

Mapping of linear elements over cultivated landscape using VHSR data

J.S. Bailly ^{1,2}, F. Levavasseur ²

¹AgroParisTech, UMR TETIS, Montpellier, France

²INRA, UMR LISAH, Montpellier, France

18th of January 2012



Linear elements of cultivated landscapes



Selected elements on plot margins :

- Open drainage channels : ditches, pipes
→ Accelerate/Decelerate water flows
- Terrace walls, embankments
→ Prevent soil erosion, infiltrate waters



Linear elements of cultivated landscapes

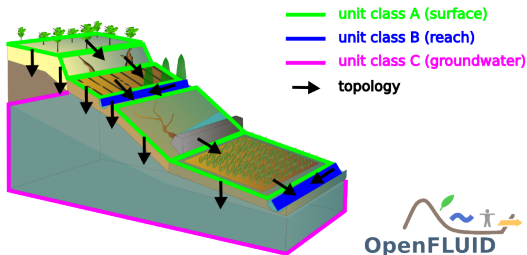


Selected elements on plot margins :

- Open drainage channels : ditches, pipes
→ Accelerate/Decelerate water flows
- Terrace walls, embankments
→ Prevent soil erosion, infiltrate waters



Cultivated landscape modelling and required maps

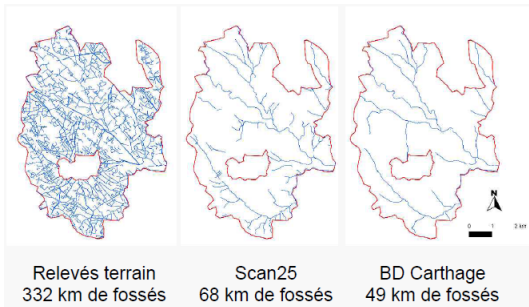


- Spatially explicit modelling (Moussa et al. 2002, Braud et al. 2008) : need **maps**
- Maps of linear elements : drainage channels, terrace walls → surface water pathways
 - Conditioning spatial model topology (Lagacherie et al. 2009)
 - Flow routing properties (Dages 2005, Hallema et al. 2010)

Channels and walls mapping background

Maps at catchment extent and segment resolution :

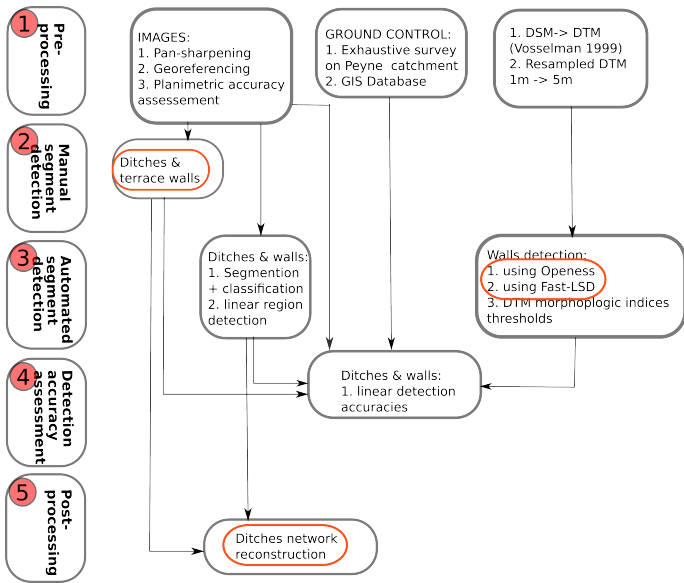
- Uncomplete in BD-TOPO©IGN
- Channels from raw LiDAR data : 40 % of omission (Bailly et al., 2008)
- Usual DTM drainage algorithm unsuitable (Duke et al. 2006)
- → Potential of low solar elevation optical image



- ① Channel and terrace wall segment detection ?
 - from optical 'Pleiades-like' images
 - from 'Pleiades-like' DEM

- ② If omissions, reconstruct entire network (channels) ?
 - from unconnected detected segments
 - using auxilliary data
 - optimized to reproduce actual hydrological functioning

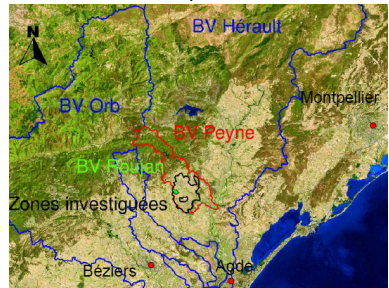
Channel and terrace walls detection : process workflow





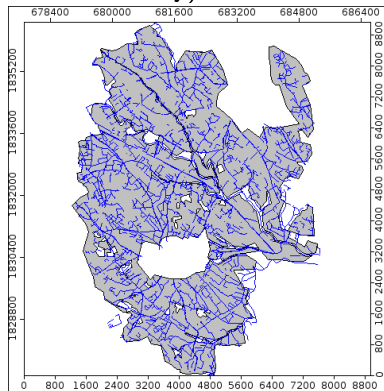
The 'Peyne' catchment (OMERE Research Observatory) : 28km^2

- linear elements :
 - 332km drainage network
 - 403km terrace walls



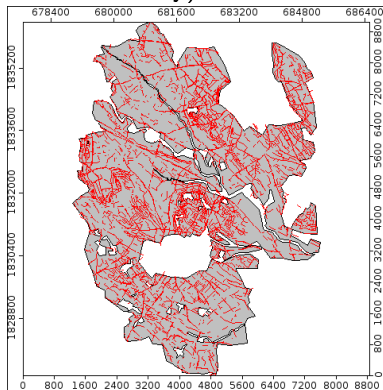
The 'Peyne' catchment (OMERE Research Observatory) : 28km^2

- linear elements :
 - 332km drainage network
 - 403km terrace walls



The 'Peyne' catchment (OMERE Research Observatory) : 28km^2

- linear elements :
 - 332km drainage network
 - 403km terrace walls



Remote sensing data



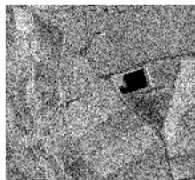
QuickBird P



QuickBird XS



QuickBird P+XS



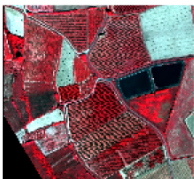
Terrasar X



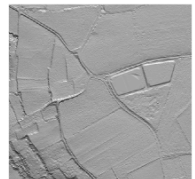
Komsat P



Komsat XS



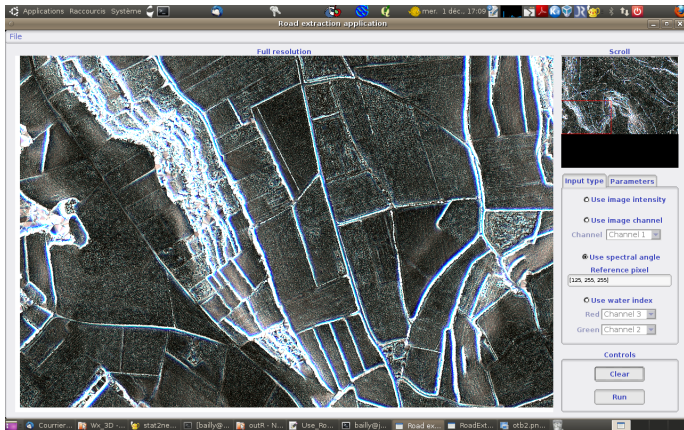
Pellican



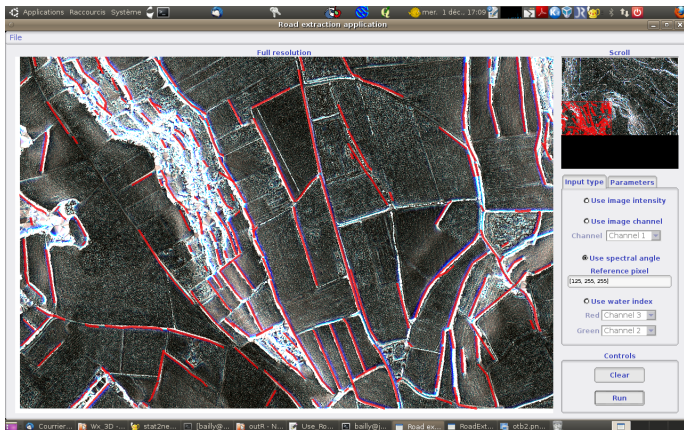
Lidar

Terrace walls detection from DTM-DSM 

- Multiresolution topographic Openess layers (Yokoyama et al. 2002)
- Linear region detection using 'spectral' angles (Christophe and Inglada 2007)

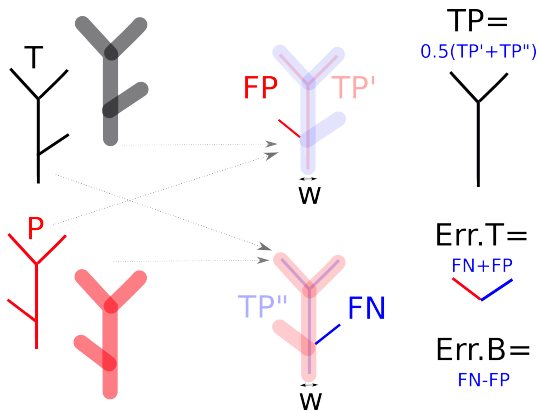


- Multiresolution topographic Openness layers (Yokoyama et al. 2002)
- Linear region detection using 'spectral' angles (Christophe and Inglada 2007)



Linear detection : accuracies assessment

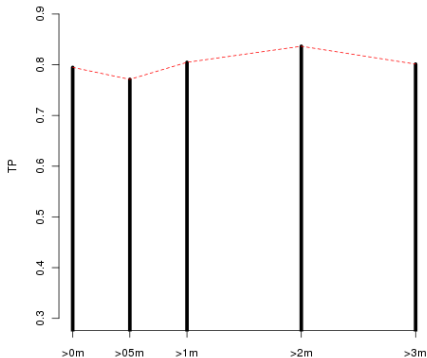
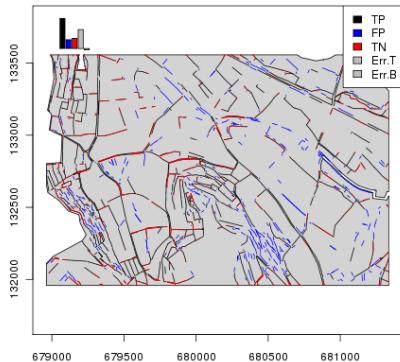
The buffer method from (Heipke et al. 1997) and (Molloy and Stepinski 2007)



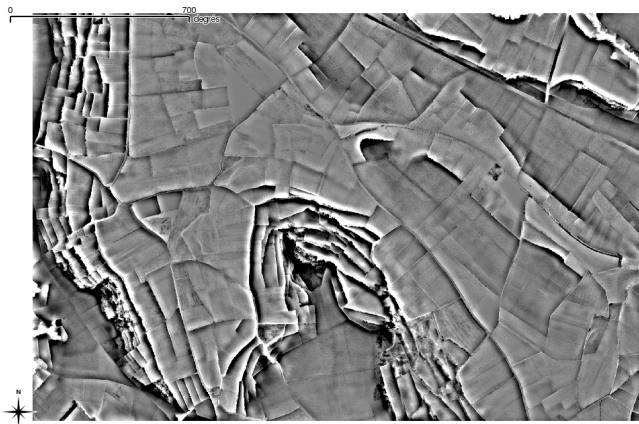
Overall :

- TP : 67 %
- FP : 15 %

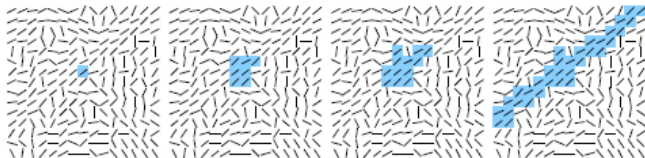
TP=f(Height) :



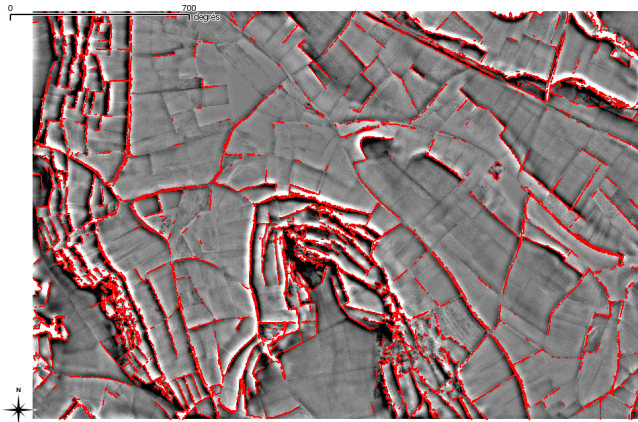
- Local contrast enhancement (Gaussian Filtering)
- LSD algorithm (Grompone von Gioi et al., 2010)
 - ① line-support region growing on aligned \perp gradient image
 - ② find and validate the line segment that best approximates each line- support region



- Local contrast enhancement (Gaussian Filtering)
- LSD algorithm (Grompone von Gioi et al., 2010)
 - 1 line-support region growing on aligned \perp gradient image
 - 2 find and validate the line segment that best approximates each line- support region



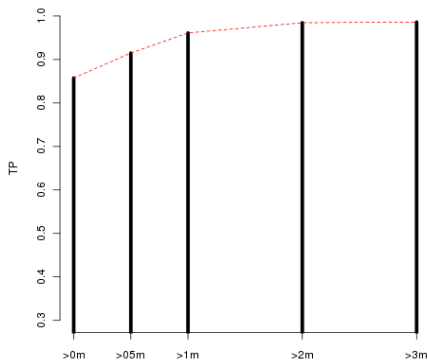
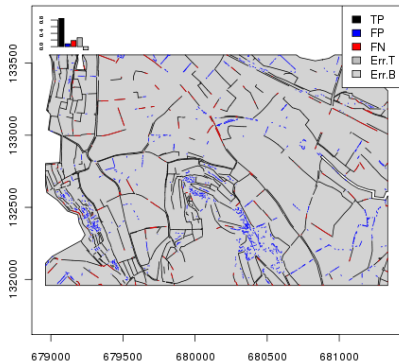
- Local contrast enhancement (Gaussian Filtering)
- LSD algorithm (Grompone von Gioi et al., 2010)
 - ① line-support region growing on aligned \perp gradient image
 - ② find and validate the line segment that best approximates each line- support region



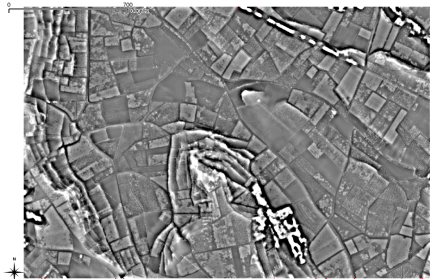
Overall :

- TP : 85 %
- FP : 11 %

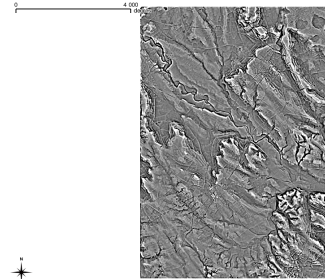
TP=f(Height) :



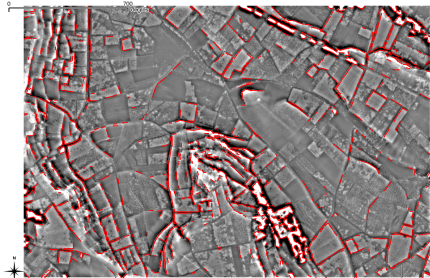
1m DSM



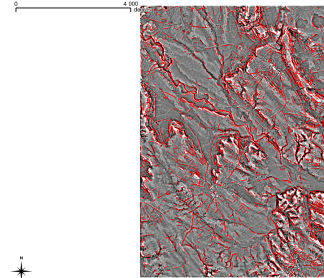
5m DTM



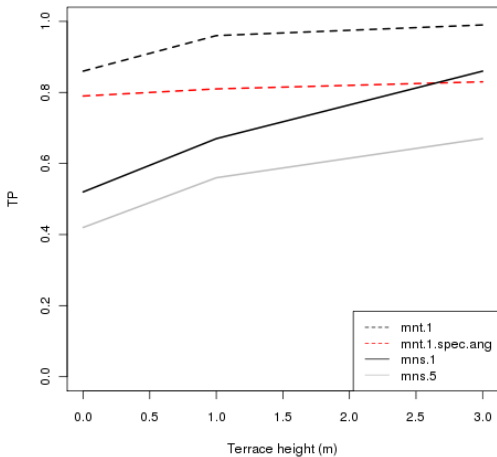
1m DSM



5m DTM



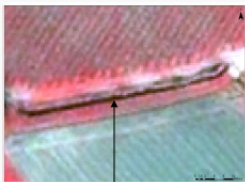
Terrace walls from DEM : result synthesis



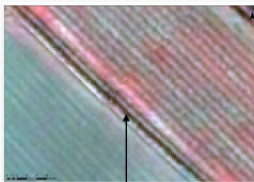
Open-channel network detection from images

Quickbird P+XS image : shadows (low solar elevation)

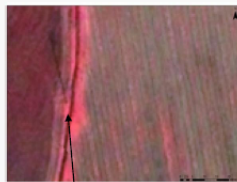
- Drainage channels



**Bande noire entre deux
bandes « claires »
fines (« bourrelets »)**



**Bande noire entre deux
bandes « claires »
fines et rectilignes**



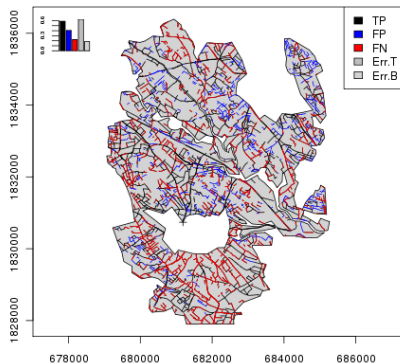
**Bande noire entre deux
bandes de végétation
basse et active**

Expert interpretation from images

Quickbird P+XS image (Pan-sharpening)

Drainage channels :

- TP : 59 %
- FP : 22 %



→ need to reconnected detected segments to provide a network

Drainage network reconstruction

Stochastic optimization algorithm :

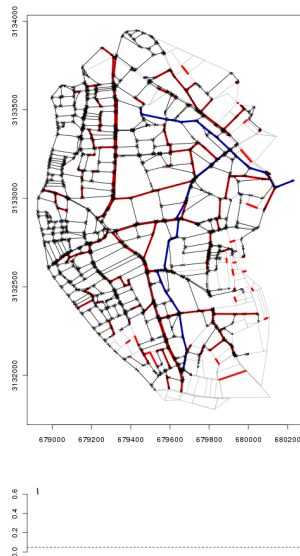
- start from unconnected segments and directed plot lattice
- uses stochastic branching-pruning converges up to a given drainage density while maximise reconnection
- produce directed tree network



Drainage network reconstruction

Stochastic optimization algorithm :

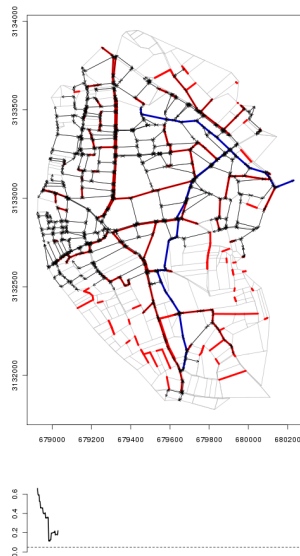
- start from unconnected segments and directed plot lattice
- uses stochastic branching-pruning converges up to a given drainage density while maximise reconnection
- produce directed tree network



Drainage network reconstruction

Stochastic optimization algorithm :

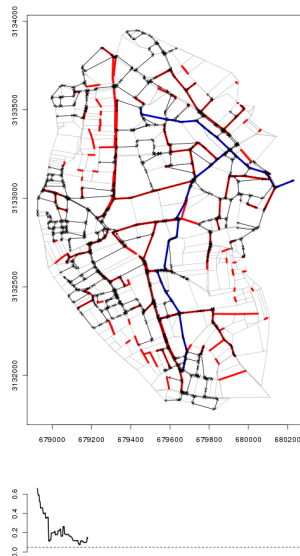
- start from unconnected segments and directed plot lattice
- uses stochastic branching-pruning converges up to a given drainage density while maximise reconnection
- produce directed tree network



Drainage network reconstruction

Stochastic optimization algorithm :

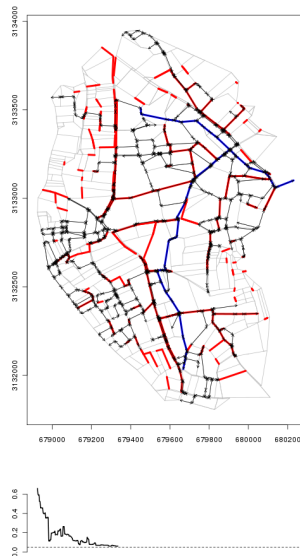
- start from unconnected segments and directed plot lattice
- uses stochastic branching-pruning converges up to a given drainage density while maximise reconnection
- produce directed tree network



Drainage network reconstruction

Stochastic optimization algorithm :

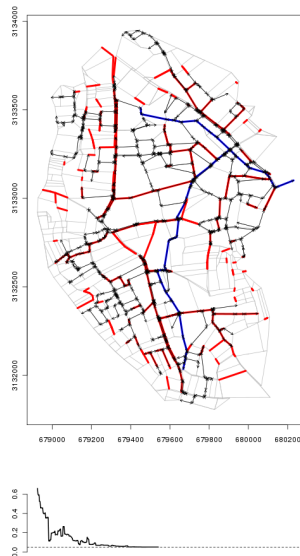
- start from unconnected segments and directed plot lattice
- uses stochastic branching-pruning converges up to a given drainage density while maximise reconnection
- produce directed tree network



Drainage network reconstruction

Stochastic optimization algorithm :

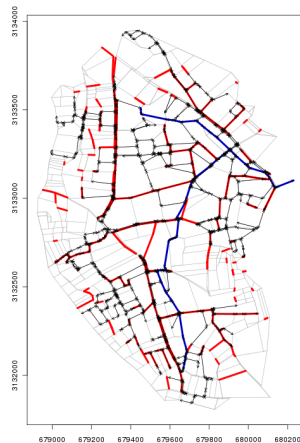
- start from unconnected segments and directed plot lattice
- uses stochastic branching-pruning converges up to a given drainage density while maximise reconnection
- produce directed tree network



Drainage network reconstruction

Stochastic optimization algorithm :

- start from unconnected segments and directed plot lattice
- uses stochastic branching-pruning converges up to a given drainage density while maximise reconnection
- produce directed tree network








Drainage network reconstruction

Stochastic optimization algorithm :

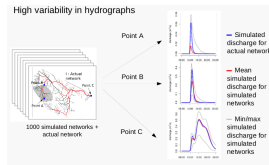
- start from unconnected segments and directed plot lattice
- uses stochastic branching-pruning converges up to a given drainage density while maximise reconnection
- produce directed tree network



Objects	From Pleiades-like	Accurate	Limitations
Channels	images		vegetation, solar azimuth
Terrace walls	images		vegetation, solar azimuth
Channels	DTM		vegetation, resolution
Terrace walls	DTM		vegetation
Channels	images + reconstruction		CPU

On going works :

- 1 Optimise network reconstruction criteria for accurate hydrological response ?
- 2 Multi-incidence SAR images for terraces walls detection



Pleiades expectations :

- 1 Validation on terrace walls detection with **actual Pleiades DSM-DTM**
- 2 Monitoring non explored usefull linear elements for hydrology : weed control practices on vineyards

