Introducing the ColorADD color coding system in map design

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Colorblindness

- 5% of world population
- mostly men
- many types

Fig. 1 Example of how color vision impaired perceive traffic lights

Fig. 2 Types of color vision impairment
Colorblindness & Map Usability

  - colorblind safe color scales – colorbrewer.org (Harrower, Brewer 2003)
  - other recommendations for map design

- **B. Jenny** and **N. V. Kelso** (2007)
  - Color Oracle – colorblindness simulator
  - clear color combinations, labels for important features, alternative visual variables, change in structure and shape

- **M. Okabe** and **K. Ito** (2008)
  - sufficient contrast between background color and object color
  - purple-green color schemes
  - completely avoid using light color shades
  - place labels directly inside the graph
ColorAdd Color Coding System

**Fig. 3** Usage of ColorAdd color coding system

**Fig. 4** Principles of ColorAdd color coding system
Fig. 5 ColorAdd color coding system
Research Design

- explorative usability study
- variation in shape vs. variation in color
- fictional administrative units
- diagram maps – 4 economic indicators: criminality, unemployment, attained university education, religiosity
- each group – same test (both map variants)
- increasing difficulty of questions

- efficiency + effectiveness
- Eye Tracking
- retrospective interviews
Fig. 5 Color map variant
Fig. 6 Coded map variant
EXPLORATORY STUDY

Test Run

- March 2016
- 35 subjects (21 – 58 years)
- 10 colorblind + 25 normal vision (4 women)
- approx. 35 min

Fig. 7 Schematic overview of testing procedure.
Basic statistics

- number of errors was not dependent on map variant nor on user group
- users with normal vision performed **significantly** faster on *colored variant* compared to the color blind users
- on the *shape coded variant* there were **no significant differences** between groups

**Fig. 8** Average task completion time [s] for standard vision group

**Fig. 9** Average task completion time [s] for color blind vision group
Interviews

• subject with standard vision preferred color variant
• half of the colorblind subjects preferred coded variant (distinguishable color shades and few categories)
• ColorAdd – usable, maybe with slight modifications (red – blue)
• association between colors and symbols was not developed
I. Understanding of Spatial Patterns

Fig. 10 Model example of the implementation of the ColorADD system on a choropleth map with a bivariate color scheme.
II. Navigation

Fig. 11 Model example of the implementation of ColorADD system on tourist maps: a) original b) simulation of color blind vision (author; Hiking.sk, 2017).
III. Interactive visualizations

- mouseover event – not visible spatial patterns (one feature at a time)
- zoom in zoom out – symbol size problem SOLVED
- replacing area symbol with point symbol – generalization methods (clustering, spider maps...) – graphic clutter problem SOLVED

http://cartocoloradd.geogr.muni.cz/app.html
Conclusion

- The conducted **exploratory study supports** the research question focused on the possibility of the **implementation of the ColorADD system** in cartographic visualizations.
- The two groups of participants do not have significantly different strategies of task solving but the **ColorADD system** seems to provide an **advantage for color blind users** while solving **more complex tasks** on the map.
- The general **validity** of results is limited by the **small number of color blind participants**.
- The **ColorADD system** represents a form of **informational redundancy**. It also increases the **graphic clutter** of the map field. However this issue can be addressed in **interactive maps** design.
Thank you for your attention

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