Visualisation of uncertainty using the HSI colour model: computations with the colours

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Biography

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Introduction

The natural resource inventories are often visualised using either (a) greyscales or colour scales for continuous variables and (b) sets of different colours (choropleth or double-crisp map) for categorical variables. With the emerging of various quantitative GIS tools, uncertainty is becoming an important product of a mapping process (Burrough et al., 1997). Its visualisation allows users to investigate the effects of different decisions. For example, a typical result of (geo)statistical interpolation is a map of predictions, accompanied with a map of the prediction error (measure of the prediction uncertainty). The two can be visualised separately, but what about the simultaneous visualisation? Another challenging task is the simultaneous visualisation of multiple membership maps derived using some continuous classification method (Goodchild et al., 1994). Hootsmans (1996) compared visualisation of uncertainty using different colour variables (saturation, intensity and hues). Jiang (1996) investigated fuzzy colour systems for visualisation of uncertainty and conducted number of perception tests. The results clearly showed that brightness is the most suitable to visualise uncertainty.

Current Developments

We have explored possibilities for visualisation of uncertainty in spatial prediction of quantitative data and visualisation of multiple membership maps using calculation with colours (Hengl et al., 2002). We first developed a new static visualisation technique for visualisation of uncertainty in interpolation of continuous data. We also developed a visualisation technique for results of continuous classification (categorical variables). In both cases we used computations with the colours and the Hue Saturation Intensity (HSI) colour model (Fig. 1a), as implemented in the

Integrated Land and Water Information System (ILWIS). We named the technique "Colour mixture" (Hengl et al., 2002).

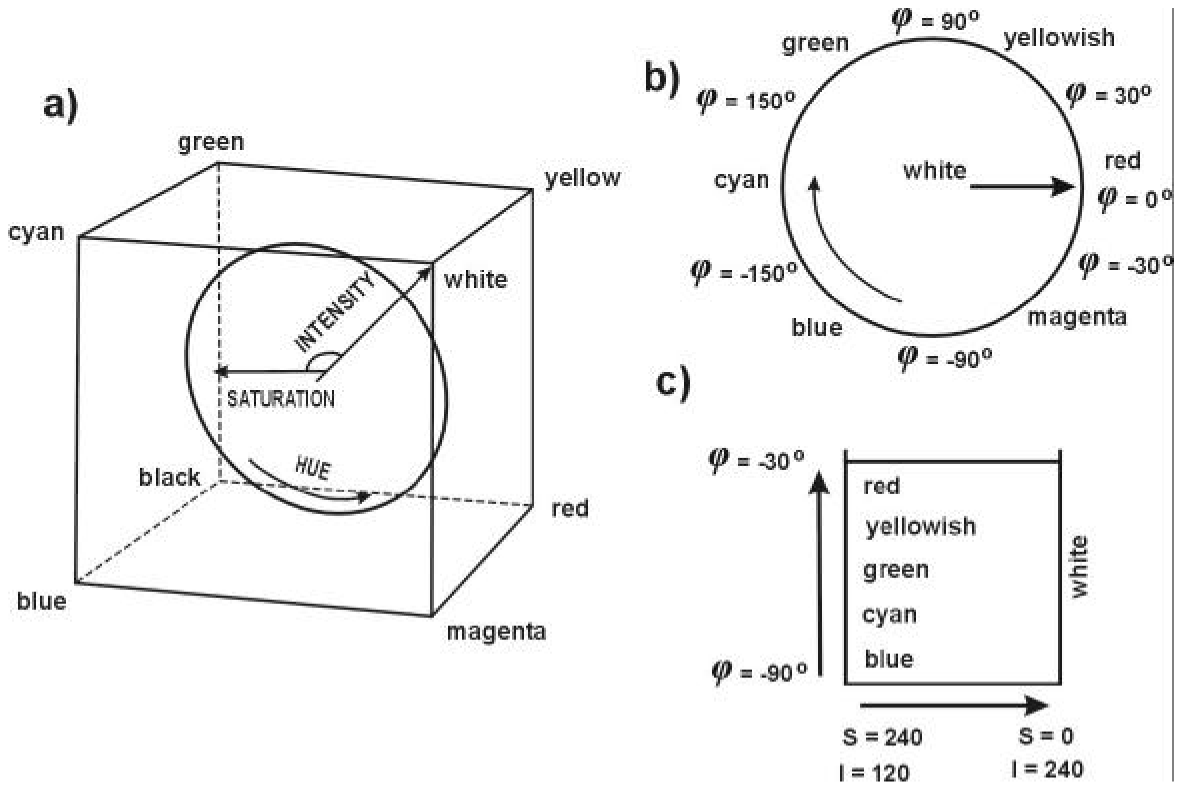

Fig. 1. Hue-Saturation-Intensity colour model in Red-Green-Blue colour cube (a), circular colour legend (colourwheel) used as a legend for the categorical data (b) and the two-dimensional legend used for visualisation of uncertainty in the quantitative data (c). f is the hue angle in degrees measured clockwise.

To accompany visualisation of uncertainty for continuous variables we developed the two-dimensional Hue-Whiteness legend (Fig. 1b). The vertical direction indicates change of prediction values (hue ranges from -90° or blue to -30° or red), while the horizontal direction indicates uncertainty and is coded with a linear increase of both intensity and saturation (whiteness). To accompany visualisation of multiple membership maps, we used the HSI colourwheel legend with maximum uncertainty located in the centre (Fig. 1c).

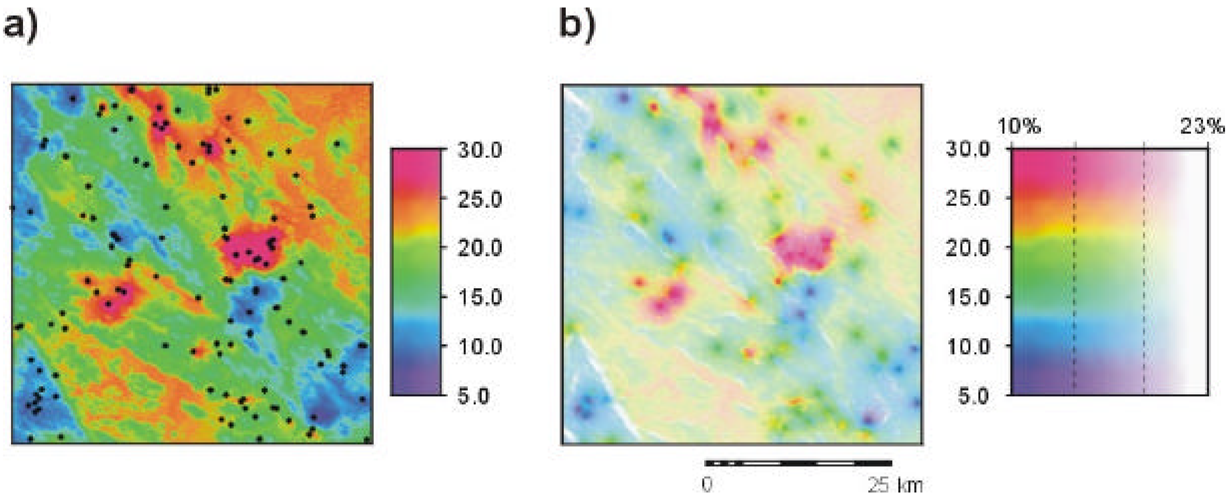

Fig. 2. Visualisation of uncertainty for a quantitative variable (topsoil thickness) interpolated using regression-kriging: (a) the common pseudo-colour legend used in many GIS packages and (b) two-dimensional legend with uncertainty coded with the whiteness.

The combined visualization gives insight into the relationship between uncertainty and input data for the given thresholds. In the example above (Fig. 2b), success of interpolation of topsoil thickness is quantified using the whiteness (paleness?). The corrected brightness values are: (a) equal to the original RGB for a relative uncertainty equal or less than 10%, and (b) completely white for relative uncertainty equal or higher than 23%.

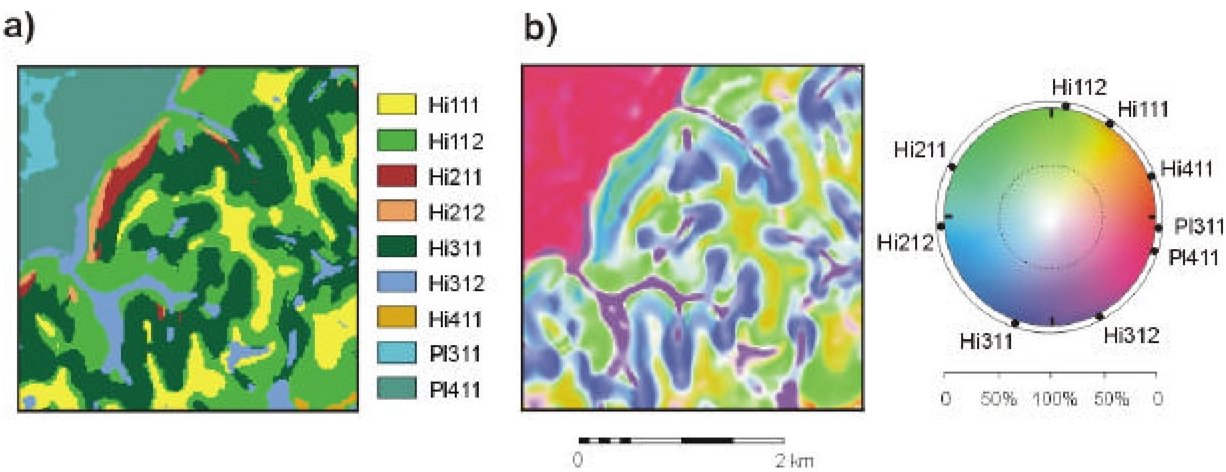

Fig. 3. Visualisation of uncertainty for a categorical variable (landform facets): (a) the common double-crisp system and (b) mixed-colour map with uncertainty coded with whiteness.

The second example (Fig. 3b) shows visualisation of results of classifying nine landform facets using supervised fuzzy k-means classification (Hengl et al., 2003). The colour values are considered to represent the taxonomic space spanned by the attribute variables. Coordinates of the nine class centres (landform facets) were first transformed from multivariate to two-dimensional attribute space, and then projected on the HSI colourwheel. The taxonomic value was coded with the Hue and confusion with whiteness. Classes that were closer in attribute space were merged into similar generic colours. The colour-mixture technique limits the derived mixed-colour map to seven generic hues independently of the total number of classes, which provides basis for automated generalisation.

Both visualisation algorithms can be applied in any image processing or general GIS package that allows computations with the colours. The next step is to advance this methodology using interactive tools such as animation and real-time linking with the input data.

References

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