

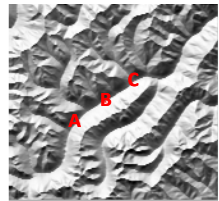
# Relief inversion effect in terrain representations: Where should we place the light source?

## Is ABC a valley or a ridge?

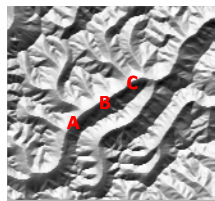
Shaded relief maps can suffer from a visual illusion called *relief inversion* (Imhof, 1967). Cartographers conventionally use NW lighting (at 315°) to avoid this illusion. There is however no empirical evidence where exactly the best illumination position is.

We conducted a user study in which we systematically changed the light direction. We measured how many participants correctly identified valleys and ridges using a 5-point Likert scale (1 "clearly a valley" to 5 "clearly a ridge"). Ratings 2 and 4 express level of certainty (confidence).

### a) 337.5°



### b) 157.5°



In the example above, you see the same digital elevation model (DEM) hillshaded in a) under incident light from 337.5° and in b) from 157.5°. The marked landmark (ABC) is a valley. Most observers perceive it correctly as a valley in a), but not in b), where they perceive a ridge.

## Methods & Results

We have shown 128 stimuli (8 terrains with 16 light directions) to naïve participants in a controlled lab-study (N=27). We measured participants' accuracy in landmark identification and their confidence. Accuracy results can be seen at the right. Confidence data suggested that participants were unaware of the illusion.

## References

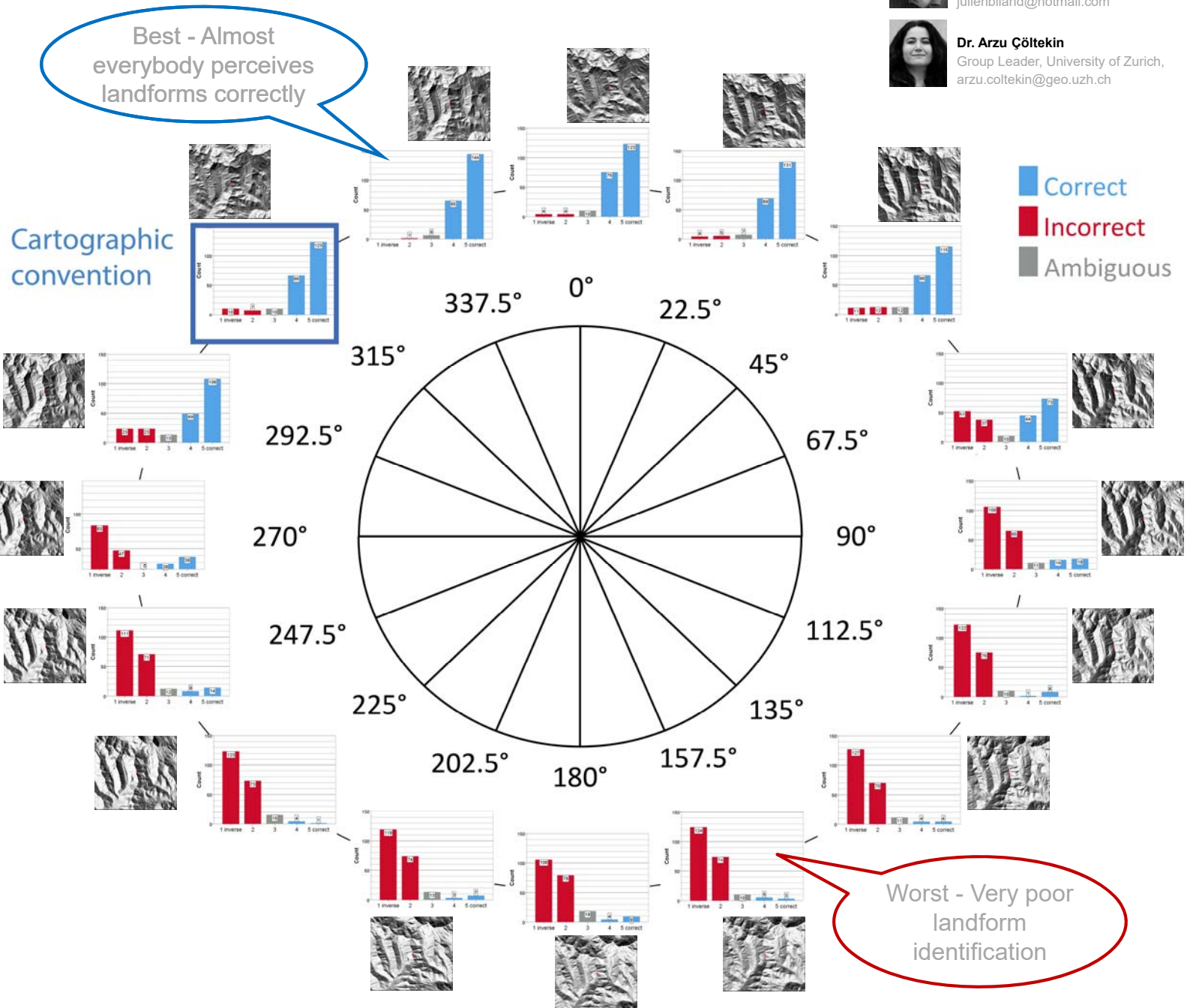
Imhof, E. (1967). Shading and Shadows. In *Cartographic Relief Representation* (Vol. 2007, pp. 159–212).

Biland, J., & Çöltekin, A. (2016). An empirical assessment of the impact of the light direction on the relief inversion effect in shaded relief maps: NNW is better than NW. *Cartography and Geographic Information Science*. DOI: <https://doi.org/10.1080/15230406.2016.1185647>

Also see

Çöltekin, A., Biland, J. (2018). Comparing the Terrain Reversal Effect in Satellite Images and in Shaded Relief Maps: An Examination of the Effects of Color and Texture on 3D Shape Perception from Shading. *International Journal of Digital Earth*. DOI: <https://doi.org/10.1080/17538947.2018.1447030>

Çöltekin, A., Rautenbach, V., Coetzee, S., Mokwena, T. (2018). Accuracy of landmark perception in shaded relief maps based on light direction: A replication study confirms that NNW is better than NW against the relief inversion effect. In: *ISPRS - International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, XLII-4, 101-106, Delft, Netherlands, October 1st-5th, 2018. DOI: <https://doi.org/10.5194/isprs-archives-XLII-4-383-2018>



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