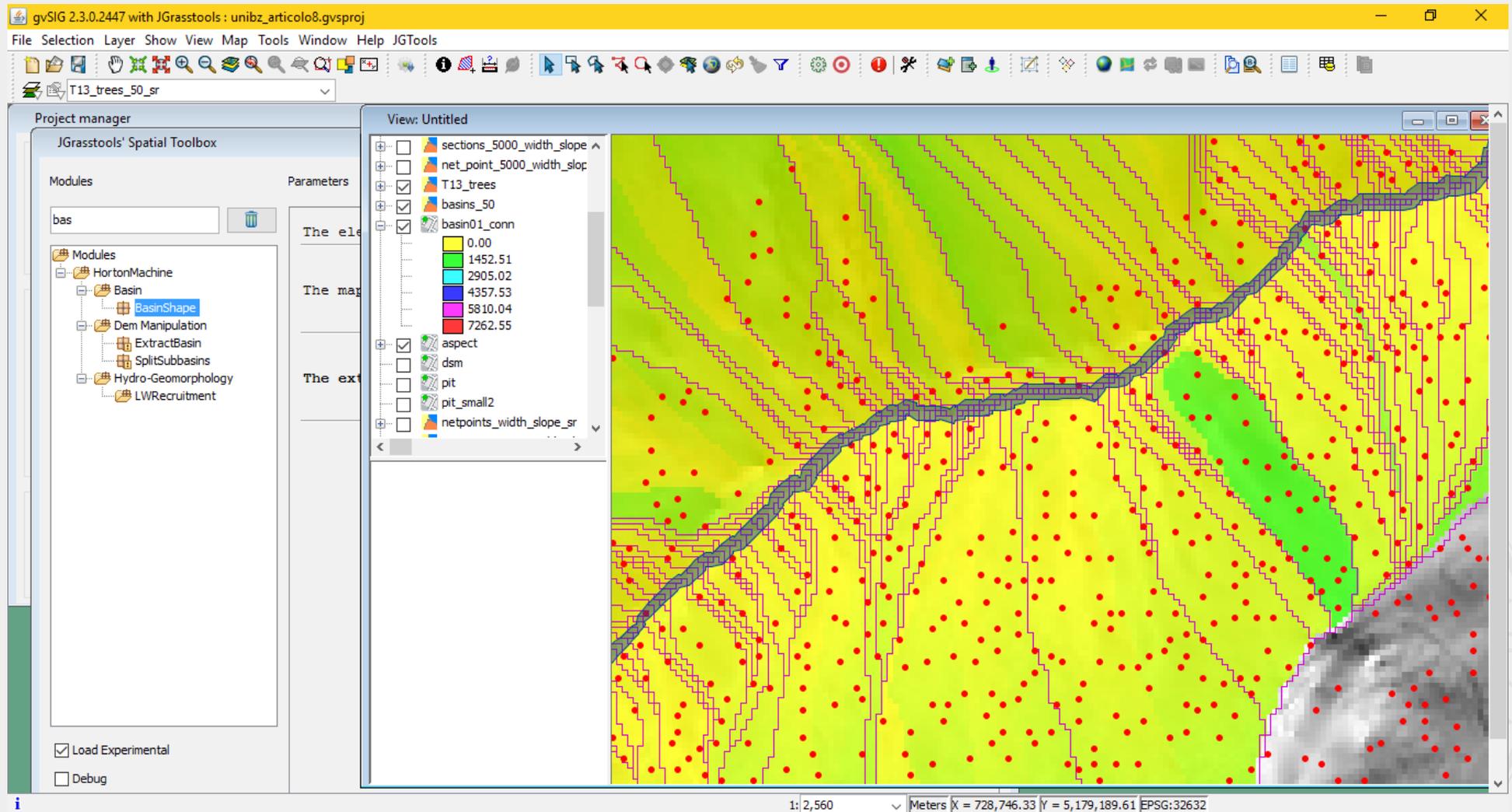
- shallow landslides on connected hillslopes deliver logs to the channels → amount of wood on the unstable and connected areas



# JGRASSTOOLS: LW from hillslopes

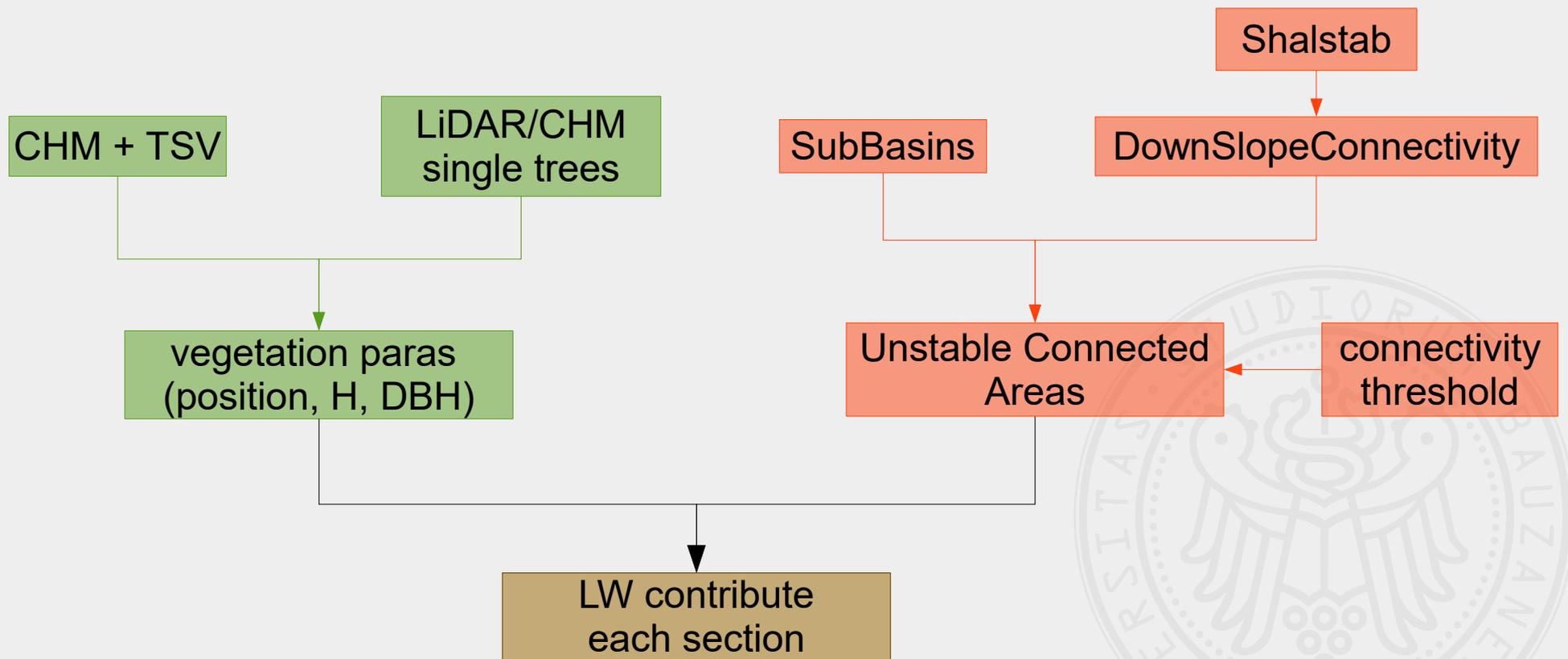


# JGRASSTOOLS: LW from hillslopes

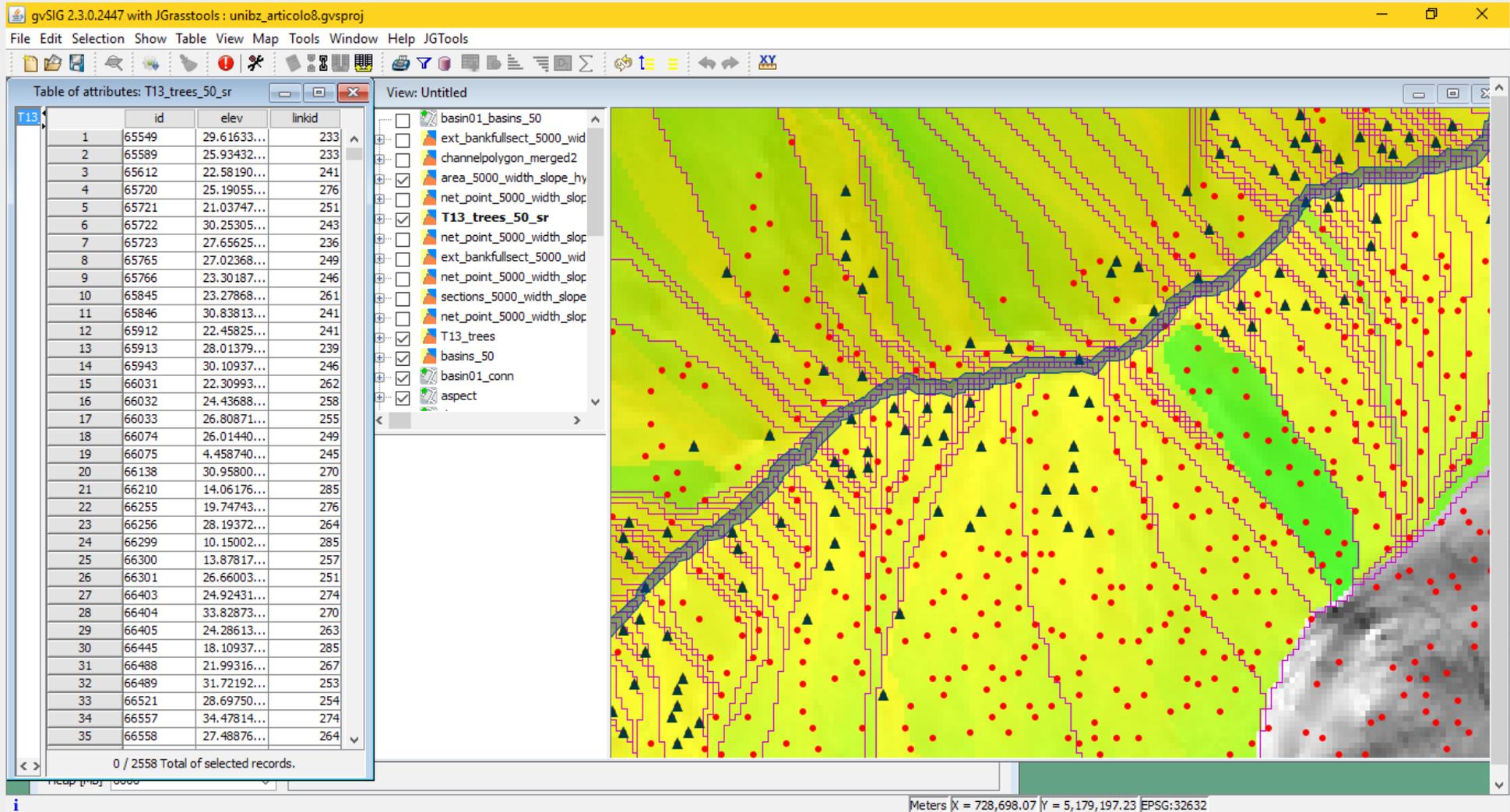


# JGRASSTOOLS: LW from hillslopes

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# JGRASSTOOLS: LW from hillslopes



# JGRASSTOOLS: LW from hillslopes

gvSIG 2.3.0.2447 with JGrasstools : unibz\_articolo8.gvsproj

File Selection Layer Show View Map Tools Window Help JGTools

T13\_trees\_50\_sr

Table of attributes: T13\_trees\_50\_sr

	id	elev	linkid	
T13	1	65549	29.61633...	233
	2	65589	25.93432...	233
	3	65612	22.58190...	241
	4	65720	25.19055...	276
	5	65721	21.03747...	251
	6	65722	30.25305...	243
	7	65723	27.65625...	236
	8	65765	27.02368...	249
	9	65766	23.30187...	246
	10	65845	23.27868...	261
	11	65846	30.83813...	241
	12	65912	22.45825...	241
	13	65913	28.01379...	239
	14	65943	30.10937...	246
	15	66031	22.30993...	262
	16	66032	24.43688...	258
	17	66033	26.80871...	255
	18	66074	26.01440...	249
	19	66075	4.458740...	245
	20	66138	30.95800...	270
	21	66210	14.06176...	285
	22	66255	19.74743...	276
	23	66256	28.19372...	264
	24	66299	10.15002...	285
	25	66300	13.87817...	257
	26	66301	26.66003...	251
	27	66403	24.92431...	274
	28	66404	33.82873...	270
	29	66405	24.28613...	263
	30	66445	18.10937...	285
	31	66488	21.99316...	267
	32	66489	31.72192...	253
	33	66521	28.69750...	254
	34	66557	34.47814...	274
	35	66558	27.48876...	264

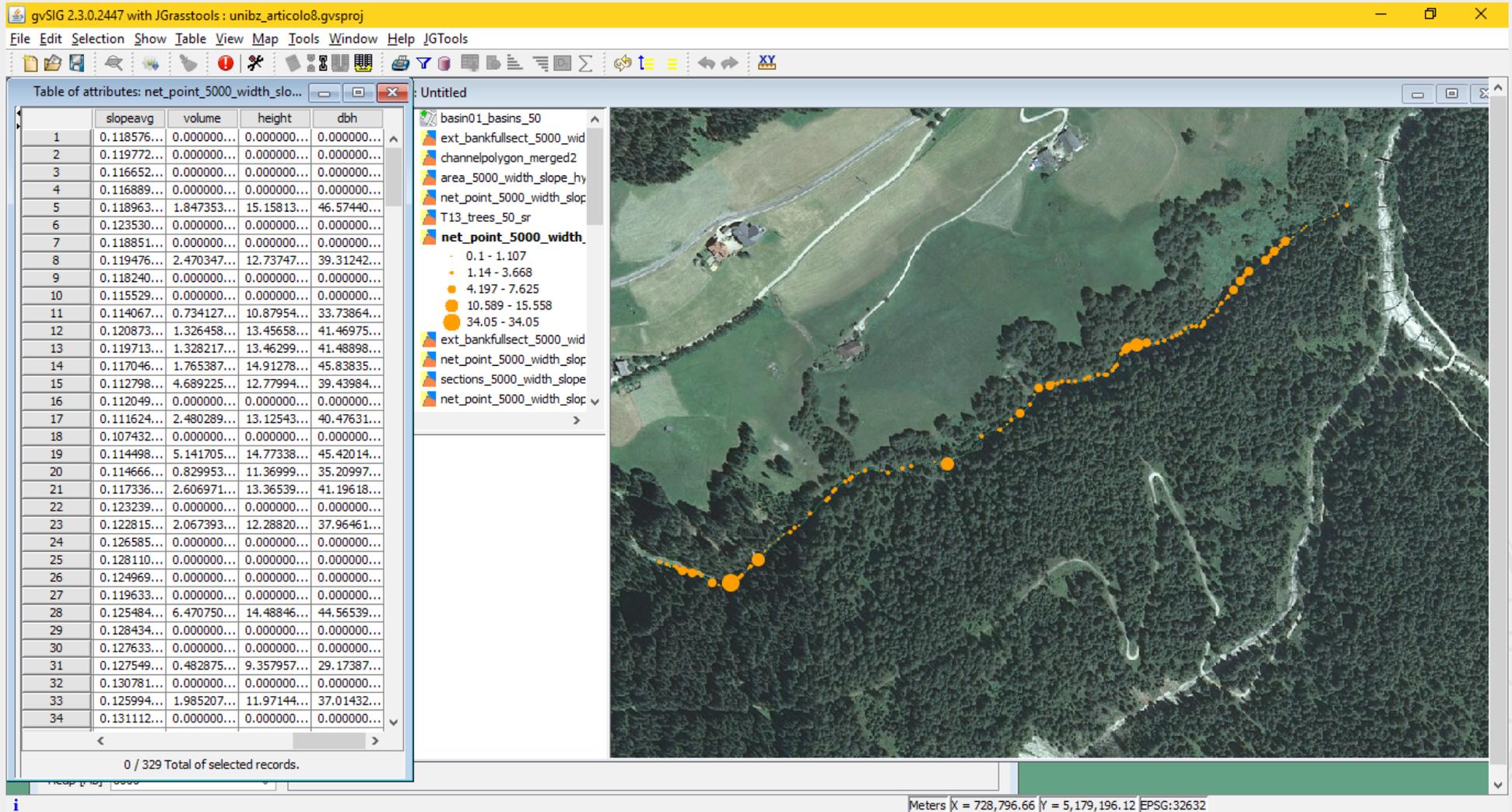
View: Untitled

- basin01\_basins\_50
- ext\_bankfullsect\_5000\_wid
- channelpolygon\_merged2
- area\_5000\_width\_slope\_hy
- net\_point\_5000\_width\_slope
- T13\_trees\_50\_sr
- net\_point\_5000\_width\_slope
- ext\_bankfullsect\_5000\_wid
- net\_point\_5000\_width\_slope
- sections\_5000\_width\_slope
- net\_point\_5000\_width\_slope
- T13\_trees
- basins\_50
- basin01\_conn
- aspect

0 / 2558 Total of selected records.

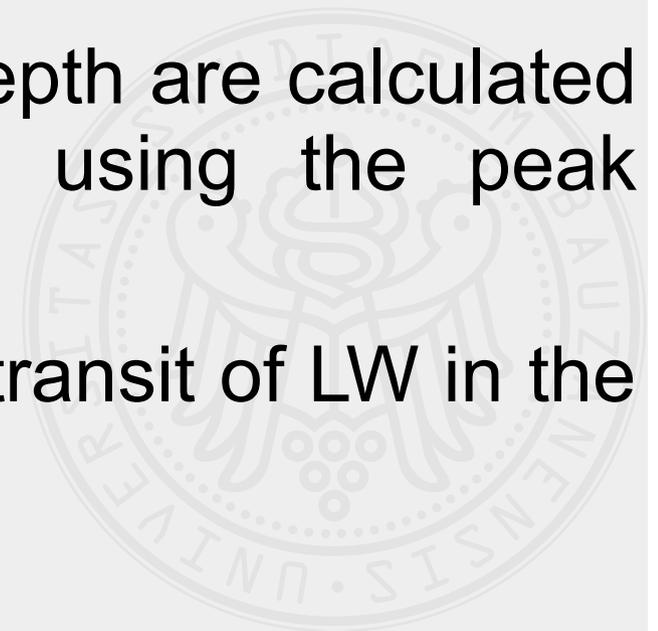
1: 1,920 Meters X = 728,671.14 Y = 5,179,194.18 EPSG:32632

# JGRASSTOOLS: LW recruitment

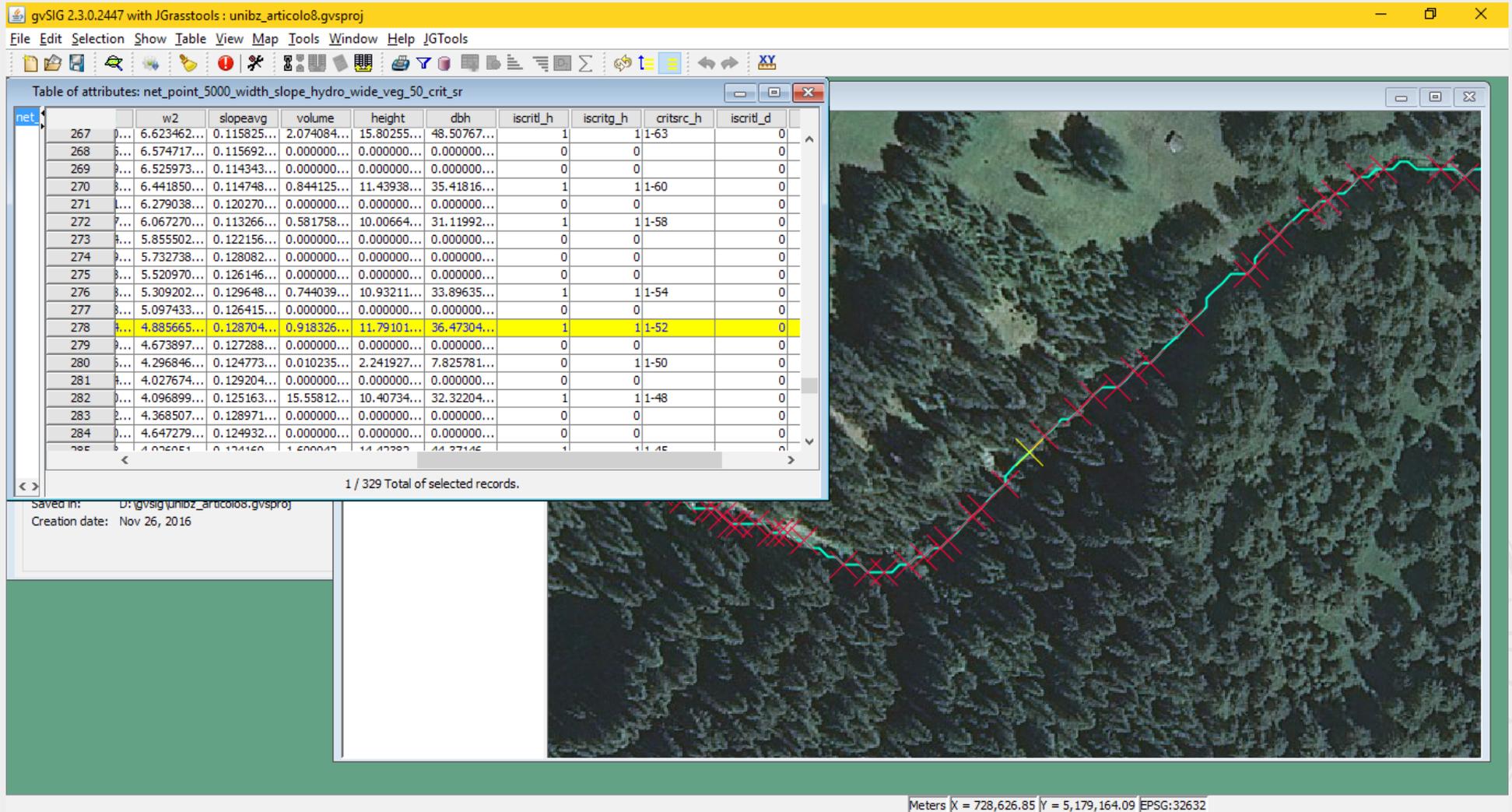


# JGRASSTOOLS: propagation

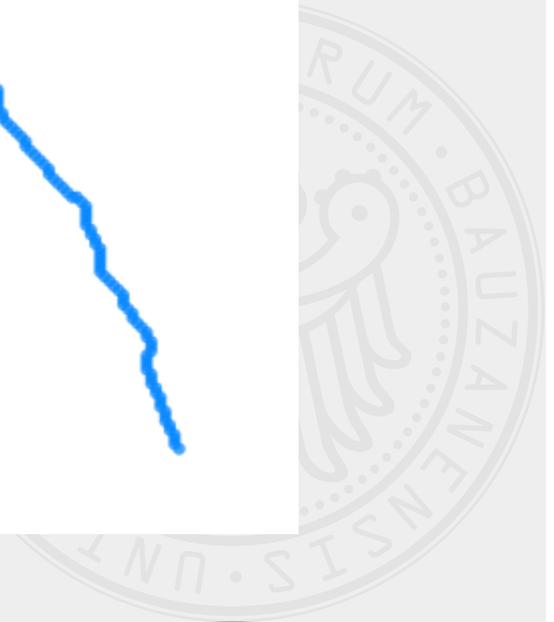
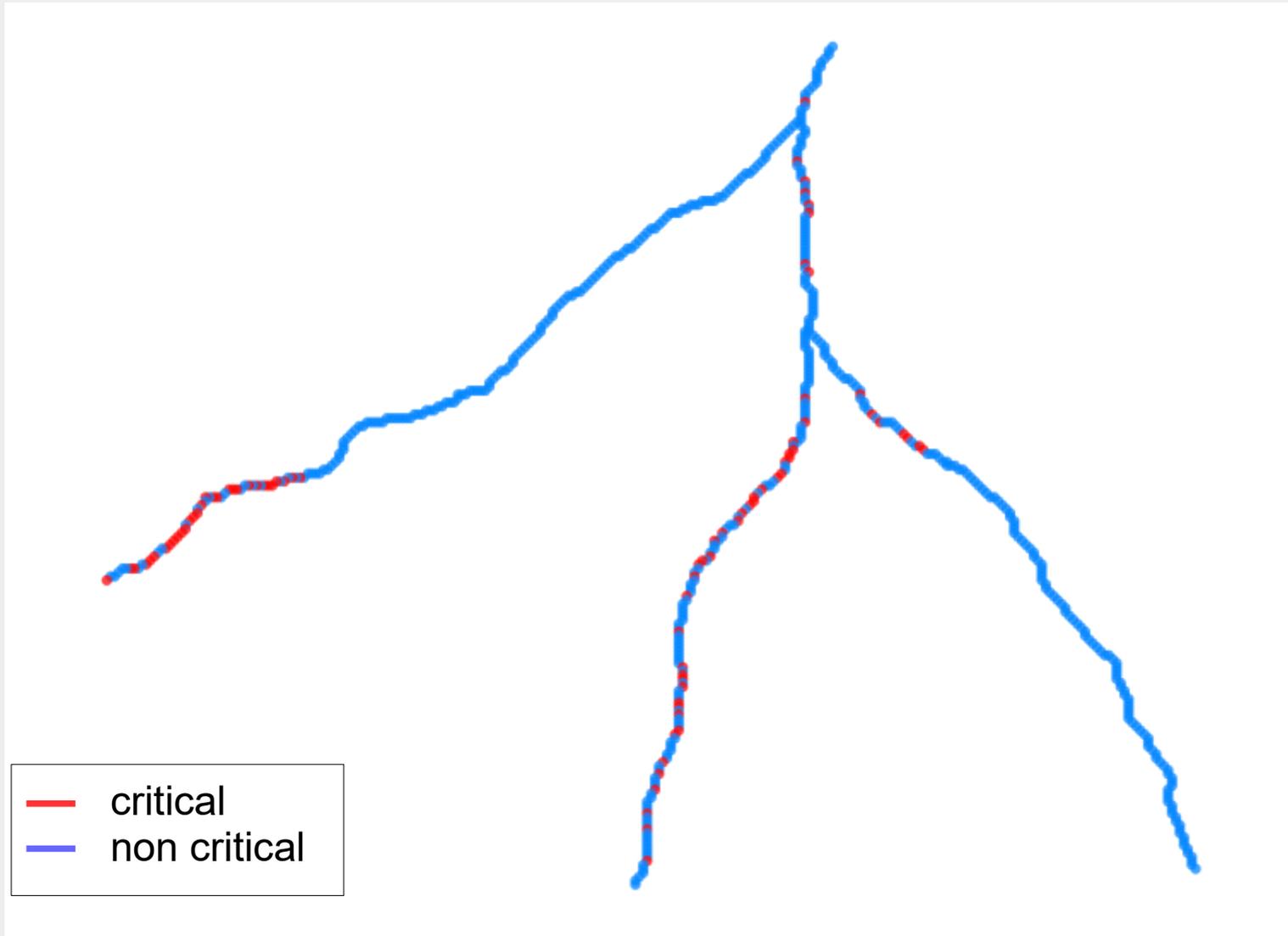
- LW is routed downstream using simple Boolean transport conditions based on:
  - ratio between the length of the logs and the width of the sections (input parameter)
  - ratio between the diameter of the logs and the water depth (input parameter)
- post-event channel width + water depth are calculated 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



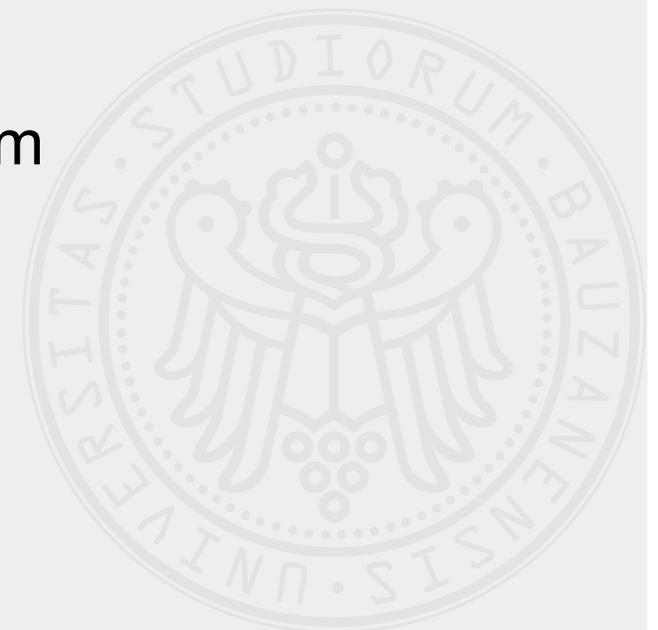
# FUTURE PLANS

- 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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silvia.franceschi@gmail.com



<http://www.jgrasstools.org>