

Derived environmental variables from DEMs: short theoretical introduction

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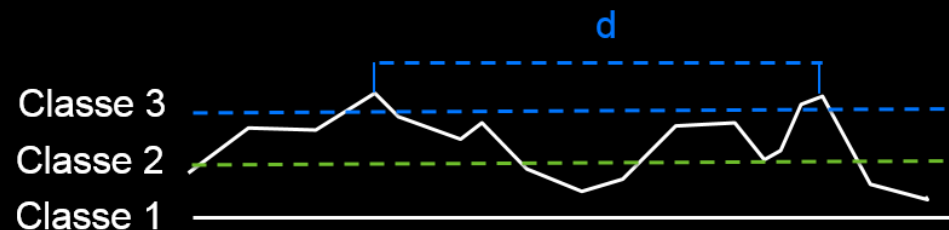
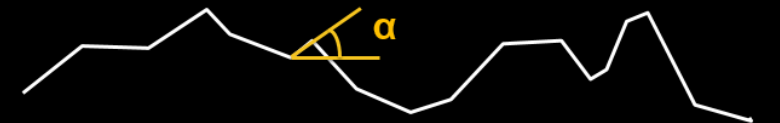
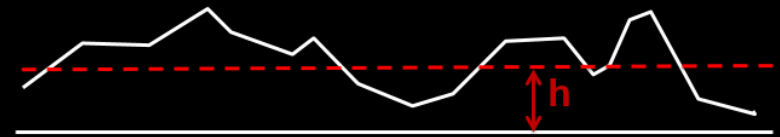
Laboratory of Geographic Information Systems (LASIG)

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Indicateurs globaux

- Altitude minimale, maximale
- Courbe hypsométrique: répartition de la surface d'un bassin versant en fonction de l'altitude
- **Altitude moyenne**
- **Pente moyenne**
- **Distance entre les sommets d'une même classe d'altitude**

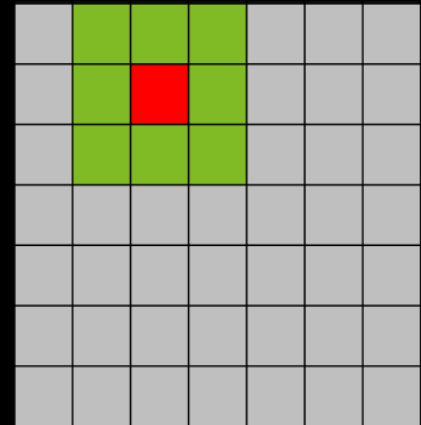
Rugosité



Indicateurs locaux – Fenêtres glissantes

Calculs par fenêtres glissantes

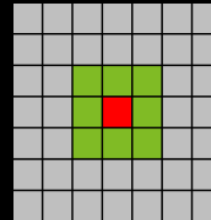
- Procédure de filtrage
- Fenêtre glissante centrée sur un pixel



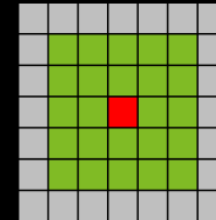
Indicateurs locaux – Fenêtres glissantes

Calculs par fenêtres glissantes *Sliding windows*

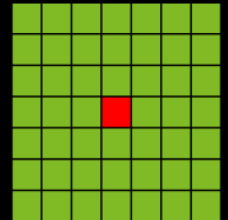
- Procédure de filtrage *Filtering process*
- Fenêtre glissante centrée sur un pixel
- Variation de la taille de la fenêtre glissante
- Variation de la forme de la fenêtre



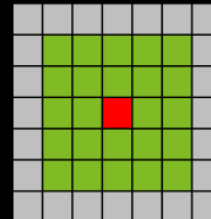
3x3



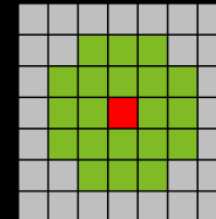
5x5



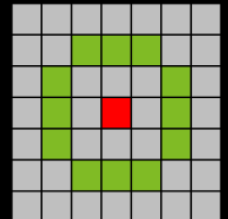
7x7



carré



disque

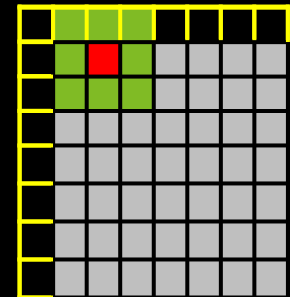
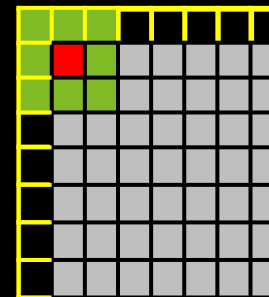
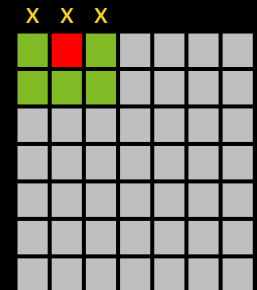
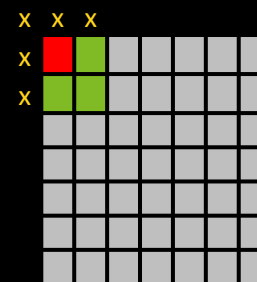


couronne

Indicateurs locaux – Fenêtre mobiles

Calculs par fenêtres glissantes

- Procédure de filtrage
- Fenêtre glissante centrée sur un pixel
- Variation de la taille de la fenêtre glissante
- Variation de la forme de la fenêtre glissante
- Effets de bord
 - Utiliser un MNA plus grand que la zone d'étude
- Lissage



Pente et Orientation

Slope and aspect

Pente: inclinaison d'une surface par rapport au plan horizontal

- Gradient de la surface
- Rapport entre la distance verticale et horizontale

Slope = gradient of a surface

Ratio between the vertical and horizontal distances

Orientation: direction de l'inclinaison par rapport aux points cardinaux

- Direction du gradient

Aspect = direction of a cline, direction of the surface gradient

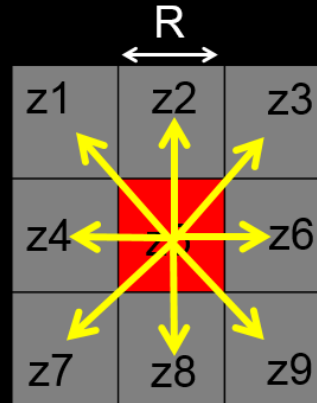
$$z = f(x, y)$$

$$pente = grad(z) = \sqrt{\left(\frac{\partial f}{\partial x}\right)^2 + \left(\frac{\partial f}{\partial y}\right)^2}$$

Pente et Orientation

Différents algorithmes de calculs selon le voisinage pris en compte:

- Fenêtre 3x3
 - Différence maximale aux voisins
 - Gradient maximal ligne – colonne
 - Modèle de Zevenbergen et Thorne (1987)
 - 4 plus proches voisins
 - **Modèle de Horn (1981)**
 - 8 plus proches voisins



R = résolution du MNT

$$G = \frac{\Delta z}{\Delta x} = \frac{(z1 + 2z4 + z7) - (z3 + 2z6 + z9)}{8R}$$

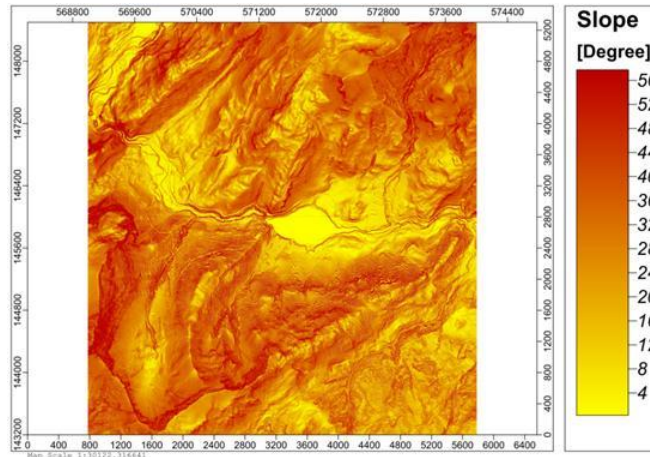
$$H = \frac{\Delta z}{\Delta y} = \frac{(z1 + 2z2 + z3) - (z7 + 2z8 + z9)}{8R}$$

$$orientation, z5(rad) = \pi - arctan\left(\frac{H}{G}\right) + \frac{\pi}{2}\left(\frac{G}{|G|}\right)$$

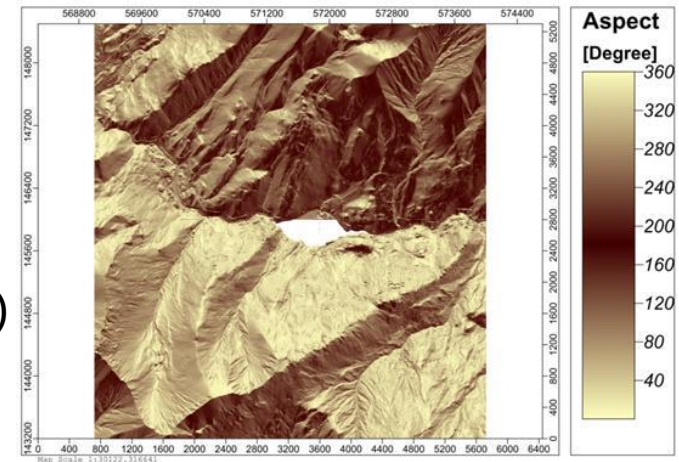
Sources of environmental data – fieldwork sources

DEM variables

Slope
(0-90°
or %)

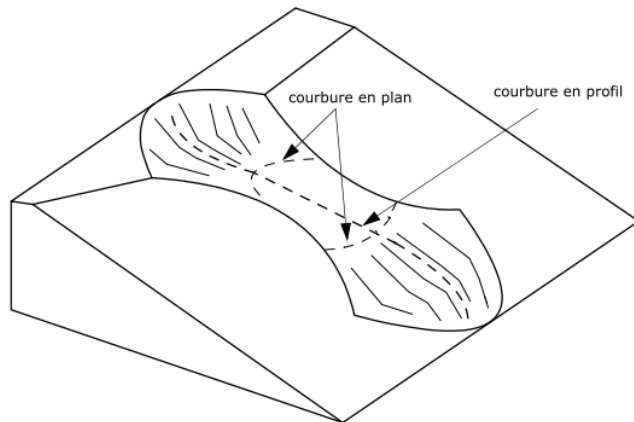


Aspect
(degrees
clockwise
from north)

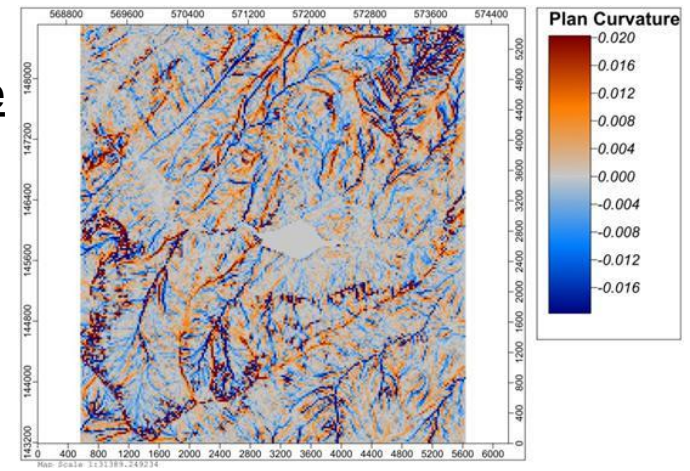


Profile
Curvature
(°/100LU)

where LU is a unit of
length, measured in
meters if Z is in
meters



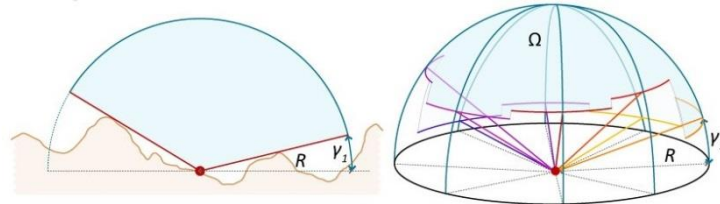
Plan
curvature
(°/100LU)



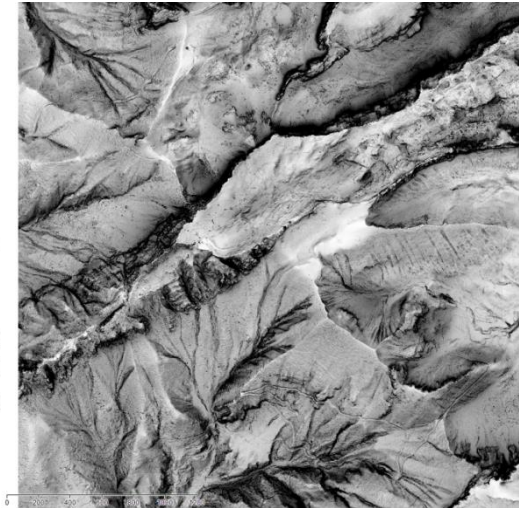
Sources of environmental data – fieldwork sources

DEM variables

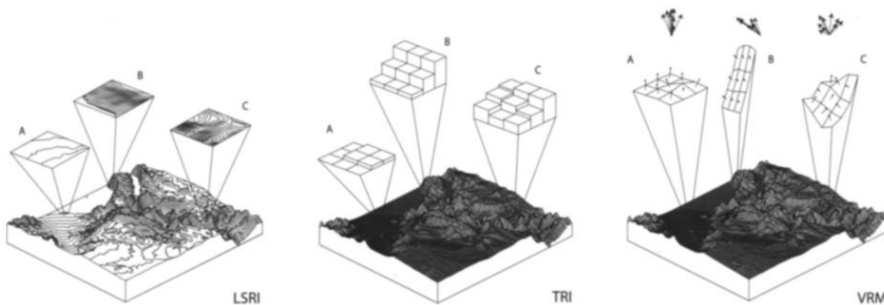
Sky View Factor (SVF)



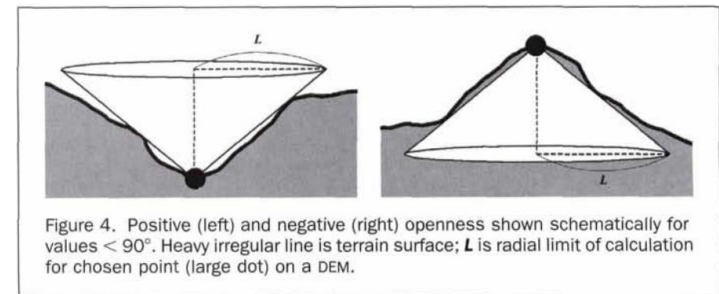
Sky-view factor is defined by the share of the visible sky (Ω) above a certain observation point (left). The algorithm computes the vertical elevation angle of the horizon γ_i in n directions to the specified radius R (right).



Vector Ruggedness Measure (VRM) (Sappington *et al.*, 2007)



Morphometric Protection Index (MPI)



Sources of environmental data – fieldwork sources

DEM variables

Insolation variables

direct insolation, diffuse insolation, total insolation, duration of insolation, sunrise, sunset.

From a period of 1 day to all year.

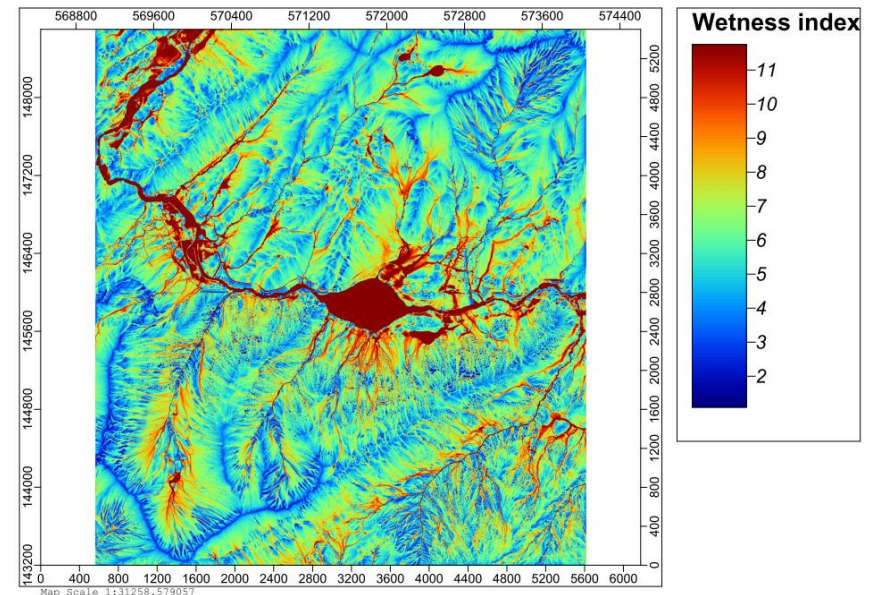
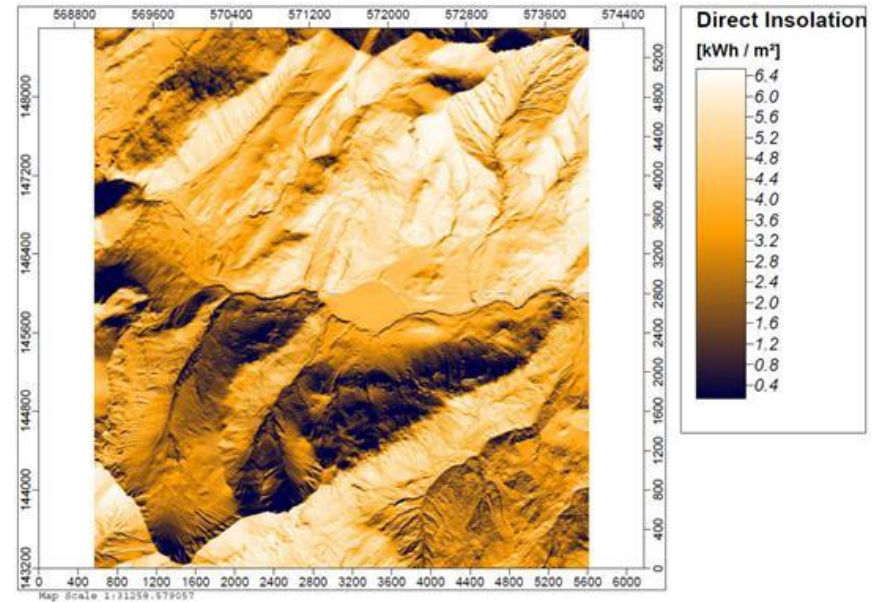
Wetness index

Tendency of a cell to produce runoff.

$$WI = \ln \left(\frac{\text{Catchment area}}{\text{slope}} \right)$$

Related to soil moisture.

The higher the value of this index in a cell, the higher is soil moisture (saturated soil).



Exercise

- Digital elevation models, calculate a slope, calculate hill shade

