CRISIS IN THE SAHEL

Possible Solutions and the Consequences of Inaction

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A report following the OASIS Conference (Organizing to Advance Solutions in the Sahel) hosted by the University of California, Berkeley and African Institute for Development Policy in Berkeley on September 21, 2012

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> *"The Western world had no idea what Sahel was because history has taken the attention of NATO and Western countries to Iraq and to Afghanistan, but Sahel is potentially even more dangerous... certainly than Afghanistan"*
>
> — Romano Prodi, UN Secretary General's Special Envoy to the Sahel

> *"Times of crisis can be creative times, times when new visions and new possibilities emerge, as the very dangers we face stimulate us to look deeper, seek alternatives, and take advantage of opportunities."*
>
> — Mark Hathaway, The Tao of Liberation: Exploring the Ecology of Transformation

The OASIS Initiative
Organizing to Advance Solutions in the Sahel
Organizer l'Avancement des Solutions au Sahel

Berkeley
UNIVERSITY OF CALIFORNIA
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Bixby Center
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AFIDEP
African Institute for Development Policy
Bridging Development Research, Policy & Practice

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PREFACE

The goal of this report is to start building a network of scientists and policy makers committed to helping the Sahel address its population, environment, and food security challenges. A compelling body of evidence is needed to inform people in governments and relevant local institutions, humanitarian organizations, foreign aid agencies, philanthropic institutions, and national security agencies concerning the startling challenges facing this neglected and highly vulnerable region.

Two years ago, I began to explore the implications of rapid population growth in the Sahel. I was fortunate to know Eliya Msiyphazi Zulu, founder of the African Institute for Development Policy (AFIDEP) in Nairobi, and to have worked with colleagues in Ahmadu Bello University in northern Nigeria, which shares some of the ecology of the Sahel. Then I met Michael Wehner, of the Lawrence Berkeley National Laboratory, who developed projections of climate change in the Sahel. As we began to understand the implications of the collision of rapid population growth and global warming on the 100 million people living in the Sahel, we were stunned.

The pace of interest accelerated. Federico Castillo became my link to experts in agriculture in UC Berkeley's College of Natural Resources. The Center for African Studies at Berkeley and the Global Fund for Women in San Francisco shared their expertise. The idea of an international meeting focused on the Sahel took root. In July 2012, I had the privilege of being invited to the landmark London Summit on Family Planning, led by Melinda Gates and the British parliamentarian Andrew Mitchell. The success of the London Summit spurred us to organize the Organizing to Advance Solutions in the Sahel (OASIS) meeting only two months later. As far as we know, it was the first time ever that such a broad multidisciplinary group from Africa and North America had gathered in one place to share perspectives in climatology, demography, agriculture, conflict, terrorism, failed states, family planning, women's empowerment, the imperative to invest in girls and young women, and human rights. Courtney Henderson, and other staff, graduate, and doctoral students, worked tirelessly to make the meeting happen.

The meeting on September 21, 2012 generated a palpable level of awareness, excitement, and realism among the 120 participants as they began to explore ways to forestall the possibility of a huge humanitarian catastrophe in the Sahel. Everyone left the meeting committed to working collaboratively to develop a more robust evidence base to define achievable solutions in more detail and to begin implementing those solutions.

Thirty years ago, as president and CEO of Family Health International, I helped initiate the first HIV prevention initiatives in Africa. In retrospect, I now know that what we did was too little and too late. I believe that, in the next 30 years, the unfolding crisis in the Sahel could bring more human pain and suffering than AIDS has in the past 30 years. It would be tragic to make the same mistake of too little, too late twice.

Malcolm Potts

EXECUTIVE SUMMARY

The following report documents how, over the next 30 to 40 years in parts of sub-Saharan Africa, between 100 million and 200 million people are likely to be without sustainable food supplies. This was the conclusion of a multidisciplinary group of experts from Africa and North America, who asked what will happen in the Sahel when new projections of global warming are combined with rapid population growth. The meeting was not the first on the Sahel, but the breadth of expertise in agriculture, climatology, demography, family planning, the status of women, terrorism, and national security was unique and the conceptualizations of the problems unusually clear and powerful.

The Sahel comprises one million square miles of arid and semi-arid land along the edge of the Sahara, stretching from the Atlantic to the Red Sea. In 1950, the region contained 31 million people; today there are more than 100 million, and in 2050, there could be more than 300 million. New projections of climate change prepared for the OASIS meeting foresee a rise of 3°C to 5°C (7°F to 10°F) above today's already high temperatures by 2050. Scientific projections several decades into the future can never be exact, and the forecasts of population and global warming made for 2050 might come a decade sooner or later, but they will occur. The projections for 2100 are startling, with a population of 600 million in the Sahel and temperatures up to 8°C (13°F) above today's norms.

It would be totally implausible to sustainably accommodate this scale of growth. Without immediate, large-scale action, death rates from food shortages will rise as crops wither and livestock die and the largest involuntary migration in history could occur. Already today, 12 million to 18 million people in this region are hungry.[1] Early marriage of girls to older men is common in many regions[2] and no progress will be made until the age of marriage is raised and girls are enabled to go to school and make a meaningful contribution to the development of their country. Conflict and terrorism are proliferating, and more failed states are likely.

The strength of the OASIS conference was its goal to create the solutions needed to stave off the worst of the catastrophe facing the region. Building the evidence base to enable decision-makers at a national, regional and global level to invest in this critical change is our immediate purpose. Climate change needs to be addressed through agricultural adaptations

and improved water management. Women need to be enabled through family planning to manage their childbearing. The key is to meet the unmet need for family planning in a human rights framework. Investing in girls and young women is critical to creating a successful and peaceful society. The meeting was unanimous that such solutions must be immediate and on a large scale.

The participants left with a commitment to construct a network of experts dedicated to strengthening scientific analysis of the problems facing the region and their solution. Everyone agreed that the cost of inaction — in depleted environment, increased hunger, humanitarian care for refugees, failed states, conflict, housing migrants, and the further spread of terrorism — will be many times that of action to improve agriculture, provide choices on childbearing, and invest in girls and young women.

SOMMAIRE EXÉCUTIF

Le rapport suivant documente comment au cours des 30 à 40 années à venir, dans certaines régions de l'Afrique du Sud Sahara, entre 100 et 200 millions de personnes se retrouveront probablement sans ressources alimentaires renouvelables. Il s'agit des conclusions formulées par un groupe d'experts pluridisciplinaire d'Afrique et d'Amérique du Nord réunis pour se poser la question de ce qu'adviendra du Sahel lorsque les nouvelles prévisions en matière de réchauffement planétaire se conjugueront à l'accroissement rapide de la population. Cette réunion n'est pas la première à se pencher sur le Sahel, mais l'étendue de l'expertise tant en matière d'agriculture, que de climatologie, de démographie, de planification des familles, du statut des femmes, du terrorisme et de la sécurité nationale, était unique, et la conceptualisation des problèmes particulièrement éclairante et convaincante.

Le Sahel s'étend sur une superficie de 2,5 millions de kilomètres carrés de terres arides et semi-arides au bord du Sahara, de l'océan Atlantique jusqu'à la Mer Rouge. En 1950, cette région comptait 31 millions d'habitants; aujourd'hui il y en a plus de 100 millions, et en l'an 2050 ce chiffre pourrait atteindre 300 millions. Les nouvelles prévisions concernant le changement climatique, préparées à l'occasion de la réunion OASIS, prévoient une hausse, d'ici 2050, de 3o à 5oC (7o à 10oF) au-dessus des températures actuelles, déjà élevées. Les prévisions scientifiques portant sur plusieurs dizaines d'années à l'avenir ne peuvent jamais être précises, et il est possible que celles-ci en matière de population et du réchauffement planétaire pour l'an 2050 adviennent plus tôt ou plus tard, mais ce qui est certain c'est qu'elles adviendront. Les prévisions pour l'an 2100 sont déconcertantes car elles prévoient une population de 600 millions d'habitants au Sahel et des températures s'élevant jusqu'à 8 oC (13oF) au-dessus des normes d'aujourd'hui.

Il serait tout à fait improbable d'accommoder de manière durable l'envergure d'une telle croissance, qui pourrait déclencher la plus grande migration involontaire au monde. La famine et le taux de mortalité augmenteraient lorsque les récoltes se dessèchent et le bétail meurt. Il y a déjà 12 à 18 millions de personnes qui souffrent de la faim dans cette région. La pratique des mariages entre jeunes filles et hommes vieux est courante dans de nombreuses régions et le progrès ne s'installera pas avant d'augmenter l'âge légal du mariage afin de permettre aux filles de bénéficier d'une éducation pour être en mesure de fournir une

contribution appréciable au développement de leur pays. Il existe aussi prolifération de conflits et du terrorisme qui entraineront la chute d'autres pays.

La réunion OASIS a eu le mérite de se fixer pour objectif l'élaboration de solutions qui permettraient d'éviter la pire des catastrophes dans cette région. La création d'une base de données probante servant à renseigner les décisions prises aux niveaux national, régional et global en matière d'investissement face à ces changements critiques constitue notre objectif immédiat. On doit s'attaquer aux changements d'ordre climatique par l'intermédiaire d'adaptations au niveau de l'agriculture et d'une gestion améliorée de l'eau. Les femmes doivent être habilitées à gérer leur procréation par l'intermédiaire de la planification des familles. Les investissements en faveur des filles et des jeunes femmes sont essentiels au succès et à l'harmonie d'une société. La réunion a opté à l'unanimité pour la mise en œuvre immédiate et à grande échelle de telles solutions.

Les participants ont quitté cette réunion en s'engageant à construire un réseau d'experts consacrés à la consolidation de l'analyse scientifique des problèmes auxquels se confrontent la région, et leur solution. Tous sont tombés d'accord que les coûts de l'inaction – en milieu appauvri, sous conditions de famine, d'aide humanitaire aux réfugiés, d'état en déroute, de conflits, de migrants et de terrorisme escaladant – seront bien supérieurs à ceux d'une action qui vise l'amélioration de l'agriculture, la présentation d'options en matière de procréation et l'investissement en faveur des filles et des jeunes femmes.

CHAPTER 1: DEFINING THE SAHEL'S CHALLENGES

"Sahel" in Arabic means "shore." Defined ecologically, the Sahel stretches almost 4,800 miles from Senegal on the Atlantic Ocean to the Horn of Africa on the Red Sea. At its narrowest point, it is less than 100 miles deep; at its broadest, it is almost 400 miles wide. It is composed of more than one million square miles of arid and semi-arid grasslands. To the north, the Sahara is an endless sea of sand. To the south, it turns slowly into a lush, green savanna (see Figure 1).

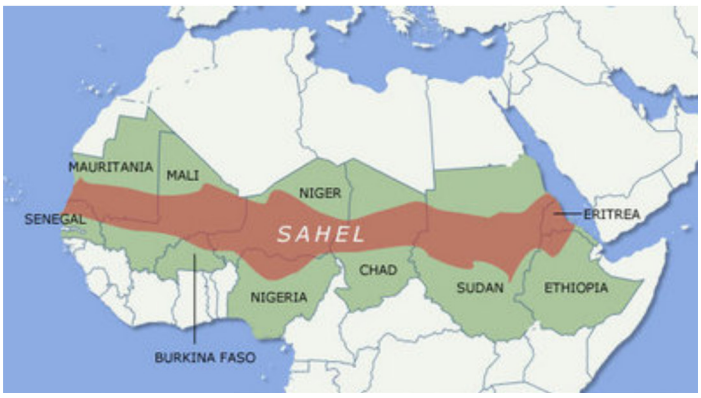

Figure 1. Map of the Sahel: an ecological region.

In a continent with many big problems, the Sahel is the part of sub-Saharan Africa that is facing some of the biggest. It is home to approximately 100 million of the world's poorest, most disempowered, and forgotten people. The Sahel is drought-stricken and famine-prone. Illiteracy and poverty are pervasive among the pastoralists and subsistence farmers who make up most of the population. Several countries in the Sahel rank on the lowest rungs of the Human Development Index.[3] Child marriage is common and the status of women is low. The Sahel has the most rapid population growth in the world.

During and following the OASIS meeting, somber new reports of the deteriorating situation in the Sahel appeared in the press. Huge, slowly moving disasters can be among the most difficult to bring to public attention, even though such mega-catastrophes, taking decades to fully build, have the greatest potential for creating human misery on an almost unimaginable scale.

The severity of the projected level of climate change has not been recognized previously and thus it is addressed first among the four elements covered in the OASIS conference. The

confluence of climate change and rapid population growth in regions already suffering from poverty and appalling gender inequities poses a humanitarian problem, which in coming decades could threaten more than 100 million people.

1. Climate

The Western Sahel has what is called a monsoon climate. In the summer, the heating of the land draws in moist air from the Atlantic Ocean and brings the possibility of rain from June to October. In the winter, winds blow out to sea and the weather becomes dry and clear. The monsoon rainfall is tied directly to food production. Government planners and agronomists watch the arrival dates for the monsoon, eager to determine the optimal date for planting. Proper forecasting of the location and likely quantity of precipitation is crucial for maintaining food stocks. The monsoon brings up to 80 inches of rain to the Ethiopian mountains, but further east, most of the Horn of Africa receives very little rain.

Since 1950, the Sahel as a whole has experienced variability in its climate. One likely driver has been the increase in atmospheric particulates drifting across the Atlantic from the industrial regions of North America where industries have been using increasing amounts of high sulfur coal.[4] Until 1970, there was some increase in precipitation, but between 1970 and 1993, there were 20 years of severe drought affecting the whole of the region. Since 1993, there have been marked changes with some very wet years and very dry years, making climate forecasts more difficult (see Figure 2).

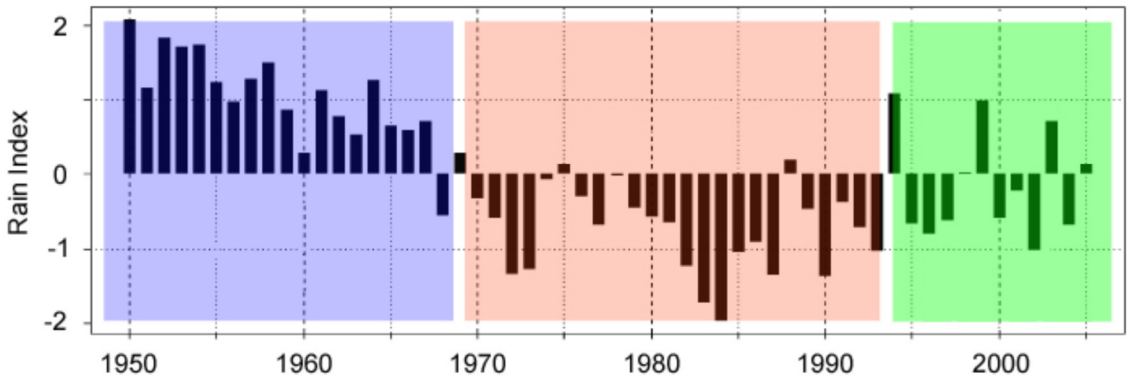

Figure 2. Climate variability in the western Sahel: 1949-69 persistent wet years; 1969-93 persistent dry years; 1994 abrupt alternative between wet and dry years.

Climatologists use past records of temperature and rainfall trends to predict future climate conditions. Although climate records in Africa are less detailed than those in North America, computer models are beginning to fit real data with increasing accuracy. Dangerous climate change will be realized by 2050, regardless of any further increase in greenhouse gas emissions. Predictions, taking into account the consensus among climate scientists that greenhouse emissions will continue to increase, gases, project that by 2050, the Sahel will be 3°C to 5°C (7°F to 10°F) warmer. Five degrees Celsius may seem a small number, but a rise of 5°C is all that separates today's world from the last Ice Age. By 2100, the mean increase from today's temperatures may be as much as 8°C (13°F) higher than today. Extreme weather events will become more common. Climate change is also likely to affect plant diseases and predation, such as migrant locusts that are an important food predator in the region.

Climate scientists are less certain about predicting future changes in rainfall, including the magnitude and timing of precipitation, than they are at projecting temperature increases. It is likely that rains will become more erratic and either delay or shorten the growing season. Even if rainfall increases, the available soil moisture that plants need is likely to decrease because of increased evaporation due to the higher temperatures. There is some uncertainty about how dry the soil will become, but it seems likely that the soils will get drier due to increased evaporation, resulting in reduced crop yields. There will be direct health impacts of heat on

the human population and on cattle, and patterns of human, plant, and animal diseases may sometimes change, sometimes for the worse.

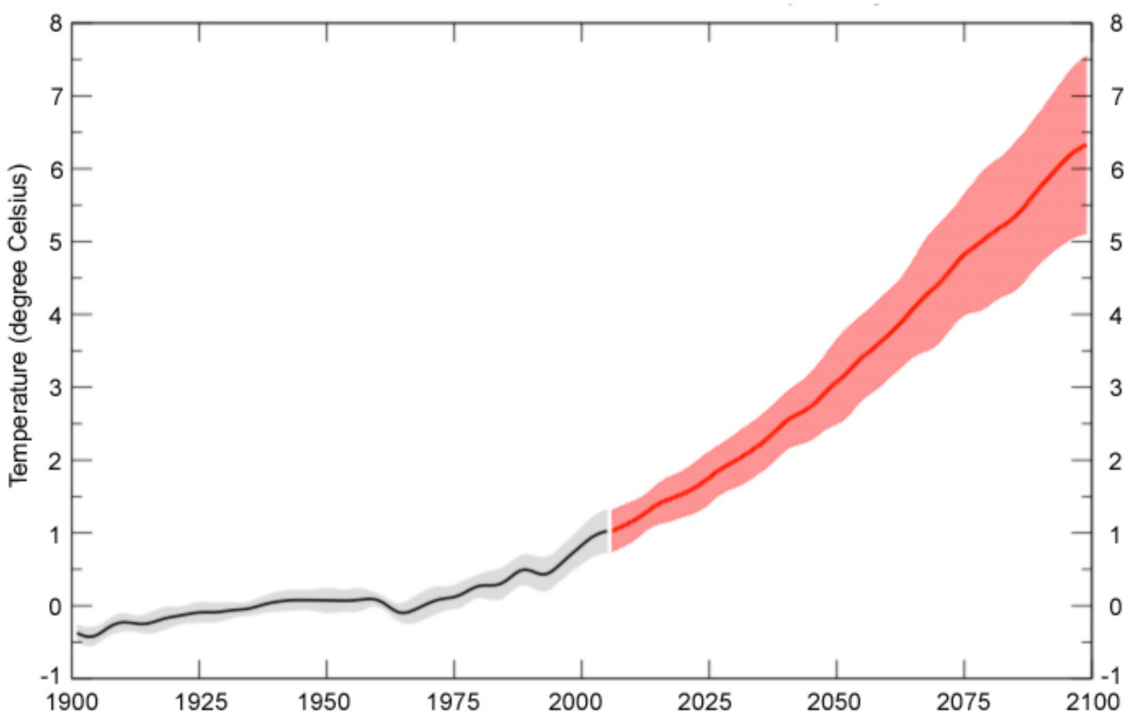

Figure 3. Niger Surface Air Temperature Change, 1900-2100 with respect to 20th century average under a "business as usual" scenario. (IPCC RC 8.5)

2. Population

Africa's share of the global population is projected to rise from 17% (1.0 billion) in 2010 to 24% (2.2 billion) in 2050, and to 35% (3.6 billion) in 2100,[5] and much of this growth will be driven by the Sahel. Defined ecologically, the Sahel cuts across a number of countries and the exact population is difficult to establish. Using a somewhat conservative definition of the Sahel, and for example omitting northern Nigeria, then in 1950 the countries making up the Sahel, from Senegal to Eritrea, had a population of just over 30 million. By 2010 they exceeded 100 million. The median age of the population in countries such as Burkina Faso is about 17 years

— for comparison, the median age in the United States is 37.2 years.[6] The young age structure of the population creates a great deal of demographic momentum.[a]

Even assuming rapid declines in family size, the population of Niger alone will grow from 16 million today to 58 million by 2050.[7] By 2050 the United Nations' projection for the whole region is 340 million. By 2100, it is 600 million.[8] These numbers, while startling, may turn out to have been overly optimistic. The United Nations' medium variant projections assume that average family size will fall slowly, and that, by 2100, average family size across nearly all low-resource countries, including most of the Sahel, will be approximately two children.[9] Unfortunately, there is no empirical evidence that family size will necessarily fall at that rate. Across most of the Sahel (with Ethiopia as an exception), the demand for children is high and the policy environment for prioritizing family planning is not encouraging. While child mortality rates have steadily declined in Africa, the decline in family size has been slow.[10] The annual increase in the contraceptive prevalence rate (CPR) has been among the most sluggish in the world.[11] In Chad between 1996 and 2010, the CPR rose at a rate of 0.05% per year.[12]

[a] Demographic momentum is the tendency for population growth to continue beyond the time that replacement-level fertility has been achieved because of if the high number of women in the fertile years born 15 to 45 years earlier when the birth rate was higher. For example, China has below replacement-level fertility, but the population still grows by about 7 million more births than deaths each year.

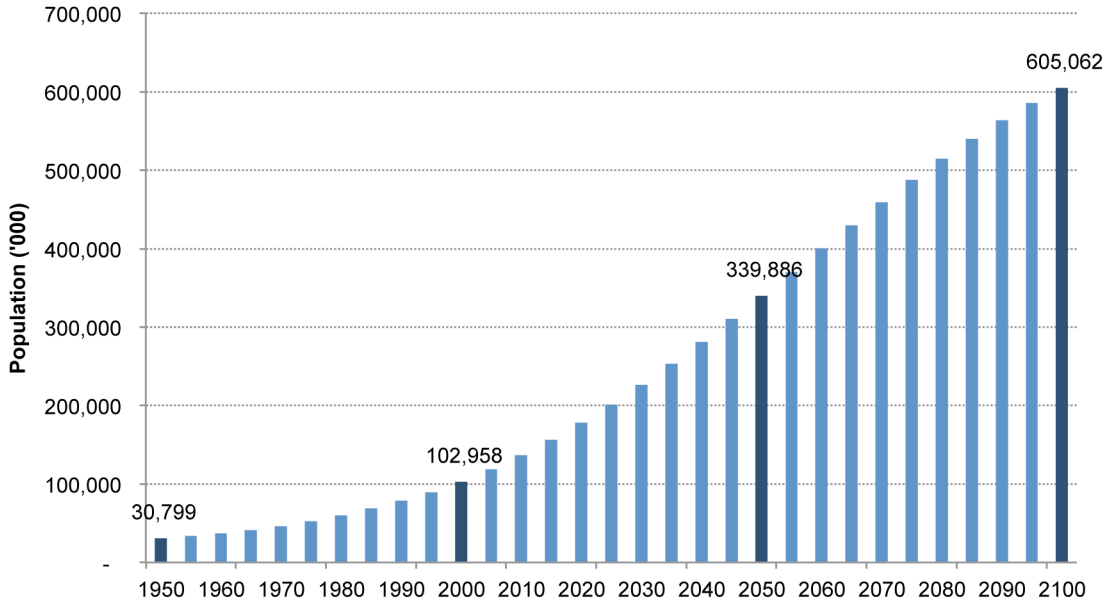

Figure 4. Past and projected population growth in the Sahel region, 1950-2100 (Benin, Burkina Faso, Central Africa Republic, Chad, Eritrea, Mali, Mauritania, Niger, Senegal, Sudan). United Nations Population Division. Medium Variant.

Unless there are major policy changes in the countries of the region, and among the international community, it is unlikely most of the Sahel will achieve a two-child family norm by 2100. Over the past 20 years, there have been limited local and international financial resources, little domestic political will to prioritize population issues, and limited local technical capacity to generate and use in-country research to guide policy formulation and program design. Despite the strong synergies between population growth and adapting to climate change, there has been limited integration of population growth and climate change at the policy and programmatic levels. The activities that are currently taking place are being implemented in silos. As a result, even if large investments in family planning are made immediately, the population of the Sahel will still continue to grow for another 70-80 years or more.

Rapid population growth poses a series of large-scale threats to economic development and environmental preservation. Rapid population growth is fueled by high levels of unplanned

pregnancies resulting from the inability of women to access and use effective methods of family planning. Family planning also contributes to the poor health of many women and undermines the well being of their children. A baby born less than 18 months after a prior birth has three times the risk of dying in the first year of life as one born 36 months or more after its sibling.[13]

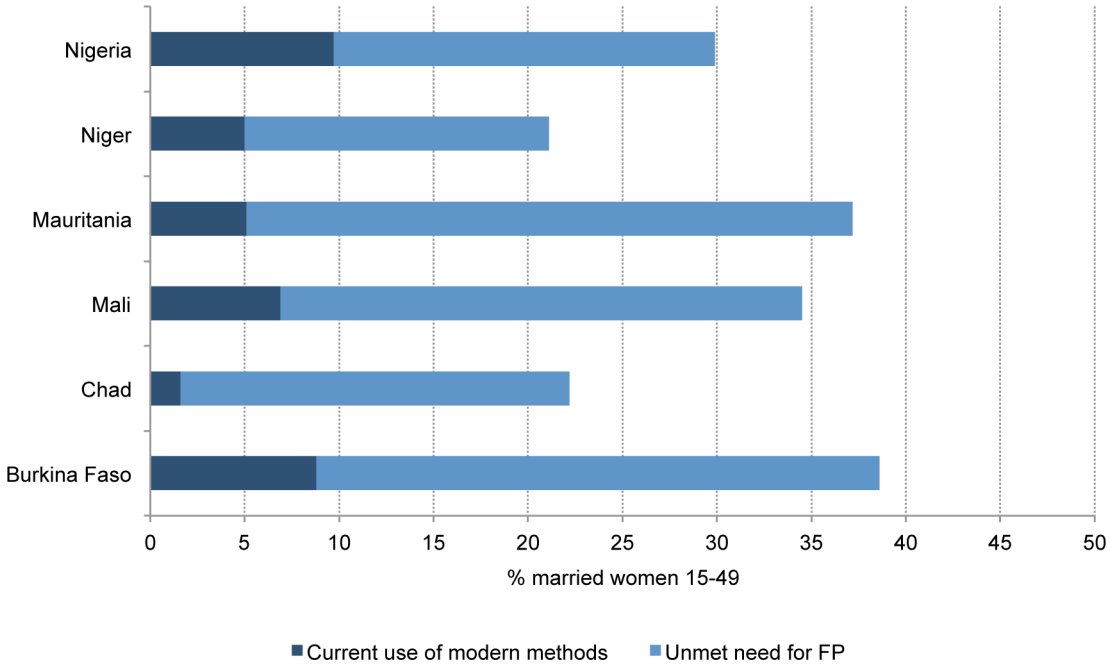

Figure 5. Use of modern methods of family planning and unmet need for family planning among married women 15-49. Demographic and Health Survey data.

The voluntary decline in family size in the west over the past 100 years has contributed to one half of the decline in maternal mortality.[14] In low-resource settings, access to family planning is an immediate way to reduce high maternal mortality and morbidity.[15]

Contraceptive use is measured every few years in the Demographic and Health Surveys. These surveys also ask women if they want any more children, or if they do not wish to have a child in the next two years. Women in the latter two categories who say they are not using contraception are classified as having an unmet need for family planning (they want to delay child-bearing, but are not using contraception). In many countries, such as Mali, Chad and

Nigeria, the unmet need for family planning among married women exceeds the current use of contraception. A high unmet need for family planning and a lack of easy access to modern contraception is a double denial of women's reproductive rights. Experience from other African countries, such as Malawi, Ethiopia and Rwanda, has shown that having a strong political will and commitment to family planning accompanied by sustained mobilization of financial and technical resources play a key role in building successful family planning programs and reduce the unmet need for family planning.[16]

The collision of rapid population growth and some of the harshest impacts of climate change present a somber challenge to the Sahel. In 1987, the United Nations defined sustainable development as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[17] Sustainable development cannot occur without slowing rapid population growth by giving women the ability to choose how many children they want. It is both a human right and an economic and demographic imperative. In order for sustainable development to occur, it will be essential to address fertility decline in combination with improvements in education, health, and improved governance. None of these factors is sufficient in isolation and it is important to recognize and develop possible synergies.[18]

3. Natural Resources

Household adaptation to cope with adverse ecological and institutional conditions has taken many forms over the years and the Sahel is not an exception to this phenomena (e.g., temporary or permanent migration). However, the negative impacts associated with climate change and rapid population growth will make the challenge greater as an already fragile ecosystem collapses in countries where the risk of political instability is increasing. The more extreme climate change effects occurring recently, such as increased droughts and floods, exacerbate already serious problems such as famines. Population growth adds to the severity of this problem. Poor and disadvantaged individuals and groups suffer disproportionately from an inability to adapt. Urgent action is going to be needed to strengthen the adaptive capacity of people in the Sahel.

At least 95% of the food production in the Sahel is based on rain-fed agriculture. The agricultural sector employs, directly or indirectly, more than half of the Sahel's population. However, lack of institutional and physical infrastructure, including lack of water delivery and storage capabilities, crop insurance schemes, and market access for small and medium-size producers, undermines efforts to improve food production. Poor rainfall, land degradation, insufficient use of mineral and organic fertilizers, lack of agricultural equipment, and inadequate technical training, along with overexploitation of agricultural land and overgrazing by pastoralists, all undermine the relationship between resource management and agricultural production. Lack of physical and financial infrastructure makes access to markets difficult. In addition, the land tenure system complicates problems for pastoralists.

Global warming will mean that in temperate lands, where much of the global crop production occurs, the most productive regions will migrate away from the equator. While the net aggregate change as a result of climate change at a global level may be slow, the regional effects in the Sahel will be more rapid, significant, and adverse. The first US National Climate Assessment report concluded that, "low income populations depending on isolated agricultural systems in semi-arid and arid regions are particularly vulnerable to hunger and severe hardship." The 2007 IPCC Summit for Policy Makers was more specific, pointing out that, in many African countries, food production "is projected to be severely compromised, [and] this would further adversely affect food security and exacerbate malnutrition." Crop losses in the region could be as high as 50%. However, the IPCC and other similar studies such as the Stern Review[19] do not emphasize the added complication of rapid population growth, and never consider slowing it through improved access to family planning and investing in women as an achievable and powerful adaptation policy. The reality is, however, that natural resource policy and population related policies are highly complimentary and can positively reinforce one other.

Predicting the impact of higher temperatures and changes in rainfall involves juggling two variables. Photosynthesis uses sunlight to combine carbon dioxide with water to produce carbohydrates. Higher carbon dioxide levels — sometimes called "carbon fertilization" — can

benefit higher crop yields, although the impact of more CO2 is greater on rice and wheat than millet and sorghum (see Table 1).

Country	Decrease crop production without carbon fertilization	Decrease crop production with carbon fertilization
Burkina Faso	24.3%	13.0%
Ethiopia*	31.3%	20.9%
Mali	35.6%	25.9%
Niger	34.1%	24.2%
Nigeria*	18.5%	6.3%
Senegal	51.9%	44.7%
Sudan *	56.1%	49.5%
WORLD Median	19.5%	16.7%

Table 1. Impact of carbon fertilization on crop production[20]

Historically, increases in crop yields in the Sahel have resulted from an expanded land base, rather than improved agricultural efficiencies. Over the last decade, cereal production has declined, reaching alarming levels in Burkina Faso, Chad, Gambia, Mali, and Mauritania. Given the dire conditions of the agricultural sector in the Sahel, a wide array of policies must be implemented in order to avoid a food supply crisis, which the area has suffered in the past. Some of these policies have already been identified and include, but are not limited to, increasing infrastructure investment levels in the rural sector, promoting agro forestry related activities, and developing small scale irrigation technologies.[21] However, to the best of our knowledge, no generalized policy framework for tackling issues associated with the rural sector, population growth, and climate change effects has been proposed.

Crop output can rise as temperatures increase, but it then reaches a tipping point before plummeting with extreme heat. Above 29° C (84° F), crop yields can fall rapidly (see Figure 6). In the case of maize, there is a 0.7% decline in crop production for each 24 hours exposure to a temperature above 29°C (84°F).[22] A temperature above 30°C (86°F) for 10 days causes a 7% decline in production, and one day of 39°C (102°F) also causes a 7% decline in production. Maize has been well studied, but the responses are probably generalizable to other crops. That

said, the tipping point is likely to vary by crop and by geographical location. A research agenda for the Sahel along these lines is imperative in order to make sure that the agricultural sector adapts in the most efficient strategies. Using a variety of climate change estimates, crop yields such as sorghum, millet, and cassava are all adversely, and in some cases substantially, affected by rising temperature.[23]

In years of low rainfall and low agricultural production, people fall back on the exploitation of natural resources, such as charcoal production for cooking. In West Africa, deforestation is a serious threat to the livelihood of millions of people. Niger is estimated to be cutting trees at twice the rate at which they are growing, and loses 1.5% of its trees annually.[24] Overgrazing by pastoralists contributes to desert encroachment and makes future droughts more likely.

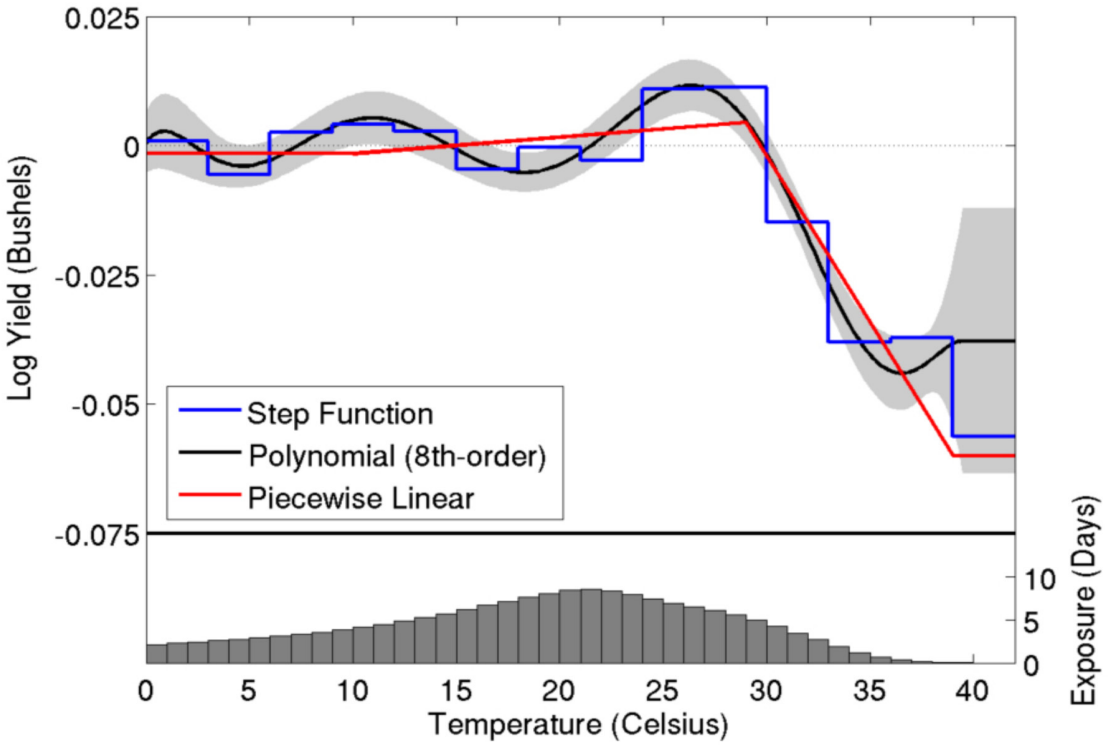

Figure 6. Maize yields decline rapidly above 29°C (84°F)

4. Status of Women

All the countries in the Sahel rank low on the Human Development Index.[25] The overwhelming majority of women are impoverished, illiterate, yet often are responsible for much of the farming and care of the animals. In parts of the Sahel, girls and women walk long distances to find, fetch, and carry water from the ever-diminishing supply of this most essential of all natural resources. Female genital mutilation, or genital cutting, is common.[26] In Burkina Faso, 70% of girls have the clitoris and inner labia excised, usually in unhygienic conditions without an anesthetic. In the Sudan, 50–90% of girls are subject to genital cutting; in Mali, it is 94%.[27] In both the Sudan[28] and Mali[29], some girls are subject to infibulation, where the outer labia are also removed, leaving only small orifice, which tears during delivery and is then commonly repaired in painful, unhygienic ways.

Many societies in the western Sahel are polygamous and child marriage is common. The mean age of marriage in Niger is 15.7 years.[30] "Child marriage" includes even 12-year-old brides often married to men 30 or 40 years old who may have several wives already. Marriage in the early teenage years is associated with an increased risk of maternal mortality and morbidity compared with girls who marry later.[31] Before a girl is fully grown, or where a girl's growth has been stunted by malnourishment, there is an increased risk of obstructed labor. For a young girl who has no access to a caesarian operation, obstructed labor can last for several days and often ends with the baby dying in the birth canal. Pressure from the baby's head damages the vaginal wall. Eventually the head begins to soften and the dead baby is expelled, but the tissue between the vagina and the bladder and/or rectum may be so damaged that it dies, leaving a fistula. Without extensive and difficult-to-obtain reparative surgery, the woman leaks urine or feces for the rest of her life. The victim can become an outcast, without dignity and sometimes shunned by her family and forced to live in isolation. To add to a woman's pain, some cultures believe that a prolonged labor is a punishment for sin. One estimate is that 350 cases of fistulae occur in every 100,000 births, or over 30,000 cases a year in the whole of the Sahel. The health services have the ability to repair only a fraction of these injuries. Given the projected growth in the population, by 2050, the total annual number of fistulae in the region could rise to over 100,000 annually.

Women with fistulae have been heard to say, "Death would be better than this." In fact, in the high-fertility societies of the Sahel, with the risks of teenage childbearing and the dangers of multiple pregnancies to older women, the maternal mortality ratio — the number of deaths per 100,000 births — is the highest in the world. Where each birth is dangerous and the number of children women have is high, then the lifetime risk of maternal death can be as high as 1 in 22 (Mali), or even 1 in 14 (Chad); for comparison, a woman in Sweden has a one in 11,400 lifetime risk of death from pregnancy or delivery.[32]

Abortion is illegal across the Sahel, and unsafe abortions account for 13% or more of all maternal deaths. Some countries have exceptions for abortion in cases of rape or when the mother's life is endangered, but these are rarely understood or offered to women. Traditional abortion methods often insert a foreign body into the uterus, such as an umbrella spoke, with a risk of perforation or infection. For every woman who dies from an unsafe abortion, many more are seriously injured.

Married women under age 18 are twice as likely as more mature women to be subjected to domestic violence. The legal and social framework in which women live out their lives is defined by customary law, Islamic law, and legislation dating from French colonial rule, as well as civil laws introduced since independence. Burkina Faso, Mali, and Senegal have replaced French colonial rule with new marriage codes, but Niger keeps part of the French colonial system. The new approach gives women some freedom but in Mali, for example, article 154 of the marriage code states that the husband is "head of the household" and the wife owes "obedience to her spouse."[33] Where there is a minimum age of marriage, it is often ignored and sometimes girls are even betrothed ***in utero.*** Where a bride price exists, the amount has increased in recent years, generating what is sometimes called an "attitude of vengeance toward a women from a husband who has paid so much."

Some couples see family planning as something that is stigmatized by religion. In Mali, Niger, and Senegal, the husband's consent is required if a woman wishes to use contraceptives. In Mali, a divorced woman must present a certificate of divorce in order to acquire contraceptives.

Although such laws may not be followed to the letter, they create an environment that is hostile for the provision of family planning and other reproductive health services to women of varying backgrounds. Girls and women are uniquely vulnerable to violence and coercion. During the difficult transitions of puberty and early adolescence, both boys and girls face challenges, but boys rarely face challenges at the level girls do with respect to sexual abuse, violence, and social isolation.

CHAPTER 2: REGION IN CRISIS

The Sahel is in crisis. While projections of population and climate change necessarily include a margin of error, from a policy perspective, nearly all the problems set out above are inescapable. Whether these challenges arise in the near term or further into the future, they most certainly and unambiguously will arise.

The multidisciplinary approach of the OASIS conference framed the crisis overshadowing the region with a new urgency and realism. When problems such as food security or the possibility of economic development are looked at in isolation from one another, then a "business as usual" set of policies might appear to offer some amelioration of the current somber situation. When the collision of rapid population growth and climate change are both thrown into the equation, then it seems highly probable that today's crisis risks turning into a colossal humanitarian calamity involving tens of millions of people. As with most disasters in low resource settings, it will be women and children who suffer the greatest burden of misery. Recent episodes of food shortages in Mali increased under five infant mortality from 104/1000 live births in 2008 to 114/1000 in 2010,[34] and rising death rates like this are likely to become more common as climate change and population growth impact one another.

As the situation worsens, it is also possible that the existing fragile states could become failed states. In 2012, half of Mali — an area the size of France — fell under the control of Ansar al-Din[35] and al-Qaeda in the Islamic Maghreb (AQIM). Although the terrorists were driven out of Timbuktu and neighboring towns, they still represent a serious threat. One United Nations official tasked with brokering peace in Mali called on the international community to promote economic development in the region, adding, "Without development, it will not be possible to resolve the crisis in Mali."[36] However, taking into account the forecasted impact of climate change and population growth, the possibility of significant economic growth in the region is slim. No country with an average of five births per woman, with the exception of some oil rich states, has ever been able to break their development shackles without improving access to family planning and curbing rapid population growth in a human rights framework.[37]

There are many things that scientists cannot predict. For example, no one really foresaw that cell phones would become so widely available even in low resource settings. Projections

about population trends, however, are relatively robust. Sexual desire is a universal human attribute and unless women and their partners are given information and the means to separate sex from childbearing, then they will go on having many children. Further reductions in infant mortality are possible even in low resource settings if there is widespread use of family planning and other life-saving technologies like immunization. However, such progress will also be interrupted as food shortages become more common. In Niger, under-five mortality fell from 318/1,000 in 1998 to 198/1,000 in 2006.[38] While obviously welcome, this will also increase the already rapid population growth even further unless there is a parallel investment in voluntary family planning programs that address both demand and supply barriers to contraceptive use.

In 2010, 195 countries joined the United Nations Convention on Climate Change to limit global temperature increases to below 2°C (3°F). Unfortunately, the goal of reducing emissions in developed countries and supporting climate change adaptation activities in developing countries is not being achieved, and as noted above, climate scientists have compelling evidence that the Sahel will get hotter — probably a lot hotter.

The media and political controversies surrounding climate change are noisier than the debate amongst climate scientists. There is no doubt that the build-up of greenhouse gases is raising global temperatures. The rate at which change will take place depends on complex interactions between cloud cover and melting ice, among other factors. Whether the change is fast or slow, the evidence is compelling that countries and international institutions must make confronting climate change a priority. While global warming could be slower than some projections, it is also scientifically possible that some factors, such as the release of methane from melting tundra in the Arctic, might interact adversely and accelerate an already serious situation.[39]

The appropriate metrics can be used to stimulate appropriate policies. In the case of the impact of voluntary family planning on slowing rapid population growth, the most useful measure is how quickly the contraceptive prevalence rate rises. If the range of policies discussed above are put in place, even recognizing the chronic shortages of trained health personnel in the Sahel, then the contraceptive prevalence rate could increase by an additional 2 percentage points per year instead of 0.5 percentage points per year (which has been the historical record

in some countries). Such seemingly small changes have a remarkable impact on the long-term population growth of any country (see Figure 8). Chad's current CPR (modern methods) is 1.6% as of the 2004 DHS. If it were to increase its CPR (see Figure 7) by 2 percentage points per year starting in 2013, then the population by 2050 would be 25 million people. However, if Chad's CPR were to increase by 0.05 percentage points per year, as it has in the past 10 years, its population would grow from today's 12 million in 2012 to 46 million people in 2050 and 328 million people in 2100.

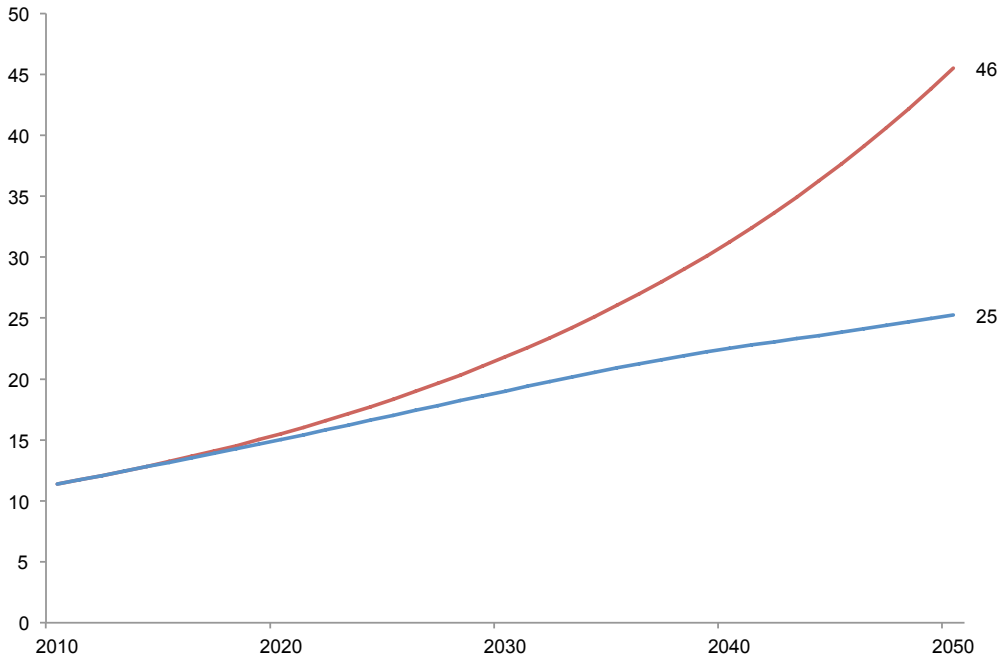

Figure 7. Chad's projected population size by 2050 will depend on the increase in the contraceptive prevalence rate (CPR) each year. Data sources: Chad Demographic and Health Surveys 1996-1997 and the UN Department of Economic and Social Affairs, Population Division.

Figure 7 displays projections of the impact of the year that country reaches replacement-level fertility on the ultimate size of its population. If Senegal were to achieve a two-child family in 2060, then its 2010 population of 12.4 million would stabilize early in the 22nd century at 50 million. If a two-child family is not reached until 2080, then Senegal's population would not

stabilize until it reached more than 65 million, or five times today's population. This increase would take place during a period of intense global warming, which in the second half of the 21st century could make food production difficult or impossible.

The harsh reality is that if population does not slow by voluntary means and the resilience to climate change is not enhanced, then the death rate, especially among young children and older people, is likely to begin to rise, perhaps rolling back many of the achievements in public health during the past 50 years. There is no escaping the conclusion that climate change and population growth in the Sahel will rapidly outstrip the food supply. The United Nations Environment Program, which normally uses nuanced diplomatic language, call feeding the Sahel "mission impossible." In 2012, there were some modest improvements in the Horn of Africa, although there are still over 600,000 Somalia refugees living in Ethiopia and Kenya. In the Western Sahel, UNICEF estimates that 15 million people face food shortages, 1.5 million children are at risk of dying, and 250,000 already suffer from severe acute malnutrition.[40] In sub-Saharan Africa as a whole, the percentage of children under five who are underweight fell from 27% in 1990 to 22% in 2010, but because of population growth, the absolute number has increased from 24.5 million to 30 million.[41]

The combination of rapid population growth and climate change are likely to trigger one of the most massive migrations in history as animals and crops die in the extreme heat. Initially, rural people are likely to move to refugee camps and to the few large cities where external aid may be available to combat malnutrition and starvation. A loss of human capital is possible. Even with outside aid, the infant mortality rate could rise and childhood stunting, which can cause long-term cognitive impairment, is likely.

An involuntary migration of well over 100 million people to the countries south of the Sahel, or to Europe and other parts of the world, would lead to additional crowding in more populated and sometimes rapidly growing areas. Cross-border migration could overwhelm services and worsen living conditions in receiving countries. Instability in living situations and food can also lead to increased chaos and conflict.[42] Industrialized countries are unlikely to need tens of millions of unskilled laborers. Cultural and economic conflicts could arise in such a scenario.

The year 2050 is the most common base for estimates of climate change and population growth focus. Predictions into the second half of the 21st century are scientifically possible and reasonably secure. The serious fall in international family planning budgets after the 1994 International Conference on Population and Development in Cairo has led to the buildup of a large amount of demographic momentum. Average family size can change in a few decades, but not in a few years. Demographic momentum cannot be reversed — unless, of course, death rates rise. In the case of both of population and climate change, the one certainty is that under a "business as usual" scenario, the situation in the Sahel after 2050 will reach calamitous levels.

The population in the Sahel is projected to reach 340 million in 2050 and 600 million in 2100. Unless major policy changes are made, it is hard to think of any plausible way in which, by 2050, the Sahel can both accommodate a tripling of the population by that year and also adapt to the level of climate change that experts predict. This implies increasing pain and misery for 100 million people, a burden on neighboring countries of an increasing number of refugees, and the possibility of political instability that will be costly across the world.

The world as a whole faces some demographic problems, which could in turn make responding to the plight of the Sahel even more formidable. The United Nations Population Division low variant for global population forecasts that the countries that currently have a TFR (total fertility rate, or the average number of children women deliver in a fertile lifetime) of over three — which include all the Least Developed Countries (LDCs) to which all the countries of the Sahel belong — will more than double from 1.2 billion today (18% of the global population) to 2.8 billion (39%), in 2100.[43] According to the high UN medium variant projection, these LDCs will grow to a stunning 6.2 billion by 2100 (45% of the global population. As the analysis of contraceptive prevalence rate shows, if the lack of focus on family planning that characterized the last 20 years continues, the division between "haves" and "have-nots" in today's world will deepen, especially after 2050.

It is difficult to estimate the overall ability to increase food production, but a recent analysis suggests that human consumption may be approaching the limits of the net primary plant production (NPP) — that is, the maximum photosynthetic production that is possible on the planet.[44] It is "not whether humans will reach the global NPP boundary but when they will do so." It seems probable that the developed countries will continue their excessively high levels of consumption. The emerging economies are likely to continue to eat more protein and a larger slice of grain production in countries with an appropriate climate for grain production will be diverted to feeding animals, or ethanol to drive automobiles. A child born in the Sahel today could belong to the first generation to come to maturity in the contemporary world where the ability to feed large numbers of ecological refugees may well diminish.

It is also possible that the secondary effects of the collision of population growth and climate change could create what scientists call an "asymmetrical uncertainty." The possible consequences of this asymmetrical uncertainty on political processes and violence could range from a slow worsening of the current situation to extremely serious conflict over resources and threats to security. Biologically, adverse factors can interact in ways that can cause a rapid downward spiral. For example, as noted above, ambient temperatures over 29°C (84°F) lead to a rapid decline in crop yields.

CHAPTER 3: SOLUTIONS

Perspectives growing out of the interdisciplinary OASIS conference have the potential to generate new responses and solutions to the problems laid out above. For example, women's participation in agricultural activities is a key element in the rural sector and the wellbeing of households. Looked at in isolation, rural agriculture in the Sahel presents a dismal picture, but viewed more broadly, the agricultural sector can be an important engine of socioeconomic improvement.

Many organizations inside and outside the Sahel are striving to address the region's challenges. Yet despite laudable initiatives, leadership and coordination have been mostly lacking. While governments, institutions, and civil society in the Sahel should take the lead, that leadership is hampered by weak institutions, sporadic political unrest, and lack of technical skills, including research capacity. Government donors and large philanthropic organizations still place their staff and interventions in administrative "silos," undermining support of integrated, multidisciplinary solutions.

1. Improving the Status of Women

It is essential to make women, particularly adolescent girls, visible and at the center of development in the Sahel development agenda.[45] Female genital mutilation scars women psychologically, as well as physically, and puts them at a lifelong disadvantage in their relations with men. Community efforts to stop these terrible practices are beginning to prove successful.[46] Child marriage is also a human rights abuse.[47] Investing in adolescent girls and young women so that they can hold on to their childhood and — defer childbearing past adolescence — is intrinsically good in and of itself. Postponing the first birth by five years in a country such as Niger can reduce population size by 18%[48] and lower maternal mortality associated with early childbearing.

Girls' education enables them to make positive choices about their own health and the health of their children. Less than 10% of girls with no education are delivered in a health facility, compared with 90% of those who have been to secondary school. Seven percent of children

of mothers with no education are immunized, compared with 60% of those with secondary education. In countries like Thailand, where family planning is easily available, there is little or no difference in contraceptive prevalence between educated and illiterate women. In the Sahel, contraceptive prevalence in women with secondary education is 37%, and just 4% among illiterate women.

However, not all girls are going to be permitted to go to school by their families and, more importantly, in much of the Sahel, there are no schools that either boys or girls could attend. The most vulnerable girls are those under age 15 and living with one parent, or married with a child. Even where schools do exist, many students leave primary school without being able to read or write. The real benefits of education come from attending secondary school, but here the picture in the Sahel is even more dismal. Moreover, rapid population growth means that each year there are more potential students ready to enter school, and even a well governed country able to invest in education is challenged trying to build new school rooms and to train and deploy teachers at the rate necessary to keep pace with population growth.

An important, culturally sensitive methodology for enhancing the development of girls, which addresses religious issues and anchors important variables such as trust and respect for culture, involves creating what are called "safe spaces." Safe spaces enable girls going through puberty to find friends, acquire basic health information, relate to adult mentors, develop literacy and financial skills, and learn about their right to personal autonomy.[49] Within safe spaces, adolescent girls can discuss openly their reproductive health concerns, acquire valuable life skills, and link with local health services. Pilot projects of safe spaces have proved successful. A cascading leadership model where the first cohort of girls trained become leaders for girls 12-14, and later 15-18, has been tested and seems to hold the potential to bring safe spaces to scale. In Northern Nigeria, a pilot safe space program brought about significant change with as little as two hours per week interaction between the girls and their mentors. At baseline the mean age of marriage was 14.5 years girls averaged at least two children by the age of 18, has made considerable progress in keeping girls in secondary school. Of the 230 girls who started six years earlier, 205 have graduated from secondary school. Seven have entered tertiary

education, only three were married, and only one had a child. The cost per girl was $34 per year, which included mentor fees, supportive supervision of the mentors, monthly training, and transportation. The cost of books and school fees was $30 per year, bringing the total cost of the intervention to $64 per girl annually. However, much greater operations research is required on the effectiveness and cost of such programs, in addition to understanding the essential elements required for bringing safe spaces to scale.

Developing girls' education through safe spaces or secondary school requires considerable community involvement with consultations with parents, community leaders, and religious leaders. It takes time and costs money, but it is a non-negotiable part of any integrated plan to both roll back the human rights abuse of child marriage and to take one essential step in slowing rapid population growth, and enhance socioeconomic development. Not only does child marriage expose a woman to more years of potential childbearing, but a teenager who has several children by the age of 20 will rarely, if ever, develop the autonomy to manage her childbearing and make substantive contributions to the household and national economic productivity later in life. In Niger, for example, 20% of women over age 40 have 10 or more children.[50]

It is also important to reach married adolescent girls, although less work has been done in this field. Young married girls are shy and find difficulty discussing reproductive health. The Partnership for Reviving Routine Immunization in Northern Nigeria: Maternal Newborn and Child Health Initiative has begun experimental work that includes theatrical shows, practical sessions in cooking, and shadowing teachers, health workers, and successful businesswomen.[51] Each group has two mentors and meets twice weekly. The program is planning to reach 24,000 girls by the end of 2013. The groups encourage participation in community institutions and activities, and provide opportunities for income-generating activities. The group strengthens literacy, financial management, and an understanding of nutrition.

2. Increasing Access to Family Planning

Family size has fallen more slowly in sub-Saharan Africa than in other parts of the world. In much of the Sahel, the contraceptive prevalence rate (CPR) remains below 10%, even though countries such as Burkina Faso and Niger have adopted policies to reduce fertility. Family planning is widely seen as a human right. Niger has set a bold goal of raising the contraceptive prevalence rate from 12% in 2012 to 25% in 2015. Women need to be empowered to choose the method of contraception with which they feel most comfortable. Unfortunately, in several countries in the Sahel, there is a lack of political will to make family planning widely available, accessible, and affordable. At the community level, there are often social and cultural norms and gender inequities, or interpretations of religion that make access to family planning services and supplies difficult. Family planning needs to be both democratized and demystified. At the individual level, low levels of basic education, lack of information, and widespread misinformation often inhibit use.

> *"The most transformative thing we can do is give people access to birth control."*
>
> — MELINDA FRENCH GATES

While the Sahel has the problems of polygamy, child marriage, and often highly patriarchal cultures, the fact that family size has fallen in many other low resource settings suggests that the problem in the Sahel may be partly that family planning has never been a genuine priority, either domestically or in the international community. When realistic access to family planning has been made available in developing countries, such as Bangladesh, family size has fallen rapidly (Bangladesh TFR 2012: 2.3).[52] Islam has positive attitudes towards child spacing and family planning.[53] When Iranians were given a range of voluntary family planning choices, the total fertility rate fell from 6.0 to 3.5 in five years (1990-95),[54] more rapidly than the corresponding decline in China. It is also important to note that as the total fertility rate falls, so does desired family size.

The objectives set out at the London Summit on Family Planning are directly relevant to the Sahel. The countries of the Sahel are poor and they will need global assistance with the supply and distribution of contraceptives for the foreseeable future. For most women in the Sahel, this means contraceptives must be available free or at a subsidized price. Logistics systems are often inadequate and stock outs are common. It is essential to have a secure unbroken supply of contraceptives. Women need access to a range of methods and correct information about the use of these methods and their possible advantages and disadvantages. Unjustified medical rules include not offering contraception to women who are not menstruating, or who are sexually active, but unmarried. Francophone Africa has had a particularly bad record of creating non-evidence-based medical barriers to the availability of contraception, such as demanding blood tests prior to oral contraceptive use — a requirement that cost the equivalent of three months' disposable income in Mali.[55]

The London Summit on Family Planning, 2012

1. *Revitalize global commitments to family planning and access to contraceptives as a cost-effective and transformative development policy*
2. *Improve the access and distribution of contraceptive supplies*
3. *Remove and reduce barriers to family planning*

Women often cite fear of contraceptive side effects as even more important than problems of access or cost. In parts of Africa, some women believe that the use of oral contraceptives leads to lifelong sterility or that it is more dangerous than childbirth, although the reality is that delivery can be 1,000 times more lethal. Radio and television soap operas, written and acted by dramatists belonging to the country, are a proven, cost-effective way of overcoming misinformation and increasing awareness of family planning. In Mali, listeners to a radio serial drama *Jigi ma Tigne* ("Hope is allowed") were more than twice as likely to know about two or more methods of contraception and where to obtain those methods than non-listeners. Listeners were also 1.8 times more likely to use a contraceptive method and 3.4 times

more likely to approve the use of the method, as compared to non-listeners. In Niger, another radio serial drama *Gobe da Haske* ("Tomorrow will be a brighter day") was listened to in 67% of households. Soap operas have also been used to help counter widespread child marriage.

In many settings, the lowest economic quintiles either have no access to health care, or they turn to the private, informal sector.[56] Government services tend to be concentrated in urban areas, and those women who are slightly richer and more informed are better able to navigate access to the methods they need. Social marketing uses the existing infrastructure as a private informal sector and provides point-of-purchase information, sometimes franchising low-volume informal health providers and trying to correct misinformation. In less than four years, a social marketing program by Population Services International increased the contraceptive prevalence rate in Bamako, Mali, by 7%. Community-based distribution (CBD) trains community volunteers to provide a range of contraceptives, usually beginning with oral contraceptives and condoms.[57] CBD provide methods close to people's homes, provides confidentiality, and ensures that distribution takes place in a culturally appropriate way as the providers re members of the community they are serving.

The only quasi-experimental study of family planning in the Sahel is the 15-year Navrongo Project in a remote region of Northern Ghana.[58] In an area where nurses distributed contraceptives and there were social mobilization activities for men, the total fertility rate fell from five in 1995 to 3.6 in 2010. Unfortunately, the contraceptive distribution system was over-medicalized (e.g., nurses were trained to take a woman's blood pressure before she could have oral contraceptives). Injectable contraceptives were the most popular method but, again, distribution was limited to nurses. Work in Ethiopia has shown that community volunteers can be trained to dispense the injectable contraceptive Depo-Provera,[59] and as 56% of women in Navrongo wished to keep the use of contraception secret, a more satisfactory result might have been reached by empowering community volunteers to dispense injectable contraceptives.

Task shifting is central to improving access to contraception. In some countries, oral contraceptives remain on prescription even though there is no evidence base for this limitation.[60] In Mali, family planning and immunization activities have been integrated. As a result, more than

200 providers were trained and equipped in 76 health centers, and between 2009 and 2012, they provided implants and intra-uterine devices to 50,000 clients.

In summary, women want and deserve correct information regarding family planning methods. A wide choice of methods is practical and affordable in any particular setting. Voluntary family planning interventions can make a significant contribution to curbing rapid population growth.[61] The final stable population of the Sahel will be determined by policies set now. Well-developed advocacy campaigns are needed to legitimize family planning (as occurred, for example in Indonesia in the 1970s and 1980s). The challenge is to convince national leaders of the urgent need to accelerate the use of contraception both to meet the basic human rights of women and couples to help countries adapt to the harsh impact of climate change.

3. Adapting Natural Resources to Climate Change

The Sahel is one of the best places in the world for generating solar power, and engineers are beginning to appreciate the potential of small-scale energy systems. The region is also suited to small-scale water management systems. As the climate changes, farmers will need to alter inputs to lessen the burden of lost crops. Farmers will need to change inputs, switch crops, and redesign and reconstruct water storage systems. Such new technologies could compensate for some of the losses in crop production, but adjusting farming systems is uncertain, time-consuming, and can take several decades. Unfortunately, many interventions are often not adopted until visible water shortages occur.

Some multinational initiatives are being suggested, of which the largest is the Great Green Wall — a plan to plant a 10-mile-deep, 4,800-mile-long band of trees between Dakar and Djibouti. Some progress is being made, for example in the Zinder region of Niger, but more research is needed to assess the impact on the climate.[62] Climate projections suggest that the Sahel may see a rise in rainfall, although the increase is likely to come in the form of flash floods. Capital projects of various sizes are needed for water management. The mechanized

restoration of degraded arid land is possible but use is limited by the expense of the tractor and maintenance and fuel costs.[63]

However, the ability of communities to adapt to climate change will largely depend upon adopting relatively small-scale appropriate technologies, which, if multiplied many times, will help increase crop yields and restore degraded environments. Central to improving crop yields is the availability of organic fertilizer. Composting pits one to three meters deep, lined with cement and stones, can produce organic compost from plant waste in just three months. Such pits cost about $100 and can be used for up to seven years.

Zai, sometimes called *tassa*, is the digging of small holes in arid regions 20-40cm deep and approximately one meter apart. These holes collect and retain water during the rainy season. A handful of manure or compost is put into each hole and covered with soil or straw. *Zai* can be used to grow cereals or trees, as well as collecting water from the rock nearby runoff handful of manure or compost is putting each hole and covered with soil or straw. They are built in the dry season, require 40 man/days work, and cost approximately $100 per hectare.

Erosion can be controlled through the construction of stone ridges. Such construction requires about 15 men-days work to construct 100 meters of stone ridges. They can be as low as 20 cm above the land surface and they can be strengthened by growing herbaceous plants or planting small trees upstream of the ridge where plants can benefit from the humidity created by the ridges. Such ridge construction has been successful in Tigre, Ethiopia, where members of the community spend up to 40 days a year on this type of work. Ridge building can lead to a 50% or more increase in grain yields and also provide more food for livestock. Stone ridges may need to be heightened after 10 years. Construction requires a source of stone and usually a truck to deliver the materials. The construction costs are between $65 and $90 per hectare. The combination of the ***zai*** and stone ridges has increased crop yields in Burkina Faso by 114-124%.

Erosion control benches are shallow stone-lined structures up to 18 meters long built on sloppy ground, with shorter arms at each end facing uphill. They have been used to rehabilitate degraded watersheds and reduce daily erosion. The cost is approximately $185 per

hectare. Erosion control benches require surveyors to draw out where the benches need to be constructed. On lands that slope at less than three degrees, the construction of crescent shaped basins can collect rainfall and focus water for crop cultivation. Organic manure is put in the basin to assist in plant growth. Construction costs are about $100 per hectare and the crescent shaped holes last about five years.

Appropriate technologies, such as those listed above, need to be used in an integrated way. For example, ***zai*** require about three tons of organic manure per hectare and may need to be combined with composting pits. The application of all these small-scale, but effective, technologies requires community involvement. Women do much of the work and improving the status of women is central to improving agriculture.[64] Efforts to give women greater autonomy and education to enable them to play a more central role in community decisions will lead to further improvements in expected outcomes.

While helping communities adapt to climate change is an essential element of any overall strategy, in the long term, as the 21st century proceeds, the combination of climate change and population growth will make it impossible to maintain the current and already inadequate per capita output of food production from the Sahel. Throughout the rest of sub-Saharan Africa, there is a potential to increase food production, but only if a number of challenges are overcome. On the one hand, few modern farming techniques have been introduced (for example, there is a potential for more extensive irrigation) in the past 30 years and crop yields are one third that of the developed world.[65] In addition, Africa has 600 million acres of uncultivated land. On the other hand, switching to large-scale commercial agriculture would displace smallholder farmers who comprise the majority of farmers, especially in the Sahel. A final serious problem is that foreign investors are buying land, but not to help feed Africans. Between 2000 and 2011, there were nearly 1,000 large land deals in Africa involving 124 million hectares — an area exceeding the area of Britain, France, and Germany.

4. Research and Management

All of the above interventions require a strong research base, excellent management capabilities, and good metrics to measure progress. It is important to introduce rapid assessment and response institutions that can facilitate the design and implementation of 'climate smart' agriculture strategies. Crop development should be prioritized, and technical training of individuals to carry out these large-scale agricultural interventions must occur. Solutions need to respond to the best scientific predictions possible. Temperature and precipitation observations in the Sahel are sparse or nonexistent and need to be improved.

All solutions need to be evidence-based. In some parts of the Sahel, there is capacity to expand water storage and irrigation, but such policies require a strong research base and a competent management capacity. Much additional research, for example, on soil moisture levels and afforestation models, will need to be completed in a multi-disciplinary fashion. It is important to identify synergies between climate adaptation and food security.

Even seemingly common-sense solutions, such as planting trees, need careful research. On the one hand, planting trees in a semiarid region can increase precipitation and ultimately eliminate the need for irrigation.[66] Reforestation can be a source of income as well as carbon sequestration. On the other hand, tree planting in West Africa could have both positive and negative impacts on the future climate in the Sahel, depending on the location of the afforestation. Research suggests that large-scale planting in the Sahel could reduce the impact of global warming, but afforestation over the savanna could worsen the impacts.

Without doubt, migration from the Sahel, which has already begun, will become more consistent and more massive. When the population grows faster than food production or employment opportunities, the impact of climate change is going to be particularly severe. International agreements to handle emergencies and relocations will improve response to

climate change. It will be essential to forecast migration trends and prepare recipient countries for tens of millions of ecological refugees.

There is a need to identify the key questions that economists can answer, and to combine modeling data and econometrics. It is essential to operate in a multidisciplinary, multilevel set of analyses at the micro, macro, and global levels.

The level of research needed will require a considerable increase in professional skills in the Sahel. Professionals trained to evaluate the changing environment and implement adaptive interventions are needed. Fortunately, the MasterCard Foundation is investing $500 million in education in Africa, from supporting students at African schools and universities to bringing selected scholars to North American universities for undergraduate and graduate studies.

Returning to afforestation, the range of human skills required is illustrated by the fact that climate change and the impact of afforestation do not recognize political boundaries, and cross-border agreements will need to be negotiated and implemented. We suggest convening a technical meeting bringing together experts of multiple disciplines from relevant institutions in the Sahel, but also including global experts, to build a network and administrative framework for a long-term commitment to evidence-based scientific innovation.

The appropriate metrics can be used to stimulate appropriate policies. In the case of the impact of voluntary family planning on slowing rapid population growth, the most useful measure is how quickly the contraceptive prevalence rate rises. If the range of policies discussed above are put in place, even recognizing the chronic shortages of trained health personnel in the Sahel, then the contraceptive prevalence rate could increase by an additional 2 percentage points per year instead of 0.5 percentage points per year (which has been the historical record in some countries). Such seemingly small changes have a remarkable impact on the long-term population growth of any country (see Figure 8). Chad's current CPR (modern methods) is 1.6% as of the 2004 DHS. If it were to increase its CPR (see Figure 8) by 2 percentage points

per year starting in 2013, then the population by 2100 would be 32 million people. However, if Chad's CPR were to increase by 0.05 percentage points per year, as it has in the past 10 years, its population would grow from today's 12 million in 2012 to 328 million people in 2100. In Ethiopia, the CPR has been increasing at 2.3 percentage points per year, although even if this rate is maintained the population will still double by the end of the century.

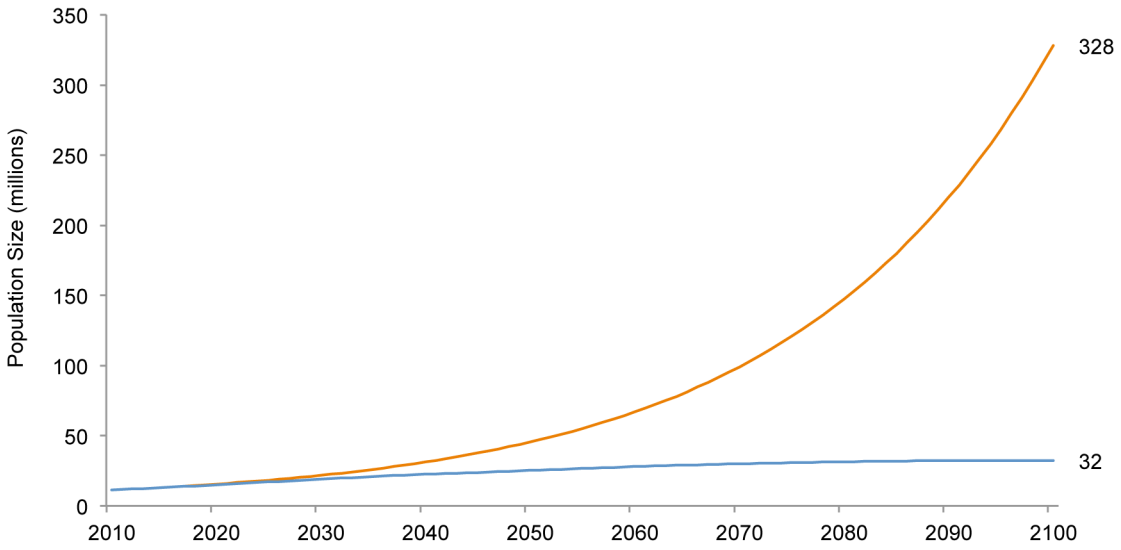

Figure 7. Chad's projected population size by 2100 will depend on the increase in the contraceptive prevalence rate (CPR) each year. Data sources: Chad Demographic and Health Surveys 1996-97 and the UN Department of Economic and Social Affairs, Population Division.

CHAPTER 4: URGENT, SIGNIFICANT ACTION

The problems facing the Sahel are genuine, large-scale, and grave. The threats of starvation, forced migration, and conflict hanging over the Sahel are real. If it were possible to draw isobars around human misery, the Sahel would be of the highest-pressure areas of the world. It is already home to some of the highest infant and maternal mortality rates in the world. Rapid population growth and climate change will only exacerbate these outcomes.

The goal of the OASIS conference's hosts was to expand the evidence base essential to generating the policies and the financial investment necessary to confront and begin to reverse these hazards. The Sahel faces an emergency, and all scientific tools must be used. We also know that there is a continuing need to test and evaluate pilot projects designed to ameliorate this crisis, and that it is imperative to build additional skills and expertise in Africa, as well as among academia in the industrialized nations.

The OASIS conference confronted the problems of hunger, weak governance, and lack of human capital and physical infrastructure. At the same time, the meeting generated palpable excitement among the 120 participants. The multidisciplinary approach helped to assess future threats to the Sahel and to develop evidence-based, achievable solutions to alleviate the unfolding crisis in the region.

> *"The poorest developing countries will be hit earliest and hardest by climate change, even though they have contributed little to causing the problem. Their low incomes make it difficult to finance adaptation. The international community has an obligation to support them in adapting to climate change. Without such support there is a serious risk that development progress will be undermined."*
>
> — THE STERN REPORT

It is Northern consumption that is driving part of global climate change, but the Sahel region, with its landlocked countries and political instability, has been a low priority for major donors (Figure 9). While the United Nations summit meetings on climate change have sometimes been marked by internal disagreement, there has been a promise by wealthier

nations to mobilize $100 billion a year by 2020 to help mitigate the impact of climate change on vulnerable countries.[67] Common sense suggests that the first call on this money should be to help defuse the crisis in the Sahel. In fact, the declaration made by the International Planned Parenthood Federation and other non-governmental organizations during the lead-up to the London Summit was specific on the need to "focus on providing information and services to those who have historically faced poor access to family planning," citing as an example "post-crisis populations."

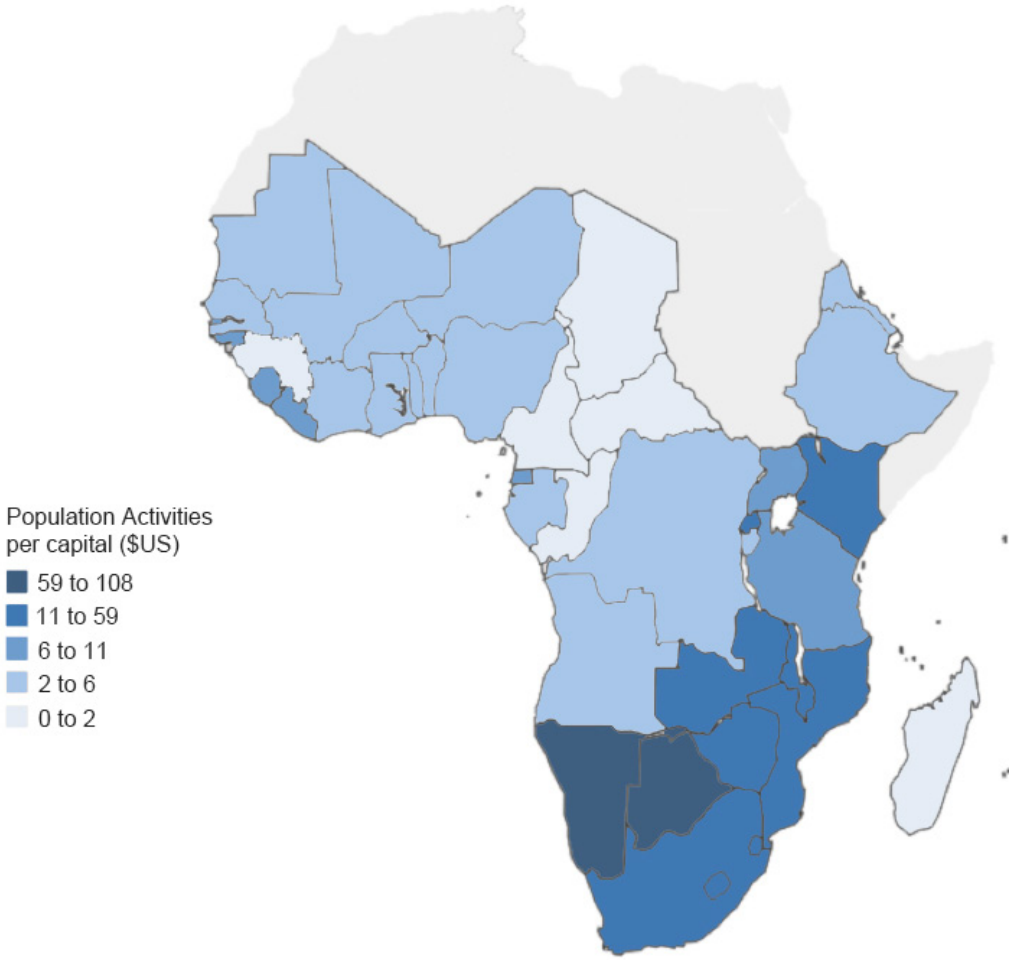

Figure 8. Population assistance per capital, Sub-Saharan Africa, 2009. UNFPA/NIDI Resource Flows database.

Unfortunately, to date, the Sahel has received only $100 million to $200 million to assist in adaptation to climate change. It is hoped that the same will not happen to the money committed to family planning at the July 2012 London Summit. While recognizing that many developing countries need external assistance in family planning, it will be essential to avoid the temptation to allot money disproportionately to relatively stable, pleasant-to-work-in countries rather than the sometimes dangerous, more challenging countries, such as Mali. Donors should make it a priority to overcome the lack of balance currently seen in the allocation of climate adaptation funds — something Archbishop Desmond Tutu has called "adaptation apartheid."[68]

A major theme of the OASIS conference was the emphasis placed on the need for an integrated, mutually supportive set of interventions. Piecemeal responses might just enable some countries to adjust to either rapid population growth or climate change, but when these two forces converge in both time and space — as they will surely in the Sahel in coming decades — then only immediate, concerted, large-scale, coordinated action can avert devastating consequences. There is no realistic way that isolated, uncoordinated pilot projects and interventions could avert the cataclysm posed by the combination of rapid population growth projected by demographers and the severe impact of climate change effects forecast by climate experts.

Unfortunately, most government aid agencies and large philanthropic donors often work in silos. For example, agriculture and family planning are often supported as isolated funding streams, when in reality, they should be seen as highly synergistic inputs. We need to make use of existing programs and infrastructure in order to expand their original purpose and include policies that help to tackle additional issues. For example, there are micro-financing networks currently in place in several Sahelian countries. These groups are based in community trust, kinship, and other social relations. In addition, they hold regular meetings, have information generation schemes in place, and reach a wide variety of stakeholders: males, females, etc. These existing networks can be expanded to include information dissemination on agricultural adaptation and family planning. The same would apply to existing programs on family planning: they could be expanded to address and disseminate information on agricultural technologies, water management, and related issues. The goal would be to build on existing programs, as

such an approach could lower costs, make use of economies of scale, and address the issue of tackling difficult problems in a small, feasible and efficient scale.

The challenge of adapting agriculture to climate change and slowing the present rate of population growth, along with the imperative for good government, all circle back to the key role of women in development: the autonomy of women to choose how many children to have, the role of women in agriculture, and the part women should be playing in civil society and in developing the economy. In Mali, for example, women cultivate the fields, fetch water, and collect firewood, but they remain totally under the control of their husbands. The majority live in polygamous marriages, usually married to older men. One reason female literacy remains low is that families tend to send their sons to school while keeping young girls at home to help fulfill domestic duties. When the status of women is improved, agricultural output rises.[69]

CHAPTER 5: THE COST OF INACTION

One thing is clear: the world cannot wait. In the Sahel, research and investment must be directed toward slowing population growth, developing sustainable agricultural practices, and investing in the wellbeing of girls and young women. In the 1980s, the world watched another global emergency emerge — the AIDS crisis. Initial investments by the international community were a small percentage of today's expenditures. Looking back, it is self-evident that a much greater investment in the 1980s would have saved money and millions of lives decades later. Today, we are faced with another choice between immediate or delayed action. While certain adaptation strategies will take time, some could have immediate impact. Investing in family planning, girls' education, and technologies to meet the Sahel's food and water needs are crucial to avert a colossal humanitarian disaster. The eventual costs of inaction in the Sahel will be much greater than taking action today.

Investing in women and slowing rapid population growth in voluntary ways is probably a more predictable way of preventing conflict over resources (as is currently occurring in Darfur), or the proliferation of terrorist cells (as has taken place in Mali) than military action. It is a slower way of defusing conflict or preempting the rise of fundamentalism, but a more sure one. The problem in the Sahel is that, for 20 years, there have been little more than pilot projects and token interventions. In order to catch up, what is needed will cost more than if similar investments had been made 20 years ago, but less than delaying action even longer.

Our goal is to ensure that this OASIS report will stimulate increased scientific efforts to build scenarios depicting what could happen in the Sahel in future decades if nothing is done. There is a need to work in such areas as refining and deepening the existing data on climate change, exploring demographic scenarios in more detail, and proposing on-the-ground studies of the most effective ways to raise the age of marriage. Compared with previous efforts, the resources needed will be considerable. Compared to further inaction, the costs will be small.

Last year, the international community spent $900 million feeding hungry people in the Sahel. In 2013, humanitarian agencies are calling on donors to provide $1.6 billion in aid, even though the 2012 harvest was better than that in 2011.[70] Rapid population growth undermines economic development and predisposes a country to fail. Military action in Mali is costing

hundreds of millions of dollars, and the long-term outcome remains uncertain. In 2011, pirates from the failed state of Somalia cost the international community $7 billion confronting piracy — in the following year, pirates seized 28 ships in the Red Sea and at the end of the year still held 154 hostages awaiting expensive ransom.[71] The challenge we face is to get decision makers in the World Bank, or the G8, or big philanthropic organizations, to understand: (a) that the only way to avoid a catastrophe several decades ahead is to act now, and (b) to accept the need for integrated, multidisciplinary action.

A sense of scale is essential. This report discusses the wellbeing of more than 100 million people and perhaps the very survival of tens of millions. Whether for humanitarian instincts, or pragmatic self-interest, the cost of action is a tiny fraction of wealth of the developed nations. For comparison, on the day after Thanksgiving, United States shoppers spend more than $50 billion in a single day. One tenth of that money, if allocated over the next 10 years, would meet the unmet need for family planning around the world. It would also help keep girls in secondary school in regions such as the Sahel, where child marriage remains a human rights abuse.

Changing attitudes about crisis that may not become fully apparent for several decades is a difficult challenge. But, as this report of the September 2012 OASIS meeting has shown, the evidence about the problem and the evidence about solutions does exist. The next step is to recruit skilled professionals in Africa and in the global North to organize, validate, display, and transmit these facts before it is too late for any interventions that could prevent an unimaginable catastrophe for the Sahel — and for the rest of the world.

THE SAHEL INITIATIVE

The Sahel Initiative is an effort to maintain the momentum generated by the first OASIS meeting.

All the participants at the OASIS meeting recognized how much they learned from people with varying backgrounds and representing different disciplines. For example, the meeting of climate and population experts underscored the seriousness of the problems facing the region. Those expert in agriculture and those committed to empowering girls and young women discovered the power of cross-disciplinary solutions to serious problems. The Sahel Initiative aims to:

- Build a network of individuals and institutions aware of the problems facing the Sahel and committed to implementing humane solutions on a large scale within a generation.
- Promote collaboration between universities in Africa, North America and Europe to validate and deepen the evidence base that large international organizations, local governments, donors and philanthropic organizations will need to generate the level of large-scale action that the OASIS meeting demonstrated is needed urgently.
- Disseminate the evidence summarized in this report and discuss with policymakers and advocates as one starting point to develop and begin to implement relevant policies and programs in the very near future.
- With the funding that is in hand, and by seeking additional funding, help build additional human capital in the Sahel and inspire young professionals in North America and Europe to see research and action in this field as promising career opportunities.
- See an expansion of the work of AFIDEP and other organizations committed to turning research into policies.
- Plan an OASIS II meeting, possibly in the Sahel, and invite donor groups and interested countries to attend. Like OASIS I, it would bring together a multidisciplinary group of experts to explore integrated solutions.

SPONSORING ORGANIZATIONS

African Institute for Development Policy (AFIDEP)
www.afidep.org

AFIDEP is a nonprofit based in Nairobi, Kenya, whose mission is to enable the formulation of policies and program interventions that are informed by research evidence in Africa. The Institute seeks to contribute to sustainable development in the region by generating and translating evidence on the linkages between population change, public health, youth development, and the environment. One key element of AFIDEP's work involves helping policy makers in the ministries of planning and finance, as well as foreign aid agencies, gain a clearer understanding of the population growth factor in health and development. In particular, AFIDEP translates evidence to help strengthen political will, increase investments, and enhance effectiveness of interventions for enabling couples to fulfill their childbearing ideals and reduce the high levels of unmet need for family planning and other reproductive health services in Africa.

Bixby Center for Population, Health & Sustainability, University of California, Berkeley
bixby.berkeley.edu

The Bixby Center for Population, Health & Sustainability is a collaboration of students, faculty, researchers, and staff working to improve maternal health and address the impact of population on global public health and the environment. The Center is located at the University of California, Berkeley, and works closely with leaders of U.S. and internationally based organizations, as well as government officials throughout Africa and Asia. The Center has been a pioneer in "task shifting" and empowering communities to take control of contraceptive and safe abortion options.

College of Natural Resources, University of California, Berkeley
nature.berkeley.edu

The College of Natural Resources generates and disseminates knowledge in the biological, physical, and social sciences in order to provide the tools both to protect the Earth's natural resources and ensure economic and ecological sustainability for future generations. The

college has four departments (Agricultural and Resource Economics, Environmental Science, Policy and Management, Plant and Microbial Biology, and Nutritional Science and Toxicology) and 16 interdisciplinary research centers and facilities. Research fields include environmental and agricultural economics as well as policy, law and justice. The college hosts the Beahrs Environmental Leadership and the Masters in Development Practice programs.

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