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ENVIRONMENTAL STRESSORS IN FRAGILE PLACES: A CASE STUDY IN THE SAHEL

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ABSTRACT: *Many areas of the world struggle on a daily basis with a multitude of environmental stressors ranging from day-to-day inconveniences to outright disasters threatening life and livelihood. The field of environmental security attempts to understand how the interrelationships between human and natural processes destabilize the environment and undermine human security. Indeed the cyclical relationship between resource depletion, poverty, and conflict has the ability to push societies to the brink of disaster. Environmental security is one component of human security, defined by the United Nations in 1994 as the intersection of economic, food, health, environmental, personal, community and political needs (Nyong, 2005). This paper delves into the ideology behind the often convoluted and relatively new idea of environmental security. Only after realizing the complexity of these relationships can one make informed, nuanced judgments about a particular geographic domain and the spatial challenges that dominate it. We will discuss environmental security and how it pertains to Africa as a whole, and end the paper using the Sahel region as a specific example of a place that is challenged.*

Keywords: *Environmental security, Sahel region of Africa*

WHAT IS ENVIRONMENTAL SECURITY?

Soon after the Cold War ended and decades of Soviet geopolitical influence abated, it became quite clear that the notion of security was about to dramatically shift to something entirely new. The dominance of bilateralism was replaced by multilateralism and, further, the natural environment began to be viewed as one of many increasingly important non-state actors. Since the mid-to-late 1980s policy-makers have struggled with the idea of linking the environment, environmental degradation, military operations, and conflict (Allenby, 2000 and Graeger, 1996).

The concept that environmental stress can induce human insecurity is not new and countless examples exist throughout history (warfare in ancient China and the collapse of Native American population centers in present day southwestern United States are just two). The post-Cold War era saw a refocus towards environmental concerns when actors such as India, China, various African states, the "new" Russia, and the European Union (EU) began to emerge and assert their newly-found influence on the world stage. In the U.S., one of the first manifestations of this new environmental security paradigm (as state policy) dates back to the first Clinton administration when concerns about military-induced environmental degradation rose to prominence. As a matter of execution, Clinton administration concerns centered on the prevention, remediation and mitigation of significant environmental problems related to military installations and efforts therefore were budgeted and staffed to meet these particular goals. The definition continued to evolve in time through the late 1990s to take on a more international flavor as the enormity, complexity, and interrelatedness of environmental malfeasances began to be realized throughout the developed and lesser developed areas of the world.

The notion that the environment was critical to security strategy made its formal U.S. policy debut in the National Security Strategy of 1991. This document outlined the four principal threats to U.S. national security, one of which was "environmental dangers." In 2005, environmentally related instability was emphasized as a fundamental strategic concern and a key player in contemporary conflicts by the Department of Defense (DOD) (DOD, 2005).

The idea of environmental security is difficult to codify, but boils down to a state's perspective. For example, the perspective can be one of ecological security if the sole goal is to address environmental concerns for the sake of the welfare of the environment. This ideology does not take into account the

possibility of conflict stemming from environmental disturbances nor does it acknowledge that the environment is inextricably tied to human populations.

Another more complex perspective is a state-centered approach where actors behave solely in their own self-interest. The state-centered approach has several glaring pitfalls. First, this method often ignores some very obvious and key trans-border considerations related to many environmental problems. It can also be quite militaristic as it reduces most environmental aspects to a conflict-driven set of problems between the state and its enemies. As a result, this narrow approach has a weak effect on diplomatic policy, mutually-derived security arrangements with other states, and the proper use of military lands, since everything about it is rather one-sided (Graeger, 1996).

A broader and more helpful perspective involves looking at environmental security matters in a supranational way. Here, the key is multi-state cooperation when security and the environment coincide, acknowledging the potential and far reaching impacts of environmental issues that are important to other states (Graeger, 1996). Modern-day examples of this include the 1989 Montreal Protocol banning the production of dangerous chemicals responsible for atmospheric ozone depletion, the 1997 Kyoto Protocol addressing climate change policy matters, and the more encompassing United Nations-driven Intergovernmental Panel on Climate Change (IPCC) which directs climatic research in an effort to provide policy-ready recommendations to states around the globe. Each of these supranational agreements has taken scientific data to generate suggestions for policy makers worldwide to consider, debate, and perhaps adopt. The implications and complexity of such supranational constructs are clear in terms of potential gain, yet fraught with inherent pitfalls as states often choose to act in their own economic self interest. Such was the case when the U.S. and Australia signed but failed to ratify the Kyoto Protocol, citing dire economic consequences and protesting the exemption of India and China. Here both states acted in their own economic self interest, essentially rendering the protocol impotent and moot.

In 1996 the United Nations (UN) took on the subject of environmental security by establishing a panel under its larger Millennium Project umbrella. The UN gathered experts in many fields in an attempt to adopt a single definition from a set of varied ones. After contentious debate the panel settled on a Millennium Project-approved definition of environmental security as "environmental viability for life support," with three sub-elements (Millennium Project, 2008):

- preventing or repairing military damage to the environment
- protecting the environment due to its inherent moral value
- preventing or responding to environmentally caused conflicts

If one generally accepts that the environment can act as a trigger or exacerbating force for conflict, and that both social and economic instability are related to the quality of the environment, the definition can be further refined as freedom from social and economic instability due to environmental stressors and degradation (Glenn et al., 1998).

ENVIRONMENTAL SECURITY IN AFRICA

Environmental security−or insecurity−in Africa can be viewed in terms of many complex and non-linear interactions. Such interactions include the instability brought on by large populations, poor infrastructure, existing conflict, the prevalence and widespread nature of endemic diseases, fragile ecosystems, weak governance, and the developing and highly uncertain specter of climate change and climate variability. As stated by the UN's Environmental Programme (UNEP), in general there continues to be a downward spiral with decreases in quality and quantity of environmental goods and services that places serious constraints on economic development and human well-being. (UNEP, 2006).

The African continent is geographically diverse in every sense of the word. It is easy to forget that the continent of Africa is larger than China, the United States, Argentina and Western Europe combined, totaling over 18.7 million square kilometers (African Studies Center, 2008). Africa consists of seven distinctive climates as defined by the Koppen climate classification system, each with different precipitation patterns, soil regimes and vegetation types. Africa's human diversity is also great−the continent is home to 53 sovereign states, 900 million inhabitants, and over 2000 languages. There are countless tribes and ethnicities, resulting in a complex and often intertwined cultural geography. Hence, environmental security in Africa is wide ranging, complex and multi-faceted. If managed correctly

Africa's vast resources offer huge potential for development; however, wise management has not often been the case.

One of the key elements of environmental security is food security. Environmental security and food security are intricately linked and are influenced by many of the same factors such as corruption, absence of human rights, fresh water resources, and climate. Internal to a county, food supply can be reduced by overpopulation, ethnic conflict, weak or ineffective government, and environmental degradation (Marsh and Grossa, 2005). External influences to a countries food supply are also numerous. For example, IMF and World Bank policies have pushed many countries towards commodity agriculture at the expense of domestic food production. Also, it is becoming increasingly common for foreign companies to purchase African farmland to supply themselves with exported food or biofuels.

Seventy percent of Africans depend on agriculture as their means of livelihood; hence African states can largely be considered rural economies. Yet for reasons cited above, over 35 percent of the people in Africa are considered hungry (Sanchez and Swaminathan, 2005). Globally, there is enough food produced to adequately feed all of humankind; however, allocation and distribution inequities occur resulting in millions of poorly nourished people (Marsh and Grossa, 2005). The poor face starvation, as they do not have the means to purchase or produce their own food. Regarding rural agriculture, overpopulation forces people into less productive marginal lands resulting in short-term production gains; these gains are unsustainable in the long term. Also, ethnic conflict and ineffective governments magnify the problem by slowing or preventing food distribution to hungry people. The poor and hungry in Africa are frequently those who live furthest from roads. The lack of road networks drives up the time and cost of distributing food; consequently further worsening hunger among the poorest communities. Thus, these factors combine to form hunger 'hotspot' regions within Africa (Figure 1). The UN Millennium Project Task Force on Hunger identified tropical sub-Saharan Africa as the region facing the greatest challenges in reaching the UN Millennium Development Goal of reducing the proportion of people who suffer from hunger by half between 1990 and 2015. Of those who are hungry, 50 percent are farmers (Sanchez and Swaminathan, 2005). This is primarily due to poor agricultural yields, mostly as a result of declining soil fertility.

Desertification is to blame for much of Africa's poor soil, particularly in the Sahel region. Desertification was defined by the UNEP in 1992 as land degradation in arid, semi-arid and dry sub-humid areas, which results from various factors including climatic variations and, most importantly, human activities. Simply, it is the process of degrading dry land primarily by human activity when those activities use the land beyond its carrying capacity, thus affecting human welfare (Hulme, 1993). Desertification in Africa is worsening for two reasons. First, overuse of the land and poor irrigation practices have created salinized soils which contain too much salt for vegetation to grow. Second, drought has intensified hot, dry climates and hastened desertification processes.

From a short-term perspective, a better understanding of climate variability is one way to combat the most immediate and tangible negative impacts of desertification. The ability to foresee the onset of seasonal events like El Niño and La Niña (events driven by sea surface temperature anomalies) and ready access to remote sensing data/technologies afford ways to mitigate and persevere through seasonally tough farming conditions. A program developed by the U.S. Agency for International Development (USAID) as an early warning system for famine and for the strategic deployment of food resources within Africa is aimed at accomplishing this very task. The program is three-pronged: integrating climate variability forecasts, monitoring the progress of each growing season, and planning near-term response activities. This system allows relief agencies, local states, and farmers to plan accordingly, thus minimizing the possible impact of desertification events that stem from climate variability episodes (Hastings, 2005).

The current inability of many Africans to feed themselves becomes even more important when one recognizes that the majority of African states have increasing populations. Rwanda, an extreme case, is on track to double its population in 17 years (US Department of State, 2008). Rwanda is one of the world's most densely populated states so overpopulation there is one of the most critical environmental stressors. In Rwanda, population growth was enabled by myriad factors including improved sanitation, healthcare, and relatively successful agricultural yields driven by fertile volcanic soils and two rainy seasons. However, overpopulation coupled with environmental degradation resulted in a reduced food supply. In an attempt to remedy this situation, agriculture was expanded into marginal lands, resulting in the further degradation of land including, erosion, further soil exhaustion, decreased water supply and, in turn, a lower agricultural yield. This cycle caused the migration of people from farms to cities ill-equipped to support them, which served to perpetuate an existing poverty cycle. This precarious situation can be exacerbated

by climate change and climate variability episodes. In Rwanda unsustainable farming practices, drought, migration, and population growth led to insufficient food supplies and consequently transformed it from a leading food producer per capita in the region in the 1980s to one of the worst in the 1990s (Diamond 2005). The combination of these factors resulted in a dangerous strain on the Rwandan population that served as a catalyst for the 1994 genocide.

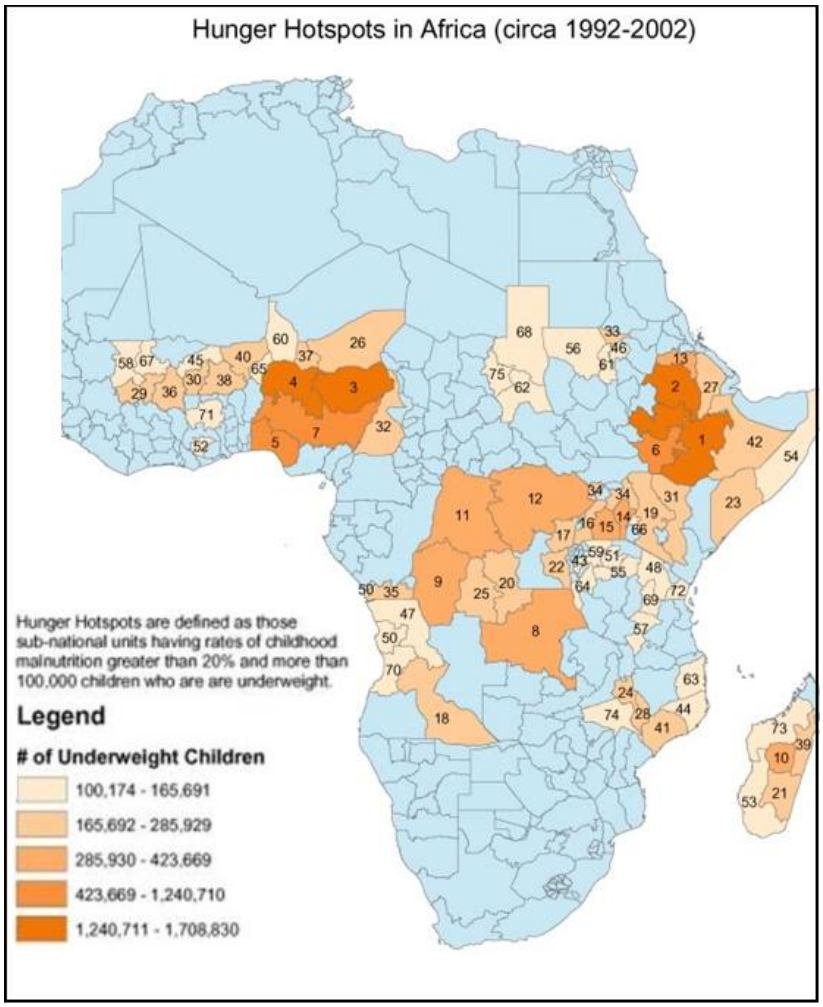

Figure 1. Hunger hotspots in Africa (CIESEN, 2008).

A key element to both food supply and human survival is access to fresh water. Fresh water stress is expected to increase in future years (Figure 2). Fresh water is also a critical component of mining, hydro power generation, tourism, and livestock production, all of which are important to healthy African economies. Parts of Africa are endowed with large fresh water reserves; however in 2005 only about 5 percent of the development potential of this resource was realized due to poor infrastructure and a lack of money to invest in development projects (UNEP, 2006). Corruption also plays a role in prohibiting development of fresh water resources. Africa's fresh water supply is not evenly distributed and in many places, evaporation exceeds precipitation more than six months of the year (Love et al., 2006). Consequently, in many African states fresh water is threatened by overuse, poor management, and stresses caused by climate variability and change. Droughts of varying intensity are common in Africa, and the continent has suffered eight serious droughts since World War II (Zerbe, 2004).

The combination of increasing populations, degraded soils, inconsistent access to fresh water, and changes in climate build the foundation for environmental security concerns in Africa.

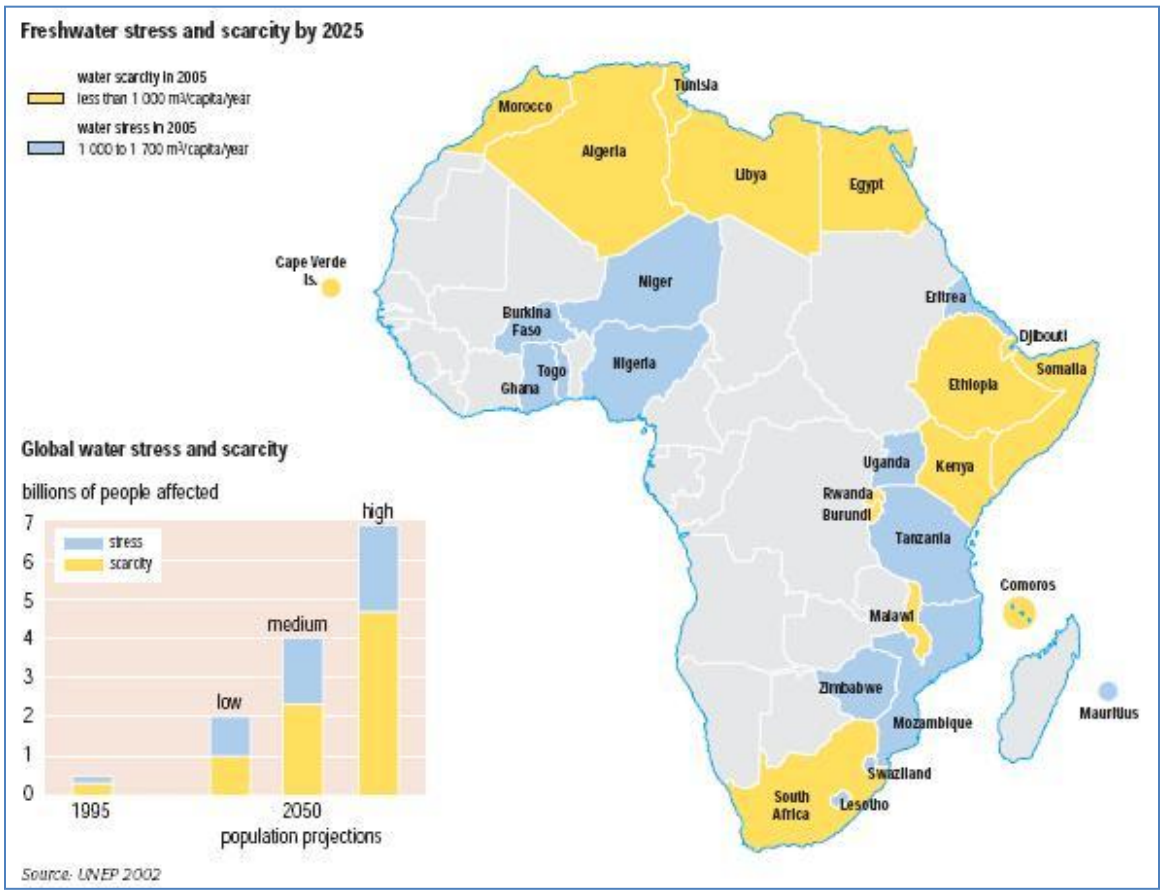

Figure 2. Freshwater resources in Africa (UNEP, 2002).

CASE STUDY: ENVIRONMENTAL SECURITY IN THE SAHEL REGION

Scientific research including numerical (computer) modeling predictions are ongoing regarding the severity of climate change and variability scenarios affecting the Sahel. All serious discussions tend to center along the argument that the future of the African climate system (including the Sahel) is likely to have severe consequences and impacts on human populations. This section will look at the Sahel region of Africa by focusing on the intersection between physical and cultural settings and juxtaposing these against climate change and variability considerations. The idea of climate change and variability is especially troublesome here because it threatens to unravel a precariously balanced and volatile region of the continent, likely affecting human security.

The Physical Setting of the Sahel

The area of Africa known as the Sahel is a strip of tropical savanna wedged between the Sahara Desert to the north and the tropical rain forests of Central Africa to the south. This is a region dominated by a contrast in climatic regimes delicately balanced between wet and dry seasons. In this region, countries like Mali, Niger, Chad and Sudan have approximately 80 percent of land area classified as true deserts with a small area that is marginal, at best, for agricultural production and economic potential. Niger, especially, is affected by the aforementioned delicate balance of wet and dry seasons. Figure 3 shows graphical depictions of climate data (temperature and precipitation) for three cities in Niger: the capital city of Niamey in the southwest, and Agadez and Bilma to the northeast. Note that each graph shows a precipitation maximum centered during the July-August timeframe, highlighting limited and seasonal

potential of agricultural activities in this part of the continent. In the southern third of the Sahel, for example, precipitation totals support marginal agricultural yields in the vicinity of Niamey while practically uninhabitable conditions dominate Bilma, which is well to the northeast and within the Sahara Desert. It is clear from this simple map that the shift in seasons governs the ebb and flow of life in the Sahel, and that the area is intricately connected to its rainfall pattern.

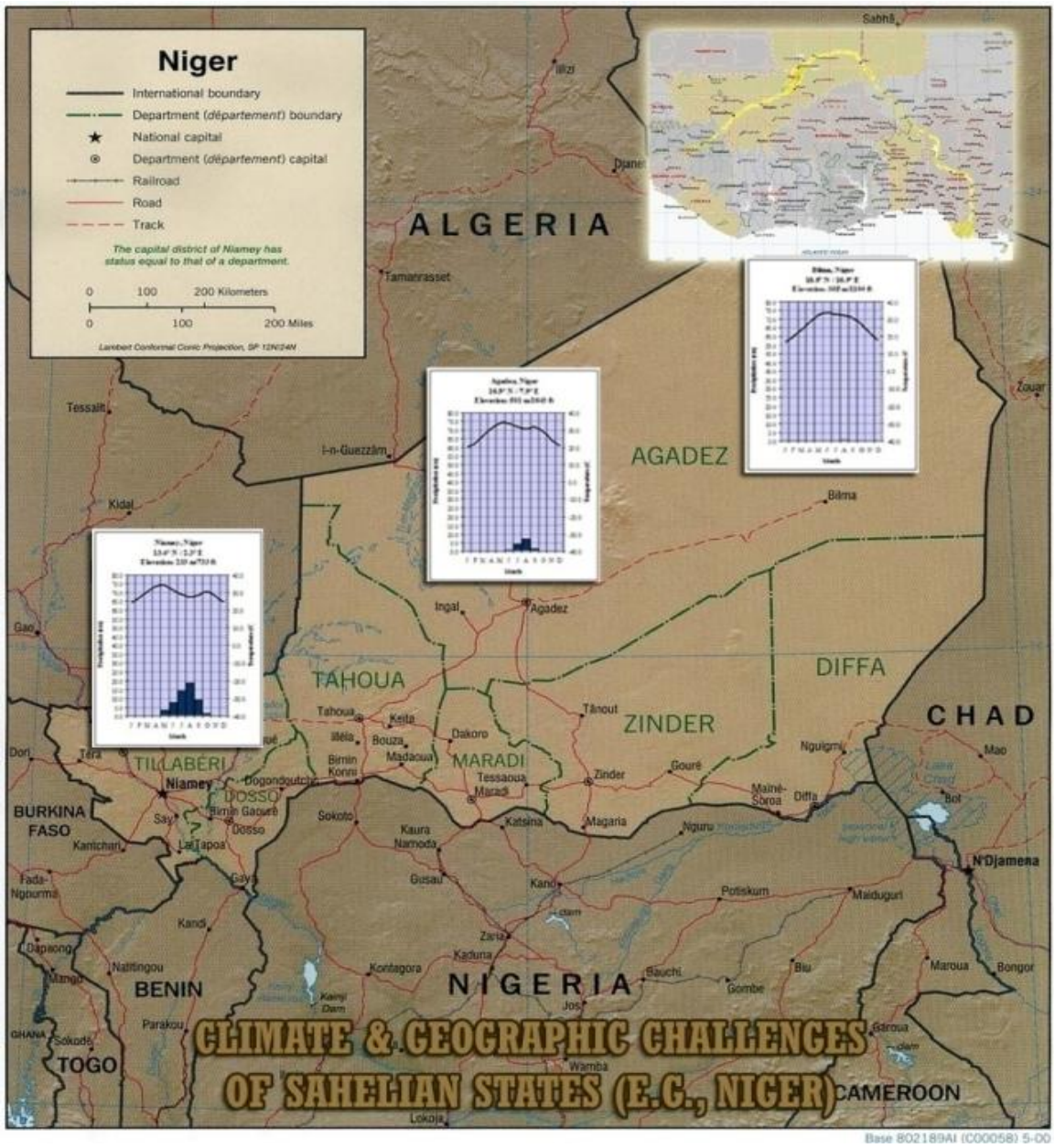

Figure 3. Graphical depiction of climate data across the Sahelian state of Niger. Climate data graphed by month. Precipitation totals provided in centimeters and temperature data provided in degrees Celsius. (University of Texas at Austin online map library).

Another aspect of the Sahel's physical geography is its access to water. More than any other physical factor and natural resource, access to clean water is paramount to a people's ability to survive and thrive. The Sahel is home to the Niger River (Figure 4), an arc-shaped stream channel with its origin in the higher elevations of Guinea and which meanders though Mali and Niger before finally flowing to the

Atlantic Ocean through its delta in southern Nigeria. When it comes to this major source of water, relative location is everything. In Niger or Mali, for example, the river traverses a true desert, with much less flow than in places benefiting from a wetter climate (Nigeria and Benin, for example). Competition and usage of this vital resource is a potential catalyst of conflict if not managed cooperatively among states that share it. The Niger is quite likely to come under increasing pressure as climate variability episodes and longer-term climate change events manifest themselves in yet-unknown ways.

Figure 4. Niger River with respect to the western half of the Sahel (Wikimedia.org 2007).

The Cultural Setting of the Sahel

Many problems in Africa are people-centered−whether clans in Somalia, rebel groups in Darfur or the constant struggle between nomadic pastoralists and subsistence farmers in Northern Africa and the Sahel. This is especially meaningful when one considers that the very complex pattern of tribal religions, languages, and cultures encountered in sub-Saharan Africa does not really fit the modern post-colonial construct of geopolitical boundaries. Religious and cultural norms also contribute to sever over population. In the Sahel, poverty is a key component of environmental degradation as people frequently adopt practices that degrade the environment because their most immediate goal is daily survival rather than long-term sustainability (Nyong, 2007).

The Impact of Climate Change and Variability on the Sahel

Evolving from a loosely regarded idea in the early 1980s to *the* environmental issue of the 21st century, the causes, societal impacts, and complex interactions of short-term climate variability and concerns about longer-term climate change have certainly taken center stage in many of today's meaningful scientific endeavors and discussions. Areas of the world like the Sahel are especially vulnerable to climate manifestations that deviate too far from the expected norm. In fact, recent examples demonstrate that even relatively small climate variations can impact humans greatly.

The great Sahelian drought that affected the area from 1968 to 1993 is an example of climate variability at its most extreme. It affected the lives of over 50 million inhabitants across the Sahel as agricultural systems collapsed. Figure 5 clearly shows that the period from 1968 to 1993 was characterized as drier than the standardized norm for every single year except for 1976, when rainfall was about the average (Dore, 2005). A significant percentage of agriculture in this area is rain-fed (over 40 percent in Niger, for example) so the implication of drought to human security is clear, especially in light of sparse or immature irrigation systems.

The IPCC, the UN chartered organization charged with the daunting task of compiling the body of work on climate change and its many implications, argues that continued changes affecting the African continent will be wide-ranging and likely severe. The observed record across the region shows that during the 20th century, the temperature across the Sahel rose 0.7°C (IPCC, 2007). Although climate models suggest a warmer planet and warmer oceans, the attendant increase in evaporation and rainfall that will follow in some places does not translate to increased rainfall for the Sahel. Some models suggest a 0.2°C to 0.5°C rise per decade or 1.5°C to 4.5°C by the year 2100, with drier conditions throughout the Sahel and northern Africa (Saharan Africa) and a net decrease in precipitation of between 10 percent and 30 percent of current norms. IPCC scientists, however, caution that the mechanisms, responses and climatic forcing factors that will drive changes in the 21st century are still not well understood. Some models, for example, indicate a modest moistening of the area, pointing to a disparate and often perplexing set of results that highlight the problematic nature of accurate climate forecasting. As a general rule climate scientists run a series of computer models that take into account not only greenhouse gas emissions and solar/terrestrial energy budgets, but factors such as the complex and non-linear atmosphere-ocean linkages in order to assess the future of the global climate system. Climate scientists often "back" forecast past climates in order to see if a particular model handles already observed phenomena (such as droughts and other climatic variations), thus gaining (or losing) confidence in a particular model. In the end, it is a process of learning and re-learning that continually hones and sharpens the overall predictive skill (Christensen et al., 2007).

Hulme et al. (2005) argue that the robustness and reliability of long-term climate change predictions over tropical regions of the world (such as tropical Africa) are especially unreliable and problematic. Poor numerical representations of key variables such as land cover-atmosphere interactions, tropical sea surface temperatures, overall areal coverage of vegetation, and the impact of dust and aerosols are often cited as examples of how little understanding there is about the mechanisms that drive prolonged desiccation episodes in the Sahel (Hunt, 2000 and Leblanc et al., 2007). Furthermore, the importance of properly depicting tropical sea surface temperatures, an integral driver of climate in the Sahel, and merging these data with the aforementioned land cover construct, makes understanding of climate forcing mechanisms in this area of the world especially difficult (Leblanc et al., 2007).

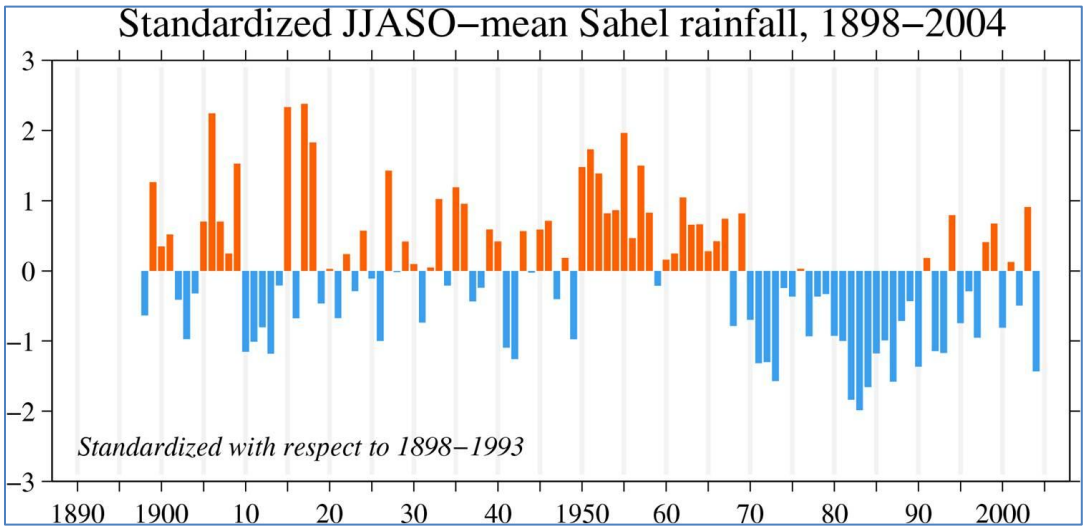

Figure 5. Sahelian rainfall deviations from standardized means for June, July, August, September and October (JJASO). Positive anomalies (above y= 0 and in red) depict wetter than average years while negative anomalies (below y=0 and in blue) depict drier than average years. (note: data averaged for the entire Sahel Region) (Tschakert, 2006).

While is it critical to systematically improve the reliability and knowledge base about these large-scale numerical models, Hastings (2005) points to the idea of human populations adapting to shorter-term variability episodes as a legitimate and pragmatic way of dealing with climate-driven calamities. The 20th century saw several of these severe multi-year/multi-decadal events throughout Africa so "…lessons from adaptation to short-term climate variability would build capacity to respond to incrementally longer-term

changes in local and regional climates" (Hastings, 2005). In the end, it is clear that these multi-faceted problems faced by the Sahel are compounded by the looming and ever-growing threat of climate uncertainty. Even if the science of forecasting the future state of the climate system is inexact and problematic, it is fortunate that the inhabitants of this region are exceptionally adaptive and innovative, and they have the attention of multinational organizations and governments. Since the effects of climate change may indeed be dire, it is imperative that action be taken in a cooperative sense, as inaction may prove far more devastating and difficult to deal with as time goes on.

CONCLUSION

Throughout the world, but especially in the lesser developed areas of the globe, environmental security plays a dominant role in the human security of states and how these states behave: as single actors or as members of the larger global stage. Although the concept of enviromental security is relatively new and often contentious, given its many definitions and perspectives, it is clear that it influences human security. Increasingly the idea of environmental security has become a necessary tool to understanding conflict, the potential for conflict, and by contrast the prospect for stability. Multi-state efforts like the Kyoto Protocol and the increasingly powerful influence of the IPCC confirms the importance of the environment in policy making.

Whether conflict arises from environmental stressors or the other way around, this multi-faceted notion within the Sahel region of Africa affects the lives of millions of Africans on a daily basis, threatening life and livelihood in tangible ways. Within this part of Africa, climate is a daily and dominant influence in the lives of its residents. The fact that the Sahel is wedged between two vastly different climate zones implies that everything about daily life is governed by how much precipitation falls, when it falls, and what can be done with it. Given the lack of sophisticated irrigation systems and the myriad other stressors within the region, climate can be the catalyst that tips a state in a negative direction, exacerbating population pressures, existing medical problems, weak governance, and the over-reliance on organizations providing aid.

The Sahel is one example of how the environment influences human security, but many places in Africa face the same challenge. Continued degradation of environmental resources coupled with population growth and weak governance position many African states to be vulnerable to environmental stresses. This vulnerability is only increased with the potential of climate change. The future security of many African states will need to address these relationships: geography offers a unique vantage point from which to understand the dynamics of environmental security.

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