r.survey: a tool to assess whether elements of specific sizes can be visually detected during field surveys

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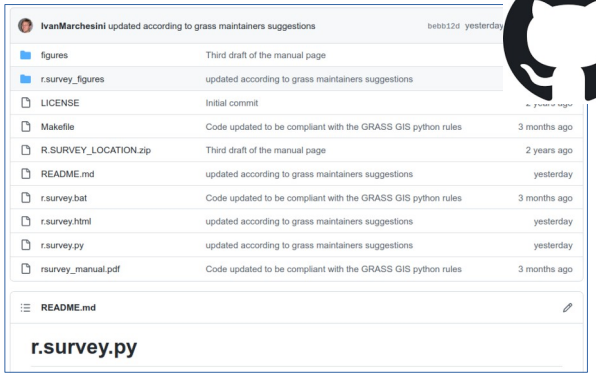
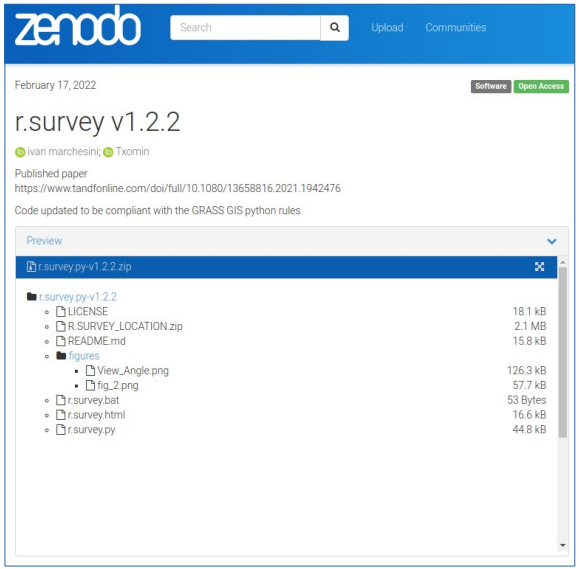
Introduction

- Terrain visibility is a key part of many scientific disciplines
- By 1964, W.F. Wood at Cornell Aeronautical Laboratory was creating DEMs to model line-of-sight calculations (Pike et al., 2008)
- Viewshed analysis (Higuchi 1983): what is visible or not visible from certain observation locations

Rationale

- Viewshed does not depend on the size of the object being viewed
- However, in some cases one can be interested in assessing the portion of the territory in which an object of a given size could be visible
  - For example: during an inspection made along roads, which is the portion of territory within which I can assume to be able to detect landslides whose area is greater than 300 square metres?





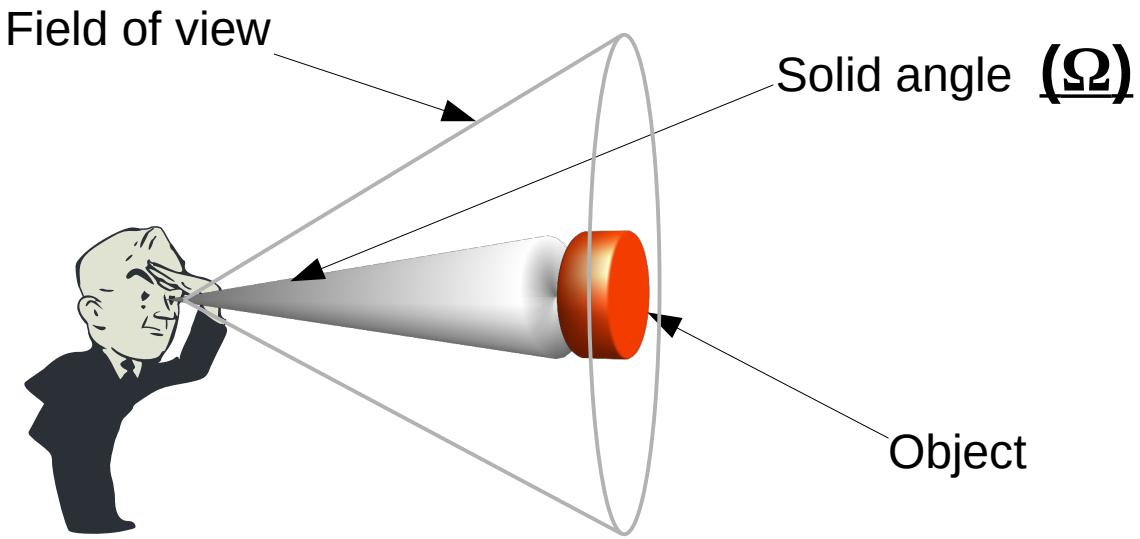
r.survey

r.survey: a tool for calculating visibility of variable-size objects based on orientation

- **Python script** for GRASS GIS
- Solidly based on **r.viewshed**
- **Parallel architecture** for calculation time optimization
- The approach is based in the **Solid Angle** concept

Solid angle

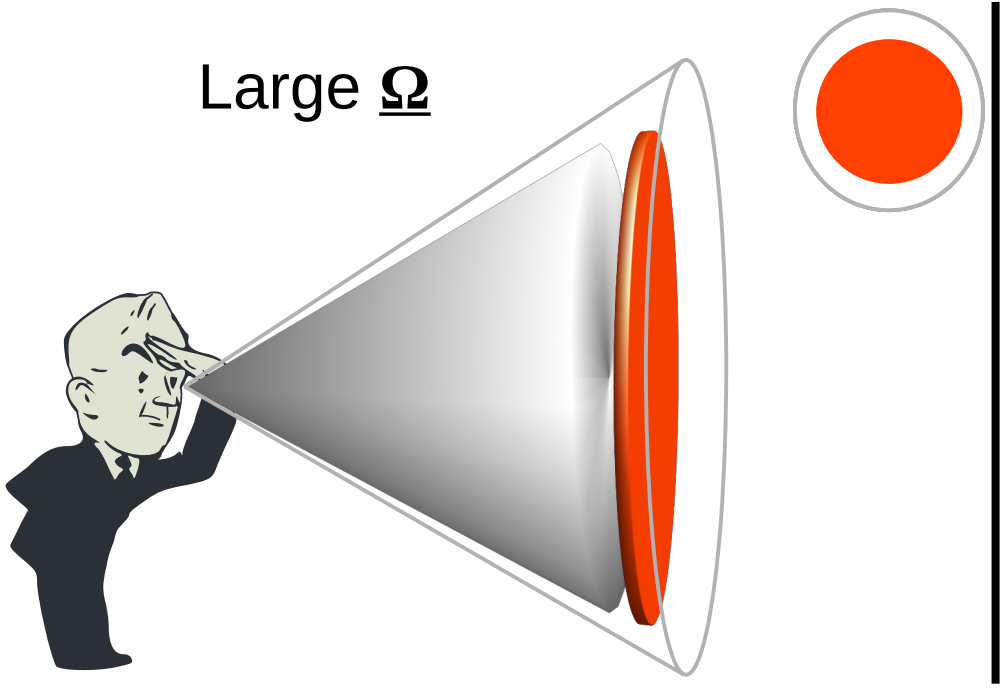
Solid Angle (Ω): a measure of the portion of the field of view occupied by the observed object (sr. ; degrees² ; mins²)



Solid angle

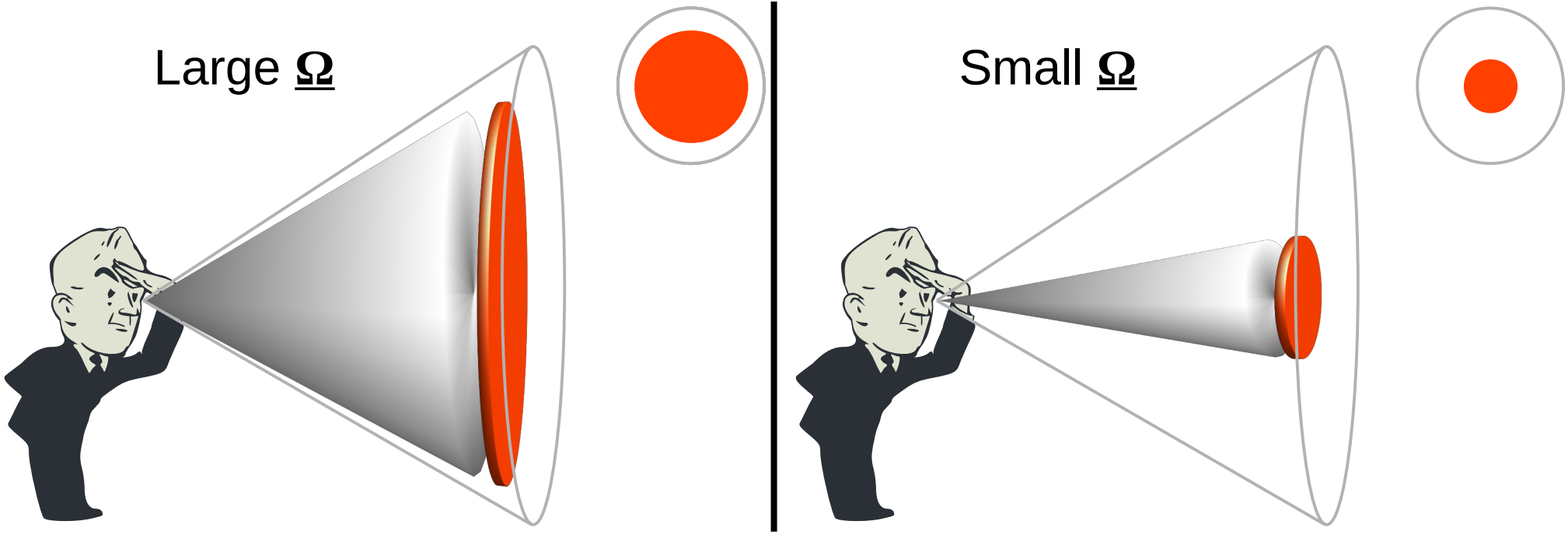
Solid Angle (Ω): depends on the size of the object

Large **Ω**



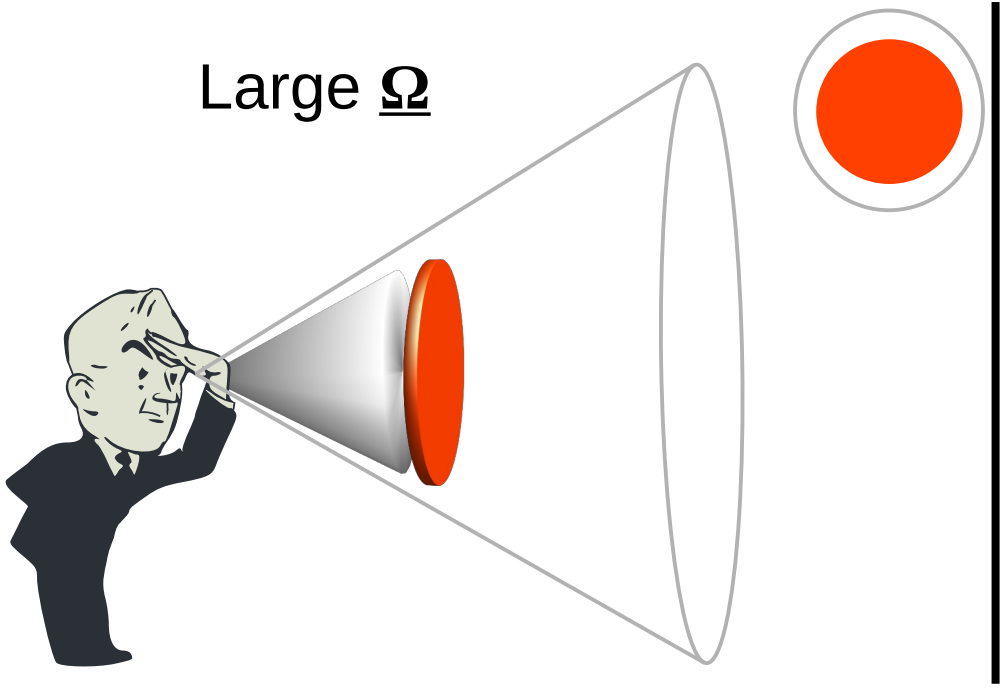
Solid angle

Solid Angle (Ω): depends on the size of the object



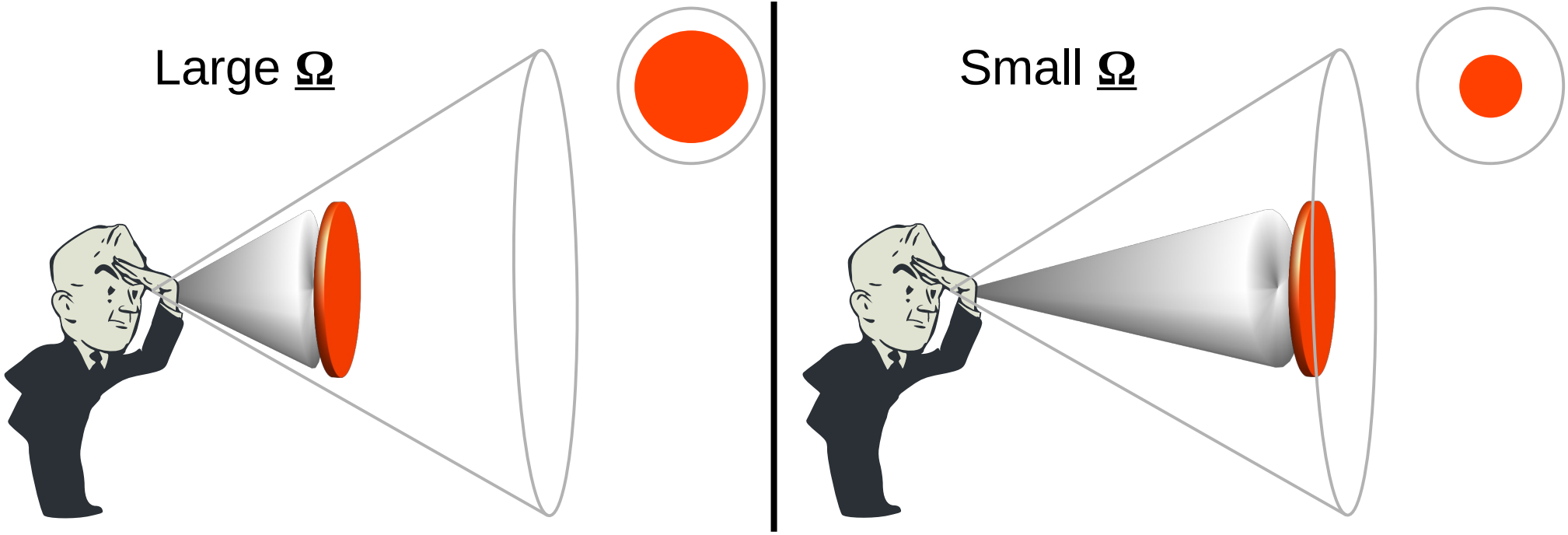
Solid angle

Solid Angle (Ω): depends on the distance from the object



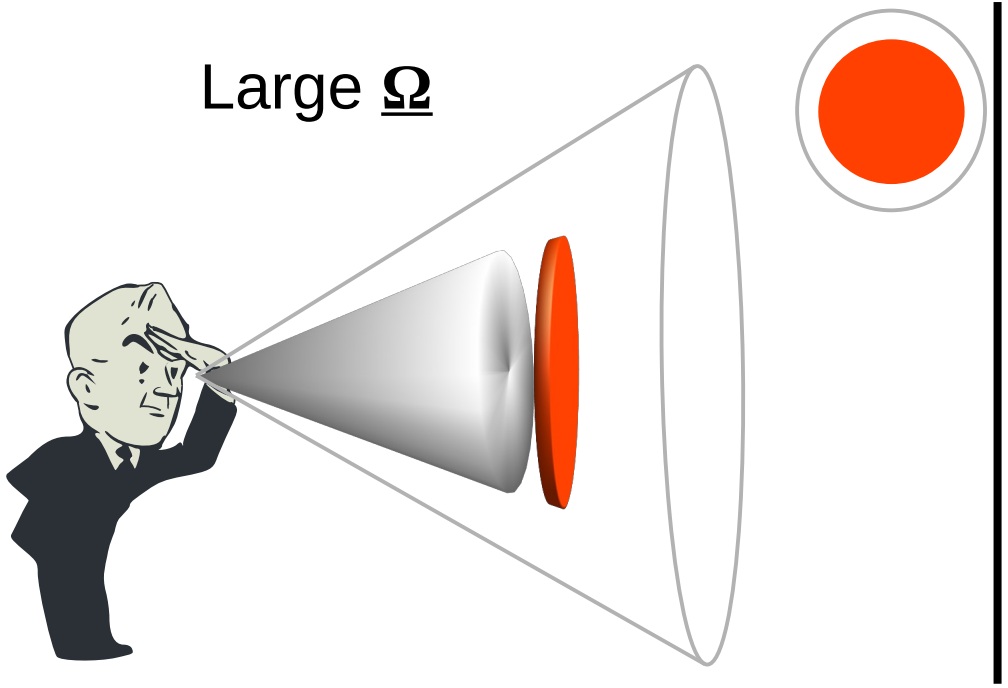
Solid angle

Solid Angle (Ω): depends on the distance from the object



Solid angle

Solid Angle (Ω): depends on the orientation of the object



Solid angle

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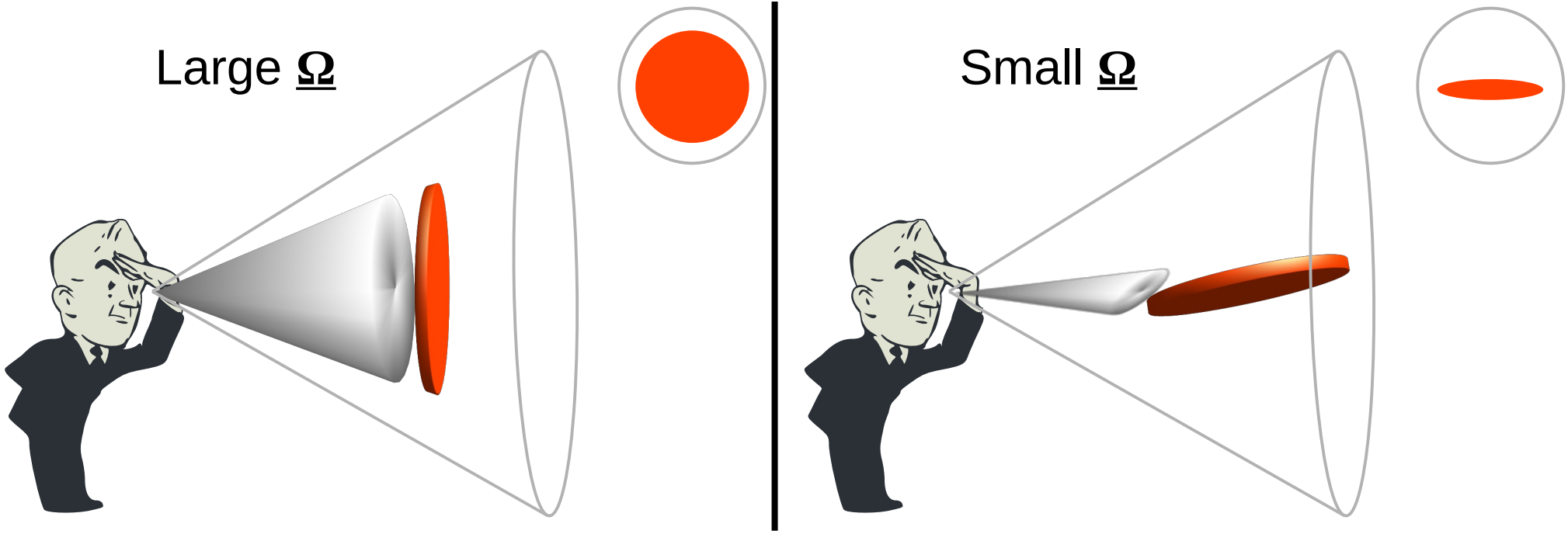


r.survey inputs

points = Name of the input points map (representing viewpoints)

dem = Name of the input DEM raster layer

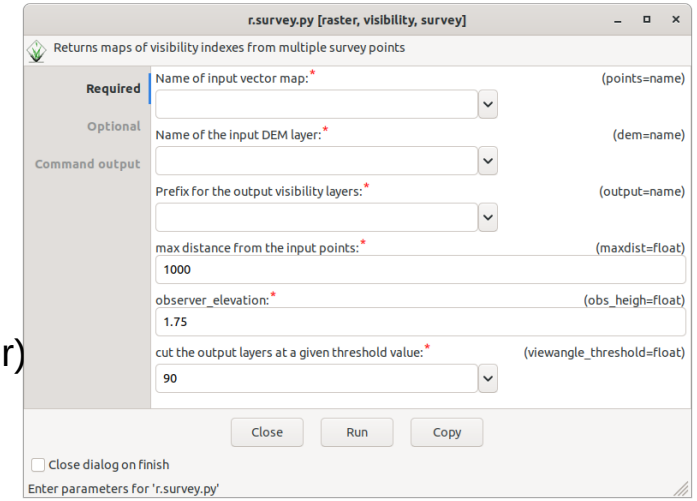
maxdist = Max distance from the viewpoints

object_radius = radius of the surveyed object in meters

obs_heigh = Observer heigh (1.75 m default)

obsabselev = viewpoints absolute elevation data (surveyor can be on a helicopter)

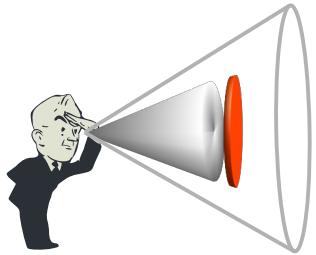
nprocs = Number of processes



treesmap = Name of the vector layer representing the forested areas
treesheigh = field of the attribute table containing information about average threes heigh
treesheighdeviation = field of the attribute table containing information about standard deviation value relate to the trees heigh
buildingsmap = Name of the vector layer representing the buildings
buildingsheigh = field of the attribute table containing information about buildings heigh

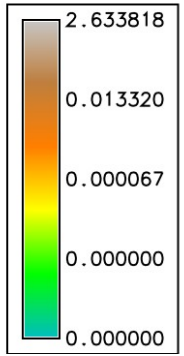
r.survey outputs

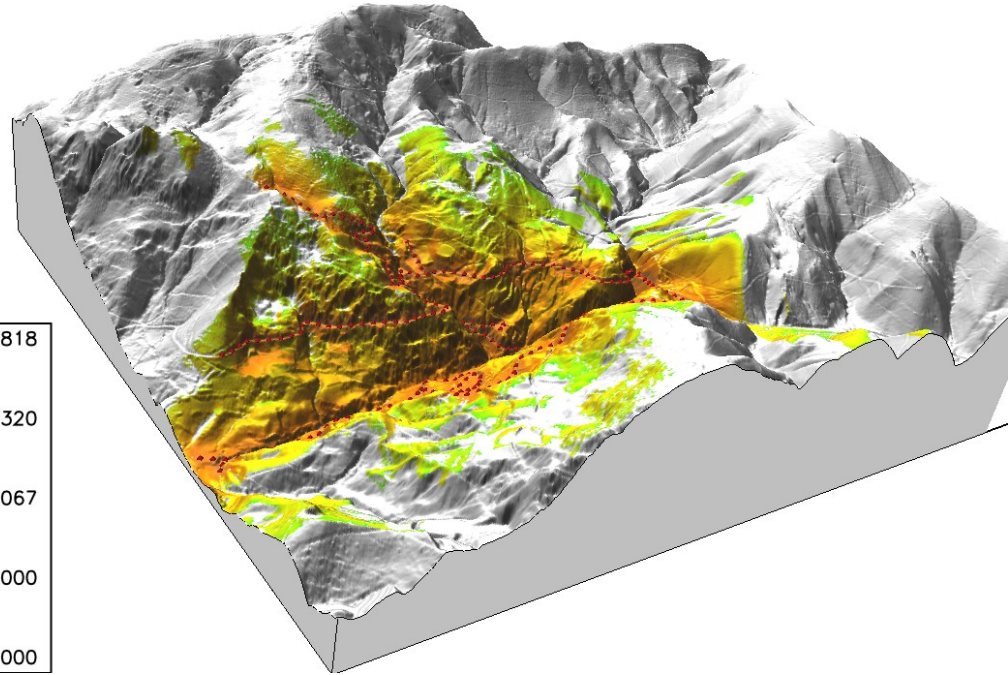
maxSolidAngle



In a raster cell: Maximum Solid Angle among those measured from multiple viewpoints

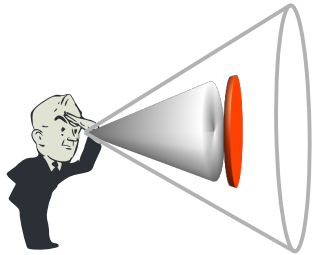
Unit of measurement: steradians
Range: 0-2π





r.survey outputs

maxSolidAngle



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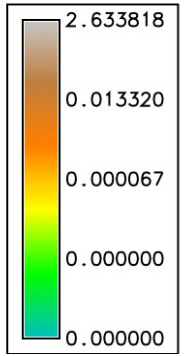
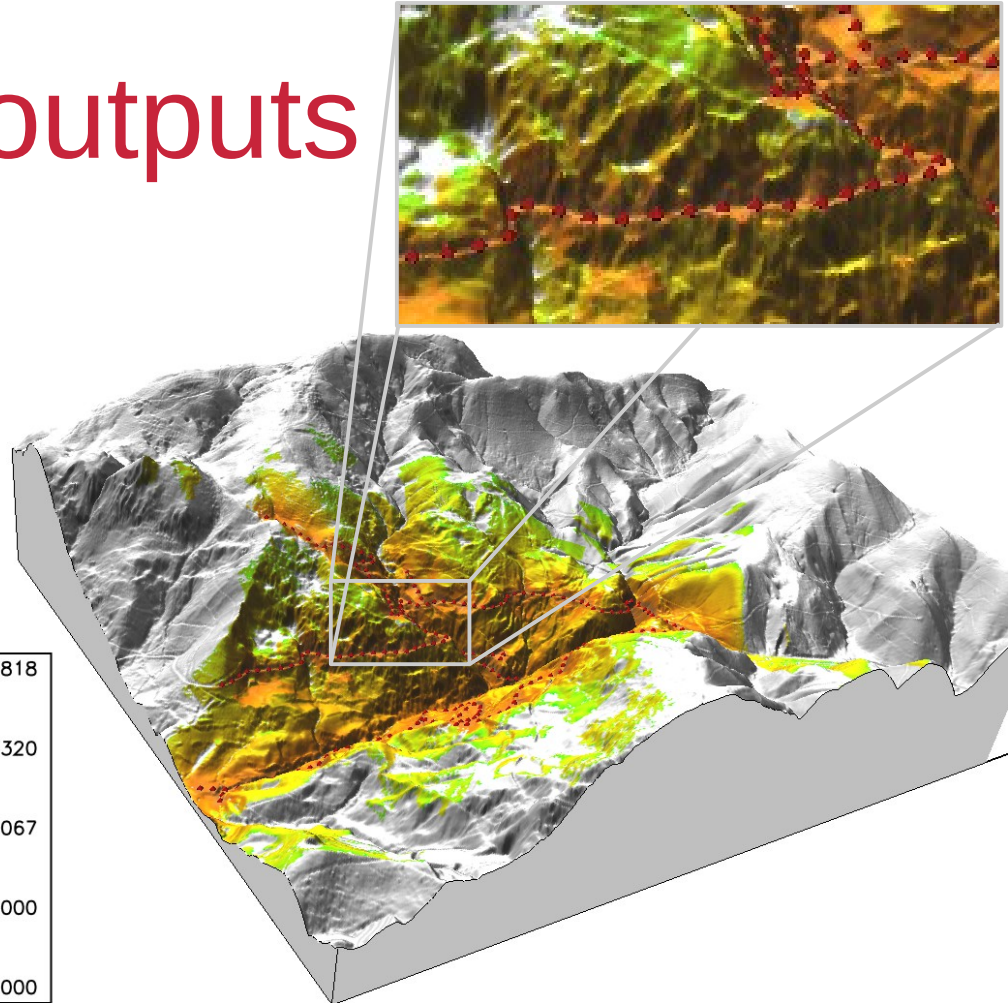


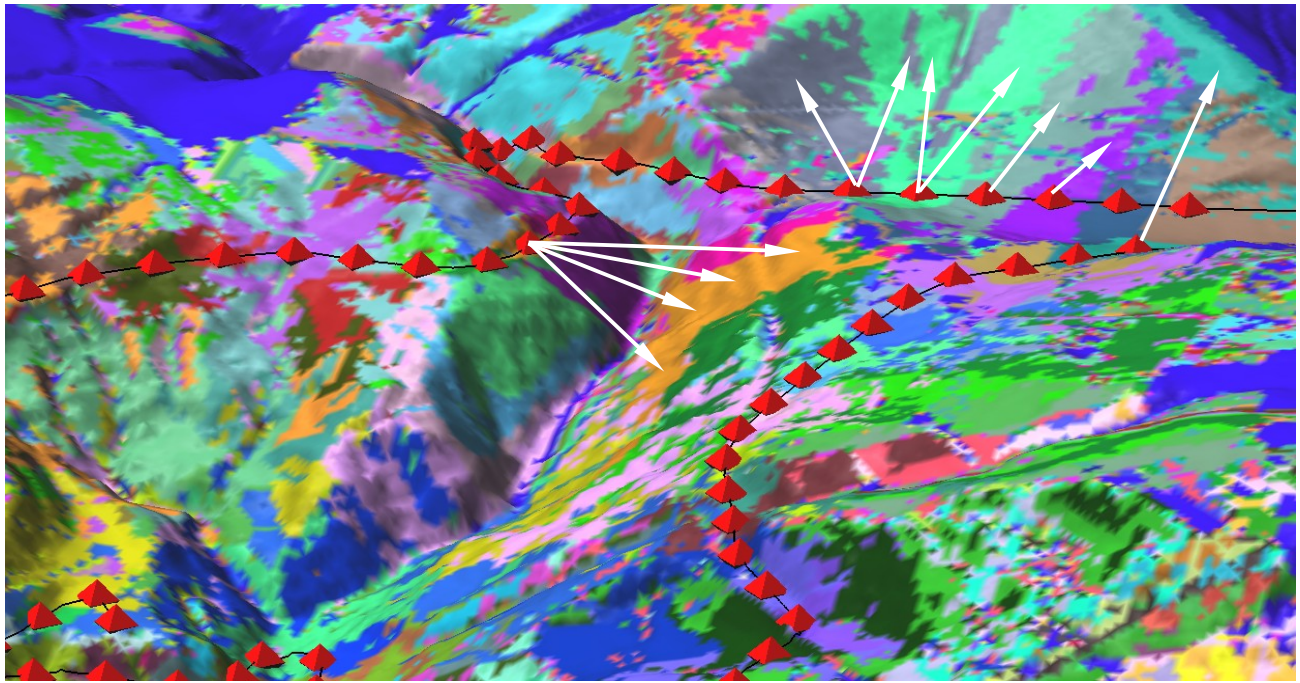


r.survey outputs

pointOfViewWithMaxSolidAngle

The category of each cell corresponds to the **identifier of the viewpoint** from where the **maximum solid angle** is calculated

Similar maps are generated for
- minimum values of 3D Distance
- maximum values of View Angle

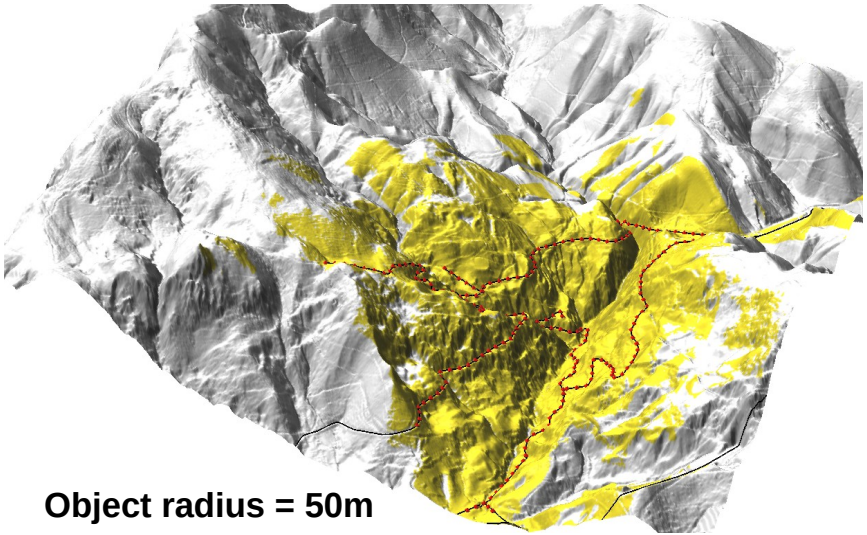


Example of r.survey usage

Size matters!

Moving along a road, what is the portion of territory in which I can clearly see an object ($\underline{\Omega}$ >1000 mins^2)?

It depends on its size!



Object radius = 50m

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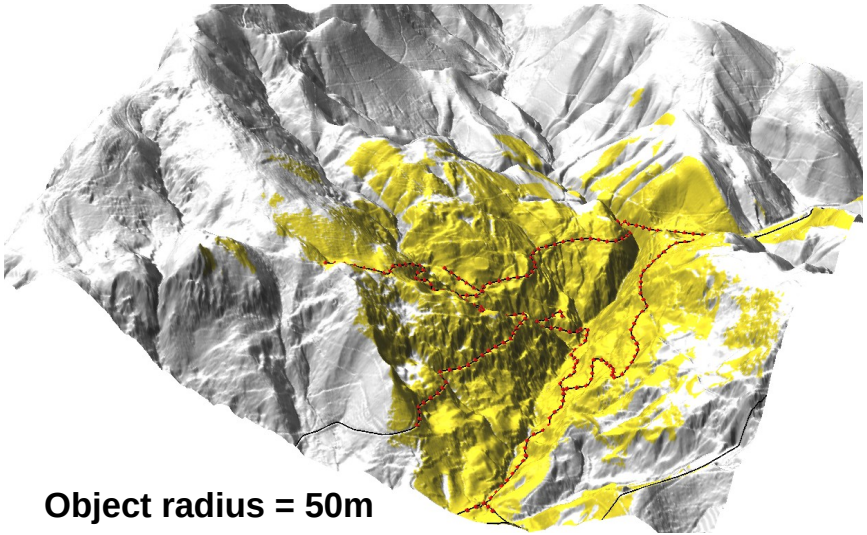
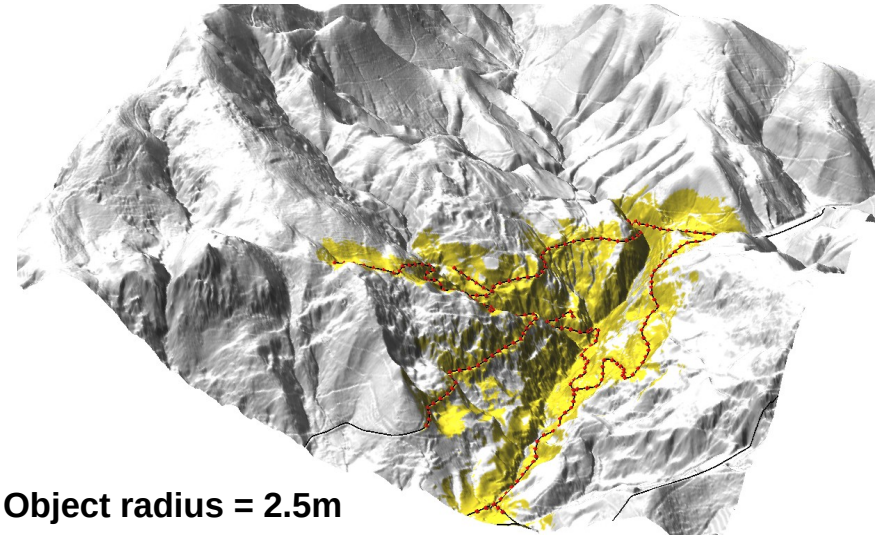


Object radius = 50m



Object radius = 2.5m

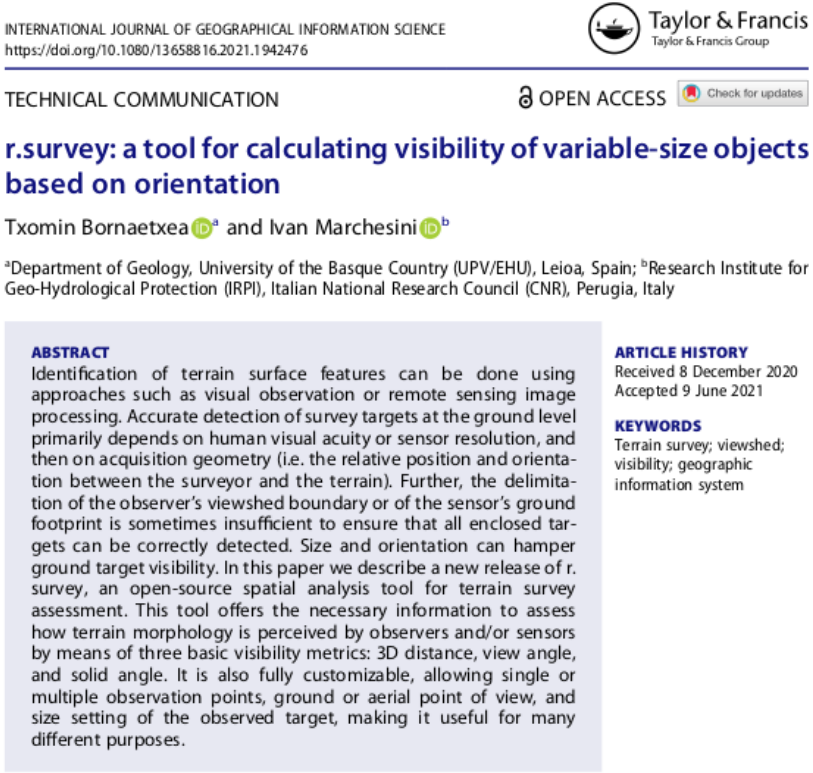
Conclusions

r.survey provides output that other tools do not generate

Simulates the visibility of objects of different sizes oriented according to the local topography

Can exploit multiple CPUs to work on large areas with a large number of viepoints

We are currently publishing it in the grass-addons repository



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r.survey: a tool for calculating visibility of variable-size objects based on orientation

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ABSTRACT

Identification of terrain surface features can be done using approaches such as visual observation or remote sensing image processing. Accurate detection of survey targets at the ground level primarily depends on human visual acuity or sensor resolution, and then on acquisition geometry (i.e. the relative position and orientation between the surveyor and the terrain). Further, the delimitation of the observer's viewshed boundary or of the sensor's ground footprint is sometimes insufficient to ensure that all enclosed targets can be correctly detected. Size and orientation can hamper ground target visibility. In this paper we describe a new release of r.survey, an open-source spatial analysis tool for terrain survey assessment. This tool offers the necessary information to assess how terrain morphology is perceived by observers and/or sensors by means of three basic visibility metrics: 3D distance, view angle, and solid angle. It is also fully customizable, allowing single or multiple observation points, ground or aerial point of view, and size setting of the observed target, making it useful for many different purposes.

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KEYWORDS
Terrain survey; viewshed; visibility; geographic information system

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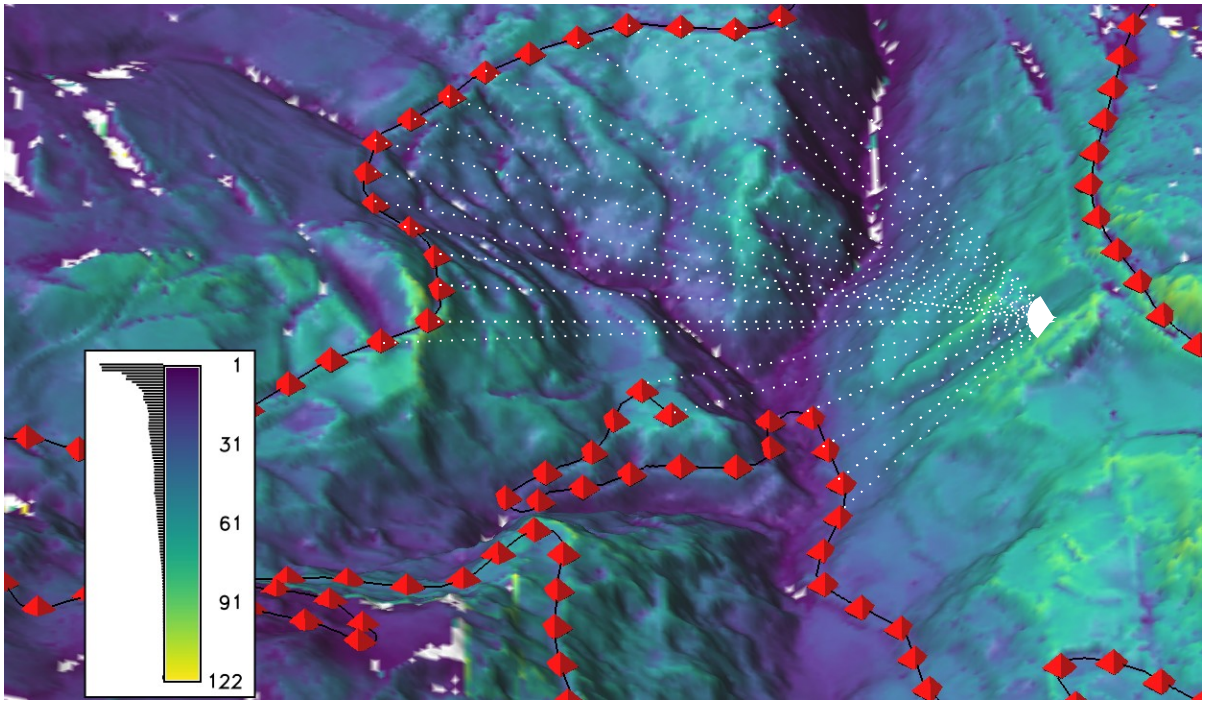
Annexes

Other r.survey outputs

numberOfViews

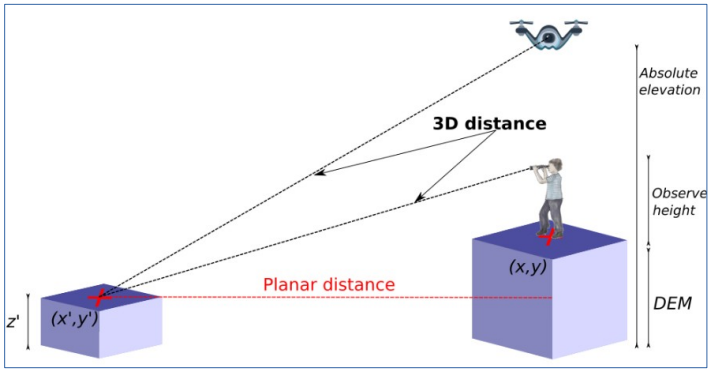
Number of viewpoints each pixel is visible from

Unit of measurement: #
Range: 0-∞



Other r.survey outputs

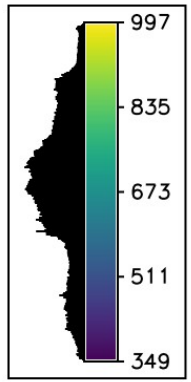
min3dDistance

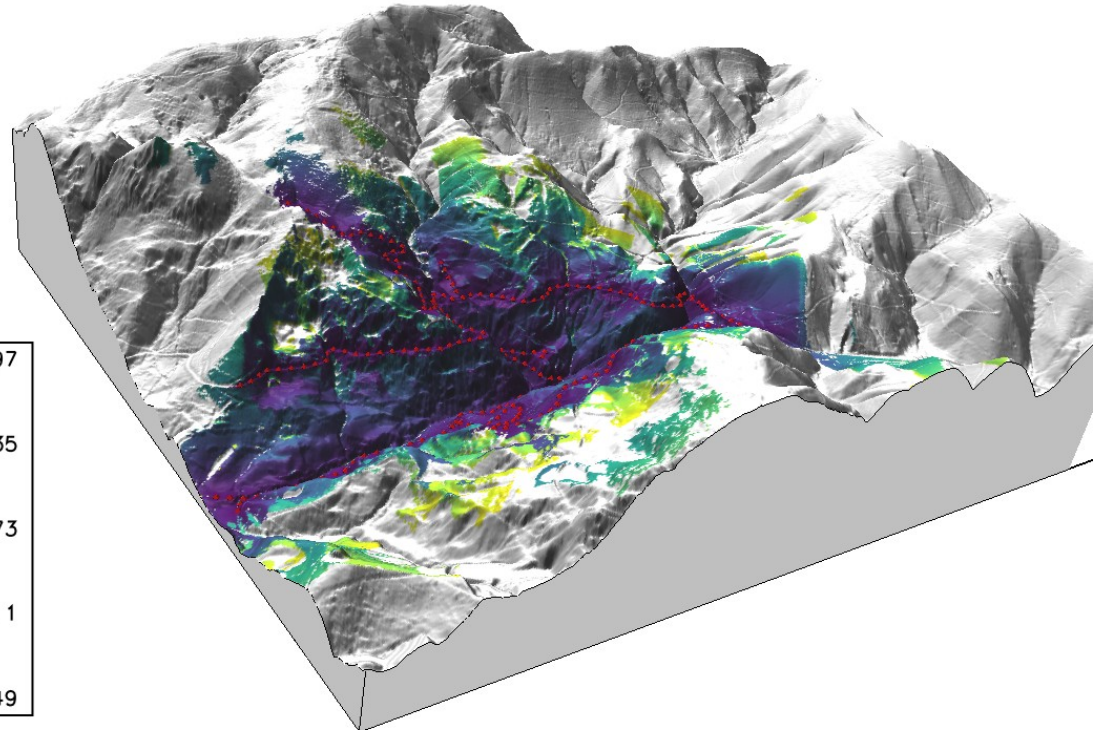


Minimum three-dimensional distance between the cell and the closest viewpoint

Unit of measurement: meter

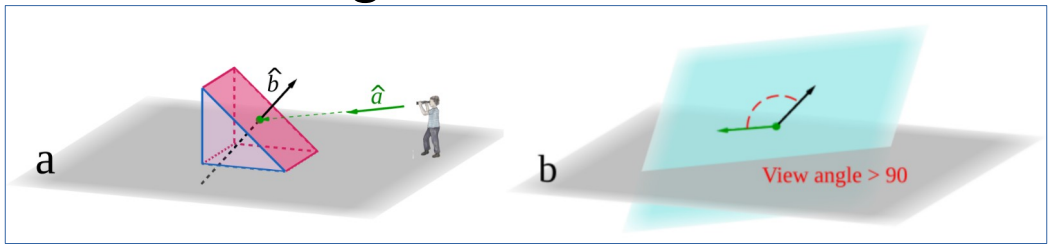
Range: 0-∞





Other r.survey outputs

maxViewAngle



In a raster cell: Maximum angle between the unit vectors describing hillslope and view directions from different viepoints

It is a measure of the most frontal view each single cell is visible from

Unit of measurement: degree
Range: 90-180