Annals of Arid Zone 42(3&4): 437-458, 2003

Reversing Desertification - In Practice

Allan Savory
The Savory Center for Holistic Management, Albuquerque, New Mexico, USA

Abstract: Electric lights were not, nor could they have been, developed by the finest candle makers. Einstein reputedly said we were unlikely to solve our problems with the same thinking that produced them. History is replete with examples of significant new thinking and problem solving arising from people in unrelated fields. Such people were not blinded by the paradigms of expertise in the area of concern. In this paper I, with a background in botany and zoology, and a wildlifer by passion, describe simply why past civilizations throughout the world failed due to the symptoms of biodiversity loss or desertification. I add field experience and logic to Smut's theory of Holism. This is combined with almost fifty years of trial and error field work in many countries, backed by research in fields seemingly unrelated to desertification. The outcome is the discovery of an unsuspected cause of desertification that explains why, despite the best efforts of range managers in many nations, deserts continue to advance. The work led to the development of a holistic framework for decision-making and policy formation, that is proving encouragingly successful through empowering people to reverse land degradation, biodiversity loss and its many symptoms wherever applied.

Key words: Desertification, biodiversity, erosion, social, economic, drought, flood, violence, genocide, civilization, overgrazing, overstocking, livestock, decision making, policy, projects, fire, overpopulation, overuse.

Desertification is as old as civilization but what is it really? Generally I believe it is viewed as land degradation of a severe nature most commonly experienced in arid environments. Desertification has brought about the failure of many civilizations and, with an estimated 24 billion tons of soil annually going down the rivers of the world today (4 tons per person on the planet) (Girardet, 2003), it now represents a global threat.

What makes desertification an enormous problem is its many associated symptoms – increasing severity and frequency of both droughts and floods, massive invasions of noxious plants, salinization, drying up of water sources, resource scarcity, poverty, social breakdown, abuse of women and children, violence, genocide, wars and the eventual breakdown of economies, governments and civilizations. These and other symptoms follow desertification just as certainly as water flows downhill. I know of no instance where desertification has led to prosperity, harmony and a better life for all other than perhaps the temporary wealth from oil under desert sands.

Reversing desertification has defied solution over thousands of years. After over 45 years of studying the problem, I believe this is mainly because we never understood what was actually causing desertification and our assumptions about its causes were not correct, as I will illustrate. As

desertification simply does not occur without the loss of soil cover, which in turn is provided by plant and animal communities. It is there, at the soil surface we need to look for the cause. Only when the root cause of soil cover loss is addressed can desertification be reversed.

When we look at the animal and plant communities on desertifying land, we realize it is biomass and diversity that we are concerned with as only from an abundant living source can soil cover be derived. Think about desertification deeply and you soon realize that it is only a symptom of the loss of biomass and diversity. Currently biodiversity loss is treated mainly as the disappearance of rare and endangered species and little consideration is given to biomass. For example, the nation of Namibia was internationally applauded for saving biodiversity through setting aside areas to save rare lizards while the whole nation and even its most prized wilderness area (the Waterburg) is losing biomass and diversity and turning to desert. Clearly such a divergent view as mine needs explanation.

Biodiversity Defined

First let me define biodiversity as I view it. It is the diversity of species and genetic diversity within species, as well as the volume of plant and animal life, or biomass. I include biomass because of experience I had as a young man. During the 1950s I was the biologist in charge of two wonderful areas in Central Africa (Luangwa Valley and lower Zambezi Valley) where we removed indigenous people to create protected areas to later become national parks. In both areas, soon after we gave them this protected status, we experienced a massive loss of species and land degradation. However, before any of the species of birds and animals were lost, the first thing to change was simply the amount of soil-covering plant material, or biomass. Only after this biomass had been reduced significantly did we observe the loss of species. I have since closely watched several areas in Zimbabwe turn to desert in the same order – loss of biomass, in terms of ground cover, followed by the loss of many species ending in desertification with the drying up of water sources as rainfall becomes ever less effective due to soil surface evaporation.

Because it is plant material – dead and alive – that provides soil cover, it is the loss of soil-covering biomass and the diversity of plant and animal life that leads first to soil exposure between plants and eventually to desertification. The earliest warning that desertification is taking place is exposure of soil between perennial grass plants over vast areas of land that might superficially look like good grassland.

Generally I find range scientists ignored the nature of the soil between grass plants. In the former Rhodesia, range science was as advanced as in any other nation and the Natural Resources Board used to present a much-coveted trophy to the rancher deemed to have the best managed rangeland every year. One year, Col. Jock Thompson, owner of Clonmore Ranch, won the award. Thompson, who cared deeply about the environment, knew that I was espousing controversial views at the time and asked me to assess his land and give an opinion. Rather than just give an opinion, I sampled in great detail the best of his rangeland (which appeared to be a sea of grass)

and had to report that between the plants over 95% of the soil was bare and eroding. With this considered the best managed rangeland in the country, one can imagine the overall desertification.

Following the logic that soil cover is dependent on plants and their litter, it becomes apparent that to reverse desertification and all of the serious downstream environmental, economic, political and social effects that flow from it, we need to reverse the loss of plant biomass which can only be achieved on any sustained basis by restoring the diversity of plant and animal species as well. For simplicity I will from here refer to desertification as the problem although clearly it is a symptom of lost biodiversity and soil cover.

Causes of Desertification

Study scientific papers, reports and the proceedings of endless conferences and the causes of desertification in say Africa are well known and documented. The things to which scientists of all disciplines attribute desertification are:

Overpopulation, overgrazing and overstocking with livestock, communal tenure of land (tragedy of the commons), poverty, ignorance and lack of education, inadequate access to capital and Western technical knowledge as well as extension services, and corruption. The list goes on but these are generally considered the prime factors with the first three – overpopulation, overstocking and communal land tenure – being blamed most.

Unfortunately these "causes" of desertification present almost insurmountable difficulties for any government or international agency; thus we witness a "Rio" or "Johannesburg" summit about every ten years where the world gathers to bemoan the fate of the earth and the rising numbers of environmental refugees. At every such gathering millions of dollars are pledged for more Bandaid attacks on the symptoms of desertification without the root cause of desertification itself ever being addressed, as I will explain.

Challenging the Known Causes of Desertification

Any scientist challenging these known causes of desertification would be ridiculed and unlikely to obtain funding for his or her research. Because this was my own experience, I searched to see if the needed "experiment" had already been done. I found that it had in North America, so let's challenge this world view concerning the causes by comparing the situation in desertifying regions of Africa with a part of the world where the climate is similar with seasonal, low and erratic rainfall, but where the known causes are absent.

In West Texas we find the following situation: A low and falling rural population. No overstocking (destocking has been taking place on a regular basis for over a century till, while there are thousands of animals in feedlot yards, there are few indeed on the land). I select West Texas rather than other seasonal low rainfall American states because Texas is a private land state without communal ownership of land. Texas ranchers and researchers love their land and do not willfully abuse it. We find in West Texas great access to capital, well-funded and excellent universities that provide good education. There are excellent

Table 1. Desertification-related practices situation in Africa and West Texas

Causes of desertification in Africa	Situation in West Africa
Overpopulation	Very low falling rural population
Overstocking/overgrazing	After over 100 years of steady destocking very few livestock on the land (many in feedlots).
Communal land ownership	Private land ownership
Poverty	Extreme wealth
Lack of education and ignorance	Considerable education and knowledge
Lack of Western technical knowledge	Western technical knowledge available
Lack of extension services	Well funded and staff extension services of both universities and government
Lack of access to capital	Great access to capital
Widespread corruption including government	Some control on corruption
Etc.	Etc.

university and government extension services together with basically efficient government, with some curbs on corruption. Table 1 compares the situation in Africa and West Texas.

It is clear that the practices in West Texas are different from those blamed for desertification in say Africa, Afghanistan or India – in fact they are the opposites in all respects. Logically therefore, if the things blamed for causing the problem on the left are correct we would not expect desertification, nor any of its many symptoms, to be occurring in West Texas.

Travel and work in West Texas as I do and you will find that both lay and professional people readily express the fact that almost all of the symptoms of desertification are severe. Rivers are silted, soil erosion is rampant, flooding and drought have become both more severe and frequent despite no significant weather change, ghost towns without a single occupant exist and vast areas of rangeland exhibit 50 to 95% of the soil bare between grass plants, and in large areas sand dunes are forming. I chose the private land in State of Texas for comparison mainly because so many attribute land degradation to communal ownership. Were it not for this one factor I could have selected vast areas turning to desert in New Mexico, Arizona, California, Colorado, Wyoming, Montana, the Dakotas, Idaho or Washington, including lands classified and/or managed as wilderness areas. Throughout the Western US states the picture of land degradation is similar with ever increasing conflict and litigation overwhelming ranchers as well as government agencies. Most alarming is the fact that the US now has more prisoners than farmers (Thomas, 2003).

Despite our total certainty as scientists and certainty over millennia, it is obvious that we simply did not, and most still do not, understand the cause of desertification. Lest there remains any doubt, Fig. 1 demonstrates the point. This sample of formerly productive grassland in New Mexico once sustained an irrigation-based civilization but is now desert. There is a fence, as we see in the middle. On one

Fig. 1. On one side of this fence is communally-managed tribal land, on the other land managed by the US National Park Service. New Mexico.

side of the fence the management entails everything that we blame for such conditions – overstocking, overgrazing, ignorance, greed, poverty and neglect because it is communal grazing land. On the other side of the fence the land is managed as a National Monument by the US National Park Service. There is no livestock and vast amounts have been spent on soil conservation measures over the last 60 years. But as we notice, the end result is the same.

The Underlying Cause of Desertification

To isolate and identify the underlying cause of desertification, one must seek a common denominator in every situation where it has occurred. And it is also helpful to look at other environments, such as the jungles of Central and South America, where civilizations also failed due to environmental degradation, rather than desertification per se. The most striking difference when one studies the abandoned cities is that in humid environments biodiversity (mass and diversity) recovered and the ruins are found under vegetation while in seasonal rainfall environments the ruins are found in deserts where no recovery was experienced after abandonment of the cities.

Whatever is causing desertification should be common to every situation. We quickly see it is not livestock, as civilizations were failing in North America before the Spaniards arrived with livestock. Also, areas from which livestock have been totally excluded in the western US – some wilderness areas and national parks, many government research plots that excluded livestock – are also turning to desert. It was not our economic, political, or management systems, as these have been many and varied.

One can go on endlessly seeking that one thing common to every situation over thousands of years, but in the end there is only one common denominator in all situations and through all ages. That one common thing is that in every situation experiencing desertification, humans made the decisions that led to this result. Thus, human decision-making is the common denominator and therefore the probable cause of desertification and its many social and economic symptoms.

Human Decision-making Framework

For most of my life I, like most people, believed that humans make conscious decisions in countless different ways – intuitively, emotionally, democratically, scientifically, rationally, culturally, dictatorially, singly, collaboratively, fearfully, etc. Upon deeper reflection I came to realize that humans make conscious decisions through one simple and universal framework. I can now see that this simple decision-making framework is as ancient as we are and identifies us as humans as much as do standing erect, having an opposing thumb, large brain and language. Along with consciousness, will, and the acquisition of tools and fire it is this simple decision-making framework that enabled humans to move from the Stone Age to atomic age and beyond.

The universal framework works like this: We make decisions to achieve an objective, goal, mission or vision. We only consider limited "tools" through which to manipulate our environment – technology in some form, from the most primitive stick, bone or stone tools to modern marvels of technology; fire; rest (non-disturbance of land or waters); and small organisms, as used by earlier agriculturalists and now in biological control of disease and pests. And we base all our decisions on one or more factors – past experience, intuition, research results, expert opinion, fear, compromise, expediency, cost, cultural norms, cash flow, laws and regulations, peer pressure, advertising, and so on endlessly.

Think about it and you soon realize that from your own household to the most sophisticated team of scientific collaborators, everyone makes decisions to achieve an objective using only technology, fire, rest or small organisms as tools to influence the environment, and basing their actions and decisions on one or more of many factors. So likewise does every government, corporation or non-profit or non-governmental organization determine every action, decision, project or policy. Some organizations – armies, or multi-national corporations, for example – might have very sophisticated decision-making techniques or procedures. But look carefully and underlying these you will recognize the same framework – objectives, goals, missions and the use of only technology, or may be fire. And in complicated situations you will find the actual decisions are made after considering a great many factors. However, always that same framework.

This conventional decision-making framework is highly successful in certain areas of our lives. In the language of today's systems thinking these areas of success all involve what are called hard systems (complicated but never leading to unpredictable, emergent properties) and generating kind problems. Hard systems also cannot self adjust or cope with missing

components. Examples include the development of weapons, flight, space travel, computers and all the many technical aspects of our cities, homes and lives. These ever-accelerating successes testify to the marvels of science and human ingenuity (as long as we ignore their long-term effects on our environment, and thus society and economies). But in those areas of our lives involving what are termed natural systems (our ecosystem, oceans, forests, etc.) and human organizations known as soft systems, we do not experience the same results. Soft and natural systems are complex rather than complicated and apart from generating unpredictable properties, they can self generate or adapt to missing components or changed circumstances to varying degrees. And most important the problems soft or natural systems develop are called wicked problems – not meaning amoral but meaning very difficult to almost impossible to solve. As we are experiencing worldwide when dealing with soft and natural systems we battle endlessly with the problems generated by our "solutions" that keep multiplying not unlike cutting off the Gorgon's head.

Faults in the Conventional Decision-making Framework

Once we had identified that humans use one simple framework for decisions, actions, projects and policies, we could focus on that framework and seek the flaws that result in such a lack of success in dealing with complex, natural and soft systems.

In 1926 when Jan Christian Smuts (1973) wrote Holism and Evolution, he warned that while the basis of science is to endeavour to understand nature, we were unlikely to do so without comprehending that nature only functions in patterns and wholes. In my mind, Smuts preceded the later Theory of Chaos and now Complexity Theory, hence my honouring his memory in the holistic decision making framework we have developed to handle problems in natural and soft systems.

Let me simply point out the major flaws in our conventional framework when dealing with nature's complexity. These flaws become obvious only from those insights that made the development of the holistic decision making framework possible. These insights are described in detail in Holistic Management: A New Framework for Decision Making (Savory and Butterfield, 1999).

First, objectives, goals and, through their attainment, visions and missions do not take into account either nature's complexity or the complexity of human families, communities or organizations – the soft systems. Objectives and goals – no matter how broad or far-sighted – do not provide guidance for decision-making or policy formation that simultaneously links our deepest spiritual and material values to our environmental life support system. Nothing that I could find in philosophy, science or religions indicated any 'guiding star' for daily decision-making or policy formation beyond the concepts of objectives, goals, visions or missions. And it was not until about 1988 when we finally came to formulating the concept of a holistic goal that we were consistently able to reverse desertification.

Prior to that time, using other elements of today's holistic decision making

framework we were achieving truly spectacular results restoring biodiversity and reversing desertification, but equally spectacular failures. Not only could I not duplicate similar results on different pieces of land, but some that were most successful subsequently failed. Clearly there remained a missing piece of the puzzle if we were ever to see consistent results. This missing piece we identified finally in the new concept of a holistic goal – an entirely new concept that took us beyond objectives, goals, visions and missions.

A holistic goal ties people's deepest spiritual and material values to their life support system so that, used as a guiding star, with other elements of the holistic decision making framework, it becomes possible for people to make all decisions, actions, projects and policies simultaneously socially, environmentally and economically sound both short and long term.

Next, with the conventional framework we note that the only tools used to manipulate or manage our environment – technology, fire, rest and small organisms, lack any tool that can sustain biological decay and thus biodiversity over about two thirds of the Earth's land surface. If we are to reverse desertification we need at least to have the tools in our decision-making that can maintain the cycle of birth, growth, death and decay essential for all life including plants so vital for soil cover essential to full ecosystem functioning and in particular effective water cycling.

In the birth to decay cycle each step, including decay is a living process. Without the billions of organisms that bring about the rapid process of decay dead material only breaks down gradually through chemical oxidation and physical weathering. For some reason we never thought to investigate the role of decay of plant material in biodiversity loss and desertification.

When we look at our impressive arsenal of technology from the Stone Age to today we note there is no technology (and is never likely to be any) that can bring about decay of annually dying plant material over vast areas of the earth. Fire, the second most used tool, involves rapid oxidation, not decay. Not only can fire never replace biological decay but it also has the marked tendency to expose soil surfaces.

Desertification, remember, does not occur as long as soils are covered. Resting land does not bring about decay, as only life forms can do so. Small living organisms that we have for thousands of years used as tools can only help bring about limited decay on croplands but not over vast areas of our river catchments, forests and rangelands. Thus we find the human decision-making framework has for probably a million years lacked any tool that could prevent or reverse desertification. The demise of those earlier civilizations was inevitable and so is it inevitable that we have today reached the position of a global threat to civilization from environmental degradation.

The Tools to Reverse Desertification

To explain why we do not have the tools in our decision-making to address desertification, I first need to describe two different types of environment. All terrestrial environments fall somewhere along what I call a scale of brittleness, regardless of how low or high the rainfall. This brittleness scale is dependent more

on the annual distribution of soil and atmospheric moisture than on total precipitation. At the low end of this scale lie environments that are perennially humid – whether low or high rainfall. At the other end of the scale lie environments that can be extremely wet for part of the year (especially where rainfall is high) but are extremely arid for major parts of the year.

At the low end of the brittleness scale most vegetation is evergreen with a small proportion dying throughout the year. Most herbivores are insects. Major predator populations are low and they generally hunt singly supported by small numbers of large herbivorous prey. The microorganisms responsible for decay enjoy high populations both at the soil surface and within the soil. Decay of dead material is rapid and the cycle of life is readily maintained with the use of one of the tools from our conventional framework – rest (of the land). As mentioned, cities formerly abandoned are found under a mass of vegetation today as those rested environments recovered. In such environments, involving roughly one third of the Earth's land surface, the tool of rest is the most powerful available to us to reverse environmental degradation.

Toward the other end of the brittleness scale things are very different. During the annual moist period (high or low rainfall) much growth of vegetation can take place. Simultaneously microorganism populations build up, ensuring decay of some of the dead material on the soil surface. However, in such environments, wetness is followed by dry conditions that can last many months. Annually, billions of tons of above-ground vegetation dies within a compressed period of a few months so that plants can remain alive over the dry period. The mostly deciduous woody vegetation in such environments has developed an ability to withdraw nutrients from leaves and then to physically shed their own leaves to keep the plants alive. Were they not able to shed their dead leaves each year these leaves would not decay as they are elevated above ground where there is little microorganism life. Instead, they would oxidize in the arid atmosphere. Oxidation and subsequent physical weathering, being a slow process, would not clear away the old leaves soon enough. In the following growing season they would block light from reaching growth points. Eventually they would kill the plant. Yet on the soil, the dead leaves would provide cover while being broken down by insects and/or decaying by the end of the next growing or moist season.

In such environments, which include the world's vast rangelands, grasslands and savannas, most soil cover is derived from the litter of perennial grass plants. These, like the bulk of the woody species, have to withdraw nutrients and then kill off most of the plant above ground annually in order to survive the dry period. But unlike woody plants, no perennial grass can shed its own dead leaves and stems. They presumably never developed this ability because nature functions in wholes and these environments are those in which a great many large herding herbivores and their attendant pack-hunting predators existed prior to modern mankind.

Large herbivores cannot digest plant material but rather do so in a symbiotic relationship with microorganisms within their moist gut. So where most micro-organisms

died off in the dry period, those in the moist gut of animals did not. For the grassland molisols to develop there had to be vast herds of herbivores to sustain the decay process, breaking down billions of tons of vegetation annually. To ensure there were adequate large herbivores, nature cleverly ensured that herding herbivores would be what we call non-self-regulating. In other words they breed and breed and breed and their numbers are controlled by accident, disease or predation. Few ever starve as in a weakened state they fall prey to disease or predation. With so many herbivores evolving with grasslands and their soils it must have been a terribly overgrazed world if mainstream range science is right about overstocking leading to overgrazing.

Why was the World Not Overgrazed Before Human Interference?

The world was not terribly overgrazed before modern humans, despite animal numbers that are unimaginable today, due to the constant movement of large herding herbivores. Constant movement was brought about by one of the defense mechanisms large grazing herbivores developed to coexist with high numbers of pack-hunting and other predators in a functioning whole. Most herding herbivore females do not have horns or other means of defense. Males generally use their horns for dominating other males and defending territory rather than protecting females and young. So to survive, females of herding herbivores seem to have developed similar strategies – drop all young over a very short period to overwhelm predators, and combine in large herds, which predators fear.

What had the bunching into very large herds to do with minimizing overgrazing of plants and maintaining plant and soil health? This is easy to understand if we look at plant physiology research rather than range research, as the Frenchman Andre Voisin (1988) did over 50 years ago.

What Voisin discovered was that overgrazing of plants is a function of time of exposure and re-exposure of plants and not a function of animal numbers. Concentrated herds of grazing animals feeding with their mouths close to the ground, dung and urinate in high concentration and thus are obliged to move off any ground within a short time and not return at least until weathering has cleaned their feed.

No creatures normally will feed on their own feces, or that of closely related species. Such constant movement, involving short periods of plant exposure followed by a longer period during which plant recovery could take place, would have minimized the overgrazing of plants (only individual plants, not whole ranges, can be overgrazed). And in fact this is just what we experience with holistic planned grazing (described in *Holistic Management: A New Framework for Decision Making* (Savory and Butterfield, 1999), which simulates nature's grazing of old.

I believe, as we build our knowledge, we will come to understand that just as soil cannot develop without life, so grassland soils could not have developed without grass, and that grass was mostly as animal-dependent as the animals were

grass-dependent. Nature only functions in wholes and patterns. With vast numbers of herbivores, as there simply had to be for the world's grasslands and their soils to have developed, most vegetation would be grazed by year's end, leaving little combustible material at the time of most frequent lightning.

Today not only is burning by humans more widespread and frequent than probably at any time in history, but I believe lightening fires are more prevalent in grasslands than would have been the case before humans killed off most herbivores. Where rapid biological decay previously prevailed, today we see gradual chemical/physical breakdown providing billions of tons of highly inflammable material over vast areas of rangeland and certain forests in the U.S., Australia and elsewhere. Toward the season of most lightening, much of the land is a tinderbox simply waiting to be ignited. In addition, the more we humans use fire as a tool to maintain grasslands or forests, the more fire-dependent and flammable the vegetation becomes.

What Changed to Initiate the Formation of the World's Vast Man-made Deserts?

"Suddenly," in a geological time frame, a new creature emerged on the grasslands of the world. This creature - modern human - was an omnivorous scavenger turned predator with the development of a large brain, language, a decision-making framework, early tools and the use of fire. In a geologically brief period this new invasive, omnivorous primate wrecked devastation on the world as humans spread. Great, and increasing, is the evidence that shortly after human arrival in any new environment, species began to disappear. In part these extinctions were brought about because our behavior differed from natural predators.

Pack-hunting predators isolate animals to kill and then many predators eat one animal. They have never hunted with fire. We, on the other hand, found it hard to isolate animals from a herd to kill them. For humans it was far easier to kill whole herds – driving them into boggy ground, over cliffs or surrounding them with fire.

Where many predators killed and ate one animal at a time and were dependent on prey numbers for their own survival, humans killed thousands of animals and only ate a few at a time. Further, humans, as omnivores, were not dependent on high numbers of any particular prey for our breeding success. As any species disappeared we simply shifted to other food sources. The research of Paul Martin, Tim Flannery and Charles Kay testifies to the killing sites found on various continents where thousands of creatures were killed and few eaten. (Flannery, 1994; Martin, 1984; Kay, 1994).

Understanding what we do today about soil, plant, herbivore and predator relationships in functioning wholes, it is relatively easy to see that the effects of humans in seasonal rainfall brittle environments was devastating. The many genera of large animals that passed into extinction at the hands of humans would not have been due solely to the manner of hunting. The method of hunting would have resulted in profound habitat change as fire unsuccessfully replaced the role of animals in the annual breakdown of dead vegetation.

Not only would the killing off of many species damage animal-dependent grasslands and savannas as they reverted to oxidization in the absence of biological decay, but replacing decay with rapid oxidation through fire increased soil exposure between plants. Why humans tried to maintain their hunting grasslands with fire is understandable if one studies the many research plots established over Western American states. These plots, mostly placed in low-rainfall, brittle environments, were designed to demonstrate that land would recover if large herbivores were excluded (because the government at the time was planning to shoot some 50,000 Navajo sheep to halt the desertification taking place on their land). Yet these plots demonstrated the opposite effect. The area within them shifted from perennial grassland to largely bare soil and herbaceous plants, as decay gave way to gradual oxidation/weathering under the tool of rest.

Only in high rainfall brittle environments is there sufficient precipitation to provide a full canopy of woody cover and consequent soil cover from leaf fall, as is well illustrated by long-standing research plots in Zambia.

Main Factors Leading to Soil Exposure and Thus Desertification

Without soil exposure, desertification does not occur. Generally, as mentioned, we have only recognized soil exposure when large areas are bare. As I described earlier with the example of Clonmore Ranch, we failed to recognize the more dangerous and widespread exposure of soil between grass plants. In the less brittle (more humid throughout the year) environments it is almost impossible to manage land in any way that produces vast areas of prolonged bare soil between plants. No technology we use does this; fires hardly burn and overgrazing of plants results in dense soil cover, while rest restores biodiversity and soil cover. Fairly large areas of land can be kept bare and exposed by felling forests, constant ploughing and/or burning, but the moment such treatment ends plants rapidly invade.

On the other hand, in brittle environments, and especially those with low precipitation, it is easy to manage land in such a way that results in literally billions of acres exhibiting a high percentage of bare soil between plants. This can be seen all over the western U.S., Australia, Africa, India, China, Pakistan and many other countries in such environments. However only two practices lead to vast areas of soil exposure between grass plants: (i) too few large herbivores (wild or domestic) wandering on the land, and (ii) fire.

Low numbers of herbivores, especially without pack-hunting predation to induce bunching behaviour, become too static and thus overgraze plants. At the same time these few plants are being overgrazed, most remain ungrazed. Without herbivores removing dead leaf and stem, gradual oxidation and weathering take over from decay, killing most animal-dependent perennial grasses. At the same time soil surfaces, which need animals to trample litter to the ground and to provide periodic disturbance to avoid sealing or capping, remain largely undisturbed. The perennial grasses that most commonly survive low herbivore numbers, and which dominate

American rangelands today, have certain characteristics. Generally, they survive high levels of rest, due to either branching stems with growth points well above ground (*Tobossa* sp.), or due to short stature and/or fine leaves (*Gramma* and *Aristida* spp.) that allow some light to reach growth points at ground level despite an overburden of oxidizing material. By contrast, many African rangelands with low herbivore numbers are more often fire-maintained and thus tend to exhibit taller perennial grass plants kept alive through fire exposing the growth points to sunlight. In either case, high percentages of the soil between plants are bare and exposed. When asked the question, what things bring about vast areas of soil exposure between plants most people will answer – drought! While this may be true with many years of successive rainfall failure, it is more commonly the other way round in that large areas of exposed soil between plants brings about both increased frequency and severity of drought and flood. The increase in drought frequency and severity results from both excessive surface runoff and excessive surface evaporation of any moisture that does get into the soil.

When there are too few herbivores on the land to maintain healthy grasslands it leads to a concept that, being a new discovery, I had to give a name – partial rest. As the research plots over the Western US illustrate so clearly within them, total rest from large herbivores causes biological decay to give way to oxidation and grassland to give way to bare algae/lichen covered (cryptogamic crusted) soil and dicotyledonous or woody plants. Even more illuminating, however, is the border of all such research plots. While total rest is the influence inside the plots, partial rest with its associated overgrazing of plants prevails outside the plots. And in all instances the overall effects are remarkably similar.

What this observation has led to is the realization that the "tool" of rest can be applied in two ways – either as total rest or partial rest; and that the effects of both forms of rest are very similar right across the brittleness scale. At the low (humid) end where there are research plots excluding large herbivores, the area both inside and outside the plots is characterized by good soil cover and healthy biological communities. As mentioned before, in such environments rest (in either form) is probably the most powerful tool we have to restore biodiversity. However, as the plots illustrate so clearly, as one moves across the brittleness scale, and particularly if rainfall also decreases, the effect of rest in either form is to decrease biodiversity and enhance desertification.

Rest in either form is, in such environments, probably the most destructive tool known to humankind. This explains the observation I made earlier – that abandoned civilizations in the perennially humid environments are found under forest, while those abandoned in low rainfall brittle environments are today found in deserts, as the land continued to desertify under partial rest over the last few thousand years. In both cases, resting the land partially or totally would have followed abandonment (Fig. 2 and 3).

As too few herbivores and fire are the most prevalent practices worldwide, from the management of major national parks and wilderness areas to sophisticated grazing

Fig. 2. New Mexico test plot after 60 years. Left side partial rest with overgrazing of plants and right side total rest with no overgrazing.

systems and the practices of nomadic pastoralists, it is not surprising that desertification is accelerating. Even in India, where I have worked and observed their extremely high cattle numbers, the same thing applies – too few large herbivores to reverse desertification.

In the 1960's John Acocks, the South African botanist, made a public statement

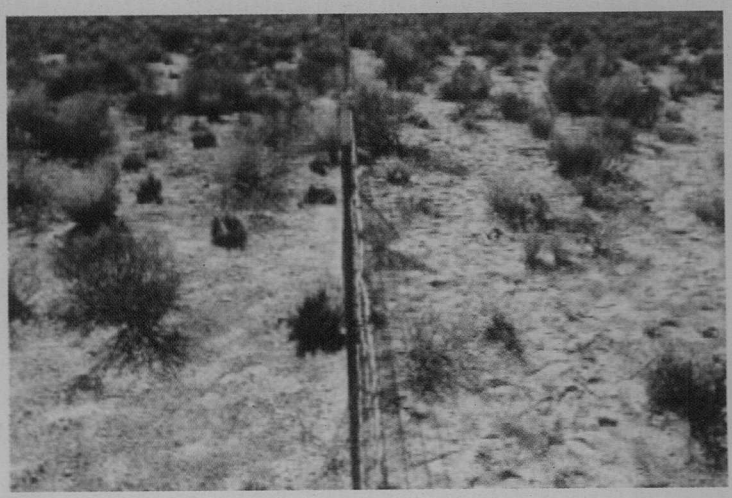

Fig. 3. California test plot after 60 years. Left side total rest and no overgrazing of plants (note old dead perennial grass plants slowly oxidizing and seen as dark clumps). Right side partial rest with overgrazing of plants. Note that on both sides all perennial grass has disappeared.

that "South Africa was overgrazed and understocked" which was greeted with much ridicule from range scientists. Following discussions with Acocks, I tested his theory in many field situations and gradually learned that he was correct, although he had arrived at this conclusion from faulty reasoning.

In the 1960's I began to believe that to reverse desertification we had not only to stop overgrazing plants but that there was somehow a connection between herbivore numbers and behaviour and land health. So we subjected this view to the test in what was called the "Liebig's Advanced Project" established on the Liebig's Company ranch in southern Zimbabwe. The idea was to subject an area of the most desertified land we could find to very high livestock numbers from the outset with no other measures than to plan the grazing to simulate herbivore movement of old. The selected area of 1,620 ha, in an area of 300 mm erratic rainfall, was completely devoid of perennial grass. Only trees and shrubs remained with annual grass and forbs proliferating in wet years (Fig. 4). We used the name Advanced Project rather than trial because we could not replicate and we intended to push it to breaking point before we took any risk with my ideas on the remaining million and a half acres of the ranch. Although the land was believed to be fully stocked (and was by conventional range management thinking), we immediately doubled the cattle numbers and planned the grazing using the process described in *Holistic Management* (Savory and Butterfield, 1999). The impact of the animals did not seem adequate so by the end of the first year we trebled the cattle numbers. In addition, the project land began to attract substantial numbers of zebra, impala, wildebeest, giraffe and some buffalo as perennial grass began almost immediately to grow.

We proceeded to produce solid perennial grassland with no measures other than breaking the rest with sufficient animal impact and minimizing overgrazing of plants. As a control we used the surrounding 89,068 hectares under the same managers. The project continued to produce five times the yield of meat per hectare compared to the control area for the next eight years. At that point the project collapsed and returned to bare soil and had to be totally destocked, thus becoming one of my many failures. As I mentioned earlier, there was still a piece of the desertification puzzle missing and this was one of those erratic results being experienced. Now that this missing piece has been identified we could sustain such results.

While on the subject of our deep beliefs and desertification there is another universal belief that I believe is incorrect. The belief advanced by many concerned ecologists and others is that environmental degradation worldwide is due largely to overpopulation and excessive exploitation. I believe there is abundant evidence to support this belief in the humid environments, including tropical forests, and in the lakes and oceans of the world. However, in the greater (about two thirds) of the Earth's land surface that is more brittle environment and essentially desertifying, I now understand that most of the degradation is due to too few people and livestock on the land leading to the high levels of partial rest observable in

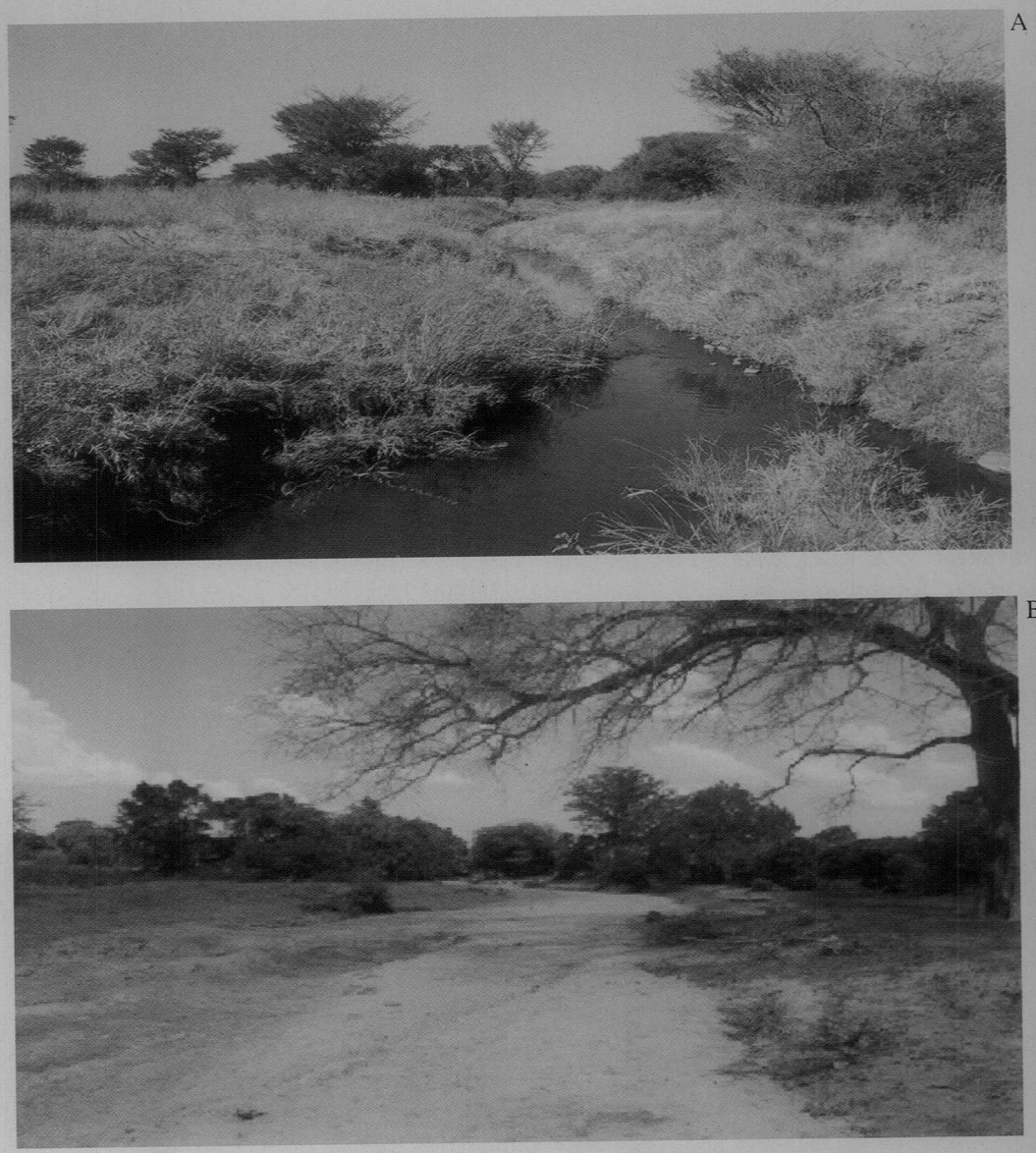

Fig. 4. View of two rivers in Zimbabwe on same day with similar soils, rainfall and only a few miles apart but managed under different decision-making frameworks. Top river (a) and its catchment is being subjected to increased livestock with holistically planned grazing and a considerable big game population while bottom river (b) and its catchment are subjected to all decisions made toward objectives and to a high level of partial rest with too few livestock and almost no big game left.

such environments. In other words desertification is resulting more from underuse than overuse.

The economic, social and political impact of this finding is almost beyond our understanding today. Tragically, many governments, NGO's and international agencies are trying to reduce or remove pastoralists, ranchers and livestock and to cull thousands of animals in a number of deteriorating national parks. The tragic culling of what is believed to be excessive numbers of elephant and other big game in some national parks in Africa began from my own early research and the data I gathered as some of our early game reserves began to deteriorate. However my conclusions were faulty as from my upbringing and education I shared the belief, still widely held by most people, that vegetation damage equals too many animals (rather than too prolonged or too frequent plant exposure to animals).

Returning to Conventional Decision-making Framework

When I discovered that a conventional decision-making framework existed, I also discovered that it lacked a focus or guiding star for testing all objectives, goals, actions, decisions, projects or policies. This led to the new concept of a holisticgoal. And we have just seen that our decision-making framework lacked tools to sustain decay over most of the Earth's land surface. Of the three tools that all professions are unconsciously taught to use to manage the Earth's environment – technology, fire and rest – two of the three bring about desertification in brittle environments and the third (technology) can never retard or reverse it. Thus, we need to add tools to our toolbox. So with the holistic decision making framework we add both animal impact and grazing as tools, in every sense of the word. Without these two tools it is simply not possible to reverse desertification.

However, there remained a further matter that our conventional framework does not address, and which is crucial to reversing desertification worldwide, and that is an economic one. To make a sound economic decision it has to be socially sound in the long run or we will regret it at some point. To make a socially sound decision it needs to be environmentally sound or again, we will regret it at some point. Thus, for us to truly make economically sound decisions in any family, community, corporation or government they need to be simultaneously socially, environmentally and economically sound both short and long term. Our conventional decision-making framework presents two major problems when we attempt to truly make economically sound decisions. First the framework in day to day decisions and policies did not recognize the simple fact that the only wealth that can truly sustain nations is derived from the photosynthetic process through four essential processes in our ecosystem - water cycling, mineral cycling, (biological) community dynamics and solar energy flow to all life. Secondly, even had our framework recognized this, as some ecological economists do, it remains extremely difficult, if not impossible, to make such sound economic decisions using this framework. This is because our minds, powerful as they are, can seldom handle more than two variables at a time. We

Table 2. Comparison of conventional and holistic decision-making frameworks.

Conventional decision-making framework	**Holistic decision-making framework** (New features in bold).
----------	**Manage in "whole" situations (people, resource base and money)**
----------	**Holisticgoal formed by all decision-makers.**
----------	**Recognize four fundamental ecosystem processes that sustain all human endeavour**
Objectives, goals, missions, visions	Objectives, goals, missions, visions
Tools: Technology, fire, rest, small organisms	Tools: Technology, fire, rest, small organisms, **animal impact and grazing.**
Actions & decisions to achieve objective based on one or more factors: past experience, expert advice, research results, intuition, cost, etc.	Actions & decisions to achieve objective based on one or more factors: past experience, expert advice, research results, intuition, cost, etc.
----------	**Seven filtering questions that ensure objective, and decisions to attain it, are leading toward the holistic goal**
Assume decisions as correct	**Assume decisions affecting environment are wrong.**
Monitor to record results	**Monitor to produce the desired result** using a feedback loop

find it hard indeed to deal with many variables or factors simultaneously as we strive to achieve an objective or goal and make decisions based on one or more of many factors as we do. Somehow we needed a simple mental crutch that could enable people to make decisions that are simultaneously socially, environmentally and economically sound both short and long term.

To attempt to reverse desertification without simultaneously attempting to ensure that decision making becomes truly economically, socially and environmentally sound (as governments have done for years) is a recipe for costly failure. This vital point we handle with the holistic decision making framework through the use of several filtering questions that test any action, decision, project or policy toward the holisticgoal created by the people in that particular "whole." This process is described in *Holistic Managemen* (Savory and Butterfield, 1999)

For ease of comparison Table 2 shows the two decision-making frameworks side by side.

Results Using Holistic Decision Making Framework (Holistic Management)

As mentioned earlier, we experienced mixed results on the land until we understood the importance of forming a holisticgoal and the rest of the new decision-making framework fell into place. After about 1988 we began to experience consistent results in reversing desertification wherever the holistic decision making framework was genuinely used. These results show in three main areas:

- A measurable increase in ground cover and species of plants and animals
- Greater harmony amongst people
- Dramatic increases in prosperity.

In Holistic Management there is a requirement to take steps to identify and deal with what is preventing progress if such results are not quickly evident – at least within about 18 months.

Because conventional decision-making was the root cause of desertification we find it is simply not possible to experience the same results when a holistic framework is used because it addresses the root cause of desertification. Thus people actually changing their decision-making framework are empowered to begin solving many wicked problems of soft and natural systems, including desertification and its symptoms. Einstein long ago stated that we were unlikely to solve our problems with the same thinking that produced them.

Dr. Deborah Stinner and her colleagues at Ohio State University did a study of 25 early adopters of Holistic Management across the US (Stinner *et al.*, 1997). They reported that 21 of the 25 showed measurable increases in plant and animal life and the group averaged 300% more profitability. This was at the same time as the US was losing hundreds of thousands of farmers to insolvency.

A great many of the "Good Stewardship" awards for land management in the US today are going to ranchers who are managing holistically with varying degrees of success.

Just as all projects and policies of NGO's, governments and international agencies are formed unknowingly using the conventional decision-making framework, so too can we knowingly form them with the holistic decision making framework. The results witnessed when analyzing and forming policies using the holistic framework are truly encouraging. In the US over 2,000 professional people from the main government land management agencies have come through a basic training in how to use the holistic framework. After only a week of training they have been able to make statements such as "We can now recognize that unsound resource management is universal in the US" Frankly, I believe it is no different in any country.

In Bhubaneshwar in India a group of Indian Forest Service officials working with the holistic framework for a week were able to look at twelve planned and present forest policies and conclude that all would lead to damage to the forests and the people dependent on them.

In Lesotho (southern Africa) senior officials of the Ministry of Agriculture, after a similar training session, were able to look at their own soil conservation policy and conclude that it will increase soil erosion.

Similarly, NGO's working with the holistic framework have been able to make such determinations about projects that they are engaged in with the aim of helping reduce poverty and to see that the most well-meaning projects are likely to increase poverty and dependence.

In all instances to date, no matter how many individuals within any institution receive such training and experience such

results, they are as powerless as any outsider to bring about change within their own bureaucracies. For this reason we do not yet have any instance of institutional change in organizations involved with land management and attempts to reverse desertification. Tragically, unsound policies, biodiversity loss, desertification and all of the others social, environmental and economic symptoms continue largely unabated worldwide.

Since 1988 we are not aware of one case where people have changed the decision-making framework and not experienced a reversal of biomass/diversity loss and consequent desertification. Over the same time thousands of people have taken elements of the new thinking (such as using large herbivores as land management tools) and applied them with the conventional decision-making framework with short-term good results but longer term disappointment. These cases, I believe, reflect exactly what I experienced in that period of erratic results before it finally became clear that the root cause of desertification was the conventional decision-making framework and it is this that has to change for lasting results.

Conclusion

Biomass/diversity loss and desertification are without question the greatest problems facing humankind. With soil erosion, which is but one symptom, reaching the level of four tons per person on the globe per annum, and environmental refugees, poverty and violence rising, it is time for the world's governments, universities, NGO's and international agencies to take desertification seriously – as seriously as we take any war. This much is commonsense. But how do we bring about such action today when our dominant organizational form is a complex soft system - bureaucracy. The great lesson from Smut's original writings to modern complexity theory and systems thinking is that in natural systems everything is connected. Thus I cannot write meaningfully about reversing desertification without paying attention to soft systems.

As systems thinkers point out, soft systems exhibit unintended emergent qualities that are unpredictable from any components and result in wicked problems. Amongst the emergent properties of bureaucracies are some that are of deep concern with regard to desertification. One of the unplanned emergent qualities of democratic organizations with elected leaders and bureaucracies is that they are almost watertight to new knowledge. This was highlighted by the research of Lord Eric Ashby (1997). While such institutions will commonly employ the very latest thinking and technology in the prevailing paradigm, as institutions they do not take kindly to new knowledge. Britain's Royal Navy is one often quoted case in which it took 200 years, after it was first clearly demonstrated, for them to officially accept that eating limes would prevent scurvy. Despite the seriousness of the problem it then took Britain's Merchant Navy a further 70 years to adopt the practice.

Bureaucracies are no different today. Overgrazing of plants is a critical piece of the desertification problem. The prevailing paradigm within universities, NGO's, environmental organizations, governments and international agencies is that overgrazing is due to too many animals.

Voisin discovered over fifty years ago that this was not so and that overgrazing is a function of time not numbers. His work was published in at least five languages and yet there is not one university, environmental organization, NGO or government that has accepted this new knowledge despite the passage of fifty years. Independent scientists, like myself, as well as many individuals within these institutions have long ago accepted Voisin's finding but not the institutions, which are likely to take another 100 to 150 years no matter how much suffering or how many environmental refugees die.

As Lord Ashby concluded from his research into how new knowledge does get into democratic societies (looking at Britain and America over the last 200 years), only when there is a critical mass of grassroots demand do our democratically elected leaders or institutions change.

John Ralston Saul, who studied the functioning of bureaucracies from the time of Voltaire and Napoleon to the present (see Voltaire's Bastards) (Saul, 1993) identified two other emergent properties of bureaucracies. Saul studied the results that flowed from the refinement of bureaucracies starting with the Age of Enlightenment when organizational management shifted from those who bought or inherited their positions to an educated corps of trained professionals. The belief at the time was that by engaging experts to run organizations we would no longer suffer the previous stupidities and blunders that characterized the performance of so many organizations. Saul traced the history of performance of bureaucracies in a number of nations and in many fields from Voltair's time to the present. What he concluded was that no matter how brilliant or well meaning the people engaged in a bureaucracy are, every outcome exhibits two unplanned properties of deep concern. What emerges from any bureaucracy lacks commonsense and lacks humanity, according to Saul. Many who have worked in or with bureaucracies can testify to the accuracy of this finding. So while there is a positive upside that we benefit from/ through bureaucracies and we do see wonderful people in such structures striving for excellence within the prevailing generally accepted paradigms, we need to be aware of the downside associated with the tremendous difficulty to achieve an openness to new thinking that conflicts with prevailing paradigms and to the tendency to produce outcomes that lack commonsense and humanity.

Today I am satisfied that we do know both what is causing desertification and how people can be empowered to begin to reverse thousands of years of damage. The threat is global but rather than requiring billions of dollars spent on countless projects with little hope of success, it will require relatively little expenditure on the root cause which is best tackled through education and training. I stress expenditure in education and training because experience shows that reversing desertification tends to make money rather than cost money provided people simply have knowledge of holistic decision making, which in itself is a pleasant change.

In every sense we are in a race against time as we witness droughts, floods, global poverty and violence spreading. However, as almost all land management today is

either directly or indirectly controlled by various institutions, we are unlikely to be able to proceed on the scale required till many institutions become open to new thinking. Fortunately with the development of the internet bringing about many changes in how people and our bureaucracies and governments relate, there is a growing awareness of the fact that what most people in the world want, and where our institutions are taking us, are very different directions. Increasingly, public anger and opinion is becoming a world super power which even multinational corporations and the governments they sustain will be forced to heed. While there is a good side to this in that it will result in change, the downside is that no matter who the public ultimately put their faith in, they will do no better at addressing the many social, economic or environmental symptoms of worldwide biodiversity loss and consequent desertification, unless there is also a widespread change in the decision-making framework used by all institutions to determine actions and formulate policies. While very necessary, thinking holistically (as many are beginning to do) or advocating systems thinking will not reverse desertification until the actual decision-making framework changes either to the holistic decision making framework or something better.

Nonetheless I feel more optimistic for humanity now than I could ever have felt had I lived at any earlier time in history as so many people in all walks of life are becoming aware and care enough to strive for new directions and solutions. I hope that Holistic Management will indeed play a role as we strive to achieve a better world where our rivers flow free once more and people learn to live in harmony with one another and our environment.

References

Ashby, Eric 1978. *Reconciling Man with the Environment.* Stanford University Press.

Charles, E. 1994. Aboriginal overkill: The role of native Americans in structuring western ecosystems. *Human Nature* 5(4): 359-398.

Flannery, Tim 1994. *The Future Eaters.* Reed Books, Chatswood NSW, Australia.

Girardet, Herbert 2003. Global village or global pillage. *Resurgence,* Jan/Feb 2003. p. 6.

Kay, Charles E. 1994. Aboriginal overkill: the role of native Americans in structuring Western ecocystem. *Human Nature* 5(4): 359-398.

Martin, P.S. 1984. Prehistoric overkill: The global model. In *Quaternary Extinctions, A Prehistoric Revolution* (Eds. P.S. Martin and R.G. Klein), pp. 354-403. University of Arizona Press. Tucson.

Saul, John Ralston 1993. *Voltaire's Bastards: The Dictatorship of Reason in the West.* Random House, New York.

Savory, Allan and Butterfield, Jody 1999. *Holistic Management: A New Framework for Decision Making,* Island Press.

Smuts, J.C. 1973. *Holism and Evolution.* Greenwood Press, Westport, Conn.

Stinner, Deborah H., Stinner, Benjamin R. and Martsolf, Edward 1997. Biodiversity as an organizing principle in agroecosystem management: Case studies of holistic resource management practitioners in the USA. *Agriculture, Ecosystems and Environment* 62: 199-213.

Thomas, Jim 2003. European Programme coordinator ETC Group. In *Nanotechnology Special Report: Promising the World, or Costing the Earth? The Ecologist* 5(4): 36.

Voisin, Andre 1988. *Grass Productivity.* Island Press, Covelo.