Mapping World Terrestrial Ecosystems - GIS and Cartographic Approaches

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Introduction

The U.S. Geological Survey, Esri, and The Nature Conservancy have collaboratively published a new map of globally comprehensive, standardized, high resolution (250 m), and data-derived World Terrestrial Ecosystems as land areas with distinct combinations of climate regime, landforms, and vegetation/land cover assemblages. 431 ecosystems were mapped at the globally aggregated level, and 1778 ecosystems were mapped when stratified by biogeographic realm (Nearctic, Neotropical, Palearctic, Afrotropical, Australasian, Indomalayan, and Oceania). The new map of these ecosystems follows in Figure 1:

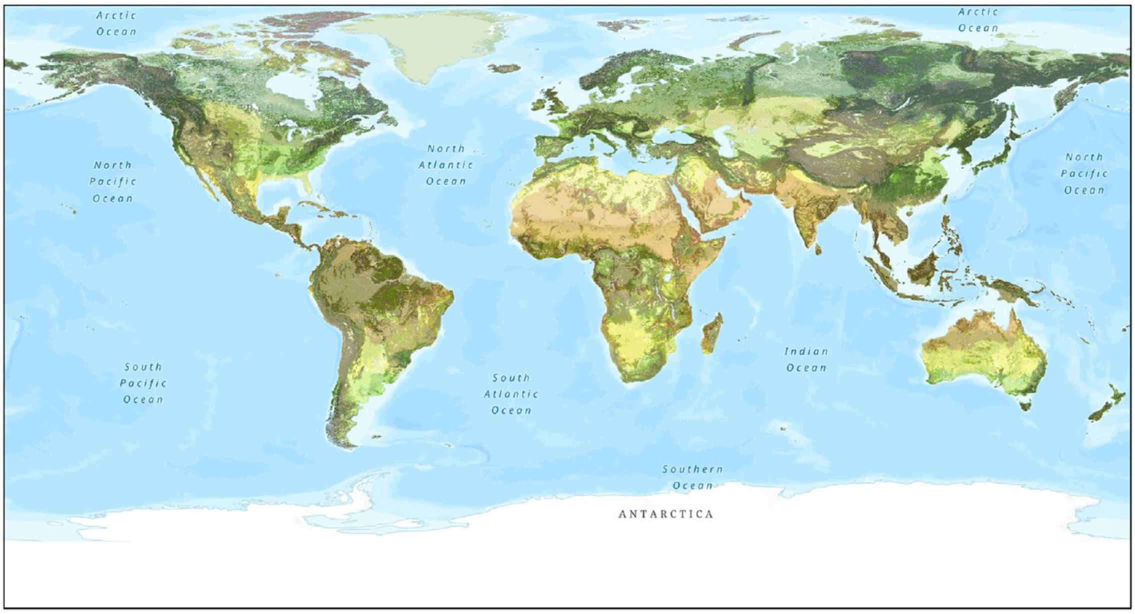

Figure 1: World Terrestrial Ecosystems (431 classes).

Ecosystems are broadly understood as assemblages of living organisms interacting with each other and with their physical environment (Odum, 1953), and exist at multiple scales from microscale (e.g. a tidepool) to macroscale (e.g. the boreal Taiga forests). The primary and secondary environmental drivers responsible for the distribution of global ecosystems are the climate regime and the morphology of the terrain, respectively (Bailey, 2009). The climate regime and the terrain diversity are examples of abiotic environmental structure, whereas the vegetation is an example of biotic structure (biomass). For the new World Terrestrial Ecosystems resource, we used an ecosystem structure-based mapping approach, including both abiotic structural elements (climate and landforms), and biotic structural elements (vegetation assemblages). We produced the final ecosystems layer as a set of sequential spatial combinations of input global datalayers. Full details of the methodology are found in Sayre et al. (2020).

GIS Approach

We sequentially combined several global datalayers, each of which were classifications of attributes of ecosystem structure. First, a six class World Temperature Domains (Polar, Boreal, Cool Temperate, Warm Temperate, Subtropical, and Tropical) layer was combined with a three class World Moisture Domains (Moist, Dry, Very Dry) layer to produce an eighteen class World Climate Regions datalayer. The World Climate Regions datalayer was then combined with a four class World Landforms (Plains, Hills, Mountains, Tablelands) datalayer resulting in 72 climate/terrain combinations. The 72 climate/terrain classes were then combined with an eight class 2015 World Vegetation/Land Cover (Forestlands, Shrublands, Grasslands, Bare Areas, Croplands, Water, Snow and Ice, and Settlements) layer to produce the World Terrestrial Ecosystems layer with 431 classes. The fundamental approach was therefore to use global classifications (categorical data) of environmental data and combine them in a GIS model to represent ecosystems as areas of distinct climate regime, terrain, and vegetation/land cover.

Cartographic Approach

The number of ecosystems that were produced (431 at the globally aggregated level, 1778 at the biogeographic realm-segregated level) is too numerous to permit human recognition and identification of individual classes using, for example, a maximum color separation approach. Even at a large format resolution, the granularity and pixel-based mapping of ecosystem occurrences often results in multiple similar but non-identical ecosystems co-occurring in proximity, and these are difficult to differentiate symbolically. We therefore adopted the cartographic approach of attempting to symbolize the ecosystems in such a manner that the map “looked natural” (i.e. resembled a satellite image of the Earth). We assigned colors based on traditional symbology for representing different vegetation types in different temperature regimes. We also attempted to differentiate moisture regime using a ‘color muting’ technique wherein moist ecosystems were the brightest, and colors for corresponding ecosystems in drier regions were the same, but muted. The cartographic approach is summarized in the following legend block (Figure 2). The legend is not intended to permit the reader to identify individual ecosystems, but rather to show how groups of similar ecosystems are symbolized with brightest colors for moist environments, muted colors for dry environments, and faintest colors for very dry environments.

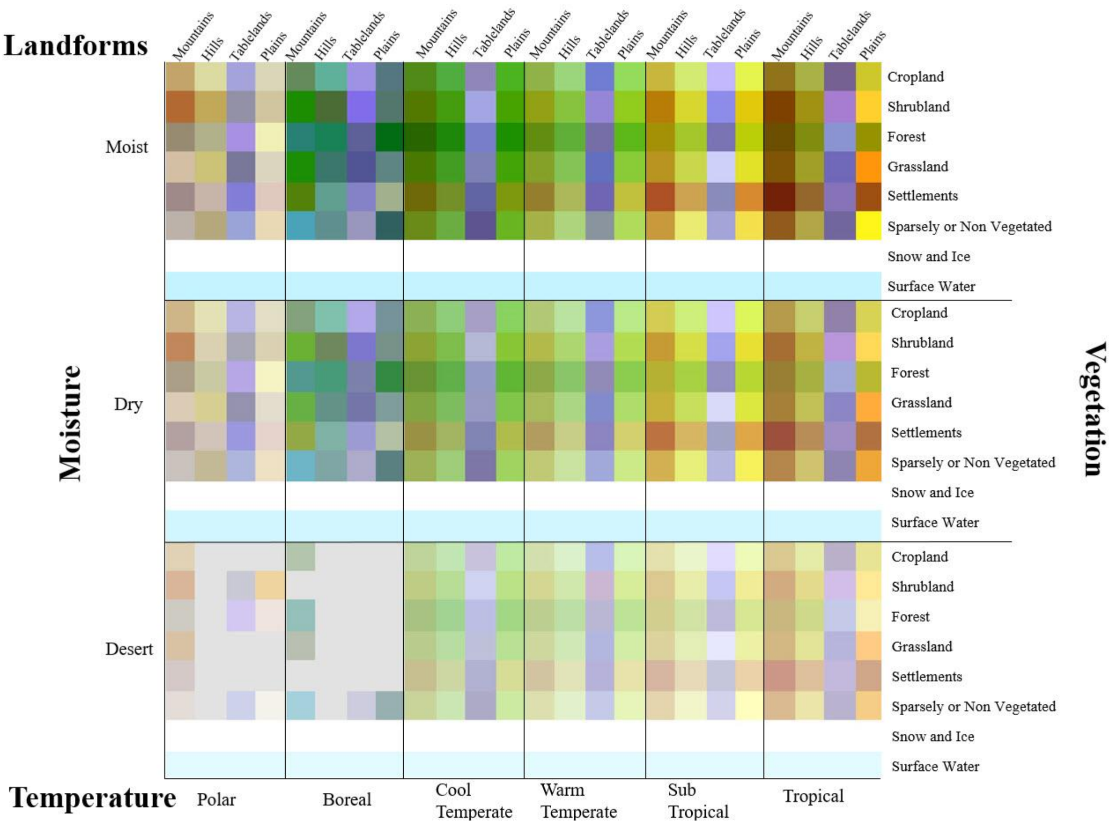

Figure 2: Legend block for the 431World Terrestrial Ecosystems classes.

The new World Ecosystems map is an example of an innovative synthesis of existing global classified datasets. The data are intended to be useful for a variety of applications including ecosystem accounting, biodiversity conservation, and natural resource management

References

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