# "A map is worth a thousand words" —if well designed

—by Ilse Genovese

We live in a society obsessed with the visual—from driving directions to decision-making, it's got to be "on the map." But, does being "on the map" automatically convey information clearly? Not necessarily, argue Jean McKendry and Gary Machlis from the University of Idaho in a paper published last year in *Climatic Change*. Poorly designed maps can distort information or make it difficult to understand and may lead to poor decision making. Fortunately, GIS cartographers themselves are calling attention to the need to raise the bar of contemporary mapping.

The devil [always] lies in the detail—in the case of mapping, it's colors and fonts, the placement of graphic symbols, or how a map projection represents the areas on the Earth. For a map to do its job properly, it should be designed with cartographic principles in mind. Unfortunately, this is not always the case. Yet, like other visual media, maps are essential to communicating information about a number of contemporary, societal challenges, including climate change. In their paper in the journal *Climatic Change*, McKendry and Machlis (2008) describe how the systematic evaluation of the cartographic design and quality of climate maps is essential but has not occurred yet. They offer one approach as demonstration.

For their demonstration, the authors chose a "high-visibility" climate change map published in 2007 by the intergovernmental Panel on Climate Change (IPCC). IPCC reports are widely considered to be a definitive source of scientific information on climate change, and they are often referenced by researchers and policy makers alike. The selected map ("Changes in physical and biological systems and surface temperature 1970-2004") appeared in the 2007 IPCC report's executive summary for policy makers (by Working Group II) and has been published in modified form in The Washington Post and other media. The original map is shown on the next page.

In their evaluation of the IPCC map, McKendry and Machlis apply a selected set of cartographic principles adapted from Brewer (2005) and Krygier and Wood (2005). They examine the map projection used to show geographic areas and the distribution of data; the level of generalization applied; map layout focus; visual variables such as color hue, color value, and color saturation; the size and shape of symbols used to represent either quantitative or qualitative data; and visual hierarchy.

Consider, for instance, the map projection used in the IPCC map. The map would benefit from the use of an equal-area map projection, which is a preferred projection for showing data distributions on small-scale maps. In the IPCC map, the projection is not equal area, and the colored squares, equal in size, do not represent the same area on the Earth. The authors rate the map projection choice as "poor."

Next they look at generalization. As a small-scale world map, countries are appropriately the smallest geographic area. However, linework symbolizing coastlines and boundaries is rather detailed. The authors rate generalization as "satisfactory."

Data classification is also evaluated; the map includes examples of both qualitative and quantitative data classification. Temperature change is an example of quantitative data (differences in amount). Such data can be grouped into classes or groups by external criteria, (e.g., into equal intervals) or by their characteristics (e.g., natural "breaks" between data points). The IPPC maps shows five temperature classes, but it is unclear how the breaks between the data classes were established, only that the ranges for the classes are not equal. Overall, the map is rated as "satisfactory" on data classification.

The authors apply two principles dealing with color to the IPCC map —color hue and color value. Different color hues (e.g., red, green, or blue) are typically used to distinguish features that are qualitatively different, such as rivers and roads. On this map, physical and biological systems are appropriately depicted with different colors (blue for physical and green for biological). The authors rate the map as "satisfactory" on this point.

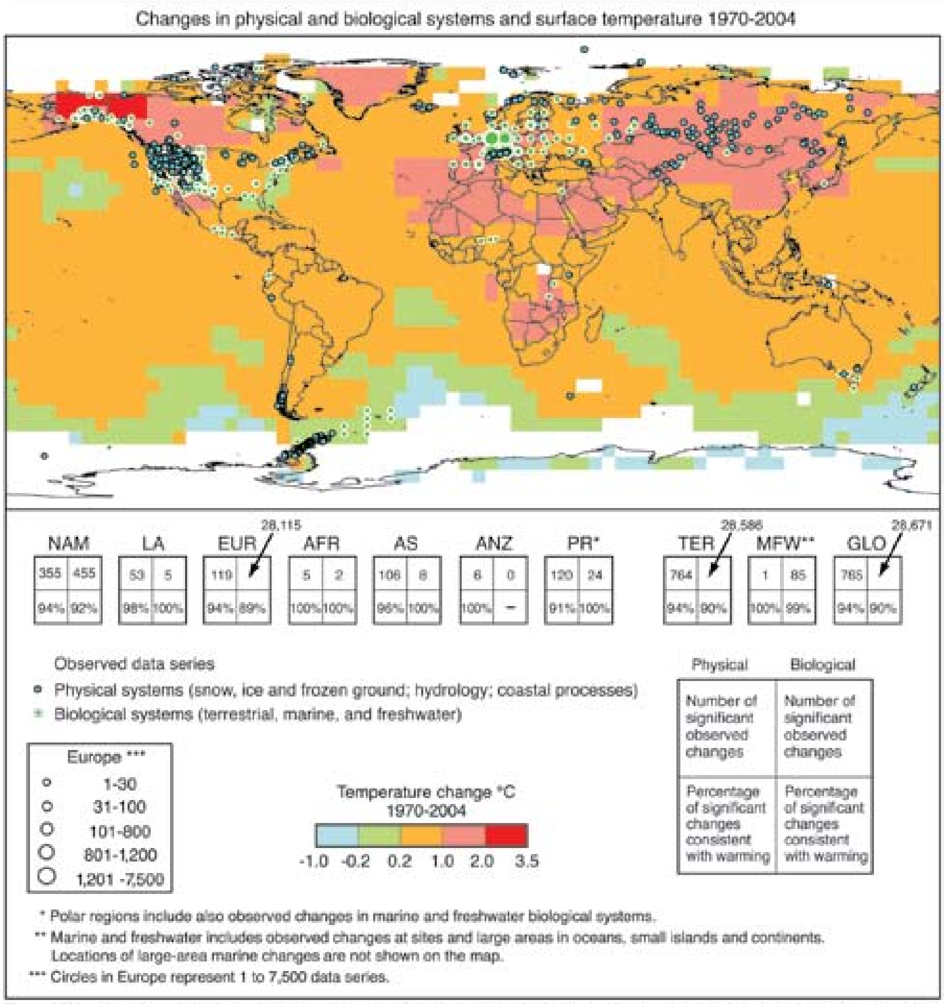


**Figure SPM.1.** *Locations of significant changes in data series of physical systems (snow, ice and frozen ground; hydrology; and coastal processes) and biological systems (terrestrial, marine, and freshwater biological systems), are shown together with surface air temperature changes over the period 1970-2004. A subset of about 29,000 data series was selected from about 80,000 data series from 577 studies. These met the following criteria: (1) ending in 1990 or later; (2) spanning a period of at least 20 years; and (3) showing a significant change in either direction, as assessed in individual studies. These data series are from about 75 studies (of which about 70 are new since the Third Assessment) and contain about 29,000 data series, of which about 28,000 are from European studies. White areas do not contain sufficient observational climate data to estimate a temperature trend. The 2 x 2 boxes show the total number of data series with significant changes (top row) and the percentage of those consistent with warming (bottom row) for (i) continental regions: North America (NAM), Latin America (LA), Europe (EUR), Africa (AFR), Asia (AS), Australia and New Zealand (ANZ), and Polar Regions (PR) and (ii) global-scale: Terrestrial (TER), Marine and Freshwater (MFW), and Global (GLO). The numbers of studies from the seven regional boxes (NAM, ..., PR) do not add up to the global (GLO) totals because numbers from regions except Polar do not include the numbers related to Marine and Freshwater (MFW) systems. Locations of large-area marine changes are not shown on the map. [Working Group II Fourth Assessment F1.8, F1.9; Working Group I Fourth Assessment F3.9b].*

However, quantitative data for temperature changes has not been accurately represented by color value (the lightness / darkness of a single hue). Value is typically light (e.g., light green) for low numbers and darker (e.g., dark green) for higher numbers. In the map, temperature data are shown using a sequence that varies by hue, not value. The authors suggest that a detailed, spectral or "rainbow" sequence has been simplified for the five classes. As a result, the visual effect produced on the map is a change in color hue, not value. Consequently, they rate the use of value as "poor."

The authors also find that the map lacks visual focus, with a complex caption, legend, and unclear headings. The visual hierarchy of some of the mapped data is poor (e.g., overlapping symbols for biological and physical systems). In addition, color hues used for these locations don't stand out enough from the map background.

The authors' evaluation—a demonstration applying selected cartographic principles for good map design to a highly visible climate change map—indicates the need to systematically examine other climate change maps.

With off-the-shelf desktop software, ready-to-use data, and Internet mapping becoming commonplace, map-making can seem easy. But are maps created with little attention to fundamentals easy to understand and do they serve the purpose for which they were created? Scientists who create poorly designed maps may not be effectively communicating scientific information about critical issues to policy makers and the public.

What next? Climate change scientists and cartographers would benefit from "lessons learned" by evaluating the cartographic design of climate change maps. The authors propose that climate change scientists "engage" with cartographers to ensure that their maps incorporate high quality cartographic design. When the human connection is not possible, the authors list numerous resources available in the literature and online. Maps can be compelling and powerful visual representations of spatial features and data—if both scientists and cartographers work together to make them so!

REFERENCES

Brewer, C.A. 2005. *Designing better maps: A guide for GIS users*. ESRI Press, Redlands, California.

Krygier, J, and D. Wood. 2005. *Making Maps: A visual guide to map design for GIS*. The Guilford Press, New York

McKendry, J.E. and G.E. Machlis. 2008. Cartographic design and the quality of climate change maps. *Climatic Change* (published online, 21 November).