Somewhere Over the Rainbow: How to Make Effective Use of Colors

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Introduction

Everyday challenges:

Big, highly complex data sets
Better understanding via visualizations
One to four-dimensional (time and space) visualizing: important part
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Common software:

- large variety of software packages
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- **most common** default palettes: Red-Green-Blue rainbow (RGB)

Choosing colors: wrong colors can cause (a variety of) problems choosing effective colors is not a trivial task
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**Main goal of our work:**

- to sensitize
- Hue-Chroma-Luminance (HCL) concept
- based on human perception
- full control choosing color palettes
The standard way

Using Red-Green-Blue based color maps
The standard way: using RGB

The RGB color space – and it’s famous rainbow color scheme.
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- the easiest way: use default color palettes in software packages
- most packages provide RGB color palettes
  - e.g.: IDL, GrADS, Python, matlab, R (by default)
The standard way: using RGB

RGB rainbow

RGB rainbow spectrum

Question

“Everybody does it – why should it be wrong?”
What’s wrong?

Hurricane Sandy
120-hour Day 1-5 Rainfall Forecast

Original figure as published by the NOAA.

What’s wrong?

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Basic color guidelines:

**Colors should be:** assisting; simple; clear; appealing
What’s wrong?

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Desaturated version of the original figure.
What’s wrong?

Assignment no longer unique

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Interpretation
Where is the maximum?

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Focus
on dark artefacts

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Colors should work everywhere; point and guide to important information
What’s wrong?

What color-blind people see (red-green weakness).

About 4.5% of all Europeans are affected.
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End-user
Who is it?
To regard
visual constraints?

Colors should consider
end-user needs
Requirements to the colors

**Summary:**

- simple and natural
Requirements to the colors

Summary:
+ simple and natural
+ point to important information
+ do not mislead the reader
## Requirements to the colors

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Requirements to the colors

Summary:
+ simple and natural
+ point to important information
+ do not mislead the reader
+ be appealing
+ customer tailored
+ should work everywhere
Requirements to the colors

In reality:

– people often do not think about it at all
– … and simply use default colors

This can lead to various problems for your **end-users** (reviewer, supervisor, colleague), your **customers**, or **your own** day-by-day **work**.
A perception-based color scheme

Introduction to the Hue-Chroma-Luminance (HCL) concept
Perception-based way: HCL

A HCL rainbow

HCL rainbow spectrum

Triplet of:
- **H**ue (defines the color)
- **C**hroma (defines the colorness)
- **L**uminance (defines the brightness)
Perception-based way: HCL

A HCL rainbow

HCL rainbow spectrum

Triplet of:

- **Hue** *(defines the color)*
Perception-based way: HCL

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Advantages:

- based on human perception
Perception-based way: HCL

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- additional information
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Advantages:
- based on human perception
- easy to control
- simple to use
- improves your work
- additional information
- helps understanding complex concepts

Hue

Chroma

Luminance
Same information, changed color scheme.
Same information, changed color scheme.
HCL version

Same information, changed color scheme.
HCL version

Same information, changed color scheme.

Colors
only two colors; no irritating gradients

Information
guiding; no hidden information

Works
screen; projector; gray-scale device
HCL version

Hurricane Sandy
120-hour Day 1-5 Rainfall Forecast

Desaturated representation of the HCL-version.
Desaturated representation of the HCL-version.

Assignment
Higher precipitation → lower luminance
HCL version

Assignment

Higher precipitation → lower luminance

Focus

on most important areas

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Desaturated representation of the HCL-version.
HCL version

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Higher precipitation → lower luminance

Focus

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Summary

Solved a lot of problems by changing the color palette
Warning map example

Colorized
Original (left)
HCL idea (right)

Warning map example

Colorized
Original (left)
HCL idea (right)

Gray-scale
Warning map example

Colorized
Original (left)
HCL idea (right)

Gray-scale

Deuteranopia
Red-Green weakness
Experiences with HCL scheme
Experiences with the HCL scheme

In the beginning

– hesitation of the colleagues
Experiences with the HCL scheme

In the beginning

- hesitation of the colleagues
- “not necessary”
- “why should we change existing products”
- “everybody does it like this”
Experiences with the HCL scheme

A few days later

+ mainly positive feedback
Experiences with the HCL scheme

A few days later

- mainly positive feedback
- “how can I make use of those palettes?”
- “does that work in my coding language?”
Experiences with the HCL scheme

A few days later

- mainly positive feedback
- "how can I make use of those palettes?"
- "does that work in my coding language?"
- "much easier to interpret"
- decrease of misinterpretation
Experiences with the HCL scheme

Complex concepts

+ easier to read
Experiences with the HCL scheme

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<td>+ HCL: powerfull tool for teaching</td>
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Tools and further reading

The HCL wizard: www.hclwizard.org
New export button

July 20, 2015  ✉ Feature

Hello everyone

Another small update today. I got asked by Arne Spekat if it would be possible to have an export button to download a tailored color palette. Of course it is :).

The Online HCL Creator now offers a Download-Button (choose your personal palette and open the "Export Options: RAW" panel) for the three different types (RGB float, RGB integer base, and HEX colors). The tool then sends a clean ASCII (simple text file) to your browser. If there is a need to change/extend the format for an easier use - please let me know!

Have a nice day,
Peter

Side note

Most of us are working with colors day-by-day. Often, the default color schemes are used which is not always the most effective way. The page gives you some first information to get in touch with the Hue-Chroma-Luminance color concept. Furthermore, we offer you a tool ready for "try and use".

Get full article

The (open access) article "Somewhere over
www.hclwizard.org
References


Side note

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Get full article

The (open access) article "Somewhere over the Rainbow: How to Make Effective Use of Colors in Meteorological Visualizations" (R. Stauffer, G. J. Mayr, A. Zeileis and M. Dabernig) is now available online. BAMS, Volume 96, Issue 2, February 2015.
How is it in your field?

Some examples from the latest issues
### Ecological Economics

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*All articles checked for color-usage and subjectively classified (Reto, Sept. 2015).*
Annual Review of Entomology

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All articles checked for color-usage and subjectively classified (Reto, Sept. 2015).
Manipulated/adapted versions of the original figure (Pascale 2015). Top: original colors; bottom: re-drawn using a HCL color map. Left to right: original colors; deutan (red-green weakness); desaturated.
### Color Usage in Articles

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*Current issue (v47 i7, October 2015). All articles checked for color-usage and subjectively classified (Reto, Sept. 2015).*
Environmental Earth Sciences
Environmental Earth Sciences

[Maps and charts showing various environmental data, including maps of different regions and graphs with data indices.]

- U-matrix
- Risk map
- DRASIC INDEX
- Index - TSI (TP)
Colors are a powerful tool and can be very effective (and pretty) if used correctly!