MAN, STATE AND THE ENVIRONMENT:
AN INQUIRY INTO WHETHER SOLUTIONS TO DESERTIFICATION
IN THE WEST AFRICAN SAHEL ARE KNOWN BUT NOT APPLIED

Michael F. Glantz

Environmental and Societal Impacts Group
National Center for Atmospheric Research
Boulder, Colorado 80307

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Introduction

The Sahelian drought and famine of the early 1970s attracted global attention not only to a specific drought in a particular region but to the broader concerns of both the impact of weather on society and the impact of human activities on the environment in arid and semiarid areas. This recent surge in interest culminated in the U.N. Conference on Desertification held in Kenya in 1977 (UNCOD, 1977). This paper focuses on desertification in the West African Sahel.

Desertification (also referred to as desertization) is the process of environmental degradation in and around arid lands, resulting from either human activities, climatic variations, or a combination of both. It has received much attention recently because of the physical and social impacts of the extended drought in the Sahel between 1968 and 1973 (inclusively). The social impact of that drought was especially severe in 1973 and well into 1974. This drought resulted in estimates of more than 100,000 human deaths and a loss of up to 12 million cattle or about 40% of the Sahelian total (see, for example, Temple and Thomas, 1973). There were also widespread migrations of herders and farmers in addition to widespread destruction of the vegetative cover of the rangelands, spectacularly, but by no means exclusively, around deep wells.
There is general agreement about many but not all of the causes of desertification (see, for example, UNCOD, 1977; Kovda, 1980). Le Houérou (1975), for example, suggested that "the cures for desertification have been known for a long time: they consist of the reverse processes, that is, biological recovery or biological revival (Fr. remontée biologique) of environmental conditions, naturally or artificially induced." There is much less agreement, however, about how to deal with those causes, not just in Africa but in other arid and semiarid areas as well (see, for example, Farvar and Milton, 1972). An increasing number of observers suggest that some solutions to several causes of desertification are known (at least in theory) but, because of political, economic, cultural or social reasons (many of which are also known), are not applied. It is important to identify some of these solutions (even theoretical ones) so that conditions conducive to their effective application can be developed.

The main purpose of this paper is not to present new factual information on the Sahel and the desertification process in that region but to present a new way of organizing and evaluating existing information. It is (as the title suggests) the new application of an existing framework for analysis (Waltz, 1959) in a search for better understanding of why known solutions to desertification in the West African Sahel are either not applied or applied with little or no success.
This paper identifies some anthropogenic causes of and solutions to various aspects of desertification. In the following discussion, these anthropogenic factors will be divided into and discussed at the individual, national and international levels of social organization. The discussion of the individual or first level will focus on human nature and behavior, including perceptions about the environment. Perceptions of reality are the basis for human activities. While these perceptions may be inaccurate reflections of "reality," the consequences of those activities will be real. Important causes of desertification can be found here.

The second level of organization—the state, includes the various effects on the environment of intra-state group interactions within the state, the competition among opposing interest groups for a share of scarce national resources including competition among government bureaucracies for power and influence. Bureaucratic inefficiency, poor communication, and competing political and environmental ideologies (among other factors within a state) can lead, directly or indirectly, to a long-term downward spiral of environmental degradation. Such statements as the following reflect an aspect of the second level of desertification: "The strict application of conservation laws is the surest guarantee of conserving the environment," and "an equilibrium between man and limited resources of semiarid and subhumid regions under demographic pressures cannot be achieved except within a clearly defined and applied economic and social policy" (Dworken, 1974).
The third level of analysis to be considered is the international level. It has been argued that the degradation of the environment has resulted from the absence of international regulations or the absence of organizations with sufficient influence or resources to bring about environmental protection. Other third-level aspects relate to the transfer of technology as well as (in general) to the international agents of transfer—technical experts. Many of these experts represent such entities as governments, consulting firms, corporations and non-governmental organizations.

The Sahel and Desertification: Recent History

The geographic limits to the region known as the Sahel vary according to how it is defined; by precipitation characteristics (UNESCO, 1975), vegetation (Stebbing, 1937), latitudes (Tanaka, et al., 1975) and the like. Some authors have noted that the zone is constantly shifting depending on the variability of climatic factors. For example, Toupet (quoted in Bernus, 1975) referring to Mauritania, noted that the difference in location of the 100 mm isohyet (line of equal precipitation) between 1941-72 and 1951-52 was on the order of 340,000 km², almost one-third of the area of Mauritania.

In this paper the Sahel is broadly delimited by the 100 and 600 mm isohyets with the 200 to 400 mm isohyets defining the Sahel in the strict sense. The 100-200 isohyets define the Saharo-Sahelian zone and the 400-600 mm the Sudano-Sahelian zone (UNESCO, 1975b). The 400-500 mm isohyets generally separate the areas suitable for
cultivation to the south from those suitable for rangelands to the north with some notable exceptions (Mattei, 1979; see also Cochemé, 1968).

There are many forms of pastoralism, ranging from pure nomadism to sedentary farmers who keep herds. There are also many different groups in the Sahel who practice these varying forms of pastoralism. While the risks of overgeneralization are high, there is a need to discuss some aspects of pastoralism in general terms, given that common elements of the different forms of pastoralism do exist. On this point Swift (1977) noted that

it is difficult to deal other than in generalizations, for example, that many pastoral economies apparently have low labor requirements, or that different domestic species have different economic and ecological characteristics based on different food preferences, different lengths of gestation period and calving interval, and thus the degree of responsiveness to changed ecological conditions such as rain after drought.

A time series of reliable precipitation records for the Sahel are scanty, because of the low quality and relatively short duration of existing precipitation records (Oguntoyinbo and Odino, 1979). Therefore, these isohyets represent only general precipitation patterns.

In the Sahel, like in other arid areas, interannual variability is high with a few rainfall seasons well above the long-term average and a much greater number of seasons below it. Often "average" is considered "normal" by those unfamiliar with meteorological statistics.
The statistical average, however, is an insufficient representation of Sahelian rainfall which is better described by a number of other measures, such as the range of precipitation, the mode (the amount of rainfall that most frequently occurs), standard deviation, and coefficient of variation.

Between 1968 and 1973, following what is considered to have been a 15-year period of weather relatively favorable to agriculture, Sahelians, pastoralists and cultivators, were plagued by recurring drought and dry spells with 1973 the worst year in terms of deaths, population movements, and land degradation. It was the third major drought in the region in the 20th century (the others occurred in 1910-14 and 1941-42). The rains returned to near average levels, in general, in the 1974 growing season. Since then, a large number of pastoralists have attempted to rebuild their herds and return to the rangelands to resume their traditional existence. By 1975, conditions on the rangeland appeared relatively favorable for expansion of herds, because although many cattle had died, the remaining livestock were no longer in excess of the range's carrying capacity.

Apparently 1974 and 1975 brought only temporary relief from drought for the Sahelian inhabitants and their governments. Sahelian rainfall amounts (but not necessarily impacts) were less in 1977 than in any other single year during the recent drought period. The 1978 rainfall was crucial to the inhabitants (Winstanley, 1978). It is more difficult now to ascertain the impact of weather fluctuations
on Sahelian social systems because there are many national and international agencies in place in that region, the presence (and activities) of which tend to mitigate or to act as buffers to some of the adverse effects of those fluctuations. Once those agencies or organizations leave (for whatever reason—political, economic, or other), the region is likely to be as vulnerable (to drought and politics in combination) as it was during the last drought (de Lattre, 1979). Sahelian farmers and pastoralists can be under increased nutritional stress if there are a few poor rainfall seasons consecutively, as was the case in the early 1970s (Monod, 1975).

During the favorable rainfall period preceding 1968 (for a recent opposing view on this seemingly favorable period, see Nicholson, 1979), cultivators were encouraged by their governments to move northward to farm land that was relatively less productive. Pastoralists in turn were obliged to move their herds from these regions even further north into normally arid areas which had recently received increased precipitation. They were further compressed between encroaching cultivators (and further south, the tsetse fly) and the extremely dry parts of the Sahelian zone and the Sahara to the north.

Some of the traditional grazing areas that the pastoralists were forced to abandon to the cultivators during this period were cleared for cultivation—only to be later abandoned because of the decreased soil fertility and because precipitation was too irregular for sustained agricultural activities. Poor crop yields, low production, and
outright crop failure during relatively more favorable rainfall periods, and more so during drought, caused the cultivators to leave those areas,subjecting the cleared land to wind erosion and, ultimately, to desertification. In other instances where cultivators remained on this land, in spite of low agricultural productivity, access to the rivers (see Dresch, 1975) or to traditional watering points or grazing areas were sometimes blocked for the traditional pastoral herd migrations, disrupting their pastoral practices. On this point Oxby (1975) noted:

Certain Malian Twareg used to rely on the borders of the river Niger for dry season pasture in times of drought; now cotton cultivation covers a large part of this area.

Also, in this favorable rainfall period, ever-expanding pastoral herds were forced to move into temporarily favorable areas which in the long run (i.e., decades) would be unreliable in terms of range-land productivity. With consecutive droughts and dry spells in 1968 and after, the vegetative cover throughout the region was reduced, as the carrying capacity of these marginal areas became increasingly overtaxed by the expanding herds. After 1968, environmental degradation was accelerated, at first slowly, and included widespread destruction of the remaining vegetative cover which, ultimately, resulted in the death or migration of a large number of pastoralists and their livestock.
Farmers as well as pastoralists in these areas considered themselves victims of a natural disaster, when in reality they were faced with a return to the "normal" rainfall conditions which are indicated by the climatic record (see WMO, 1976). In fact, reports have noted that the recent drought only aggravated the process of ecological deterioration of the rangelands that was apparently well under way before the drought began (i.e., Dumond, 1969; Rapp, 1974; Clyburn, 1974). Yet another report noted that "computer simulations and historical accounts agree that chronic overgrazing in the Sahel began in the early 1960s" (Picardi and Siefert, 1976).

In summary, then, some of the generally accepted causes of desertification of the Sahelian rangelands include an overtaxed rangeland carrying capacity (too many cattle on a dwindling vegetative resource base), human population increases within and to the south of the Sahel, misuse in some instances and non-use in others of climatological and meteorological information, ever-expanding herds, cultivation in meteorologically marginal areas, reduced fallow time, deep well construction, technology transfer, political and cultural rivalries, low level of international and regional planning, systems of land tenure, competing political and economic ideologies, among others.

All of this is now well known. Yet why are many of these known causes of desertification not dealt with successfully? Some of these causes can be discussed in terms of the three analytic levels referred
to earlier. Through an analysis of desertification at three different levels of social organization, it is hoped that causes and their actual solutions might be more readily identified. This level of analysis approach may be especially useful in exposing the role of human activities—both within and outside the Sahel—in perpetuating (in addition to causing) rather than preventing desertification in arid and semiarid areas. Only a few examples of anthropogenic aspects of desertification are used for each of the three levels of social organization. These examples may well involve factors which could be described at each of the three levels. However, the illustrations of social factors in desertification to be considered below will be described at a single level, one chosen according to the author's perceptions about whether they are predominantly first, second or third level.

FIRST LEVEL - Human Nature and Behavior

The question for policy is often not "What is reality?" but rather, "Whose reality will prevail?"

(Padelford and Lincoln, 1962)

First level causes of desertification are related to human nature and behavior, a primary aspect of which are human perceptions of the activities of others and of nature. Perceptions of reality are important in the study of environmental problems in general and of desertification in particular. These perceptions should be made
explicit, whether or not they are accurate reflections of reality, because the consequences of actions taken based on them will be real.

The perceptions held by the various individuals or groups of individuals in a society are not equally influential in the environmental policy-making process. Those perceptions that national leaders have about the relationship of man to nature constitute the dominant (in political terms) ideological perspective, while different perceptions held by other groups can be considered as subordinate ideologies. While the varying views of the man-nature relationship in reality can be spread across a continuum, only two major (often opposing) views related to desertification in the West African Sahel will be discussed: "man-over-nature" and "man-in-balance-with-nature." These two categories represent a condensation of three categories suggested by Kluckhohn et al. (1961) with their third category—man subordinate to nature—subsumed under man-in-balance-with-nature. Man-over-nature is the dominant ideological stance in the Sahel and, as such, is a major first level cause of desertification.

It can be argued that many leaders in developed states pursue policies that favor man-over-nature, that is the use of human ingenuity to overcome obstacles (or constraints) laid down by nature and that in general they have the economic resources (if not the political will) to deal more effectively with many of their environmental problems. For example, the U.S. Department of Interior's Bureau of Land Manage-
ment (BLM, 1979) is presently undertaking a major assessment of
desertification in the United States, the goals of which are "to
prevent and to arrest the advance of desertification and to reclaim,
where possible, desertified lands for productive use." The tactical
objectives of the program are "to promote understanding of the deserti-
fication processes in the United States and to support the development
of practices and resources in arid and semiarid lands consistent with
the restoration, maintenance, and enhancement of productivity in
accordance with national needs."

In developing countries the situation is different. As one
author (Clarke, 1978) commenting on the recent Sahelian drought,
suggested that the Twareg

became the victims of a total ecological collapse,
the sort of collapse that could have been postponed or
perhaps averted by money and technology in a rich
country but which in a poor one is called an "act
of God."

National leaders in developing countries tend to favor the use of
technology to deal with development problems, despite a widespread
awareness that many other, and often more serious, environmental
problems accompany the use of that technology. These countries do
not have the financial resources needed to deal effectively with
their environmental problems. By most criteria 5 of the 6 Sahelian
states are among the poorest in the world.

Most leaders of developing countries often see their choice as
one of either economic development based primarily on the infusion
of foreign technology and expertise or no development at all. On this point a recent SCOPE (1978) report noted that

Lack of familiarity with the scientific and technical means to solve environmental problems leads some developing nations to assume that environmental management implies that their further growth in energy and material demands must be controlled and their rate of development may be restricted.

In many instances they receive moral and material support from foreign technical advisors. Invariably development paths are chosen without consideration of the environmental degradation likely to follow and development often occurs at the expense of the environment. Many observers have commented on this tendency, noting that the central priority of Third World leaders was development and that solutions to environmental problems in their countries could therefore only be reached through development. This commitment to development at any cost to the environment is often in sharp contrast to the way some groups within these countries, such as the Sahelian pastoralists, have traditionally perceived their relationship with their physical environment. In addition, "Societies afflicted with widespread malnutrition and disease, high infant mortality, low life expectancy, high illiteracy levels and endemic unemployment are not likely to place the same value on degradation of the natural environment as societies in which these kinds of problems have been overcome. This means that identical objectively perceived environmental damage may be accorded quite different social weights in different countries" (Walter and Ugelow, 1979).
Pastoralists have lived for centuries in "balance" more or less with their natural environment, a balance maintained at times deliberately by themselves and at times by nature. Adversities such as droughts, famine, diseases, wars, and cattle raids each in its own way served to keep both human and animal populations somewhat in balance with the available natural resources. The "balance" was also maintained through a combination of social relationships, intra-regional migrations, out migrations to the wetter south and to the coastal states (see Lovejoy and Baier, 1976), and death among other social and physical responses to environmental stressful conditions. As Johnson (1969) noted:

The alteration of wet and dry years serves as a natural mechanism to keep the herds, and the nomads living off them, in balance with their environment. The adjustment or balance achieved by a group of nomads is not a stable equilibrium in terms of herd numbers, although it undoubtedly represents a stable adjustment insofar as human and animal alteration of vegetation is concerned. Rather it is a dynamic equilibrium between the nomad and his environment which is often disrupted by both natural and human factors, but which up to recent times has generally been reestablished.

In periods of relatively favorable rains the pastoralists migrated with their herds to take advantage of seasonal pastures and water sources (i.e., Breman, Diallo, Traoré and Djeyeye, 1978). For example, in the rainy season in the Sahel they might have grazed their livestock in depressions and shallow ponds; they often moved in the beginning of the dry season near shallow (man-made) watering
points and in the heart of the dry season to the wetter areas to the south; only to return to the north with the reappearance of the northward moving rains (Boudet, 1975).

With colonial contact and rule came Western technology and the dominance of the ideology of man over the constraints of nature and all the economic development tactics and strategies that such an ideological stance entailed. The traditional ways of dealing with environmental variability from year to year by the pastoralists were blocked by factors often beyond their control; for example, the colonial introduction of cash crop schemes, veterinary medicine, deep wells and international borders arbitrarily drawn, and the curbing of such events as cattle raids by one ethnic group against another (see, for example, Ball, 1978). The introduction of these and other factors was not accompanied by attempts of the colonial powers to compensate for the social, economic and environmental disruptions that such factors might have caused (Clarke, 1978). Yet, the pastoralists themselves were (and for that matter still are) ultimately blamed for having degraded their arid ecosystems.

The fact that the farmers to the south were often at odds with the pastoralists reinforced the political and social isolation of the pastoral population (Clarke, 1978). The farmers received support from their government (they were settled, taxable, less autonomous and participated in the modern economic sector). Whenever conflict arose between farmers and pastoralists, it was the farmer who generally received support from the government. In fact, most Sahelian
governments (except Mauritania) are controlled by people whose roots are in the agricultural sector. These farmer-pastoralists conflicts and government reactions to them reinforced the pastoralist's distrust of his central government, its bureaucratic representatives and the farmers.

Distrust of others was not monopolized by the pastoralists. Distrust also existed between farmers and the government. One cause of this (indirectly) was population pressure, the effects of which spilled over into the environment; that is, the need for wood increased in urban as well as rural areas. The demand for firewood to cook meals led to the disappearance of such woody species from around settlements and ultimately to desertification (e.g., Eckholm, 1976; Bradley, 1977).

In a response to the firewood crisis and resulting desertification, governments instructed local administrators to enforce laws that prohibited the destruction of woody species in protected areas. Such laws, however, were often passed (and enforced) with little consideration given to alternate sources of fuel (to cook meals). While some complied with these regulations, other continued to take firewood from restricted areas, justifying their actions on at least two counts: 1) their basic need for firewood to cook, and 2) the government steals from them so they steal from the government (Thomson, 1977). This example suggests that, perhaps, even logical anti-desertification measures may be doomed to failure in part because of mutual distrust between government and the governed.
Other conflicts (political, economic and ethnic) between the pastoralists and their governments (independent and colonial) served to reinforce the conflicting views of the man-nature relationship. Therefore, pastoralists views on such matters as the economic development of the rangelands (i.e., ranching schemes or schemes designed to increase offtake from the herds) were generally not sought by their government and, if offered by them or those sympathetic to their views were seldom (if ever) taken seriously. These "reinforced cleavages" heightened the distrust that existed between the pastoralists and their governments, with "each side tend[ing] to be suspicious about the other's intentions" (Hjort, 1976).

In general, one author suggested that in East Africa the administration viewed the pastoralists as "a community in the process of destroying itself," one which refused to participate "in the mainstream of the market economy on a commercial basis" (Baker, 1974). While these statements were made for East Africa, they relate closely to the situation in West Africa. A recent UNESCO report (quoted in SCOPE 10 (1978) noted that "the impact of the Sahel drought had been worsened by a lack of understanding by governments of the traditional ways in which the pastoral nomads were in equilibrium with their environment."

As for the pastoralists, they saw their government as intent on destroying their way of life by forcing them to settle and farm, by overtaxing them, by forcing them to destock, and by robbing them of their traditional grazing areas. The nomadic attitudes toward the
national administration, wrote Hjort in 1976 (quoting from Spencer, 1965), "are reflected in his actions: he often treats the administration as another ecological factor—an external constraint similar to unreliable rainfall, that he must take proper precautions to cope with."

A first-level example with a third (international) level component was noted by Clarke (1978) who wrote that

the growth-oriented technology was introduced in the Sahel without restraints and without either consultation with or consultation for the people whom it would affect the most....It was felt [by government officials] that a foreign technology could maximize and rationalize what was mistakenly perceived to be a minimal and irrational use of resources [by nomads].

Finally, Clarke (1978) alluded to a perceptual difference between farmers and pastoralists with respect to nature.

In economies scarcely more advanced than Niger's it is said that herders try to accommodate themselves to nature, adjusting their migrations and herd size to available resources, while farmers try to fight nature, to transform it through technology by means of irrigating, fertilizing, weeding and crop rotation.

Thus, dominant commitments to the man-over-nature ethic (as opposed to man-in-balance-with-nature), and government and bureaucratic actions based on this perception on man's place in nature, inevitably lead to the environmental degradation of the Sahelian rangelands.
SECOND LEVEL - The State

Even if the development plans had been technically perfect in all respects, the changes were great in the Nigerian case that their execution would still have run into administrative problems.

(Ojetunji Aboyade, 1968)

Second level causes of desertification encompass how groups within a state interact with each other and with their government. The primary focus is on group action (whether of social groups or of groups within government) and not on the first level perceptions of individual group members upon which those actions were based. Included at this level are the varying effects (mentioned earlier) on the environment of the competition among opposing groups for a share of scarce national resources as well as competition among government bureaucracies for resources, power and influence. The first part of the following section focuses on the bureaucracy in the Sahelian state. The second part deals with various second-level aspects of pastoral herds.

Bureaucracies and Desertification

An important second level cause of desertification in the Sahel is the bureaucracy. With the following figure (and legend), Baker (1975) succinctly summarizes the role of the Sahelian bureaucracy in the management of an environmental problem. It shows a commonly occurring pattern of sectorally oriented planning and administration and the main ways in which such a structure defies any attempt at
holistic or ecologically based planning. The real problem, range-
land management, is shown encompassed by a circle that represents
the boundary of the problem. The circle is divided into segments or
symptoms of the problem, the boundaries of these symptoms being fixed
by the terms of reference, fields of action, and, thus, perception
of the various ministries. The largely neglected social factors are
shaded differently to emphasize the fact that usually no ministry or
department chooses to incorporate these into their terms of reference
in rangeland management.
Weaknesses occur at the following numbered points:

1. As a consequence of limiting terms of reference, no branch of government perceives or deals with the problem holistically. The body concerned will extract the area of symptoms over which it has some control.

2. The approach to the "problem" depends upon its perception by what is often an urbanized elite drawn from an agricultural background and educated in Western techniques and norms.

3. The national plan may introduce blanket policies that have a widely varying impact depending on the regional socio-economic and physical circumstances in the country; it does not necessarily ensure intersectoral cooperation.

4. A request for technical assistance will lay down terms of reference based on what the client ministry thinks is appropriate.

5. The response could incorporate fashions and fancies of the aid scenario at the time, political expediency, accounting convenience, and so on.

6. The research will be limited by time, the terms of reference of the client's brief, the perception of the "problem" conditioned by the researchers' background and time available.

7. The suggested program or project to deal with the symptom is subject to ministerial revamping including the possibility of expediency, political kudos, and corruption.

This pattern is repeated for all the departments and ministries concerned, which frequently suffer from an almost total lack of contact with each other. The advantages of regional planning or special area planning are self-evident.

An example of the involvement of the Sahelian bureaucracy in the desertification process is the construction of deep wells in the arid Sahelian environment. Deep wells have been perceived by government officials responsible for water resources and by international aid
experts to be useful, quick technological responses to the long-range (often underlying) problem of water shortages in the Sahel. They are relatively inexpensive as a form of technical assistance and are relatively easy to provide. A major shortcoming of these government-sponsored construction projects resulting from a failure to look at the plan holistically, has been that little (if any) consideration was given to the availability of adequate pastures, which often fails under the jurisdiction of a different section within the government bureaucracy. In ordinary times but especially under drought conditions, large increases in animal populations sharply increase the grazing pressures in the areas surrounding deep wells (i.e., Swift, 1973), especially as other sources of water become either less reliable or nonexistent throughout the season.

In earlier times pastoral dependence on seasonal water sources caused them to move with their herds from one watering point to another as those sources dried up. This movement amounted to de facto rotational grazing, that is, an ecologically favorable distribution of grazing pressures on the rangelands. Deep wells, however, disturbed the balance that apparently existed between water and pasture availability and use, by converting seasonal pastures (near the seasonal sources of water) into year-round ones. This conversion led to excessive livestock concentrations for longer periods of time at deep well sites resulting in the destruction of the vegetative cover and the soils surrounding the wells. This resulted in desertification around well sites: Clarke (1978) wrote that "Miniature deserts
continued to grow around the wells, pumps and pools...across a twenty-six-hundred-mile stretch of Sahelian pastureland—wherever similar 'development' programs had been introduced." The soils were affected, for example, by trampling, which caused a reduction in soil porosity (thus increasing the rate of water runoff). Grazing pressures also led to the removal of preferred vegetative species and an invasion of less palatable ones, or ultimately to wind erosion and desertification.

As preferred vegetation disappeared from 20-30 kilometers surrounding the well sites and with an invasion of less palatable species around the wells, the livestock were forced to travel longer distances for forage. For the most part the livestock, in their weakened condition, were unable to survive the search for water and forage during the drought and perished. A major FAO-Swedish International Development Agency study (1974) suggested that "the cause of heavy mortality of stock in 1973 was the lack of forage much more than the lack of water."

The large number of livestock deaths and the deterioration around the wells resulted not so much from the construction of the wells as from the compartmentalization of the bureaucracy which did not enable bureaucratic subunits to deal effectively with the rangeland ecosystem. In other words, to the engineers who dug them, the wells were not an integral part of their fragile ecological setting; the availability of pasture was someone else's responsibility. Well construction
in the Sahel serves as a prime example of what Caldwell (1972) referred to as technological success accompanied by ecological failure. Swift (1973) summarized the problem of what happened when the government bureaucracy lacks a holistic perspective:

Permanent increases in livestock production are impossible since soil and vegetation receive no technological boost, and thus remain limiting factors. Nomad economies and societies are tightly integrated and functional wholes, with numerous checks and balances. Proposed changes must act ecologically on the whole system, not just isolated parts of it.

Pastoral Herds

In virtually every article on the causes of desertification (as well as on the social and environmental impact of the recent drought in the Sahel), herd size has received a prominent place. Some claim that large herds have been a major cause of environmental degradation in and around arid lands. Others have claimed that pastoral herd size is a symptom of deeper, more important causes of desertification such as human population increases in the Sahel as well as in regions adjacent to it, inappropriate technology transfer, ethnic rivalries, bureaucratic competition, and the lack of holistic planning in the Sahelian states. To be sure each of these contributes to the desertification process. However, herd size is a common link to each of these factors.

Traditionally it has been a part of the pastoral ethos to maintain as large a herd as possible. Aside from the fact that
pastoralists depend (to varying degrees) on their herds for food, fertilizer, fuel, trade, transportation, and cultural reasons (Johnson, 1969), there are also biological reasons to be considered. Some scientists, for example, have calculated that about five cattle are needed to support each pastoralist (Brown, 1971; Widstrand, 1975). Thus, human population increases require increases in cattle population just to maintain the nutritional status quo. Given pre-Colonial constraints on pastoral activities (i.e., the absence of vaccine programs, deep wells, national borders, and the existence of cattle raids, slaves, trans-Saharan trade, and so on) such strategies were apparently sound.

Added to these reasons for keeping large herds is that, for the pastoralist, large herds are to some extent a buffer from the impact of adverse weather events or of livestock diseases. As Oxbury (1975) noted, "In the absence of any insurance policy against drought and bad years, it is clear that a policy of herd maximization is the rational solution for the pastoral nomad, and that given present conditions, no amount of persuasion from outsiders will alter this."

The correctness of their view has been indirectly underscored by past government actions which reaffirmed that in times of crisis pastoralists could not depend on their governments for relief. The obvious response by pastoralists to this type of government hostility was to continue to keep as many cattle as possible in their herds.
Herd-related strategies such as cattle dispersals and loans fall under the broader activity called "the circulation of stock" (Dahl and Hjort, 1976). Those with cattle loan some of their surplus stock to those who either lost theirs to drought or disease to those who may need breeding stock. Such loans represent a social responsibility by the "haves" within the pastoral community to the "have-nots." In addition, they represent a drought strategy because in times of drought stress they can call in their loans.

Pastoralists are not unaware of the adverse implications of weather (and economic) fluctuations or of the political realities of government policies (see, for example, Laya, 1975). With respect to the former, they know that such fluctuation will recur in the future. They have given weather-related names to many of their drier years. Historical and climatological evidence confirmed their expectations. One researcher recently commenting on the drought in Mauritania noted that "those nomads who had most preserved their traditional values and skills were best able to resist" (Toupet, 1977). With respect to weather fluctuations and to politics some people have likened their circulation of stock to a banking system "where surplus is invested and to an insurance system if households are victims of economic fluctuations regardless of cause" (Dahl and Hjort, 1976).

Attempts to "encourage" pastoralists to destock have also been pursued by the government, without consideration of the problem as a whole. For example, the construction of modern abattoirs to
encourage legal (as opposed to clandestine) slaughter of cattle to
get meat into the modern trade sector often failed because government
representatives would use the abattoir as a place to "catch" and tax
those hard-to-find pastoralists' herds (Stryker, 1974). Also, working
against the use of the government abattoirs has been the poor price
of meat which is kept low by the government in order to satisfy the
needs of the more politically important urban populations. Thus,
in light of the pastoralists' need for a minimum number of cattle
for all the reasons noted earlier, it seems difficult to reduce herd
size to a level that might be acceptable to both the pastoralists
and their government bureaucrats. Furthermore, as Bernus has suggested,
"Any legislation--no matter how well conceived--will be worth nothing
more than the paper on which it is written, if the pastoralists do
not perceive its significance for their own livelihood and well-being."

The division of the bureaucracy into subunits each of which
deals with a unique aspect of the rangelands such as veterinary
medicine, water, agricultural marketing, security, and health, with
each subunit having a high degree of autonomy in its functional area
and each locked in a perceived zero-sum political competition with
others for scarce resources and influence, has precluded the treatment
of rangeland problems holistically. This competition caused each
subunit to deal with its own disciplinary activity, thereby setting
the stage for the inability of any group to see, let alone accept, the
holistic nature of the rangelands and, therefore, of rangeland manage-
ment (Baker, 1974).
THIRD LEVEL - The International System

Technology is the answer, but what was the question?

(Harlan Cleveland, 1974)

At least two important causes of desertification can be assigned to the third level—the transfer of technology from developed to developing state and the role of the international technical advisor in the economic development process.

Political leaders in the developing state have generally been reluctant to divert scarce resources away from economic development and toward the protection of the environment. They are often eager to accept technological inputs from the developed countries, including advice from technical aid personnel. Yet, there are numerous readily available publications which confirm that technological transfers to regions like the Sahel have often had negative effects on the social and natural environments (Farvar and Milton, 1972). Yet, technology can be viewed as neutral. How and where it is used determine what value—positive or negative—it might have to various individuals and groups within the society.

Some of these technological inputs in the Sahel have not only failed to achieve their objectives but have in the long run precipitated other environmental problems. Deep wells have already been discussed as primarily a second-level problem but it is one with a definite, third-level component (technology transfer).
Other third-level factors include the transfer of meat marketing strategies, veterinary medicine, tsetse eradication, irrigation projects, cash crop schemes, and weather and climate modification schemes. Each of these technological transfers has contributed in some way to the desertification process, partly because technology is so often applied to resolve problems the root causes of which are primarily social in origin. Consider, for example, weather and climate modification schemes that have been suggested during the twentieth century for the Sahara and those areas surrounding it (Glantz, 1977c).

Most of these schemes, including the creation of inland seas, the creation of thermal mountains, vegetation modification (tree belts), and cloud seeding, were extremely popular during droughts or immediately thereafter. They were often suggested in order to rejuvenate once-productive but then abandoned land or to counteract the ongoing tendency toward the degradation of traditionally productive land as a result of poor land management practices. A major problem with these schemes is that they have indirectly contributed to desertification because they have drawn attention away from the real problems of poor land management and have cultivated the hope that large, spectacular projects can save society from the adverse effect of its mismanagement of the land.

Ranching schemes provide another example of technology transfer with adverse side effects. These schemes are often primarily designed to increase meat production in the Sahel. The Texas Tech-
Africare Mixed Ranching Scheme (1974) was based on the transfer of capital-intensive development plans to capital-scarce but labor-surplus regions in the Sahel. That scheme was not implemented, because it was considered an inappropriate transfer of technology. However, other expensive (and often unworkable) schemes have been undertaken. The Tanganyika Groundnut scheme is one example. The site of this scheme, developed in the early 1950s, was poorly chosen from a climatological standpoint in that regional climatic data strongly suggested that drought could be expected more often than not (Sakamoto, et al., 1979). The project failed after several years and an expenditure of several million pounds sterling (Yao, 1973).

At the end of the 1960s a conference was held on the environmental implications of international development projects (Farvar and Milton, 1972). The case studies that were presented highlighted the fact that such development projects have—not only in arid and semiarid areas but in other climate regimes as well—often adversely affected the physical and social environments that they were meant to enhance.

As suggested earlier, technology can be considered neutral. The agents of transfer—the technical advisors—however, cannot. Support for, and sources of, technological transfer come for the most part from the developed world, with those advisors representing such entities as governments, consulting firms, corporations, and non-governmental organizations. The history of economic development projects undertaken in West Africa shows that they aimed at higher efficiency, but
also that modern strategies come more from outside inspiration (i.e., from contract companies and development organizations, courses for technicians, specialized literature and so on) than from observing the local environments and carefully examining the traditional strategies (UNESCO/MAB #9, 1978).

In many instances, advisors from the developed states have given in to (or worse yet, encouraged; Swift, 1977) requests for technological fixes (such as dams, ranching schemes, remote sensing capability, agricultural schemes), even when they knew from experience that such schemes by themselves would not only fail to lead to stable, long-term development but would in all probability be likely to lead to desertification in the long run. One reason for this is that advisors are usually expected by their governments and those they are assisting to address only the technical aspects of a problem without interfering in the internal affairs of the recipient state. However, solutions to many of the problems they are asked to deal with may be found in the realm of domestic economics and politics and not necessarily in technology. Thus, the agents of technology transfer in some ways can become part of the problem and not part of the solution to combating desertification in the West African Sahel. This is truly a third-level problem that reflects another contribution of the international system to desertification.
Concluding Perspective

The prime motivation for this paper was the belief that several solutions to apparent causes of desertification in the West African Sahel were known but not applied. I have found that many solutions are apparently known and in some cases are applied to the apparent causes but that in many instances they have proven to be ineffective or even counterproductive. In other cases known solutions have not been applied and the causes of desertification have continued unabated or have been intensified. The reason they are not applied, or if applied, have little effect, often relate to human nature and behavior, that is, at the first level of the analysis. Yet, on the social side this aspect of the desertification problem is the most overlooked compared to second- and third-level aspects.

It appears from the literature that second- and third-level aspects of desertification have received the most attention from research and technical assistance establishments, as well as from the popular press. It seems that while many of the apparent, highly visible causes of desertification are known and in many ways are dealt with, little attention is focused on the deeper, underlying problem of those perceptions which foster the continual abuse of fragile Sahelian ecosystems. Yet, the above analysis of the three levels of socio-political organization, however preliminary, suggests the importance of the first level in the process of desertification in the West African Sahel. Few, if any, programs, however, have
dealt directly with first-level aspects of this extremely important environmental problem.

The real (as opposed to apparent) or underlying (as opposed to precipitant) causes of desertification appear to be associated less with technology transfer, for example, or with the competition of social groups for scarce (and ever-dwindling) resources than with the perceptions that both individuals and groups of individuals have about each other and that each has about its environment. The perceptions of reality of both the dominant and subordinate groups must, therefore, become a major focus of attention and must be coupled with existing second- and third-level analyses to combat effectively desertification in the West African Sahel.

New schemes, more funds, additional technological transfers in the long run only serve to accelerate the process of environmental degradation, in part because the preceding discussions suggest that all too often technological solutions have been and continue to be applied to problems which are in fact social or economic in nature. Similarly, second- and third-level solutions are often applied to what are primarily first-level problems. What is needed is an awareness of all three levels and of how they relate to each other.

Assuming that first-level causes of desertification are the prime targets for dealing with desertification, how might one alter, for example, misperceptions these groups have about one another or to remove the "we-they" dichotomy that so often develops and fosters a "diabolical enemy image" among groups in the various Sahelian countries.
In theory, at least, the solutions to the first-level problems are easily identified. They consist of altering the perceptions that subnational groups have toward each other and toward their physical environment. First of all, trust must be developed between these groups. In addition, those groups must recognize and accept the limitations imposed on them by the fragility of their ecosystem.

With respect to the former suggestion, the initiative would have to come from the national government leaders as well as through the various bureaucratic subunits. Pastoralists believe that many of their problems are linked to government policies. Distrust that has developed over decades and has been reinforced during the recent drought episode [i.e., government discrimination within the refugee camps in the favor of the cultivators (Kloth et al., 1974) on the export of cash crops in the midst of drought and famine (Lofchie, 1975)] is in large measure the direct result of government actions, both colonial and independent.

Changes in the perceptions of political leaders in these states, while a necessary condition for combating desertification, is not a sufficient one. Also required would be a change in the development ideologies of various Western foreign assistance organizations. Western technical assistance experts, too, must question their reluctance to include the local populations in the planning and development of the land on which they live (Sachs, 1974) as well as their attitude about the unassessed transfer of technology to West Africa. Their
reluctance to include, for example, the pastoralists in any phase of the development is still apparent despite the growing awareness (as well as lip service) to the fact that their inputs may well hold the key to the success of any development plans for the grazing lands of the West African Sahel. As Clarke summarized (1978): "The growth-oriented technology was introduced in the Sahel without restraints and without either consultation with or consideration for the people whom it would affect the most. One of the foremost reasons why the nomads were never consulted by their benefactors was the continued belief in the myth that the nomads were unproductive, inefficient, aimless, and irrational wanderers."

Such changes in perceptions (and strategies) of the experts about the pastoralists and their environment could effectively reinforce the efforts of government leaders to create a new relationship with the pastoralists, one based on acceptance, understanding and trust.

The second solution suggested above, i.e., improved knowledge about and acceptance of the limits of the ecological setting, is also an essential factor. To live within the limits of an ecosystem, it is imperative first to accept the fact that there are limits, and, second, to determine what those limitations are and what demand they impose upon social policy.

In summary, while it may be easy to identify solutions to the causes of desertification in theory, it is in reality quite difficult
to apply those solutions. As many of the causes of desertification are related to human perceptions of man's relationship to nature, so too are the reasons that known remedies are not applied. For example, it is extremely difficult to alter perceptions based on (hostile) relationships that have taken place over long periods of time. It appears that reinforcing this history of distrust are the conflicting goals of the dominant and subordinate ideologies. There appears to be little if any desire on the part of those representing the dominant ideology to compromise "their" development goals and to give up on their hope that technology can save them from the limitations imposed on them by their harsh environment. In addition, their lack of interest in compromising with the pastoralists is reinforced by other groups in society which, in general, tend to side with the government—i.e., urban dwellers (including in general the bureaucrats) and cultivators.

The social causes of desertification cited in this paper to exemplify the three levels chosen for analysis are but a few of those that might have been chosen. The examples chosen for this paper were related to one environmental problem in one geographic region. Furthermore, each example was interpreted at only one of the several levels of social organization. Nevertheless, the significance of the different levels of social causation of desertification remain clear. The present analysis suggests that the first-level factors are more important than most commentators have recognized.
This does not mean that all solutions to the causes of desertification are reducible to the first-level factors. What it does mean is that there has to be a redirection of attention to include first-level, as well as second- and third-level factors, if there is to be any hope of lasting success in combatting desertification. Dealing with only second- and third-level factors to resolve the crises associated with environmental degradation will mean that in the long run the desert sands and the desert winds will win out over civilization in the Sahelian zone of West Africa. This would be a defeat for the governments of less developed nations suffering from problems of desertification, as well as for developed nations and their representatives who genuinely seek to combat desertification.


