Background for **"Mainstreaming carbon and biofuels, with agroforestry, into education"**

Arthur Jokela, International Director of MAFUWA (a Malawi NGO), awjokela@yahoo.com

Abstract

The countries of tropical Africa are favored for survival in our challenged planetary future of global change and resource limitations. The advantage is in the land base and the closeness of Africans to it. This will be so for food security in the rapidly-arriving *post-petroleum era*. It may be especially so for biofuels. A new study [1] shows that the usable land base in the U.S. and most European and Asian countries can supply less than 10% of their total energy demand if devoted to new bioenergy crops in ways that do not take away land now used to grow food, while also not contributing to deforestation.

The study assumed use of crops as feedstocks for new technologies of cellulosic ethanol. But a great amount of biomass is now burned annually in Africa, over 400 million tons as carbon in the Miombo Woodlands Region surrounding the symposium site. This equates to about 1.5 billion metric tons as CO2 due to human-induced burning. A similar amount is emitted by chopping of trees for fuelwood and charcoal, and clearing agricultural land. The numbers are higher if emitted N2O and methane are included, among other gases.

A great challenge of agroforestry may be to convert some of that burned and chopped natural biomass production into cellulosic ethanol for biofuels, and into soil carbon, new crops and standing woodland, thereby reducing emissions and deforestation. The value of reduced emissions is now about $8 USD per ton of CO2 on the voluntary carbon market.

As stated in the Announcement, "The general objective of the symposium is to establish mechanisms for [i] tackling biodiversity conservation, [ii] mitigation of climate change, and [iii] the global shift towards bio-energy with SSA tertiary agriculture and NRM institutions playing a central role." All three require increased use of plant materials, and need attention to the diverse, locally varied conditions of these lands and their biota.

There is no substitute in Africa for the capability and scientific authority of the combined ANAFE institutions regarding the required mechanisms. A major problem to address is how to devise and develop that "central role" or even to find the center. Bio-energy may be the most difficult to tackle, as it is a new and urgent subject of world attention, with little history of oversight and regulation. Here are some steps to consider:

A. Recommend that the African Union and NEPAD convene a high level panel, as done for biotechnology, to explore "Strategic ways of building Africa's scientific capacity for regionally oriented regulation and management" for biofuels, carbon, and global change adaptation. Microbiology will be important here. Many of the prior panel's conclusions may apply, including protection of intellectual property.
B. Consider models of engagement of stakeholders under local scientific leadership and oversight. The example of California in establishing local self-regulation of land use projects, beginning 40 years ago, will be discussed.
C. Develop strategies for mainstreaming carbon, bio-energy and adaptation, along with agroforestry, into education everywhere, at every level, in tropical Africa. Use of an existing digital media satellite will be noted as a potential asset.

Keywords: miombo woodlands, biodiversity, biofuels, education, carbon

Introduction 1. *Needed: A consensus idea on design for a future Africa*

You and your institutions and colleagues are the appropriate designers and developers of the African continent you need, one that has the best chance of surviving global climate change. This could be a human-managed 'agro-forest', an approximation to what may be 'natural' in the dry tropics, and may have preceded human and proto-human intervention – even before the establishment of miombo woodlands as a leading pattern of land use.

Miombo is a less dense version maintained by fire at a lower level of carbon storage. Grassland and crops retain even less in storage. Productivity is put into the atmosphere as greenhouse gas (GHG) emissions and not into the soil and standing vegetation.

If tertiary agriculture and NRM institutions are not in a central role, you may get a continent that can be a worse victim of climate change than the one you have. In an image now widely held in the carbon finance and biofuels development industries, Africa can become a vast plantation for *jatropha* and other specialized biofuel vegetation, and Africans will provide the workforce. Carbon storage can be minimal.

A laughable illustration of that fate was the offer of a biofuel developer to a government officer to replace every miombo woodland tree cut with a '*jatropha* tree'! Tens of tons of carbon could thus be lost per hectare, mostly from the soil, with perhaps 1200 liters of fuel produced per year per hectare. That's about a ton of fuel, all intended to be burned.

We humans co-evolved with the ecology of Miombo Woodlands, our native habitat on the planet. Our proto-human antecedents, upon discovery of the control of fire ½ million years ago, found it convenient to burn the forest seasonally to expand their territory. Their descendants today continue to burn, habitually and traditionally, as if it is in their DNA to prevent the return of the canopy forest. We may be 'hard-wired' for arson.

If we leave it alone we might allow it to return voluntarily [2]. If we find ways to utilize excess understory biomass, we support the natural defenses of these trees and woodlands against fire. We also stimulate soil life, cover and cool the soil, and let it absorb whatever moisture falls. [Compare Nebraska, where cropland soils are hot and exposed; rainfall of less than a centimeter at a time doesn't soak in and reach the roots of maize plants.]

The potential to capture and store greenhouse gases through intelligent human effort can be hundreds of tons of carbon per hectare, times 3.6 to be expressed as CO2 equivalent. That's a lot of money to invest in conservation measures and reduced deforestation, at about $8 USD per ton of CO2e for reduced emissions on the voluntary market. It may not be necessary to account in detail for results. $8 per hectare might produce a lot of effect as a 'bonus' subsidy, considering that many measures can be profitable on their own.

A very graphic illustration

The extent of present burning in Africa, and thus of the potential for restoration, is well illustrated in Al Gore's book in an image from space of the planet at night over six months time (*An Inconvenient Truth,* pp. 230-231). The lights of industrial nations are prominent in white. Burning gas wells, most prominent in Siberia, are seen in greenish yellow. Fishing fleets offshore, especially in the Far East, are seen in blue.

Africa is dominant in red, showing fires on the land from the Sahara and Horn of Africa to the Kalahari, with the exception of rain forest areas of the Congo and West Africa. Smaller red areas

are seen in Southeast Asia, Northern Australia, Central America and a few others. Most notable is the comparative absence of fire in South America, where primary productivity is similar to that of tropical Africa. Why is that?

In my view, while fires have been maintained continually by conventional practice in Africa throughout human history and long before, it took thousands of years for our species to transit East Asia and North America. By the time we made it to South America we'd forgotten to burn every year (or two or three) everywhere. Burning of woodland was practiced on a regular basis by forebears of Native Americans in what are now Western states, but apparently only after years of excess biomass accumulation.

A curiosity of the Amazon Basin is the apparently purposeful accumulation by natives there of massive amounts of carbon as well as mineral materials to enhance productivity of otherwise poor, leached-out soils. These are the *terra preta* black soils of former village sites and more widespread *terra mulata* brown soils, extending over an area the size of France. They learned to live with the forest through carbon storage. A population of ten million is estimated to have lived in the Amazon rain forest before they were decimated and chased away upon the invasion of Europeans. The soils were forgotten, except by enterprising farmers who rediscovered their richness.

To conclude this section, a consensus most favorable to agroforestry and to the ANAFE institutions can be to advocate returning much of tropical Africa, over the generational time scale of climate change, toward its natural condition of climax deciduous canopy forest, managed by human populations to maximize carbon storage and productivity. The main keys are to abate the use of fire, destructive wood cutting, and land conversion.

2. *Items for a basic toolkit on biofuels*

There is opportunity, integrated with nature and agroforestry, to utilize new and old approaches to biofuel development in support of woodland restoration. National policy development in each country can move toward prescribing such practices, and linkages to conservation in these countries. But it will require a strong scientific consensus of feasibility and benefit, together with practical demonstrations and proof of the results.

The present dialogue about biofuels in the public media and in the carbon finance industry is not even close to supporting such an analysis and view. It has got beyond corn/ethanol, which is widely discredited (though U.S. policy will continue to advocate increased production). But it now tends to focus on sugar cane as a feedstock for ethanol, to be followed by biomass cellulose such as prairie grasses – all directed toward large processing plants on the scale of 100 million gallons per year. Such processes generally entail enzymatic digestion of chemically prepared cellulose.

On the side of biodiesel the emphasis is on *jatropha* and other oily plants, including palm oil that has caused devastation of great areas of rainforest in South Asia. India figures its requirement will be 134 million hectares of *jatropha* to replace their present use of diesel fuel (this happens to equal half the area of Miombo Woodlands). Brazil favors castor bean. In each case large scale, single purpose plantings are assumed to be needed. 'Unproductive' lands of Africa are commonly looked at as a main target.

Solid wood is also favored, especially in the Nordic countries, and mainly for direct use as fuel. A bioenergy conference in Sweden in June focused on large scale production of forest products for energy, plus a few novelties such as a pellet-driven automobile.

There is little discussion of approaches that may be adaptive to small-scale, diversified production that can provide real answers for development in rural Africa, in both liquid and solid biofuels. A wide array of agroforestry practices can provide a foundation. Here are examples of others that are now or may become deployable:

- Direct digestion of cellulosic materials by specialized microbes. This new field, now in intensive development in the U.S., Europe and the Orient, is highly significant for potential future use of biomass in the dry tropics as production feedstock. Examples in recent press:
    - Direct production of ethanol from a wide variety of feedstocks, based on a bacterium isolated and developed at UMass, Amherst (see www.sunethanol.org). A five million gallon per year plant is planned, and smaller units later. A founding partner (personal comm.) assures me that adaptation to grasses and understory of African woodlands is a priority for them, and may be only a few years out. [He also says that the Stanford/Carnegie study cited at [1] underestimates U.S. capacity by not including cellulosic waste such as recycled paper, and industrial wastes.]
    - Direct conversion of sugar to gasoline-like hydrocarbons by modified organisms (Amyris Corp., based on their having developed anti-malarial synthetic artemesunin for the Gates Foundation, scaling up to production quantities).
- High production cassava (Ohio State University: 2.6 x the normal yield) that may be field-digestible to ethanol mash for shipping or further field-processing. Other such crops may include sweet sorghum. Cassava is now a common feedstock for ethanol in China.
- Direct production of ethanol and methanol (then called "wood alcohol") by artisan distillation methods used in World War II and the Great Depression, and from the time before cheap petroleum pushed out liquid biofuels a century ago [Methanol and byproducts such as embalming fluids were made by the ancient Egyptians.]
- Efficient ways to produce charcoal, including from unusual source materials. An award-winning Indian method makes charcoal powder from sugar leaves in a stainless steel device that is village-deployed [3]; briquettes are then made and burnt in special, efficient cookers.
- Improved methods for fuelwood use, such as the Malawi Rocket Stove, which achieves up to 90% reduction of wood demand in industrial size cookstoves, and other such stoves adapted to village use in households, made with local clay and other domestic materials.
- Solar cookers (not a biofuel but equivalent in effect, except under canopy forest.)
- Improved browse for livestock, including domesticated African native species. This element has major potential for converting new forms of 'understory' to biogas for local electrification and power supply, and for production of high quality soil amendments.
- Many other methods well known to this audience, well documented, among other sources, in publications of ICRAF, the World Agroforestry Centre.

The net effect of all the above, together with timber and numerous non-timber products (honey, mushrooms, herbs, natural material handicrafts, etc.) traditional in woodlands, can be to build an economic base for living in and near the forest at population densities equal to or greater than those now predicted for far less diverse, less productive landscapes in the emerging future of tropical Africa.

Mechanisms of engagement: Building a central role for tertiary agriculture and NRM

What are the means of engagement for your institutions, even with your own national officers? Here are a few key ingredients that may be required to get from here to there:

1. An agreed idea of what the desired continent will look like a few generations from now. The 'human-managed agro-forest' can be the basis for a working hypothesis.
2. An agreed basic toolkit, beyond the obvious agroforestry methods for which you as a group are the experts. There are many items to add to the summary just above.
3. A financial mechanism: Carbon can pay for restoring the native woodlands; the more carbon and larger the area, the better. Biofuels can help.
4. A strategy of engagement, particularly at the project level, where your authority is particularly strong and is most needed: at the local, district and national levels.
5. A structure of authority that begins with the assumption that your institutions are in the center. I believe this can be established rapidly, and can be built on the strength and unique position in Africa of your institutions themselves.
6. An education plan and public relations strategy.

3. *Carbon funding as a financial mechanism*

The design that is best for Africa may also be best to serve the planet. Global warming is now accepted as an urgent matter. The carbon industry is well funded to seek answers. The agro-forest woodland can serve as a gigantic *Global Carbon Bank*.

There are very large sums available to support such a development but it is not yet under consideration by the industry. Carbon alone was a $60 billion USD industry last year, and may be $80 billion USD this year. Added to Reduced Emissions due to Deforestation and land Degradation (REDD), climate change adaptation and biofuels the combined global mitigation finance enterprise may soon approach $100 billion per year.

'Carbon finance' is predicted to reach a trillion dollars ($1,000,000,000,000) by the year 2020 and still be growing. That's more than a million times the annual budget of our host, Bunda College. Once again, Bunda College and your institutions are the appropriate architects and developers. If you're not in a central role, the next Africa may be designed and built for you, by people who are not so well prepared.

A lot of the work will be done from a distance by consultants and brokers employed by the carbon finance and biofuels industries. Those industries are basically not interested in complicated problems if they can instead choose simple ones that may be profitable. But as we say, "for every complex problem there's a simple answer that's wrong!"

They will favor plans that make it as convenient as possible for themselves. They have the money, and the attention of UN system and World Bank officers (and are now being solicited as financial partners by many of your own national authorities). Again, if you are not in the picture they will together decide what to do without your help.

World Bank, the UN and the carbon industry are the people who took your funds for projects under the Kyoto Protocol, which were intended to benefit poor countries, and spent them in China to reduce industrial emissions, mainly of chlorofluorocarbons and N2O. That has been

half of the Clean Development Mechanism (CDM) budget of $5 billion USD per year in recent years under Kyoto.

The unsolvable part of the global warming problem is industrial emissions of coal-fired industry in China and India. The World Bank has announced plans to use CDM funds to reduce emissions in a 4000 megawatt giant coal-fired power plant in India. In my view, China and India are part of the problem and Africa is part of the solution.

The UN System and World Bank Group can go either way. They are there to facilitate, and in the case of CDM, to regulate the results. But they are limited by what is currently deemed to be practical and appropriate. They are not asking for your advice. Yet.

Like China, India is assumed to have the capacity to use the funds and Africa is not. Only one percent (1%) of the CDM funds have been allocated to tropical Africa, and it appears that most of that money stayed in Northern financial centers to pay "transaction costs". The excuse is that African projects don't satisfy the CDM rules – which may as well have been written by the Chinese to be sure that they can satisfy the rules and you can't.

Your institutions don't even have a central role in the very small African CDM picture. If you make an adequate case for your capacity and authority, even the consultants and brokers of biofuels and carbon finance may prefer to work with you to produce better projects. It's a growth industry and they can afford to share.

The World Bank, UN and carbon industry seem to have overlooked Africa to this point in carbon finance but that's changing. Several African countries were represented at the leading Carbon Expo in Koeln, Germany, in early May, mainly by officers of Designated National Authorities (DNA), managing CDM for each country. They were sponsored by the World Bank Carbon Finance department and were looking for financial partners. [A senior Bank officer in BioCarbon (personal comm.) has expressed interest in the Bank having access to a nation-based African university network for consultation.]

The next main event, among several forthcoming, will be an Africa Carbon Expo in Dakar, Senegal, a month from now. "The train is leaving the station" for carbon finance and biofuels in Africa. New approaches to industry practice, and to facilitation by the UN System and World Bank Group may be put in place in the next several months.

Policies are now in negotiation on carbon rules for the post-Kyoto era after 2012. They will be set by next June, six months in advance of concluding negotiations at a meeting in Copenhagen in December 2009. It was the prior round of such rule-setting in Kyoto that left Africa at the station for the present era.

If tertiary agriculture and NRM institutions of Africa want to join this picture, whether in a central role or a marginal one, this is the time to mobilize.

<u>The benefit of reduced burning and deforestation; linkages to food security</u>

The stakes are high. In miombo woodlands alone, more than 400 million tons of carbon are emitted annually by human-induced burning. That's about 1.5 billion tons, expressed as CO2, of GHG emissions, and more if methane, N2O and other gases are included. Much of the nitrogen stock is lost [an Argentinian medical missionary, gazing across an open field, commented to me "they're burning their fertilizer".]

Similar amounts of carbon and other GHG components are emitted through deforestation and land degradation, much of it for inefficient use of wood as fuel. In Malawi, for example, 25% of deforestation has been attributed to harvesting trees for curing tobacco. Efficiency of burning can be improved by half in this use [4].

[Or Malawi might consider growing alternative biomass products such as bamboo, kanaf and hemp that are not intended to be burned in their use. Conversion might qualify for carbon emission credits. Industrial hemp is now grown freely in Europe and Canada but banned in the U.S. and tropical Africa. It produces food and fiber, was recommended by Thomas Jefferson as superior to tobacco in enhancing the soil instead of degrading it.]

Woodland is now being lost in the miombo region at rates of up to 2% or 2 ½% per year due to wood chopping and land conversion. What remains can be lost or damaged, possibly beyond recovery, within a generation or two at present rates of population growth, and of encroachment such as pressure for agricultural use.

A primary damage of conversion to agriculture is loss of soil carbon, which is typically 60% to 2/3rds of the carbon in storage in mature woodland, of the total of 90 tons or so. Much of this is living matter such as the web of mycorrizal fungi that is symbiotic with standing woodland – a legacy of evolution. Soil carbon typically declines by 40% upon conversion to agriculture and doesn't recover under fallow [5].

A key feature of soil carbon is that it takes the place of expensive, petroleum-based inputs in conventional agriculture. These inputs are rapidly increasing in cost. In Malawi food security in recent years has relied on fertilizer subsidies to farmers. But the price of a 50 kg. bag, which was already unaffordable, has tripled this year from 3000 Malawi kwacha to 10,000 Mk (about $70 USD). Donor support for fertilizer and other inputs may be unsustainable when conventional petroleum supplies are exhausted in a few decades.

The coming *post-petroleum* future of Africa

The example of Cuba is instructive. Cuba's agriculture was highly industrialized, and dependent on imports of chemical inputs, machinery and fuel at the time of collapse of the Soviet Union, its main supplier, in 1990. Even the majority of food calories were imported from the Soviet Bloc. All this ended very abruptly. Cuba had to adapt to the new *post-petroleum* reality under emergency conditions of threatened starvation [6].

Cuba converted in a few years from industrial, centralized, petroleum-based agriculture to diversified, locally-controlled, self-reliant methods, closer to historic practice there. A main addition was development of biofertilizers and biopesticides, produced in artisan-quality rural facilities, typically by young *campesinos* with some college education.

The large science community of Cuba (11% of scientists of Latin America, with only 2% of the population) was crucial, together with a base of organic agricultural science and established practice. The 'alternative' approach prevailed over the 'conventional' system in national policy. Similar alternatives now exist widely in the industrial countries and in less industrialized ones, but more as an ideal than as adopted, mainstream practice.

The result in Cuba might serve as a very large laboratory for the future of Africa, which is now threatened by a longer lead-time emergency. A reliable source in the oil industry, British Petroleum, projected in 2005 that 40.5 years then remained of conventional supplies of petroleum at current rates of use.

The reality of the world economy is that rich nations will 'export the shortages' as long as possible, avoiding the need to overcome a far larger barrier than Africa's in their use of petroleum-based fuel. R. Buckminster Fuller warned, emphatically in the 1960s, that we must use cheap oil to build the solar age. That hasn't happened.

An early 'wake-up call' of the oil crises of the 1970s was ignored. The horsepower of American private automobiles has doubled since then. It now takes five to ten calories of petroleum energy to put a calorie of food energy on the table in the U.S. and Europe. How will they feed themselves in the future? They appear to be betting their lives on a new and affordable source of energy showing up to replace petroleum. That doesn't yet seem to exist in science and public policy. What are the prospects for biofuels?

Africa has a better chance to survive, without major impact on lifestyle, into the post-petroleum future. Indeed, Africa is best suited to serve as a very large demonstration platform for the entire planet. The population is still thinly-spread over an enormous land base. It is the least urbanized continent by far. People remain close to the land, even those living in cities. Giant 'conurbations' are foreign to tropical Africa and likely to remain so.

Because the poor nations are damaged 'first and worst' by shortages, the permanent 'wake-up call' can be relied on to arrive here first. As in Cuba, success in survival may rely on the agricultural science community, and on established organic agriculture.

<u>The worst news on global warming may be sea level rise; Africa holds the 'high ground'</u>

The above considerations are made far worse, especially for the other continents, by climate change. For Africa the reality may be less dire than predicted, particularly if a strategy of revegetation can be effective. Rainfall is still high, far more than is used, and the crisis of climate change may be possible to delay through management practices. Also, 'forest attracts rainfall', according to local tradition and scientific observation [7].

In contrast, continents most impacted by sea level rise have little choice, and potential defenses may be limited. The bad news now seems sure to be worse than they assume, and coming sooner. A top authority, Dr. James E. Hansen, Director of NASA's Goddard Institute of Space Sciences [8], states that sea level rise will be measurable in meters in this century, and not in centimeters as the UN science team has predicted. Sea level rise alone can result in 100 million refugees within a century.

Much of Hansen's analysis is based on climate change in the geological record. But the most compelling present evidence is the loss of floating sea ice in the Arctic Ocean, which will speed Arctic warming and the loss of stored water in the Greenland Ice Cap.

This was unimaginable a half century ago when I first visited the Greenland Ice Cap as a young field technician, or when I served as chief-and-only scientist the winter and spring of 1962-3 on an ice island in the mid-Arctic Ocean.

I had the advantage of an early, wide-ranging career in earth sciences, including work on rift zone geology and oceanography in this part of the world, and on the geochemistry of tracer isotopes at a time when earth changes became major subjects at the best places.

The science was already convincing in the 1960s on long term resource limitations and on the apparent risk of global climate warming. It was clear that preparing for the future would require far more than further study. 1968 was a moment when ordinary people, perhaps especially in

California, learned they could have a voice. I took up organizing, public policy, and regulation. There were some successes that may have application at present in Africa, which I will discuss next. I soon returned to academia, but in planning and design for a resource-limited, environmentally-challenged future.

4. *Self-Regulation of Environmental Quality:* The case of California local government

Regarding the potential for project-level engagement with government officers, I am reminded of the situation in California local government in the late 1960s at the beginning of the 'environmental movement'. Land development has historically been a primary focus of municipalities and, to that point, had been controlled by deal-making between developers and local decisionmakers. Public staff was at hand to facilitate and the public was allowed to object if they were well enough organized.

Within a few years this system was transformed into a process of 'full disclosure' and dialogue among all the parties, paid for by developers on each project. The record was formalized as an environmental assessment. Issues that remained unsettled were decided by local elected officials serving in a quasi-judicial mode. There were many forms of local process, leadership and organization. All were subject to review, ultimately in the court system, generally based on judgment of their success in addressing the declarations of public policy under the California Environmental Quality Act of 1970 [9].

This brief, accelerated development of only a few years was initially driven in part by dialogue between academic scientists (of which I was one) and local government officers, with the intent of establishing in local government a forum and process for managing the environment at the local, regional and state levels. A result was the rapid formation of a large, well-funded planning and assessment industry, commonly led by former activists.

My view of the comparison in Africa today is that an urgent dialogue is warranted at every level between academic scientists (particularly of the institutions represented here) and government officers. A way to formalize that dialogue could be to include national universities as working partners with government in each Designated National Authority (DNA) for managing the CDM and related processes.

A second venue may be the process motivated by TerrAfrica (an initiative of NEPAD, the World Bank, national governments and others) to establish in each country a Strategic Land Management (SLM) plan. Three planning activity areas are: 1. Coalition-building; 2. Knowledge management; and 3. Finance. Again, ANAFE institutions are most likely candidates to play a central role. In Africa, knowledge management for SLM is largely about agriculture and natural resources. Universities are leading repositories and active agents in preparing for the future in these subjects. They are not mentioned in a three page summary of activity area 2. in the 2007 TerrAfrica Annual Report.

Thirdly, of course, is the need noted above on local projects to "Consider models of engagement of stakeholders under local scientific leadership and oversight". A main point, as in California but moreso, is that African conditions can be highly variable in local detail of soils, biota, human culture and habitation, history, leadership and so forth.

For any project there can be a multitude of alternatives, including some discussed herein. Long term social development can be addressed in every project. This may or may not be in keeping, for example, with regarding local people as plantation workforce.

It could be desirable to establish throughout Africa "a large, well-funded planning and assessment industry" with strong presence in rural areas, and strong linkages to local and regional academic and research organizations, NGOs, traditional authorities, extension services and government at all levels. This is easily affordable under carbon finance.

The need for engagement, process and dialogue may be higher for biofuels than for carbon finance under CDM and other such measures which benefit from the regulatory oversight of the UNFCCC and its Executive Board. Biofuels are fundamentally reliant on national oversight and regulation, if any. They have great potential to be damaging.

Woodland is already being destroyed for land conversion and biofuels (firewood and charcoal). There may be a need to establish a policy framework based in scientific understanding. On this point, projects can be required to provide a net gain of carbon, and preferably a net restoration of soils and even of woodland.

5. *The need for a policy framework: A proposed conference resolution*

A way forward may be to establish a background analysis and policy framework for the future of Africa. This can include advice on what to try to accomplish through mitigation finance. It can start with a high level African science panel on carbon mitigation and biofuels like the process and report of the NEPAD / African Union biotechnology panel, *"Freedom to Innovate"* [10]. The new panel may even be staged as an extension and practical application of that prior work. Microbiology will be important here. Many of the prior panel's conclusions may apply, including protection of intellectual property.

A major requirement overall is for a shared reference and, in effect, a constitution for the environment. Our version was the California Environmental Quality Act of 1970, a State descendant of the National Environmental Policy Act of 1969—but stronger. [In Malawi the National Environmental Action Plan may serve some of the same purposes, together with those of other African countries, regional groups, NEPAD and the African Union.]

The chance of establishing a policy with the force of law in the subjects discussed above, soon enough and on a wide enough basis in Africa, is not good. But a strong statement based on solid scientific consensus could: 1. be endorsed by NEPAD, the African Union, national governments and other authorities; 2. be advocated and referenced by NGOs, CBOs and others having concern with local issues and projects; 3. support establishment of a widely-based planning and assessment industry; 4. support engagement in project origination and review by stakeholders including universities, research organizations, extension services, NRM agencies and 'third party' government organizations; 5. encourage individuals, businesses, farmer groups to express their voice in issues and projects that concern them; and 6. give project advocates and developers a public framework of policy (a 'rule book') to respond to with their plans and proposals.

This Symposium appears to provide an adequate representation of institutions that may be most relevant to this discussion, as well as a wide spectrum of the science and education community stakeholders of Africa. I suggest you resolve as a group to:

> "Recommend that the African Union and NEPAD convene a high level panel, as it did for biotechnology, to explore 'Strategic ways of building Africa's scientific capacity for regionally oriented regulation and management' for biofuels, carbon, and global change adaptation."

Such a panel can begin, on better authority than mine, with a review of the fundamentals of what appears to be happening on the planet, how it affects Africa, and what measures can be taken to best address those subjects and issues.

Since universities have unique, independent authority in Africa, and since much of the need and opportunity for analysis, policy recommendations and implementation may be based in the universities, the membership of such a panel may best emphasize leadership of the institutions themselves, and/or their designates. In my own research on carbon and education of the past year [with 40 years of practice in 'institutional ecology'] I've been most impressed with the capability, collegiality and broad view of such leaders.

A main conclusion and recommendation of the prior panel was to establish "regional innovation communities anchored in 'local innovation areas'". This can be a good prescription for the new subject areas of biofuels, carbon and global change adaptation.

Considering the urgency of responding, for example, to biofuels development and to the revision of CDM rules for the post-Kyoto era, it may be possible to reverse the process and begin in this case with a strong regional panel and draft policy framework.

The Miombo Woodlands Region as a model, and a good place to start

The project for such a panel can begin here in Lilongwe and at other 'local innovation areas' associated with ANAFE institutions. In Malawi a national-level 'brain trust' was organized in recent years for very related purposes, the Agricultural Science Association of Malawi (ASAM). It is not currently active but can be renewed, giving new impetus to NEAP and other measures, and providing an organizing focus for cooperation of tertiary education and NRM institutions with other stakeholders.

On the larger scale of forming "regional innovation communities" anchored in 'local innovation areas', this can be another name for a process that is already underway, led by Bunda College, to establish a 'reforestation alliance for Miombo Woodlands' [11].

Miombo has many advantages as a prototype for the dry tropics in general, and as a model for institutional development for Africa. It has the integrity of a well-defined ecological region that is recognized for its importance on a planetary scale. It also has the comparative advantage of having potentially greater climate stability than other regions of Africa. It underlies the Intertropical Convergence Zone of global circulation in the southern summer, bringing trade winds and moisture from the Indian Ocean, as it has through major global climate cycles in Pleistocene ice ages and before. In the preceding Pliocene time there were rain forests in some presently dry parts of East Africa.

This region extends from about Dar Es Salaam in Tanzania to Beira in Central Mozambique, and inland well into Angola, an area of about 280 million hectares, roughly the size of the American West but with rainfall more like that of the farmlands of the U.S. Midwest. It has a population of over 70 million.

The Miombo region has the great advantage of social and political stability on a very large scale at present, an asset of the human community much deserving of support. Universities have a history of collegiality and cooperation here that is apart from politics and territoriality. Building a shared basis for shaping the future of the region, responding to projects and utilizing project finance can help carry that process forward.

6. *Education and public relations strategy*

Changing tradition and habit may be the hard part. That's a job for the educational system and the research establishment, including yourselves. But it will require, if taken up as a real cause, mobilization of far more, including public media, governmental regulation, theater, religion, business and civic enterprise. Universities can become effective leaders and initiators, beginning with agriculture and natural resources management (NRM) faculties but engaging all subject areas. If carbon is to be taken seriously as public policy and access provided to the level of funding now available, everybody has a role to play.

H.G.Wells, the American historian and commentator of a century ago, famously stated that "***Civilization is a race between education and chaos***". At this moment in planetary history, there is far greater risk than is widely understood. It's not just civilization but the survival of a livable habitat on earth that's in a race between education and chaos [12].

In Africa a great risk of chaos is the incapacity of the land to keep up with population growth, given the continued use of practices such as slash-and-burn agriculture. It seems there's not enough land, incredibly, in a continent this vast, with comparatively low population densities overall. Biofuel production can add to the crowding, damage and overload. Smallholders may find their lands or traditional rights, for grazing and other uses, are committed on their behalf to new uses, without recourse.

The risk is compounded by major loss of experienced and educated adults to HIV/AIDS: teachers, skilled farmers, entrepreneurs, tradespeople, government officers, leaders of all kinds. The median age of Africans is now in the middle-upper years of secondary school. Few of that age are actually attending school. For those who are, maintaining woodland is not likely to be emphasized in the curriculum. How can education possibly keep up?

A premise of this symposium is that agroforestry is an essential part of the answer. But how can it be possible to convince the average African teenager out of school that with agroforestry there may be land enough for a prosperous and stable future? There may even be enough rainfall, despite climate change, if runoff and evaporation are reduced – converted to evapotranspiration, possibly contributing to increased rainfall downwind.

Engaging youth is an essential element to making any viable strategies sustainable.

The proportion of children in school is low enough at elementary grades but appalling in secondary levels, worst at higher grades. Access to tertiary education is limited to very few seats, and the universities are in a struggle to maintain standards and even to keep the doors open. This makes no sense if there needs to be a serious effort in Africa to improve woodland, capture and store carbon, diversify productivity around agroforestry and other points addressed above. This is everybody's business.

As discussed above, Africa is under-rated in its ability to contribute to global carbon mitigation, reduced deforestation, climate change adaptation, and bioenergy. The real opportunity is not in fast-turnaround, large scale plantation strategies but in long term, diverse development. The fundamental investment may best start with education itself.

"Mainstreaming" can mean working to support the formal education system and expand it but also to 'take it to the streets', into the mainstream of population that is not served.

The work of our small NGO, MAFUWA, has emphasized the potential for non-formal education of young people out-of-school, especially at the secondary level. One element is to recognize that everyone has a village, and young people can become leading agents for delivery of ideas, products, enterprise and change to rural areas, and forming business opportunities for themselves and others. There are a few ways this can occur:

1. Our group is engaged in strategies to establish display settings for public access, to show ideas, technologies, crops, services and products of all kinds that can help develop diversified, productive economies focused on villages and smallholders. These settings can, in effect, be 'theme parks for the future of Africa'. Universities and research institutions can be organizers and sponsors, providing displays and education.

2. I have some experience with Project-Based Learning (commonly called 'problem-based' in Africa) at the tertiary level and especially in graduate school, but also in high school. I can commend two examples of success models for what I call 'post-colonial education', in which children in early teenage years are treated as professionals in training, from day one. The curriculum can be entirely organized around projects but still be academically rigorous. The magic is in structuring the projects to satisfy the required teaching content (what we call the "State Frameworks" for each grade). It works [13].

The "charter school" movement in the U.S. frees schools to organize themselves in many ways that may bear some discussion in Africa. If projects can be taken up, for example, to address development needs of communities, including diverse approaches such as the 'toolkit' for biofuels listed above, can it be organized as non-formal project-based learning? Does it matter, if children aren't being served by the formal system anyway?

Our NGO has offered to start an entirely practical academy for upper grades in a district of ½ million population where the upper two grades of secondary school are not taught. This would be a four year program in forestry, agriculture and industrial arts, leading to a PBL equivalent of a U.S. community college credential. Students would be required to start businesses as a condition of graduation (an element of one of the California models), preferably in their home communities away from the town. A long term objective may be to plant para-professional village foresters, agronomists, mechanics and business people.

3. I've noted the phenomenon of very large secondary schools, under-housed and under-staffed, some operating on two or even three shifts. If the service territory were defined as a project area, for example, for carbon conservation and development, and/or diverse biofuel investment (as compared to plantation management hiring 'labor force'), may this not require a great number of people to learn what to do and how to get involved? At the level of project finance discussed above, a lot of educational services, staff and facilities might be paid for. It helps if the plan is long term, even generational. Much content may be addressed in the ½ or 2/3rds of 'down time' students have during the school day.

If fire abatement is a serious prospect in the 'bush', organizing youth-based fire brigades can be taken up as job training – and attitude development. Much fire-setting is done by young people (including the very young) without a lot of other distractions available. Older siblings, friends and mentors engaged in suppressing fire, and doing related work such as fire break development, and maybe producing their own biofuel for transport, can help 'mainstream' the movement of habit and tradition away from fire-setting.

4. Satellite communications can be an important part of engagement of young people with the world. Notification of fires is now available Africa-wide, within 15 minutes of their reaching a half hectare in size. Payment for fire suppression may be fundable by carbon. But it's far better if integrated with a program of diversion of biomass. The most likely approach is through agroforestry [14]. Meanwhile, there are forestry plantation companies (and some forms of biofuel development) in the woodlands that may wish to get started along these lines as an approach to areawide 'fire insurance'.

A digital radio and multimedia broadcast satellite is in orbit over the Congo, reaching everywhere in Africa, now, at affordable cost. This satellite, AfriStar, was put aloft nine years ago by an African entrepreneur who wanted to build 'information affluence' in rural Africa by providing digital audio and multimedia broadcast. Bandwidth is available at low cost for education and social service development. Five percent was donated to a non-profit organization (www.firstvoiceint.org). They have shown interest in a Miombo project in five languages (Chichewa, Swahili, English, Portuguese and French).

This satellite can be central to a region-wide mainstreaming strategy. ANAFE institutions are the most likely candidates to provide content. All manner of ideas, resources and projects can be provided to anyone with a $100 digital radio, such as listener groups based in schools, churches, CBOs, or farmer coops. Only a few tons of carbon can pay for a radio, which typically reaches 200 people through groups and retransmission. A few more tons might buy a laptop to accumulate curricula and renewable Web content to help provide for community-based learning and self-instruction. It can be the equivalent for Africa of the Carnegie Library in small towns of rural America in the 20th Century.

ANAFE itself may consider taking a leading role in helping develop an integrated strategy for education to reach rural and remote areas. It took decades for 'hard copy' books to reach everywhere. A satellite-based system could be in place next year. The service life of this satellite, AfriStar, is limited. There's a backup satellite available. But proof is needed in the next few years that the use is productive – maybe of carbon credits.

Conclusion: A few steps toward implementation

There is an historic opportunity at this time to move tropical Africa toward a stable and durable condition that can better survive climate change than the land we now have -- which is headed toward a less stable and less durable condition.

The decisions that make the difference are made at all times in large and small ways. If they are not made with some purposeful intent, such as moving toward stability, they can be made randomly, with chaotic results – sure to move us toward less stability.

Much of the land has had deciduous canopy forest as its climax vegetation through many cycles of climatic change of the past few million years, while humans have been evolving in East Africa. The patterns have varied with time, but have returned to the pattern of potential we can now observe. The opportunity we may now enjoy is to move back toward a condition more like nature itself tries to restore if we don't interfere [15].

If an ambitious enough program is planned, with full engagement of many constituencies, it may be possible to secure funds: Large scale, large finance. Likely sources may be donor countries that are not limited by prescribed monitoring and verification of details on specific projects. The 'leverage' can be high for large scale restoration of woodland.

A post-industrial, self reliant, information-rich economy based on agroforestry can be credibly built in Africa. It may help public policy in Africa for the science community, and notably the ANAFE institutions, to begin to illustrate how that can be made so.

It can begin in many ways, even on a local, small scale, within the framework of wide scientific consensus and framework of policy, and in keeping with plans that may be rendered, in time, at the regional and national level.

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[1] J. Elliott Campbell, et al. "The Global Potential of Bioenergy on Abandoned Agricultural Lands", *Environmental Science and Technology* (online) June 25, 2008.

[2] Dr. Dennis Kayambazinthu (pers. comm.), Director of the Malawi Dept. of Forestry: An example is Chimaliru Forest Reserve near Kasungu, part of which has fully recovered from agricultural use since it was set aside and protected in 1927. Dr. G.Y. Kanyama-Phiri, Principal of Bunda College, adds that cemeteries in Central Malawi are also protected by law and cultural tradition, and typically show full canopy cover.

[3] www.ashdenawards.org, Year 2002 annual award for sustainable energy. The same organization, ATRI, has a compact biogas digester that utilizes sugar or starch (e.g., bush-able cassava or sugar cane); it outperforms manure by 20 times, and is far faster.

[4] "The GTZ Rocket Curing System" (Vincent Gondwe of proBEC, pers. comm.)

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[11] Jokela, et al., "Proposal on a reforestation alliance for Miombo Woodlands", June 14, 2008.

[12] The ultimate, long term risk is "runaway global warming" which would result in a very different planet, far hotter, less habitable by humans and other biota. The earth could become ice-free, for the first time in about 50 million years, with far higher sea level.

[13] The models are International Polytechnic High School, Cal Poly University Pomona and the School of Arts and Enterprise in the Arts Colony of Downtown Pomona.

[14] Dr. Robert Scholes, CSIR South Africa, pers. comm.

[15] But commitments are being made: e.g., in Tanzania, investors are securing concessions for as little as $20 per ha, allowing replacement of standing miombo woodland with *Jatropha.*