LETTERS

edited by Jennifer Sills

Make Way for Ethanol

IN HIS NEWS STORY "IS THERE A ROAD AHEAD FOR CELLULOSIC ETHANOL?" (SPECIAL SECTION ON Scaling Up Alternative Energy, 13 August, p. 784), R. F. Service identifies factors contributing to fading enthusiasm for cellulosic ethanol and observes that policy-makers' decisions this year could shape the nascent U.S. biofuels industry for decades. It is critical at this time to distinguish the fundamental from the ephemeral and to base policy on the former rather than the latter.

Biomass is by far the most viable sustainable source of liquid fuels, which will be needed for a long time, if not indefinitely. Batteries are completely impractical for aviation and likely for long-haul trucks as well. In the most aggressive scenarios for electrification of light-duty vehicles, liquid fuels still provide more than 50% of U.S. transportation energy (*1*). Policy debates are often framed as if large-scale use of biofuels is discretionary, but achieving a sustainable transportation sector is much more likely with biofuels than without them, and turning away from biofuels entails substantial risks.

Sugar cane in Brazil.

The most important next step in the biofuels arena is commercial production of ethanol from cellulosic feedstocks. The alternative—converting sources of readily fermentable sugars (mostly from corn and sugar cane) to fuel molecules other than ethanol—might allow us to retain current infrastructure, but would contribute little to our larger goals: creating a sustainable energy supply, reducing greenhouse gas emissions, assuring energy security, and promoting rural economic development. Ethanol will very likely be the world's first cellulosic biofuel because it is unrealistic to commercialize new technology for converting lignocellulose to sugars at the same time as new technology for converting sugars to fuels. Infrastructural challenges associated with distribution and utilization of ethanol are readily solvable, as the Brazilian experience shows, and decidedly small compared to challenges associated with other petroleum alternatives such as batteries or hydrogen.

Sharply divergent conclusions have been drawn about biofuel-related land-use issues, contributing to uncertainty among policy-makers. Pessimists typically ask: What are the impacts of adding large-scale use of today's version of biofuels to the world that will exist if current trends and practices continue? Optimists typically ask: What role could the advanced biofuels of the future play in a world reconfigured to meet energy-related challenges? Both questions merit consideration, but only the second illuminates a promising way forward. There is increasing evidence that large-scale biofuel production can be gracefully reconciled with feeding humanity and preserving the environment, provided that changes are made pursuant to this goal. Change is necessary, given that humanity cannot hope to achieve a sustainable and secure future by continuing the practices that have led to the unsustainable and insecure present.

Most of the factors mentioned in Service's News story are peculiar to the United States. Brazil, for example, did not experience the recent economic downturn, does not have a "blend-wall" (ethanol production approaching the maximum amount that can be accommodated in 10% gasoline blends) or policy uncertainty relative to bioethanol, and is confident of the sustainability of its land-use practices. Ethanol is produced in volumes exceeding gasoline usage (*2*) from about 1.5% of Brazil's arable land, and the cane used to produce this fuel is grown on former pastureland while total pasture output has increased (*3*). The international community should be careful not to draw negative conclusions from the U.S. malaise, particularly in light of the high stakes involved.

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References and Notes

1. Light duty vehicles (LDVs) account for 59% of total U.S. transportation energy (*4*). Of the total miles driven in LDVs, about 70% are in vehicles that drive less than 60 miles per day (*5*). If half of all LDVs were dedicated electric vehicles and the other half were plug-in hybrid electric vehicles that used batteries for the first 60 miles driven per day—a more aggressive electrification scenario than any proposed thus far—the fraction of transportation energy provided by electricity would still be only half [(0.5 + 0.5 × 0.7) × 0.59].
2. National Agency of Petroleum, Natural Gas and Biofuels, "Oil, natural gas, and biofuels statistical yearbook - 2010" (Ministry of Mining and Energy, Rio de Janeiro, 2010), Table 4.9; www.anp.gov.br/?dw=31814.
3. J. Goldemberg, S. T. Coelho, P. Guardabassi, *Energy Pol.* **36**, 2086 (2008).
4. U.S. Department of Energy, *Transportation Energy Data Book* (Center for Transportation Analysis, Knoxville, TN, ed. 29, 2010); www-cta.ornl.gov/data/index.shtml.
5. U.S. Department of Transportation, "2010 national household travel survey" (Oak Ridge National Laboratory, Oak Ridge, TN, 2010); http://nhts.ornl.gov/tools.shtml.

Permafrost and Wetland Carbon Stocks

IN THEIR REPORT "GLOBAL CONVERGENCE in the temperature sensitivity of respiration at ecosystem level" (13 August, p. 838), M. D. Mahecha *et al.* have done a fine study

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Birth and death of cosmic rays

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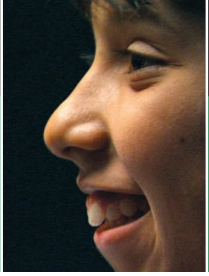

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to tease apart the distinction between intrinsic and apparent temperature sensitivities (*1*). However, they omitted the soil carbon stocks most vulnerable to climate change—northern permafrost and most wetlands were excluded from the data (*2*).

In his related Perspective "The carbon dioxide exchange" (13 August, p. 774), P. B. Reich concludes that Mahecha *et al.*'s study "reduces fears" that biotic feedbacks to climate change will amplify the effects of temperature increase. Yet Mahecha *et al.*'s analysis of data from mostly upland forests, grasslands, and croplands cannot represent the temperature sensitivity of decomposition during the phase change from frozen to liquid water in thawing permafrost (*3*). Similarly, large stocks of relatively labile carbon become exposed to aerobic decomposition when wetlands drain, and this climate sensitivity cannot be modeled with data dominated by upland ecosystems.

When carbon stocks hitherto protected by frozen or anaerobic conditions become vulnerable to high rates of decomposition due to climate change, temperature will be important. I urge readers not to be lulled into a false sense of security by misinterpretations of Mahecha *et al.*'s results.

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3. C. J. Mikan, J. P. Schimel, A. P. Doyle, *Soil Biol. Biochem.* **34**, 1785 (2002).

Response

I APPLAUD DAVIDSON FOR REMINDING US TO be careful of how general statements may be perceived, both in and out of context. Mahecha *et al.*'s conclusions were based on analyses of upland ecosystems, primarily forests and grasslands. When I wrote that their work "reduces fears that respiration fluxes may increase strongly with temperature, accelerating climate change," I intended my interpretation to be applied only within the narrow constraints of the study conditions.

It is true that such conclusions cannot be applied to long-term responses of wetlands and permafrost, where much belowground carbon resides globally. Mahecha *et al.*'s conclusion that the medium-term sensitivity of ecosystem respiration to temperature may be modest could greatly underpredict carbon losses as permafrost thaws or wetlands drain, and it would be an illogical way to model processes involving large, episodic disturbances.

In the long term, changes in amounts and temporal patterns of precipitation may lead to more droughts and floods. Climate change can also indirectly influence terrestrial ecosystem structure and function, resulting in more fires, windstorms, and disease and pest outbreaks. If these direct or indirect climate effects lead to structural breakdown of existing communities (which often occur with floods, severe droughts, forest dieback, or wildfires) or slower but substantive shifts in structure as communities metamorphosize, carbon losses from decomposition and combustion would spike upward, too. Applying short-term analysis of ecosystem respiration by temperature would not serve as an accurate metric for modeling such processes either.

Davidson provides a valuable reminder that we need to maintain a holistic, long-term, and global perspective on biotic feedbacks to the global carbon cycle.

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LIFE IN SCIENCE

Lab Family Feud

I had just returned from a year-long sabbatical abroad. Refreshed, I looked forward to beginning another productive year. My plans were soon derailed. In my absence, the social fabric of my lab had deteriorated to a point where squabbling, backstabbing, and even screaming were common. My response to this turmoil was indecisive at best. After one particularly painful encounter, it dawned on me that I was in way over my head.

In desperation, I turned to the head of my university's human resources office, who was a trained family therapist. After talking to her individually, she suggested group sessions with all of the lab members. After just one session, she gave us her diagnosis: We were a dysfunctional family, complete with rebellious adolescents (senior students), impressionable children (junior students), and impotent parents (technicians and the principal investigator).

I don't know if it was the shock of forced group therapy or the skill of the therapist, but the sessions worked. The students and technicians relearned how to live and work together, the new students in the lab weren't exposed to continued tension, and I regained control of the lab.

Years in science had done little to prepare me for the psychological challenges of running a lab. I've since recommended the use of an organizational psychologist to several other lab heads. A few hours of concentrated work can go a long way toward resolving interpersonal problems, and more productive science is sure to follow.

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EDITOR'S NOTE

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