FORUM

The Need for Improved Maps of Global Cropland

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Food security is a key global concern. By 2050, the global population will exceed 9 billion, and a 50% increase in annual agricultural output will be required to keep up with demand. There are significant additional pressures on existing agricultural land through increased competition from the biofuel sector and the need to elevate feed production, which is being driven by higher levels of meat consumption in low- and middle-income countries.

To make future policy, investment, and logistical decisions that address food security, accurate and reliable information on cropland and the location of major crop types is required. In addition, there are many other fields that require this information, such as the future of energy resources and environmental change (e.g., determination of greenhouse gases, initiatives that are part of the United Nations Collaborative Programme on Reducing Emissions from Deforestation and Forest Degradation in Developing Countries, and implications of climate change on crop production).

Such information is vitally important to assess accurately the drivers and implications of future land use change, where the prerequisite is accurate knowledge of the current situation. Our aim in this Forum is to draw attention to the poor quality of current global cropland information and to call on the community to help improve this information in the short term.

Problems With Current Sources of Cropland Information

Coarse-resolution, satellite-derived global land cover maps, such as GlobCover and maps made using data from the Moderate Resolution Imaging Spectrometer (MODIS), are some of the main sources of current cropland information. However, because these products were originally designed to serve the climate change community and characterize land cover more generally, their quality and reliability in capturing croplands are highly variable. For example, GlobCover estimates 20% more cropland than MODIS globally, and when considered spatially, the differences in cropland are very large for different regions [*Fritz et al.*, 2011a].

The United Nations Food and Agricultural Organization estimates cropland in Africa to have been roughly 319 million hectares in 2010. In contrast, estimates from MODIS are 277 million hectares, compared to only 152 million hectares from GlobCover. Thus, not only do these products underestimate cropland compared to the official statistics, but they also disagree with one another.

Another source of information is specific cropland products, such as the M3-Cropland layer of agricultural lands in the year 2000 [Ramankutty et al., 2008] and the cropland probability layer from MODIS [Pittman et al., 2010]. However, these types of products either have insufficient accuracy in many crucial areas or are at a resolution too coarse for assessment and planning purposes. As these products form the basis for developing crop type maps, such as maize or wheat distributions, the resulting outputs will also be problematic.

Initial Progress Through a Hybrid Product

Better cropland information can come from two complementary sources. The first involves further development of automated methods to generate global cropland maps on an annual basis using the new generation of global moderate-resolution satellite data (e.g., Landsat and Sentinel). Although promising, this is a longer-term solution.

Better cropland information can also be realized though hybridization, which integrates all available maps into a single product and can be achieved in the short term. Some progress toward reaching this goal has already been made through the establishment of a mapping subtask within the Group on Earth Observation's Global Agricultural Monitoring System Task, a framework for mobilizing international efforts to improve agricultural monitoring [*Becker-Reshef et al.*, 2009]. The agricultural mapping subtask, which is being led by the International Institute for Applied Systems Analysis, was initiated through a recent workshop [*See et al.*, 2012] to address the lack of reliable information on cropland.

A number of different national and regional land cover products were contributed, which were then merged with global land cover products to produce a global cropland map calibrated with national and subnational crop statistics [*Fritz et al.*, 2011b]. The first global hybrid cropland map is now openly available in beta version at http://beta-hybrid.geo-wiki.org and is currently being used to map crop type distributions.

Community Involvement to Improve Global Cropland Information

Although the beta product represents a promising short-term solution, it should only be viewed as a bridge between the current situation and a future state in which improved global cropland information is available. The beta product still requires rigorous validation, and improvements must be made in a number of countries, including Botswana and the Central African Republic, where the global maps currently disagree or are inaccurate. National and regional mapping experts and members of the Earth science community can help to improve the beta product by using the tools embedded at http://beta-hybrid.geo-wiki.org. Within this Geo-Wiki branch, the beta product can be visualized on top of Google Earth (where cropland areas can be distinguished in many cases) and annotated using the drawing and comment tools to indicate areas that are incorrectly mapped. Moreover, the input of individuals with expert knowledge of different regions and countries is welcomed in order to examine the maps and provide feedback.

The Earth science community can also participate more generally via crowdsourcing using Geo-Wiki [*Fritz et al.*, 2012]. A number of competitions are run throughout the year whereby participants examine satellite imagery (from Google Earth™ or Bing™) and indicate the type of land cover. These crowdsourced data contribute to a growing open source database of land cover information that can be used to calibrate and validate land cover maps, including the beta product. For example, crowdsourced information can help to determine which global land cover products are the most accurate at a national level and will be implemented in the next version of the hybrid product. Contact info@geo-wiki.org for more information.

Other Mechanisms to Improve Global Cropland Information

The ultimate goal is to obtain accurate cropland information from each country for inclusion in the hybrid product. However, this relies on the willingness of organizations and governments to openly share their information. The beta product currently contains national products from fewer than 25 countries worldwide (a list of contributing countries can be found at http://beta-hybrid.geo-wiki.org/docs/BetaHybridNationalMapContributions.pdf). While we applaud those that have already contributed national data, greater international collaboration in openly sharing data is needed, especially from those countries where detailed land cover information exists but has not been made available. The Earth science community can contribute by putting pressure on governments and mapping organizations to make the data open access. For those countries where the information does not exist, a priority list must be drawn up so that international efforts can be targeted toward funding new mapping initiatives in these areas.

If the global community is serious about accurately determining land use change and planning sustainably for a highly uncertain future, it is fundamental that stakeholders recognize the need for better cropland information as a vital ingredient in this process. With higher resolution and better calibrated data on the spatial and temporal patterns of agricultural land use, the scientific and policy communities will be much better placed to reliably evaluate land use policies, explore long-term sustainability, and better evaluate tradeoffs between, e.g., food and biofuel feedstock production or between biofuel production and afforestation projects. The Earth science community can help achieve this goal.

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