THE CARBON RANCH: FIGHTING CLIMATE CHANGE ONE ACRE AT A TIME[1]

Courtney White©

The Anguished Question

"What we do in the next two to three years will determine our future. This is the defining moment." Dr. Rajendra Pachauri, head of the UN's Intergovernmental Panel on Climate Change, in 2007. The climate challenge now confronting all societies on the planet is as daunting as it is straightforward: under a Business-As-Usual scenario, the rising content of heat-trapping trace gases in the atmosphere principally carbon dioxide, methane, and nitrous oxide pose a dramatic and potentially catastrophic threat to life on Earth.

I won't go into a detailed review of the science of climate change here, or enter into the debate about human versus natural causes of global warming, though its correlation with industrial activity seems clear. For the purpose of this essay, the challenge and the opportunity we face can be summed up in three pertinent graphs from the **Scripps Institute at UC San Diego** which chart the rise of the atmospheric content of carbon dioxide (CO2), a heat-trapping gas that has significantly contributed to a 0.8 Celsius rise in the Earth's temperature since 1750. [1]

Graph One: The Famous Keeling Curve

This graph represents concentrations of atmospheric CO2 in parts-per-million (ppm) as measured by the Scripps Institute's observatory on Mauna Loa, Hawaii , under the direction of Dr. Charles Keeling.

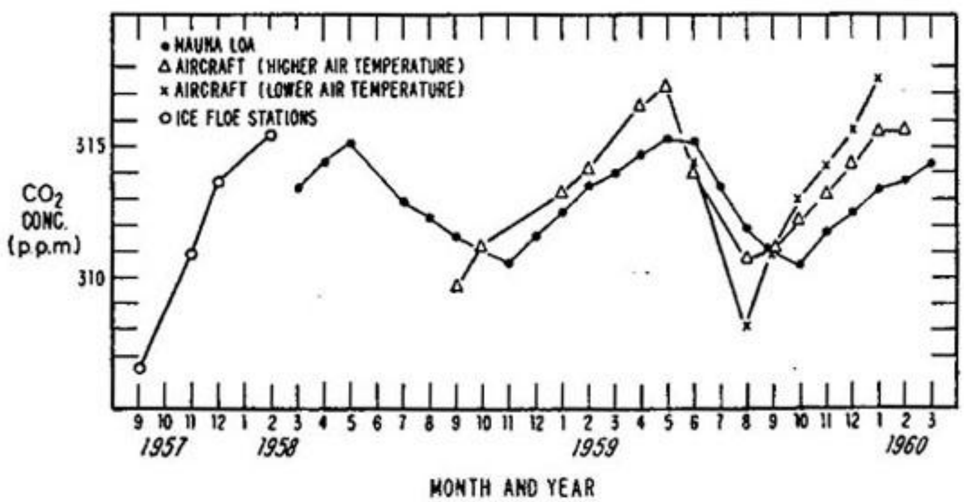

Fig. 1. Variation in concentration of atmospheric carbon dioxide in the Northern Hemisphere.

Tellus XII (1960), 2

[1] Green Fire Times, November 26, 2010

The annual highs and lows reflect the amount of CO2 'breathed in' by the planet's vegetation in the spring and 'exhaled' in the fall. In 1780, the amount of CO2 in the atmosphere was approximately 280 ppm

Graph Two: A Comparison of Current CO2 ppm to the Historical Record

This graph places the current amount of atmospheric CO 2 in a historical context. The dips correspond with planetary cooling periods ("ice ages") and the subsequent rises correlate with warming trends. Note that past CO2 maximums barely exceeded 300 ppm. Today, it is 391 ppm the highest level in at least 2.1 millions years. [2]

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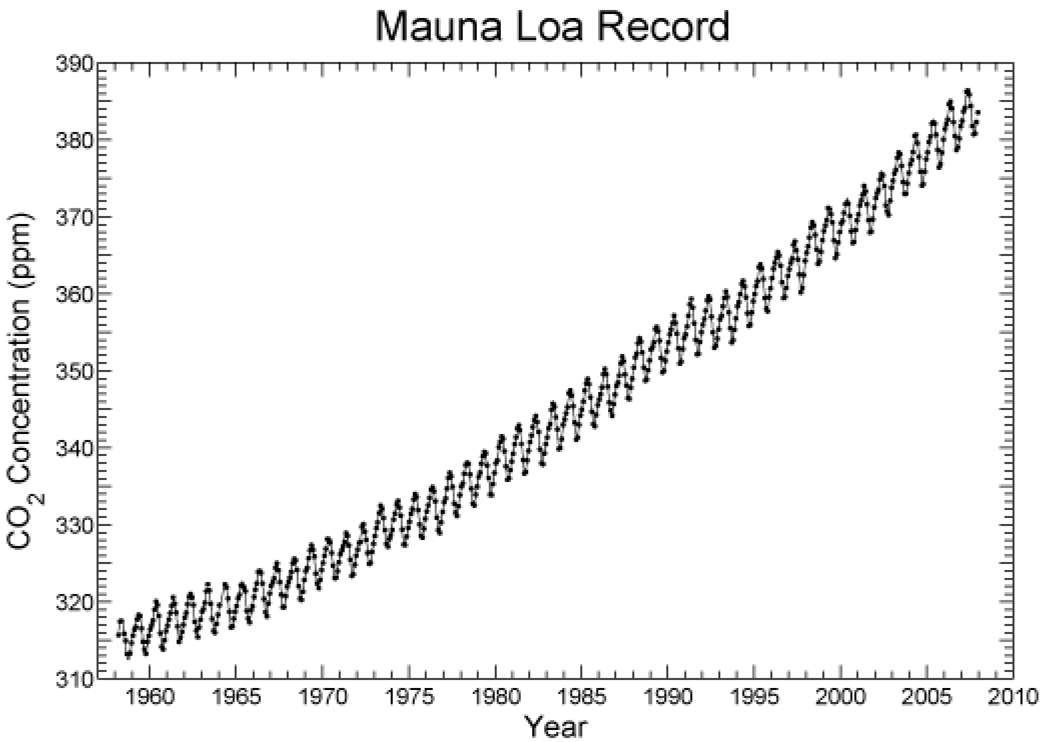
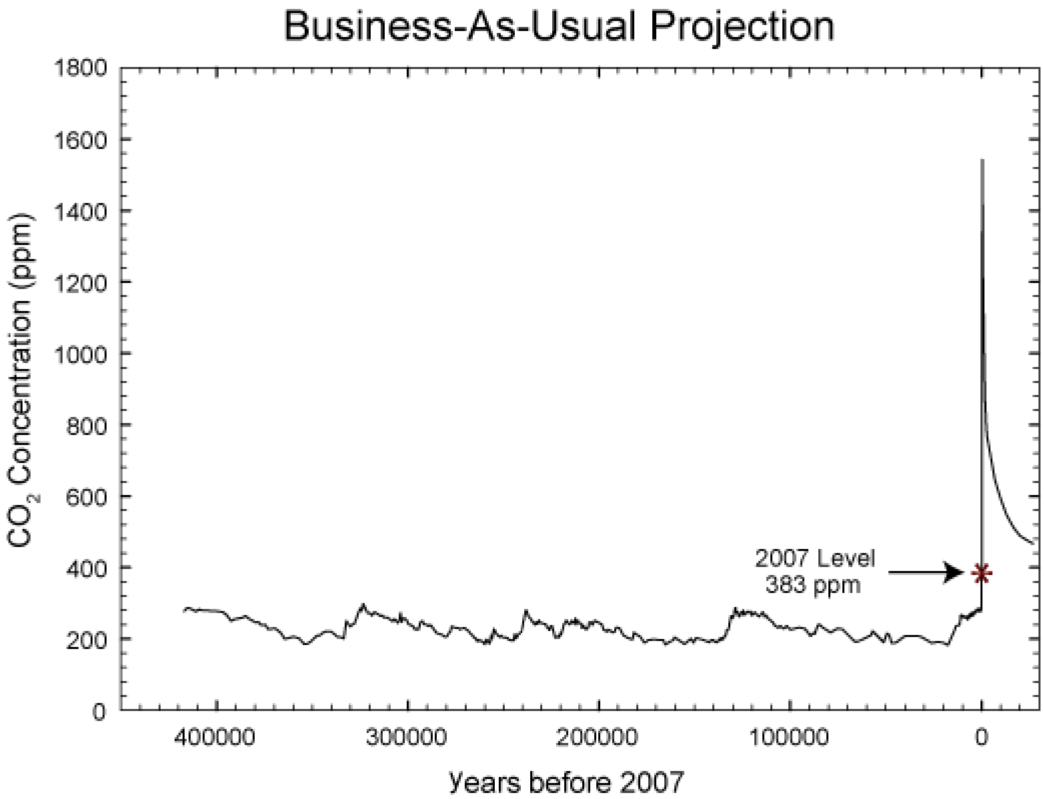


Graph Three: A Scientific Projection of CO2 Under Current Emission Trends

Under a Business-as-Usual model, CO2 will rise to 1500 ppm, or thereabouts, and not return to pre-industrial levels even tens of thousands of years into the future. What does this mean? A comparable rise in CO2 took place during the Permian period, culminating 251 million years ago in the "Great Dying" when 90% of all species on the planet went extinct. The difference is that during the Permian, it took millions of years to reach 1500 ppm, whereas it might only take us a few centuries. Furthermore, human civilization is coterminous with the current Holocene period, whose remarkably stable climate over the past 10,000 years gave rise to the agricultural revolution, among many other developments. However, a rising level of CO2 in the atmosphere jeopardizes this stability, perhaps permanently (on human time-scales), even without reaching Permian-like CO2 maximums

The situation is very serious. Dr. James Hansen, the Director of NASA's Goddard Institute for Space Studies, and the nation's top climate scientist, puts it this way: "Business-as-usual greenhouse gas emissions, without any doubt, will commit the planet to global warming of a magnitude that will lead eventually to an ice-free planet." [3] Clearly, action is required and I'll propose a specific strategy in this essay. But before I can proceed, a critical question needs to be addressed: what 'safe' level of CO2 ppm should we aim for? (note: I am focusing on CO2 for two reasons: (1) it is the most prevalent and long-lasting greenhouse gas in the atmosphere; and (2) the warming effect of the other trace gases is being offset currently by the cooling effect of atmospheric aerosols, such as soot and other forms of pollution that reflect solar radiation back into space).



As recently as five years ago, calls to limit atmospheric CO2 focused on staying below the doubled pre-industrial level of 280 ppm. For example, in a 2004 paper published in Science, two Princeton University scientists argued for the stabilization of CO2 at 500 ppm, which required that greenhouse gas emissions be held near the (then) present level of seven billion tons of carbon per year (GtC/year) for the next fifty years. [4] As recently as five years ago, calls to limit atmospheric CO2 focused on staying below the doubled pre-industrial level of 280 ppm. For example, in a 2004 paper published in Science, two Princeton University scientists argued for the stabilization of CO2 at 500 ppm, which required that greenhouse gas emissions be held near the (then) present level of seven billion tons of carbon per year (GtC/year) for the next fifty years. [4]

By 2007, in response to new research, the United Nations' Intergovernmental Panel on Climate Change (IPCC) lowered the CO2 target to 450 ppm while also calling for a substantially speeded up time line for emissions reduction. This new target became widely accepted among many non-scientists, who saw it as a politically 'realistic' goal that also kept overall global warming within acceptable levels of concern. [5] Then in the fall of 2008, Dr. Hansen co-authored a paper that set a new CO2 target: 350 ppm. The reason for the lower target was twofold: (1) Hansen et al, argued that slow planetary feedback processes, such as polar ice sheet disintegration and methane gas releases, were not included in previous models of global warming and may come into play much faster than anyone anticipated meaning that more warming is already in the 'pipeline' than previously calculated; and (2) their analysis of the paleoclimate record indicates that a CO2 amount on the order of 450 ppm, if maintained, would push Earth toward an ice-free state a critical tipping point that must be avoided. In summary, they wrote: "Paleoclimate evidence and ongoing global changes imply that today's CO2 , is already too high to maintain the climate to which humanity, wildlife, and the rest of the biosphere are adapted." (emphasis added) [6].

Since 2008, many climate activists, researchers and policy makers around the world have embraced the 350 ppm target. For example, journalist Bill McKibben, who raised the first popular alarm about global warming back in 1989 with his book The End of Nature, has founded a nonprofit organization titled 350.org, whose mission is to get atmospheric CO2 back down by inspiring "the world to rise to the challenge of the climate crisis [and] create a new sense of urgency and of possibility for our planet."[7] If we accept the arguments that Hansen, McKibben, and many others make for an atmospheric CO2 target of 350 ppm, and I do, then how do we get there? Historian and novelist Wallace Stegner once said that all books should try to answer an "anguished question."[8] The same is true for ideas, movements, and emergency efforts, I believe. In the case of climate change, the anguished question is this: what can we do right now to help reduce atmospheric CO2 from its current level back to 350 ppm?

In an editorial published in July of 2009, Dr. Hansen proposed an answer: "cut off the largest source of these emissions coal and allow CO2 to drop back down to 350 ppm through agricultural and forestry practices that increase carbon storage in trees and soil." [9] In their 2008 paper, Hansen et al specifically say that a 50 ppm drawdown via forestry and agricultural practices is quite plausible. I consider these words to be a sort of 'Operating Instructions' for the 21 st century. Personally, I'm not sure what to do about the coal side of his equation, which requires governmental action, but I have an idea about how to increase carbon storage in soils. I call it a carbon ranch.

What Goes Up Must Come Down

Carbon is the basic building block for life. It is only a pollutant when in excess in the atmosphere or dissolved in water. Over millennia a highly effective carbon cycle has evolved to capture, store, transfer, release and recapture biochemical energy in the form of carbon compounds. The health of the soil - and therefore the vitality of plants, animals and people, depends on the effective functioning of this cycle. The purpose of a carbon ranch is to mitigate climate change by sequestering additional CO2 in plants and soils, reducing greenhouse gas emissions, and producing co-benefits that build ecological and economic resilience in local landscapes. According to the dictionary, "sequester" means: to withdraw for safekeeping, to place in seclusion, to place into custody, or to hold in solution all of which are good definitions for the process of sequestering CO2 in plants and soils via photosynthesis and sound stewardship.

To understand how a carbon ranch works, we have to start with the fundamentals. The process by which atmospheric CO2 gets converted into soil carbon is neither new nor mysterious. It has been going on for tens of millions of years and all it requires is sunlight, green plants, water, nutrients, and soil microbes (I will lean here on the work of Dr. Christine Jones, for details see her web site: **http://www.amazingcarbon.com**).

There are four basic steps to the CO2/soil carbon process:

(1) **Photosynthesis:** This is the process by which energy in sunlight is transformed into biochemical energy, in the form of a simple sugar called glucose, via green plants which use CO_2 from the air and water from the soil, releasing oxygen as a byproduct.

(2) **Resynthesis:** Through a complex sequence of chemical reactions, glucose is resynthesized into a wide variety of carbon compounds, including carbohydrates (such as cellulose and starch), proteins, organic acids, waxes, and oils (including hydrocarbons) all of which serve as 'fuel' for life on Earth.

(3) **Exudation:** Around 30-40% of the carbon created by photosynthesis can be exuded directly into soil to nurture the microbes that grow plants and build healthy soil. This process is essential to the creation of topsoil from the lifeless mineral soil produced by the weathering of rocks over time. The amount of increase in organic carbon is governed by the volume of plant roots per unit of soil and their rate of growth. More active green leaves mean more roots, which mean more carbon exuded.

(4) **Humification:** or the creation of humus a chemically stable type of organic matter composed of large, complex molecules made up of carbon, nitrogen, minerals, and soil particles. Visually, humus is the dark, rich layer of topsoil that people generally associate with stable wetlands, healthy rangelands, and productive farmland. Land management practices that promote the high ecological integrity of the soil are key to the creation and maintenance of humus. Once carbon is sequestered as humus it has a high resistance to decomposition, and therefore can remain intact and stable for hundreds or thousands of years. A lack of humus can mean that the carbon exuded from plant roots simply oxidizes and recycles back to the atmosphere as CO_2.

Additionally, high humus content in soil improves water infiltration and storage, due to its sponge-like quality and high water-retaining capacity. Recent research demonstrates that one part humus can retain as much as four parts water. This has important positive consequences for the recharge of aquifers and base flows to rivers and streams.

In sum, the natural process of converting sunlight into humus is an organic way to pull CO_2 out of the atmosphere and sequester it in soil for long periods of time. If the land is bare, degraded, or unstable due to erosion and if it can be restored to a healthy condition, with properly functioning carbon, water, mineral, and nutrient cycles, and covered with green plants with deep roots, then the quantity of CO_2 that can be sequestered is potentially high. Conversely, when healthy, stable land becomes degraded or loses green plants, the carbon cycle can become disrupted and will release stored CO_2 back into the atmosphere. In other words, healthy soil = healthy carbon cycle = storage of atmospheric CO_2. Any land management activity that encourages this equation, especially if it results in the additional storage of CO_2 , can help fight climate change. Or as Dr. Christine Jones puts it: "Any.practice that improves soil structure is building soil carbon." [10]

What Would Those Practices Be?

In my experience in the arid rangelands of the Southwestern United State, there are six strategies to increase or maintain soil health and thus the carbon content of grass or shrub-dominated ecosystems. Sequestration strategies include:

- planned grazing systems, especially on degraded soils;
- active restoration of riparian, riverine, and wetland zones; and

- removal of woody vegetation, where appropriate, so that grass may grow in its stead.

Maintenance strategies include:

- the conservation of open space, so there is no further loss of carbon-storing soils;
- the implementation of no-till farming practices; and
- management of land for long-term resilience, i.e., increasing the capacity of land and people to adjust to perturbation and changing climatic conditions.

Fortunately, a great deal of the land management 'toolbox' required to implement these strategies has been tried-and tested by practitioners, landowners, agencies and researchers. Some of it remains controversial in certain quarters, despite its demonstrated on-the-ground success, and much of it is currently blocked by economic, bureaucratic, and paradigmatic obstacles. I won't delve into these debates or obstacles in this essay. Instead, I will focus on each strategy through the lens of carbon sequestration in soils and briefly review their role in the holistic vision I call a carbon ranch.

Carbon Sequestions strategies include:

(1) **Planned grazing systems.** The carbon content of soil can be increased by three principal methods: the establishment of green plants on previously bare ground; deepening the roots of existing healthy plants; and the general improvement of nutrient, mineral, and water cycles in a given area. Planned grazing is key to all three. By controlling the timing, intensity, and frequency of animal impact on the land, the 'carbon rancher' can improve plant density, diversity, and vigor. Specific actions include: the soil cap-breaking action of herbivore hooves, which promotes seed-to-soil contact and water infiltration; the 'herd' effect of concentrated animals, which can provide a positive form of perturbation to a landscape by turning plant litter back into the soil (an intensive version of this effect is sometimes called a 'poop-and-stomp'); the stimulative effect of grazing on plants, followed by a long interval of rest (often a year), which causes roots to expand while removing old, oxidized forage; targeted grazing of noxious or invasive plants which promotes native species diversity and vigor; and the targeted application of animal waste, which provides important nutrients to plants and soil microbes. Additionally, planned grazing systems including management-intensive, time-controlled, short-duration, and mob grazing systems have the advantage of focusing the practitioner's attention on the day-to-day and week-to-week condition of the land. This enables the manager to achieve specific ecological goals effectively, such as the goal of increased quantity, density, and vigor of green plants (and thus increased carbon storage).

(2) **Active restoration of riparian, riverine, and wetland areas.** Many arroyos, creeks, rivers, and wetlands in the Southwest exist in a degraded condition, the result of historical overuse by humans, livestock, and industry. The consequence has been widespread soil erosion, loss of riparian vegetation, the disruption of hydrological cycles, the decline of water storage capacity in stream banks, the loss of wetlands, and many other examples of land 'sickness.' The restoration of these areas to health, especially efforts that contribute to soil retention and formation, such as the reestablishment of humus-rich wetlands, will result in additional storage of atmospheric CO_2 in soils. The 'toolbox' for the restoration of these areas is now well-developed, practical and could be implemented at scale if desired. There are many co-benefits of restoring riparian areas and wetlands to health as well, including improved habitat for wildlife, increased forage for herbivores, improved water quality and quantity for downstream users, and a reduction in erosion and sediment transport.

(3) **Removal of woody vegetation.** Many meadows, valleys, and rangelands have witnessed a dramatic invasion of woody species, such as pinon and juniper trees, over the past century, mostly as a consequence of the suppression of natural fire and overgrazing by livestock (which removes the grass needed to carry a fire). The elimination of over-abundant trees by agencies and landowners, via prescribed fire or other means, has been the focus of much restoration activity in the Southwest recently. The general goal of this work is to encourage grass species to grow in place of trees, thus improving the carbon-storing capacity of the soil. Not only can soils store more CO_2 than trees, they also have the advantage of relative permanence. Trees can burn up, be cut down, die of disease or old age, all of which can ultimately release stored CO_2 back into the atmosphere. Additionally, the removal of trees has an important co-benefit: they are a potential source of local biomass energy production, which can help reduce a ranch's 'carbon footprint.'

Maintenance strategies that help keep stored CO_2 in soils, so they won't be lost back into the atmosphere, include:

(1) **The conservation of open space.** The loss of forest, range, or agricultural land to subdivision or other types of development can dramatically reduce or eliminate the land's ability to pull CO_2 out of the atmosphere via green plants. Fortunately, there are multiple strategies that conserve open space today, including public parks, private purchase, conservation easements, tax incentives, zoning, and economic diversification that helps to keep a farm or ranch in operation. Perhaps most importantly, the protection of the planet's forests and peatlands from destruction is crucial to an overall climate change mitigation effort. Not only are forests and peatlands important sinks for CO_2, their destruction releases large amounts of stored carbon back into the atmosphere. Note: "protection" may still result in the loss of stored carbon if the land stewardship practices don't maintain or improve the health of plants and soil. A farm or ranch, for instance, may be protected from development by a conservation easement but its poor ecological condition (or its poor management) may cause CO_2 to leak back into the atmosphere. This is one reason why those farms and ranches that have already improved the health of their land, and thus improved the carbon storage capacity of their soils, need to be supported economically, socially and politically so that they benefit from their good work and continue to practice good stewardship.

(2) **The implementation of no-till farming practices**. Plowing exposes stored soil carbon to the elements, including the erosive power of wind and rain, which can quickly cause it dissipate back into the atmosphere as CO_2 .No-till farming practices, especially organic ones (no pesticides or herbicides), not only protect soil carbon and reduce erosion, they often improve soil structure by promoting the creation of humus. Additionally, farming practices that leave plants in the ground year-round both protect stored soil carbon and promote increased storage via photosynthesis. An important co-benefit of organic no-till practices is the production of healthy food.

(3) **Building long-term resilience.** Nature, like society, doesn't stand still for long. Things change constantly, sometimes slowly, sometimes in a rush. Some changes are significant, such as a major forest fire or a prolonged drought, and can result in ecological threshold-crossing events, often with deleterious consequences. "Resilience" refers to the capacity of land, or people, to 'bend' with these changes without 'breaking.' Managing a forest through thinning and prescribed fire so that it can avoid a destructive, catastrophic fire is an example of building resilience into a system. Managing land for long-term carbon sequestration in vegetation and soils requires building resilience as well, including the economic resilience of

the landowners, managers, and community members. For example, cooperation among disparate individuals or groups, such as biologists, conservationists, ranchers, and policy-makers, with the goal of improving land health, can help to build ecological and economic resilience within a watershed. This can have two important effects: direct storage of CO_2 in the soil, as humus is created, and the strengthening of relationships required for the maintenance of healthy soil over time. All of these strategies have been demonstrated to be effective in a wide variety of landscapes. The difficult job now is how to integrate them into a 'climate-friendly' landscape that sequesters increasing amounts of CO_2 each year, and does so economically. But this raises an important question: is CO_2 sequestration in soils actually worth pursuing? In other words, can the potential amount of CO_2 stored as soil carbon make a difference in the Big Picture? The quick answer is "yes."

A Report published in 2007 by the Congressional Budget Office said that about half of total annual CO_2 emissions planet-wide are currently being absorbed by the world's oceans, soils, and vegetation, which together with the atmosphere form the planet's only natural carbon sinks. The other half of those emissions remain in the atmosphere. The United States produces about six billion metric tons of CO_2 per year (6GtC), which is one-quarter of the global total, while its current land-use and forestry practices have the net effect of removing the equivalent of about .8 billion metric tons of CO_2 from the atmosphere annually. According to the Report, "Studies estimate that biological sequestration has the technological potential to sequester about 40 billion to 60 billion metric tons of CO_2 in the United States over the course of 50 years and another few tens of billions of tons over the following half-century." [11] That's approximately 1GtC per year, or one-sixth of what the U.S. produces annually. A billion metric tons of CO_2 = 1 gigaton (GtC) and 1ppm of CO_2 = 2.12 GtC.

Therefore, sequestering 1 GtC per year in the United States would reduce .5 ppm of CO_2 per year. Since the atmospheric content of CO_2 is rising at a rate of 2 ppm annually, soils could potentially have a significant effect on climate change. According to Dr. Hansen, while fossil fuels are adding 8.5 GtC per year into the atmosphere, the atmospheric increase of CO_2 is only 4.5 GtC per year which means 4 GtC is going into carbon sinks. He estimates that 3 GtC are being absorbed by the oceans, which means 1 GtC is being absorbed by everything else. He sees this as good news. "The fact that Earth's land masses continue to produce a net sink of carbon dioxide provides a glimmer of hope for the task of stabilizing climate," he writes. "This carbon sink occurs despite large-scale deforestation in many parts of the world, as well as agricultural practices that tend to release soil carbon to the atmosphere. Improved agricultural and forestry practices could significantly increase the uptake of carbon dioxide." [12]

How is this possible? There is a simple answer: two-thirds of the Earth's land mass is grassland and home to two billion people who depend on livestock at least partially for their livelihood. This means that managing the land for CO_2 sequestration, even on a small scale, could have a big impact on people and the planet. Livestock are key both economically and ecologically. They are an important source of food and wealth (and culture) to much of the Earth's human population and thus could be mobilized for carbon action. "Healthy grasslands, livestock and associated livelihoods constitute a win-win option for addressing climate change in fragile dryland areas where pastoralism remains the most rational strategy for the wellbeing of communities," write the authors of a new FAO report from the United Nations. "It is a win-win scenario for sequestering carbon, reversing environmental degradation and improving the health, well-being and long term sustainability of livestock based livelihoods." [13] Critics who view livestock grazing as a negative environmental stressor, and argue for its complete cessation, might be surprised to learn that early research, according to Dr. Peter Smith, indicates that "carbon accrual on optimally grazed lands is often greater than on ungrazed or overgrazed land."[14] Taken together, sequestering CO_2 in the soil has the potential to significantly mitigate the climate crisis. However, a 'carbon ranch' must do more than just photosynthesize energy.

The Sins of Emission

"Let's be clear. We will still have to radically reduce carbon emissions, and do so quickly. We will still have to eliminate the use of fossil fuels and adopt substantially more sustainable agricultural methods. We will still have to deal with the effects of ecosystems damaged by carbon overload." Editors of The Wall Street Journal Reality check: the increased sequestration of CO_2 in soils won't solve climate change. It won't even be close if the emissions of greenhouse gases are not dramatically reduced at the same time. According to experts, this reduction must be on the order of 50-80% of current emissions levels within fifty years in order avoid surpassing the 450 ppm threshold that many consider an upper limit for a viable planet. Accomplishing this goal will require a massive rearrangement of our energy sector toward fossil fuel-free technologies as well as big changes in the everyday lives of Americans. That's a Tall Order, of course, but if we are serious about slowing or reversing the accumulation of CO_2 in the atmosphere, then it should be clear that Business-As-Usual can't continue much longer.

A carbon ranch can help in three ways:

(1) by measuring and then reducing the amount of greenhouse gas emissions it contributes to the atmosphere;
(2) by producing renewable energy 'on-ranch' which it can use itself and/or sell to a local or regional power grid; and
(3) by participating in local food, recreation, and restoration activities that lower our economy's dependence on fossil fuels.

It is important to note that the current 'CO_2 crisis' is not a post-World War II development, but began with the invention of agriculture 10,000 years ago. Plowing, clearing, burning, desiccation, erosion, and the draining of wetlands all contributed to an important loss of stored soil carbon back into the atmosphere as CO_2 . In fact, some scientists calculate that fossil fuel burning surpassed agriculture and deforestation as the primary source of CO_2 only in the 1970s. Today, more than four times as much global warming comes from fossil fuels than from land use activities. Also, much of the CO_2 released historically by agriculture has fallen back to earth. Lastly, a carbon ranch can help by confronting the controversy over 'offsets' and carbon 'credits' which are the two strategies most frequently touted by governments, businesses, agencies, and others for encouraging the creation of a so-called 'carbon marketplace.' In this marketplace, 'credits' created by the sequestration of CO_2 in one place can be 'sold' or traded to 'offset' a CO_2 polluting entity, such as a coal plant or airline company, someplace else, supposedly to the benefit of all. In reality, these schemes appear to mostly offset our guilty feelings rather than actually affect climate change

Here are these ideas in more detail:

Reducing the 'footprint' of a carbon ranch. This is a two-step process: Assess the amount of greenhouse gas emissions that are rising from a particular landscape or operation; and second, follow this assessment with a concerted effort to reduce these emissions. One way to measure this carbon footprint is to conduct a Life-Cycle Assessment (LCA) of an enterprise - which is an inventory of the material and energy inputs and outputs characteristic of each stage of a product's life cycle. This is a well-recognized procedure for tracking the ecological impacts of, say, a television set or a refrigerator, and different types of LCAs exist for different types of products. [15] For a carbon ranch, there are four important measures of its LCA: cumulative energy use; ecological footprint; greenhouse gas emissions; and eutrophying emissions. The first three measurements are relatively straightforward and there are many credible methodologies today to calculate energy use, ecological footprints, and emissions, though most are designed for urban contexts or industrial agriculture. However, the fourth measurement eutrophying emissions, has been the source of considerable controversy in recent years. It refers to the amount of methane produced by the digestive system of livestock (and released by belching and farting) during its time on the ranch, farm, or feedlot and in the public's mind the connotation is negative. That's because research indicates that the amount of methane produced by ruminants can be considerable.

For example, a United Nations report released in 2006 titled " Livestock's Long Shadow" determined "that livestock are responsible for 18 percent of greenhouse gas emissions, a bigger share than that of transport." [16] This total is due to chemical fertilizer production, deforestation for pasture, cultivation of feed crops (corn), feed transport, animal production (fermentation and methane and nitrous oxide emissions) and the transportation of animal products. In other words: the report rolled together a natural biological process eutrophying emissions with fossil fuel-intensive industrial livestock production activities, especially those employed in feedlots, and branded the entire system with a negative stigma. As a result, the report created an impression among the public at large, promoted vigorously by some advocacy organizations, that the answer to the climate crisis is to 'eat less red meat.'

Personally, I think an answer is to eat more meat from a carbon ranch. When considering the 'methane question' in regard to climate change, there are a number of important points to keep in mind:

- As already noted, the warming effects of methane and nitrous oxide are currently being offset by heat-reflecting aerosols in the atmosphere;
- The largest single source of methane worldwide is wetlands (22%), followed by coal, oil and natural gas (19%), livestock (16%), rice cultivation (12%), with burning, landfill, sewage, manure, termites and release from the ocean making up the remaining 31%.
- Methane is also produced by rainforests, whales, termites, bison, reindeer, camels, giraffes, and many other animals, and has been rising into the atmosphere for millions of years.
- The methane we should really be worried about is the type found in frozen beds of methane hydrates, located below permafrost layers and shallow seabeds, which when melted will release very significant amounts of the potent greenhouse gas into the atmosphere.
- According to the Soil Association of the United Kingdom "Grassland left ungrazed on fields unsuitable for ploughing emits as much methane when it decays over-winter as if consumed by ruminants." [17]
- The vast majority of methane produced by the agricultural sector comes from a system drenched in fossil fuels.

Author Michael Pollan put this last point this way: "We transformed a system that in 1940 produced 2.3 calories of food energy for every calorie of fossil-fuel energy it used into one that now takes 10 calories of fossil-fuel energy to produce a single calorie of modern supermarket food. Put another way, when we eat from the industrial food system, we are eating oil and spewing greenhouse gases." [18] The answer, Pollan says, is to "resolarize" the American economy which means weaning Americans off their heavy 20th -century diet of fossil fuel and put them back on a diet of contemporary sunshine. "If any part of the modern economy can be freed from its dependence on oil and successfully resolarized," Pollan writes, "surely it is food."

For the purposes of a carbon ranch, the methane emission issue is just one part of the overall 'footprint' assessment. The goal of a Life-Cycle Analysis is to measure an operation's energy use and emissions so that it can reduce both over time. Ultimately, the goal is to become carbon-neutral or, ideally, carbon-negative meaning, the amount of CO_2 sequestered is greater than the ranch's carbon footprint.

Producing renewable energy. Anything that a carbon ranch can do to produce energy on-site will help balance its energy 'footprint' and could reduce the economy's overall dependence on fossil fuels. This includes: wind and solar farms, the production of biodiesel from certain on-site crops for use in ranch vehicles, biomass for cogeneration projects (this is especially attractive if it uses the woody debris being removed from the ranch anyway), micro-hydro, micro-wind and solar for domestic use, and perhaps other as yet unrealized renewable energy alternatives.

Participating in a local economy. A carbon ranch should carefully consider its role in the 'footprint' of the greater economy. Are its products traveling long distances or otherwise burning large amounts of fossil fuels? Ditto for visitors, ranch owners and employees. Does participating in a local economy food, recreation, and energy increase or decrease the overall 'footprint' of the ranch? How else can it reduce greenhouse gas emissions locally or regionally? For example, it is generally accepted that involvement in a local food market, where the distances between producer and eater are short, shrinks the fossil 'footprint' of a ranch considerably. There is some contradictory research on this point, however. In my opinion, the technical issues of local vs. global food systems in terms of food miles traveled is largely neutralized by the wide variety of co-benefits that local food brings economically and ecologically. This will be discussed in the next section.

The trouble with offsets. In the past few years, efforts to monetize or incentivize carbon sequestration have focused on creating a carbon 'marketplace' complete with so-called carbon 'credits' that can be bought or traded to 'offset' the carbon emissions of a polluting entity. This marketplace generally requires a 'cap' on total carbon emissions, whether regionally or nationally, so that a 'value' or price can be placed on the credits themselves. In other words, if a polluter exceeds its 'cap' by a certain percentage, then it can buy or trade for an offset that brings it back into compliance. This 'cap-and-trade' idea was the heart of the Waxman-Markey bill passed by the U.S. House of Representatives in 2009, which sought to confront climate change by stimulating private markets. However, many observers myself included have become increasingly skeptical of the offset concept at regional or national scales. Objections to offsets include:

We need actual net reductions of atmospheric CO_2 not just the neutralizing 'offset' of a polluter by a sequesterer. And we need these net reductions soon. It is not acceptable to let a big, industrial polluter 'off the hook' with an offset simply because they have money or political clout. Also, there are moral and ethical implications to letting polluters redeem themselves with offsets, the way medieval nobles bought indulgences from the Church for their sins (for a powerful parody of this situation see **www.cheatneutral.com**, where philandering adults can buy offsets from monogamous couples so they can keep on cheating). It is unrealistic to expect the same system that created the climate problem in the first place i.e., our current economy and specifically its financial sector to solve this problem and to do so with the same tools. Furthermore, it is not ok for Wall Street to profit from a problem it helped to create. Besides, isn't that like having the fox guard the henhouse? 'Cap-and-trade' can easily become 'cap-and-swindle.' At best, offsets may be illusory; at worst they're fraudulent thus imperiling the whole purpose of the idea. This concern is captured in an investigative report by the Christian Science Monitor published on April 20 th , 2010, titled "Buying carbon offsets may ease eco-guilt but not global warming." [19] The investigation found that people buying offsets are getting "vague promises instead of the reductions in greenhouse gases they expect." They are buying into projects that are never completed, or are paying for ones that would have been done anyway. Mostly they feed shady middlemen and promoters seeking profits from green schemes, said the report's authors. "Carbon offsets are the environmental equivalent of financial derivatives: complex, unregulated, unchecked and in many cases not worth the price," they write. In a spectacular example, The Vatican was swindled. In 2007, Cardinal Paul Poupard accepted a gold-framed certificate from a company promising to help it become the "first carbon-neutral sovereign state" on the planet. The promised forest in Hungary was never planted. A papal spokesman told the Monitor that "the case is being studied to take legal action in order to defend the Vatican 's reputation."

The monitoring required to quantitatively verify actual and additional (meaning a net increase) in CO_2 sequestration in the soil in order to satisfy the marketplace is too complicated, cumbersome, expensive, and intrusive for many landowners. Out West, this is an especially sensitive topic, as many ranchers already feel like there are too many people-with-clipboards walking across their land. If protocols are not considered comprehensible and 'user friendly' by landowners, then skepticism will remain high in a community that already has doubts about climate change generally. For these reasons and more, offsets and carbon credits may not be the economic engine of the future that so many proponents tout it to be. Nevertheless, the trouble with offsets highlights an important challenge for carbon ranching: profitability. If not offsets, then how can a landowner who desires to mitigate climate change earn a paycheck, without which there will no carbon ranching?

One positive thought about offsets: a more appropriate marketplace might be at the local level. A county government, for example, could help to create a local carbon market to help offset its judicial buildings or schools or prisons. It could possibly do so through its ability to tax, zone, and otherwise regulate at the county level. It would still have to deal with some of the other challenges confronting offsets, but at least it would keep the marketplace local.

Another idea: reward landowners financially for meeting sequestration and emissions goals. The federal government routinely subsidizes rural economic development enterprises that the private marketplace won't touch, such as the current effort to bring high-speed broadband Internet to rural communities. Additionally, the government often provides incentives to businesses for market-based approaches, including corn-based ethanol production, solar power development, and wind technology (and don't forget the federal government's catalyzing role in the birth of the Internet). It would be perfectly logical, therefore, to reward early adopters of carbon ranching with a direct financial payment as a means to wake up traditional markets.

In sum, although the main purpose of a carbon ranch is to sequester additional CO_2 in plants and soils, it must take every step possible to reduce the amount of greenhouse gas emissions it contributes to the atmosphere with the ultimate goal of becoming a 'carbon-neutral' or even 'carbon-negative' operation.

The Joy of Co-Benefits

"Carbon ranching has no downside." John Wick, rancher and director of the Marin Carbon Project In its effort to sequester carbon in soil and reduce emissions, a carbon ranch also produces a list of co-benefits that make the whole enterprise even more vital. They include: Local grassfed and organic food. By managing land for a healthy grass cover, a carbon ranch is the natural setting for raising grass-fed livestock, whose environmental and human-health benefits are well-documented. Additionally, the market for organic, grass-fed meat is growing steadily, which means this could be a way to monetize 'climate-friendly' beef as an economic strategy.

Improved ecosystem services. In 2005, the United Nations published its Millennium Ecosystem Assessment, a global evaluation of ecosystem services on which human well-being and environmental health depend. These services include the provision of food, fresh water, wood, fiber, fuel, and biodiversity; flood, pest and disease regulation; nutrient cycling, soil stability, biotic integrity, watershed function, and photosynthesis; and spiritual, educational, recreational, and aesthetic experiences. According to the Assessment, nearly all of these services are in gradual or steep decline. By improving soil structure and grass cover via grazing management, riparian and wetland restoration, tree thinning, open space protection, and no-till farming practices, a carbon ranch can contribute substantially to reversing the decline in these essential services.

Habitat protection. In addition to the protection of the open space necessary for wildlife, a carbon ranch promotes the peaceful coexistence of domestic and wild animal populations. That's because it operates on the principle that the natural processes that sustain wildlife habitat, biological diversity and functioning watersheds are the same processes that make land productive for livestock. Healthy land, in other words, is the basis for healthy relationships between all living things.

Rural economic development. Producing local food, restoring creeks and rangelands, marketing 'climate-friendly' enterprises, and developing local energy will require a great deal of work, and therefore could create, potentially, a great deal of paychecks for rural residents. The number of eroded creeks and wetlands in the Southwest that could be restored, for example, is huge, which means the potential for employing people in restoration jobs is equally huge.

Maintenance of culture and diversity. Since a carbon ranch involves livestock, horses, roping, branding, as well as farming, irrigating, timber harvesting, wildlife viewing and many other traditional activities, it can strengthen and support local and regional land-based cultures. It will require a mixing of innovation with tradition, but this can be a healthy way of rejuvenating a sense of community and cultural continuity.

Educational opportunities. A carbon ranch requires a careful blending of ecology, economics, stewardship, restoration activities, monitoring, collaboration, and innovation, which means it has the potential to become a dynamic site for a wide variety of educational opportunities, including tours, workshops, field trips, Outdoor Classrooms, clinics, and training programs.

Bridging the Urban-Rural Divide. Many people concerned about climate change live in cities or other urban arrangements while most carbon sequestration work will take place in the countryside, which means a carbon ranch has a huge potential to bridge the long-standing and expanding gulf that separates urban and rural residents today. In other words, urban can support rural economically, politically, and socially, while rural delivers the climate change mitigation that we all need so urgently.

Participation in a local economy. Much has been written in recent years about the value of local economies. A carbon ranch can help by its emphasis on local food production, energy development, and localized restoration activities.

Opportunities for the next generation. If a carbon ranch could become a profitable enterprise, then it would undoubtedly become attractive to young people who want to get into (or back to) farming, ranching, restoration or otherwise pitch in with the effort to fight climate change. Additionally, older famers and ranchers could be enlisted to help mentor the next generation of land managers, especially if they have expertise in one or more of the necessary skills to run a carbon ranch.

There are other important co-benefits that carbon ranching can provide, including: (1) reconnecting urban residents with a source of their food; (2) softening the effects of drought on landowners; and (3) assisting with the terribly important challenge of feeding a global population that is expected to reach nine billion people by mid-century.

On the first point, not only is human well-being wrapped up with how food is produced, including the issue of carbon footprints and efforts to protect and restore carbon sinks, food is something everyone understands. That means it can play a key educational role in fighting climate change. "By focusing on food systems, climate action will become more real to people," write Sara Scherr and Sajal Sthapit in a 2009 report for the WorldWatch Institute. "The status of farmers and land managers will be enhanced as their responsibility as stewards for a stable climate is recognized and rewarded. And society will reconnect in a new way with its ancient roots in the cultivation of land for food." [20]

On the second point, strategies that combat drought, especially in the arid parts of the developing world, will become critical as the desertifying effects of climate change become more apparent. For many around the globe, this issue will be a matter of life and death. "Livestock are an irreplaceable source of livelihoods for the poor," write the authors of the 2010 FAO report cited earlier. "Livestock is the fastest growing sector, and in some countries accounts for 80% of the GDP, in particular in drylands. Seventy percent of the 880 million rural poor people living on less than $1 per day are at least partially dependent on livestock for their livelihoods and subsequent food security." [21] Progressive grassland management, they argue, can increase productivity and food security, provide development opportunities in resource-poor drylands and reduce impacts of drought and climate change.

On the third point, the issue is simple and profound: how can we feed nine billion people sustainably? In the past, the answer was to bring more and more land into production, especially marginal land (steep, dry, or heavily forested). This is less and less an option today for a wide variety of reasons, including urbanization, conservation concerns, and erosion. Meanwhile, according to a recent study, the world will require 70-100% more food by 2050 than we produce currently. [22] One answer, according to this study, is to produce more food with the same amount of land (or less), which they call sustainable intensification, which involves increasing agricultural yields. Too often, this becomes an argument for increased genetic engineering of crops or the development of new types of pesticides. But it could also describe the rise in stocking rate of cattle on a ranch that practices herding or another type of intensive management. In any case, it won't be easy, as the authors of the report note. "Any optimism must be tempered by the enormous challenges of making food production sustainable while controlling greenhouse gas emission and conserving dwindling water supplies, as well as meeting.the goal of ending hunger."

That sounds like a job for a carbon ranch. None of this will be easy. In fact, the obstacles standing in the way of implementing a carbon ranch and sharing its many co-benefits are large, diverse, and discouraging. But is it worth trying anyway? Absolutely. If a carbon ranch could it make a difference in the fight against climate change which I consider the overarching crisis of the 21st century then I think must try. The alternative not trying means we consign our future to politics, technology, and wishful thinking, none of which have made a difference so far. Remember the old joke about how to eat an elephant? One bite at a time. It is the same with carbon ranching: the only way we can succeed is one acre at a time. Will it be fast enough? Will it make a difference? Will it work? I don't know no one does. That's because we face an unprecedented future. We live on a planet that has not seen CO2 levels this high for two million years almost as long as there have been humans. We face a collective challenge that is literally unimaginable, though with each passing day scientists clear a little bit more of our future's fog, revealing a worrisome picture. Some see salvation in high technology, including the 'capture' of CO2 at its source, to be stored underground, or the 'scrubbing' of greenhouse gases from the atmosphere by hundred of thousands of boxcar-sized filtering machines. Unfortunately, these technologies, even if practical, are years away from deployment. And the climate crisis, as evidenced by recent headlines, is happening now

Which leads to a question: what about low technology? Carbon ranching doesn't need to be invented. It already exists. We know how to grow grass using animals. We've learned how to fix creeks and heal wetlands. We're getting good at producing local grass-fed food. We'll figure out how to reduce our carbon footprint, and develop local renewable energy sources profitably. We don't need high technology we have the miracle of photosynthesis already. What we lack is the will to try something old. Low technology won't save the planet by itself, of course, but it is essential to the quality of life on Earth no matter how much CO2 exists in the atmosphere. Too often, however, our eyes seem fixed on the stars and our minds dazzled by distant horizons, blinding us to possibilities closer to home. Perhaps we should be looking down, not up.

At the grass and the roots.

Citations:

[1] For more information on all aspects of climate change, including the role of carbon dioxide, see the IPCC's 4 th Assessment, a synthesis of which can be found at: **http://www.ipcc.ch/publications_and_data/publications_ipc...**

[2] The Earth Institute at Columbia University (2009, June 21). "Carbon Dioxide Higher Today Than Last 2.1 Million Years." ScienceDaily. Retrieved from **http://www.sciencedaily.com/releases/2009/06/090618143950...**

[3] James Hansen. Storms of My Grandchildren: The Truth About the Coming Climate Catastrophe and Our Last Chance to Save Humanity **http://www.amazon.com/Storms-My-Grandchildren-Catastrophe...** . Bloomsbury Books, New York , 2009.

[4] "Stabilization Wedges: Solving the Climate Problem for the Next 50 Years with Current Technology" / Pacala and Socolow, Science, vol. 305, August 2004

[5] " Is 450 ppm (or less) politically possible? **http://climateprogress.org/2008/03/31/is-450-ppm-carbon-d...** " posted March 31, 2008, by Joe Romm, who writes the influential blog Climate Progress.

[6] "Target Atmospheric CO2: Where Should Humanity Aim?" / Hansen, J. et al, Open Atmospheric Science Journal (online), vol. 2, 2008.

[7] **www.350.org/mission**

[8] Wallace Stegner, "The Law of Nature and the Dream of Man: Ruminations on the Art of Fiction" in Where the Bluebird Sings to the Lemonade Springs: Living and Writing in the West. Random House, New York , 1992.
[9] "G-8 Failure Reflects U.S. Failure on Climate Change," published online at: **http://www.huffingtonpost.com/dr-james-hansen/g-8-failure...**
[10] "The Back Forty Down Under: Adapting Farming to Climate Variability," by Christine Jones. Published in The Quivira Coalition Journal, vol. 35, February, 2010. **http://quiviracoalition.org/images/pdfs/2055-Journal35.pdf**
[11] "The Potential for Carbon Sequestration in the United States ." Paper, Congressional Budget Office, 2007. **http://www.cbo.gov/ftpdocs/86xx/doc8624/09-12-CarbonSeque...**
[12] James Hansen, Storms of My Grandchildren.
[13] "Review of Evidence on Drylands Pastoral Systems and Climate Change: Implications and Opportunities for Mitigation and Adaptation." Edited by C. Neely , S. Bunning and A. Wilkes . Land and Water Discussion Paper no. 8, Food & Agriculture Organization of the United Nationa, Rome , 2009. **ftp://ftp.fao.org/docrep/fao/012/i1135e/i1135e00.pdf**
[14] Peter Smith. "Soaking Up the Carbon," in What is Land For?: the Food, Fuel, and Climate Change Debate, edited by Michael Winter and Matt Lobley. Earthscan Publishing, London , 2009.
[15] see: **http://www.epa.gov/nrmrl/lcaccess/pdfs/600r06060.pdf**
[16] **ftp://ftp.fao.org/docrep/fao/010/a0701e/a0701e00.pdf**
[17] "The Role of livestock in sustainable food systems." By the Soil Association (UK) **http://www.soilassociation.org/LinkClick.aspx?fileticket=...**
[18] "Farmer in Chief." By Michael Pollan. The New York Times Magazine, October 12, 2008. **http://www.nytimes.com/2008/10/12/magazine/12policy-t.html**
[19] **http://www.csmonitor.com/Environment/2010/0420/Buying-car...**
[20] "Mitigating Climate Change Through Food and Land Use." By Sara J. Scherr and Sajal Sthapit. WorldWatch Report no. 179. WorldWatch Institute, Washington , D.C. 2009. **http://www.worldwatch.org/node/6126**
[21] "Review of Evidence on Drylands Pastoral Systems and Climate Change: Implications and Opportunities for Mitigation and Adaptation." Edited by C. Neely , S. Bunning and A. Wilkes . FAO, Rome . 2009.
[22] "Food Security: The Challenge of Feeding 9 Billion People." Multiple authors, Science, vol. 327, Feb. 2010. **http://www.sciencemag.org/cgi/content/full/327/5967/812**