GCEP Progress Report
Biomass energy: the climate-protective domain
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Interest and investment in biomass fuels is surging, but a series of papers published over the last few months has highlighted the environmental risks, and especially the climate risks, associated with unwise investments in biomass energy. These recent studies effectively frame the challenge of this project, which is defining the locations where biomass fuels can be produced in a way that effectively offsets warming and quantifying the amount of "climate-protective" biomass energy likely to be available. Our work is focused not on any particular technology for biomass energy production but on the ways and sites to utilize any of the relevant biomass energy technologies.

In this project, we are providing two deliverables. The first is a set of tools for quantifying the integrated impacts on climate of expanding the area utilized for biomass energy production. The second is a series of global maps of net climate forcing from biomass deployment, as a function of biofuels production technologies and efficiencies. The new contribution of our research is a careful assessment of the climate consequences of converting landscapes from their previous uses to biofuels. This includes net climate forcing from both greenhouse gases (not limited to CO_2) and surface albedo (reflectance).

This project, which began in February, 2008, represents the full-scale deployment of a set of concepts developed in a one-year GCEP feasibility study. With support from the feasibility funding, we published one paper, outlining our approach and setting an upper level for energy obtainable from biomass energy, under relatively strict constraints (Field et al. 2008). With support from the full project, we have completed one additional paper, now in press (Campbell et al. 2008). This paper extends the analysis to the country scale, identifying countries with the potential to make biomass energy a major fraction of future energy supplies.

In addition to the papers, we have assembled most of the project team, and we have begun work on a series of next-step projects. The project team will include Elliot Campbell (PhD, University of Iowa -- working with Field on carbon cycle modeling), Holly Gibbs (PhD, University of Wisconsin – working with Naylor on indirect effects on forest of increasing areas in cultivation), and Scott Loarie (PhD, Duke University – working with Asner on remote sensing of carbon-cycle consequences of expanding agriculture). Campbell joined the group in the summer of 2007, Loarie will arrive in May of 2008, and Gibbs will arrive in the Fall of 2008. We are still searching for a post-doc to work with Lobell on climate forcing from albedo effects of biofuels. In addition, we are fortunate to have been joined by Luis Fernandez, a visiting investigator at

Carnegie (who is working at no cost to the GCEP project). Fernandez, an expert in agent-based modeling with extensive experience in Brazil, has already made 2 trips to Brazil to coordinate a Brazilian case study.

The striking result from the work to date is that the global potential for climate-protective biomass energy is limited. Using a conservative definition of the area available for biomass energy production as the global area used for agriculture sometime in the last 300 years but currently abandoned, we estimate an available area of 386 x 10^6 Ha. The likely net primary production from this land is about 1.2 x 10^9 ton C. If half of this could be harvested, the energy available content of the harvested material would be about 27 EJ or about 5% of global primary energy (Field et al. 2008).

Although the total quantity of energy is not great, it is a large fraction of primary energy demand in several countries (Figure 1).

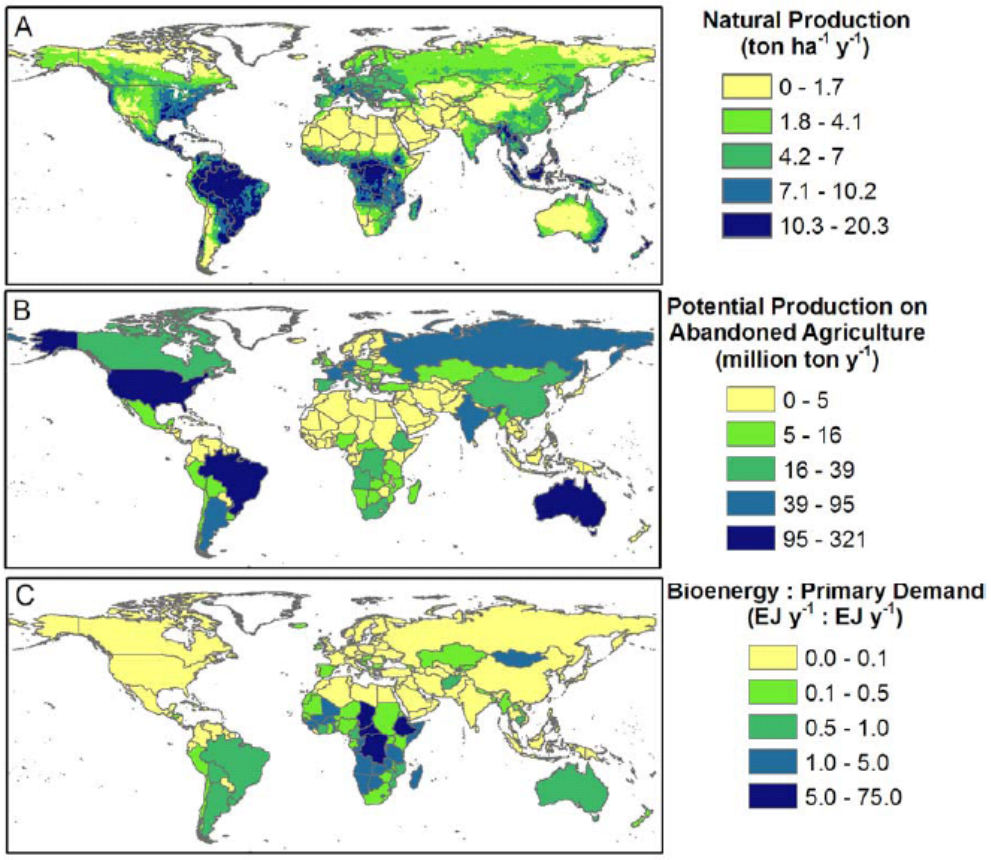

Figure 1: Biomass production potential on abandoned agriculture lands. a, Natural above-ground production of biomass on all lands determined from the CASA model, assuming 50% of the biomass is above-ground and the ratio (by mass) of biomass to carbon is 2.2. **b,** Potential above-ground production of biomass on abandoned agriculture lands at the country-level. **c,** The ratio of the energy content of the biomass on abandoned agriculture lands relative to the current primary energy demand at the country-level. The energy content of biomass is assumed to be 20kJ g^{-1}. From (Campbell et al. 2008).

In the phase of the work just getting started, we will be using the analysis already completed as a foundation for developing the project in several directions. Naylor and Gibbs will focus on modeling to assess the impacts of expanding biofuels production on existing agricultural land for carbon balance. Their focus will be improving estimates of indirect deforestation, in which expanding replacing cropland with biofuels in one location may lead to expanded cropping (and consequent deforestation) in others. Fernandez is examining the implications of this in Brazil, where the hypothesis is that expanding sugar cane leads to a shift in the area used for soy, which shifts the area used for ranching, which pushes ranches into forest. Testing this hypothesis will be his primary focus for the coming year. Asner and Loarie will be using satellite data to estimate carbon releases from biomass losses in several locations where biofuels production is expanding.

In addition to these projects, the entire team is working on becoming expert with the latest biofuels technologies, so that we have an accurate estimate of the energy costs and benefits of the basic production, which we will then extend with our ecological analysis.

Finally, in the politically charged debate over biofuels, our group is becoming an increasingly recognized source of thoughtful advice. We have presented biofuels overviews at several events, including the 2007 GCEP annual meeting, and a 2008 Stanford Business school session on sustainable supply chains. We have discussed sustainable biofuels with leaders of biofuels activites at Shell, Chevron, and Ranch Capital (an owner of ethanol plants in Brazil). Upcoming presentations where one or more of our team is scheduled to discuss the GCEP project and present a biofuels overview include a Harvard Kennedy School executive discussion in Venice (May, 2008), a Princeton discussion on sustainable biofuels (June 2008), an earth System Science Partnership Biofuels Conference (Brazil, July, 2008), the Global Economic Symposium (Germany, September, 2008), and the SCOPE Rapid Assessment of Biofuels (Germany, September, 2008).

References

Campbell, J. E., D. B. Lobell, R. C. Genova, and C. B. Field. 2008. The global potential of bioenergy on abandoned agriculture lands. Environmental Science & Technology **(in press)**.

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