Modeling Global, Standardized, Terrestrial Ecosystems – The GEOSS Approach

R. Sayre

Climate and Land Use Change Program, United States Geological Survey, Reston, VA 20192 USA – (rsayre@usgs.gov)

Abstract

One of the tasks in the GEOSS (Global Earth Observation System of Systems) intergovernmental protocol is an effort to map standardized ecosystems of the planet. The United States Geological Survey (USGS) is leading this effort, working with the conservation NGO NatureServe and regional partners. Completed classifications and maps of standardized, robust, and practical ecosystems have been completed for South America, the United States, and Africa. The GEOSS ecosystem mapping approach includes mapping the major physical environment attributes that contribute to ecosystem structure, and subsequently using these as predictors of vegetation occurrences on the landscape. As input layers into the process, key environmental layers are first developed for large regions or continents, including landforms, bioclimate regions, and surficial lithology. These predictor datasets are then used with expert-derived vegetation classifications to model robust terrestrial ecosystems at spatial and thematic resolutions finer than existing ecoregionalizations.

Keywords: ecosystems, terrestrial, geospatial, modeling, landscapes,

1. INTRODUCTION AND METHOD

As the provider of goods (e.g. food, fiber, fuel, etc.) and services (water provision and quality, carbon sequestration, etc.) necessary for the survival of humankind, ecosystems need to be increasingly well managed. A knowledge of the distribution of ecosystems on the ground is a pre-requisite to management. A methodology to map the distributions of terrestrial ecosystems based upon an assessment of vegetation distributions in a physical environmental context is presented herein. The ecosystem mapping model predicts the locations of described vegetation types by associating vegetation types with their environmental attributes using expert-based rulesets or a classification and regression tree (CART) geostatistical model. The predictor layers are raster characterizations of the physical environment, and include landforms, lithology, climate regime, and land cover. These input layers represent the major structural elements of ecosystems. They are mapped out over continental regions using best available data sources. The datasets are then used as input predictor (explanatory) data for the ecosystem model. A schematic of this methodology is depicted in Figure 1.

The Global Earth Observation System of Systems (GEOSS) is an intergovernmental protocol that promotes the use of earth observations to address societal issues like climate change, hazards, water availability and ecosystem degradation. A number of Tasks comprise the agenda of GEOSS, and one of these is a global ecosystem classification and mapping effort to produce a standardized ecosystem map of the planet. The approach described herein is the methodology being used for the development of the global ecosystems map (Sayre et al., 2007).

2. RESULTS AND DISCUSSION

The results of the ecosystem modeling for South America (Sayre et al., 2008), the United States (Sayre et al., 2009), and sub-Saharan Africa (unpublished manuscript) are reproduced in Figures 2,3, and 4, respectively. Working resolutions for South America, the United States, and Africa were 450m, 30m, and 90m, respectively. The numbers of ecosystems mapped for South America, the United States, and sub-Saharan Africa were 659, 419, and 107, respectively. Each of these maps represents the most comprehensive and finest scale characterization of the biophysical environments yet produced for these three regions. The stratification approach to map ecosystems as unique physical environments and their associated vegetation assemblages is robust, highly replicable, and exportable to other large regions.

3. CONCLUSION

Ecosystem distributions can be predicted from a knowledge and geospatial characterization of their major structural elements, primarily including landforms, lithology, bioclimate, and land cover. Using this standardized GEOSS methodology, new maps of standardized terrestrial ecosystems for the US, South America, and sub-Saharan Africa have been produced. These maps of relatively fine scale ecosystems (30m-450m) are useful for a variety of applications, including biodiversity conservation planning, climate change impacts studies, ecosystem services assessments, and resource management. An effort to map standardized terrestrial ecosystems of Australia under the GEOSS method is underway.

Figure 1. The GEOSS ecosystem mapping methodology.
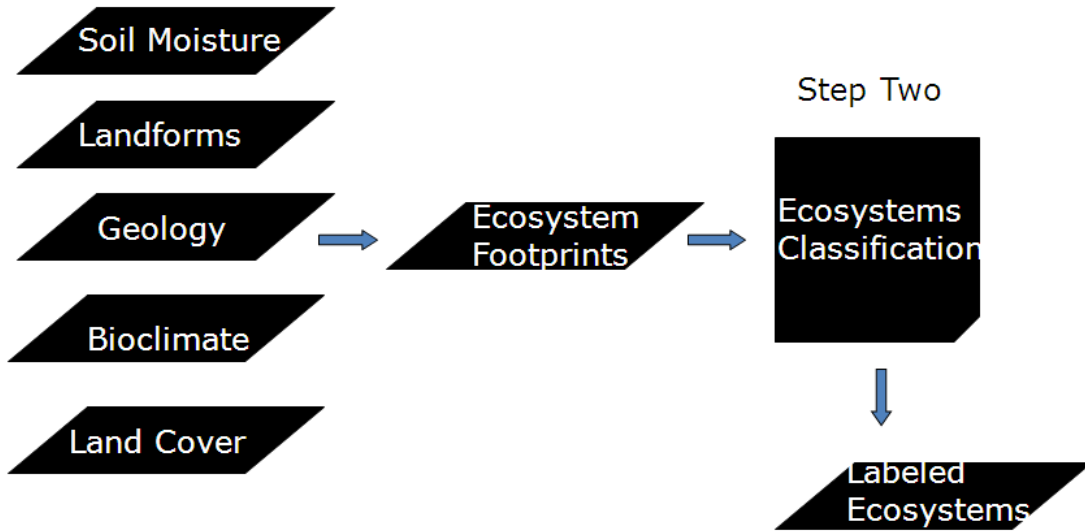

Figure 2 – Standardized terrestrial ecosystems of South

America.

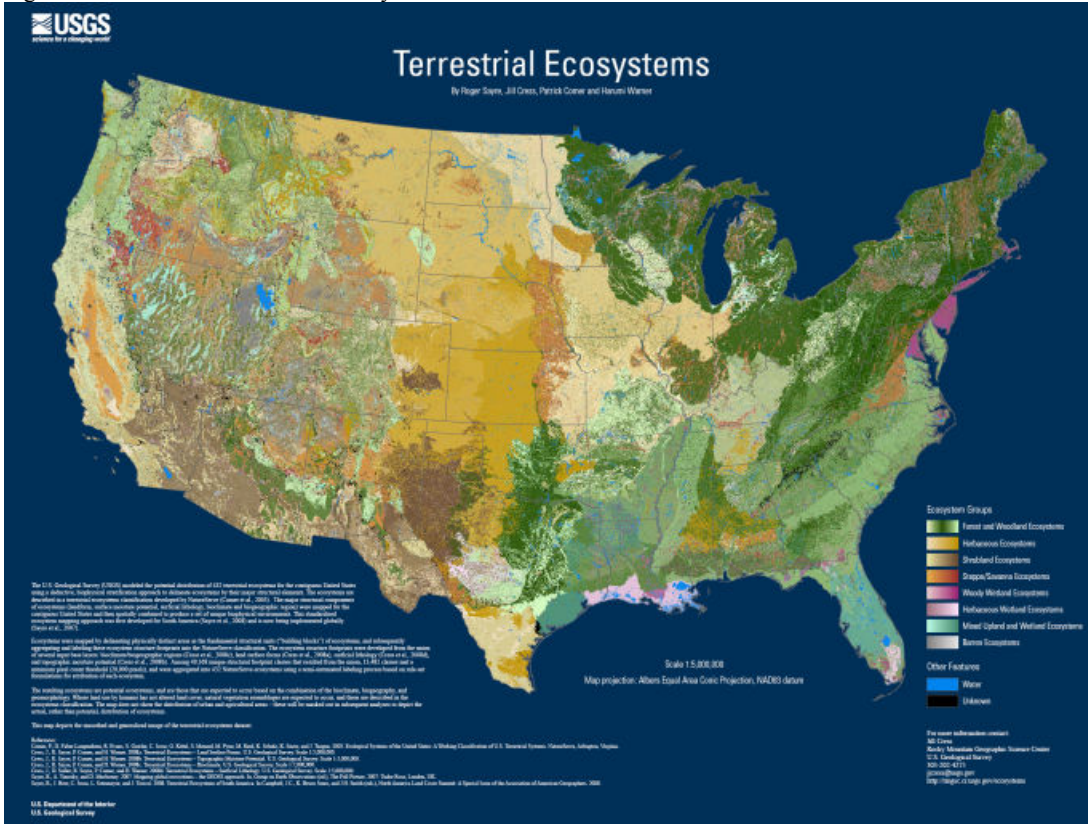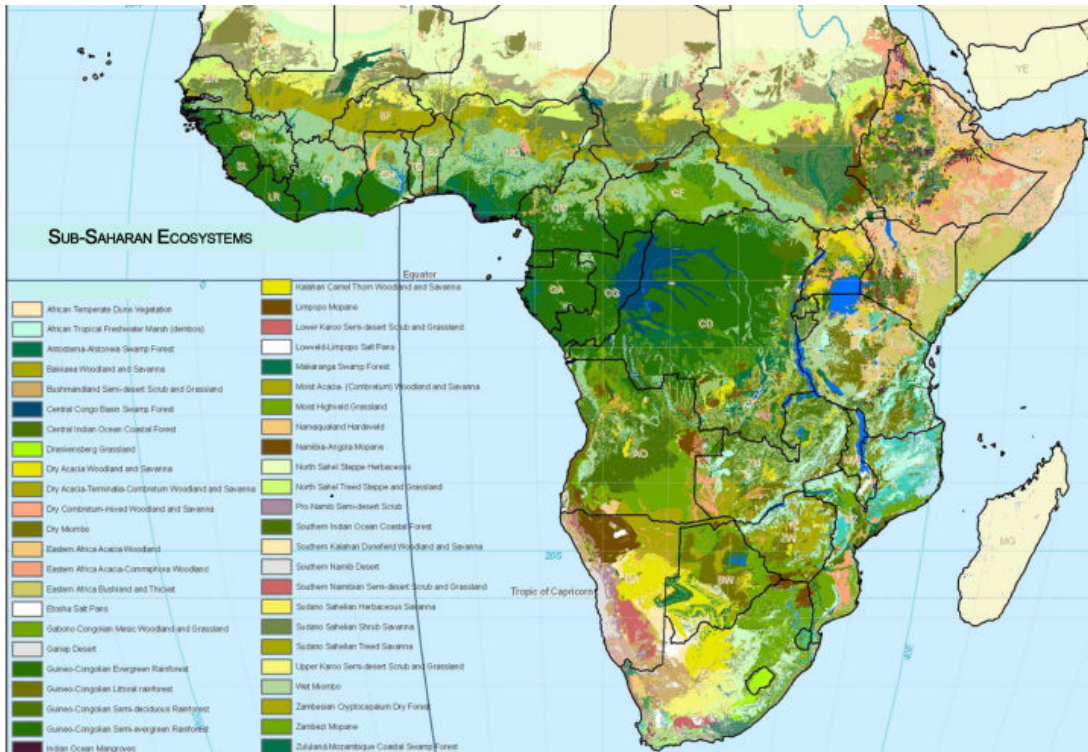Figure 3 – Standardized terrestrial ecosystems of the United States.

Figure 4 – Standardized terrestrial ecosystems of sub-Saharan Africa.

REFERENCES

Sayre, Roger, Yanosky, Alberto, and Muchoney, Douglas, 2007. Mapping global ecosystems; The GEOSS [Global Earth Observation System of Systems] approach, *in* Group on Earth Observations Secretariat, ed., The full picture: Leicester, U.K., Tudor Rose, p. 231–232. (Also available online at http://www.earthobservations.org/docs_pub.shtml.)

Sayre, Roger, Bow, Jacquie, Josse, Carmen, Sotomayor, Leonardo, and Touval, Jerry, 2008. Terrestrial ecosystems of South America, chap. 9 *of* Campbell, J.C., Jones, K.B., Smith, J.H., and Koeppe, M.T., eds., North America Land Cover Summit: Washington, D.C., Association of American Geographers, p. 131–152. (Also available online at http://www.aag.org/books/nalcs/.)

Sayre, Roger, Comer, Patrick, Warner, Harumi, and Cress, Jill, 2009. A new map of standardized terrestrial ecosystems of the conterminous United States: U.S. Geological Survey Professional Paper 1768, 17 p. (Also available online at http://pubs.usgs.gov/pp/1768.)