**Practical International Development**

**Adventures in creative environmental science around the world**

**© Jon C. Cooper**

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**SECTION I. INTRODUCTION**

**CHAPTER 1: NO FRENCH FOR "FUN"**

During an assignment in France I had the opportunity to work with a lovely Alsatian anthropologist who was bilingual. After work one day I said to her in English "let’s go have some fun." She, of course, knew what that meant - any range of activities from taking a walk, coffee, a glass of wine, going to a sports game or whatever. When we tried to find a way to say that in French we were stumped. We tried "amusant" (amusing), quelgue interesant" (something interesting), and other terms. The French culture just wanted to be more precise than the English and approached that part of their worldview differently. This was a good example of different approaches to life by another culture.

Bringing creativity to science --- solutions are not just straight engineering or scientific principles. Its working between the intersection of cultural possibilities, cultural acceptance and needs. There are so many demands for resource needs, that the best is to leverage the needs to find win-win solutions. For instance solving problems with corrosion in the power plants, by removing sulfur from the oil used to create steam in the industrial machine, would also result in less money spent on sulfur for the tea plants, and would provide a ready source of this needed material (sulfur) for the plants. There were known processes available, they just had to be applied in a creative and coordinated manner.

The concept of multiculturalism is central to international development. Projects just do not work unless cultural differences are taken into account. Over the years I have been in adventures around the world as I pursued a career in environmental policy and analysis. Before you decide to go on to another book (perhaps this area of environmental studies is not interesting to you), that work involved fascinating activities on using water, power generation, growing rice, and using pesticides to control locust invasions in Africa. In Asia I looked at water pollution and the disposal of chemical waste (along with building chemical testing labs - again doing cooperation between Japanese and Indonesian cultures). I looked at ways to protect rivers from pollution and provide more drinking water to cities in Fez, Morocco, all this along with raising a family and dragging then around the world. To this day my daughter remembers well living in a village in eastern Senegal, swimming in the Ivory Coast and buying roasted chicken with her grandmother on a shopping street in Paris. Here are some of those stories. I hope that they will illustrate to you several important principles of international development

Figures 1 and 2. here - my, daughter, Emily, age 3, playing in village, and age 10, in a restaurant in France

International development is an exciting field. It presents enormous opportunities to help people: “Consider government: it’s real service, and you can affect [the laws of] hundreds of millions of people. And if you’re working for USAID (The U.S. Agency for International Development) . . ., you can affect billions of people.” (Dominus, 2014)

**CHAPTER 2: ORGANIZATION AND THEMES**

This BOOK is intended to help those individuals who are or will be working and planning foreign aid projects and to provide some technical materials related to these projects.

While this book may undoubtedly be seen as an environmental work, its main purpose is to show the "three-legged stool" basis for international development, by which I mean that for each project my planning needs to be supported by a clear balance between the three "E's": ECONOMICS, ENVIRONMENT AND ENGINEERING.

The reader may also ask why the emphasis on Africa. As we learned from William Shakespeare's Hamlet, the future is the "forgotten country" and some of the strongest future foreign development is the development and emergence of Africa on the world scene. Africa is also where I learned strong applications of so many principles that are discussed here. More principles were also applied in Asia and they are applicable to projects around the world.

This book is designed to teach Planning (Table 1) principles and Technical/analytical principles. The prime Planning principles, already mentioned, is maintaining a multicultural perspective. Other examples of Planning principles include political perspectives, maintaining some stability in priorities for a program, keeping the search for the “best” from paralyzing a project (“the best as enemy of the good”), or letting one of the three “E’s” dominant the project.

Technical/analytical principles inform the Planning principles in a range of ways. Some, for instance, remind us to ask questions about a project in a systematic way (Programmatic assessments) and to see if a project can be better defined. Other principles include using a full perspective in “mass-balance” techniques, derived from science to determine if a project will, overall, improve a situation (or would a project, for instance, simply shift one aspect of a problem, so that there is more food of some type, but less of another).

Examples of these principles are given in the stories about Africa and Asia in the early chapters. The principles are then discussed in depth in later chapters. We start with our tour of Africa (Figure 3) and some of Asia (Figure 4). See if you can pick out some of these principles. Enjoy!

**Table X. Checklist of Principles**

I. Planning Principles

A. Aware of multicultural perspectives?

B. What aspects address and/or meet political concerns?

C. How are shifting priorities/concerns handled in project?

D. What measures of success are appropriate to gauge progress and outcome of project?

E. Has the project clearly and explicitly coordinated with other projects, either in that discipline or another relevant field?

F. How are overreaching issues such as population growth, gender issues and climate change handled or analyzed?

G. Has there been a balance between economic, environmental and engineering consideration?

H. Does the project funding have a role of providing initial funding for a comprehensive project?

II. Technical/Analytical Principles.

A. Has the project used a programmatic or similar device to identify or consider win-win solutions?

B. Has the program conserved some form of a mass balance analysis – one that considers all inputs and outputs to the projects to assure a net benefit of the project? Alternatively, has it considered explicably all trade-offs on which some things are lost and other things gained?

C. How are issues related to natural resources or food security considered?

D. Specifically, how are water, energy, and transportation resources considered?

E. What consideration is given of issues related to cities and large urban areas?

F. Is this project preventing a problem, or is it only fixing one that has become substantiated?

G. What are the roles of new or future technologies in leap-frogging earlier technologies or possibly avoiding problems earlier encountered in developed countries?

H. Is the project utilizing appropriate technologies for this stage of development for this country?

I. Will developing large budgets or planning large-scale projects necessarily solve the development issue?

J. Is the “Best” the enemy of the “Good”?

For each chapter, I suggest that the reader considers which of these principles might apply – and have their application or the applications of other principles might be useful in planning or re-visiting existing programs.

SECTION II. AFRICA

**CHAPTER 3: PESTICIDES IN EIGHT COUNTRIES (But I’m leaving out Cameron and Yemen form this chapter and covering Sudan in the next.)**

Africa, as much of the world, has a food security problem – the lowest incomes of the world are in these countries. So many of issues related to food security relate to agricultural production and items that affect the crops. From biblical times, locusts have been seen as a plague upon crops. In modern times, there have been large incidents of locust swarms and in the 1980's countries in Africa from the west in Mali, Ivory Coast and Senegal, through central Africa (including the Central African Republic) through East Africa including Tanzania, Kenya and Ethiopia, and even extending to the Middle East in Yemen (Figures 3 and 4). The USAID, working with the United Nations, decided to fund programs to fight locusts, mainly with pesticides. There were minor components for IPM (integrated pest management) and training. There were also components for the destruction of obsolete and dangerous pesticide stocks. This project is presented because it was “fun” but also because it illustrates many of the principles

As with many large programs – and for programs spanning several countries, the USAID decided to first do a Programmatic Environmental Assessment (PEA) for the entire program. In this analysis, USAID proposed a review of the extent of the locust problem and a review of which pesticides would be suitable under various conditions. For instance some pesticides might be safe in areas that were inland, but unsafe around aquatic resources. In other words, birds might not be affected, but fish might be. The use of pesticides raised many questions, scientific, economic and political. Ever since side effects of pesticides were severely questioned in the 1959 book of Rachel Carson (who discussed the loss of eagles and other large predators, known as raptors, due to the thinning of eggshells as a result of their ingestion of prey such as fish that had dangerous levels of DDT and its break down product, DBE). (Carson).

Locusts have been blamed since biblical times as agents of destruction - they were even one of the ten plagues brought upon Egypt through Moses by God in Exodus. In modern times they are blamed for loss of crops across Africa - and contributed to famine in some of the poorest countries in the world. There is, by the way, some debate among economists and agriculture folks about how bad the problem is. Many of them point out that much of the crop lost is due to other insects, drought and other agricultural practices (such as farming in areas that are marginal for having the proper conditions for crops.). For instances many crops are planted in areas near the Sahara and have poor nutrients and very low rainfall.

Programmatic Environmental Assessments are a familiar feature to practitioners in the environmental area. They arose from a requirement in the environmental law – The National Environmental Policy Act (NEPA) – that requires the preparation of an environmental assessment (EA) for any major Federal project. Basically, an EA is designed to ask systematic questions about the potential for a project to have environmental (which includes health) impacts. EA’s have now evolved in the Programmatic Environmental Assessments, which ask a broader set of questions and are also excellent planning tools for government programs (Cooper, 1994). Thus, PEA’s and similar devices from a good technical principle for international development projects.

Some of the original pesticides such as DDT, as well as classes of other "artificial" pesticides, such as Dieldrin, were thought of as miracle chemicals because they were so effective against insects and because they were persistent enough that they were only applied once or twice a season. Eventually, it was found that insects became resistant to them and that there were the "bio-concentration" effects, in which small levels of the persistent chemicals built up in concentration as they were taken up by plants, small animals and passed on through the food chain to the predators. Several species of fish used by humans, such as perch in the great lakes and xxx along the coast became "unsafe" for consumption. And fish consumed by eagles lead to the damage identified by Carson, so that reproduction was reduced.

The next generation of pesticides were derived from plant or chemically-copied from "natural" sources, such as pyrethrins from marigolds. These avoided the problem of bioaccumulation/bio-concentration, but were much more acutely toxic - they were much more poisonous immediately to humans and many animals (the original pesticides such as DDT were not acutely toxic to birds, humans and fish). Therefore there was a need to try to avoid aquatic resources, - river, streams and lakes, so as not to kill the endemic organisms.

As with the first generation of pesticides, organisms also became resistant to the new pesticides, so there were a variety of innovations - modifying the basic structure, using mixtures, and adding other chemicals that would "potentiate" (increase) chemical toxicity. In a third generation, there is an on-going to effort to find chemicals that are more selective as pesticides, such a pesticide that just works against only one pest, such as one cucumber pest. Alternatively "natural" pesticides were developed - either chemicals derived from nature - such asNEEM (from the Neem tree), or biological solutions, such as viruses (for example, bacillus thurensis - or BT, which is becoming widely available). As a complete alternative to pesticides, there is also an increased use of integrated pest management (IPM) to try to use ecological solutions to control pests. For instance, growing marigolds around vegetable crops such as tomatoes keeps pests away because of the natural repellant action of chemicals released by the marigold. Other methods include planting some trees in the shade of others (that makes the habitat less inviting for some insects). In some of the newest applications, there are changes to soil preparation and mulching operations that may be avoiding some insect pests.

I should also mention that another major innovation, also highly controversial, is the genetic modification of crops. These modifications are generally used in two ways. In both cases a gene is added or modified into the plant seeds. Either the plant becomes resistant to a pesticide so that the pesticide applied to the fields kills everything except for the modified plant. Or the gene makes the plant secrete a chemical that kills or repels the insect pests. This approach saves labor for the farmer, who avoids repeated applications of pesticides, the expense of the chemical and all the assorted purchase and repair of equipment (a major tractor can cost in excess of $100,000).

This limited introduction to pesticides is to allow the student to follow the rest of this chapter. A more detailed discussion and background is presented in Chapters \_\_\_\_\_. Toxicology and the way that the toxicity of pesticides are assessed, as well as the ways in which they are regulated.

**THE DESERT**

Besides the pesticide issues in this program, there were also a host of economic and policy issues as well. The economists were trying to separate out an understanding of economic losses due to locusts versus other pests and other factors such as drought. They pointed out that many of the crop losses were due to farming on or in marginal areas - areas with poor soils and historically low rain falls - many of them bordered on the Sahara. In fact, many climatologists had suggested that these farming’s practices were responsible for the desertification of the areas and the enlargement of the Sahara desert. (CEQ, 1980) The mechanisms were mainly that tilling of desert soils caused them to dry out and to become unstable. Otherwise the sparse, but natural vegetation would be expected to keep the areas intact. (Post, 1974) In fact, the 1981 (?) State of the environment from the council for Economic Quality (CEQ), discussed this phenomenon in detail (although the report was withdrawn by the Reagan Administration). There were few studies that documented losses due to locusts, except for one special instance in which the locust became trapped in a valley and destroyed all of the crops. More typically head minors and drought destroyed the crops.

Ecologists pointed out that in some ways the locusts represented the genius of nature. Locusts would lie quiet for often decades and only came out when there was rainfall - again in areas that might not receive significant rainfall for a decade. Once the rains did come there would be this amazing explosion of a population of locusts who would blanket the sky for miles and cast a shadow that would darken the sun. Certainly the locusts would consume vegetation, but they moved along fast enough that some was left behind. And with the locusts came a feast for the birds, which were so full that they had trouble flying. When the locusts passed, like a biological hurricane, the birds stayed and controlled dramatically the insect populations, including the mosquitoes, who were the vectors for malaria and other diseases. Ecologists would argue that there would be better places for farming and that would make areas more productive, and also avoid the conflict between humans and nature. Of course, the African natives saw it differently - that population growth required expanded fields in all those farming areas. The USAID wanted to support them, and also felt that they had obligations for us support.

[“Story insert 1 here – Lauren Van der Post. A far off place – dessert scenes”]

The desert would become an important multi-alluvial consideration for the Planning and Technical principles for the project.

**THE ASSESSMENT**

In order to do the PEA we needed to do an assessment in eight countries - basically that was a process of looking at the bigger questions - which pesticides were safe to use in each situation and which would be the most effective. Once that was finished, as discussed below, we then did country specific assessments that got into specific questions and issues for each of the countries in the program.

I had lived and worked in many places previously, but the sweep through Africa as a member of the program assessment team was a dream of a life time. The adventure started in Washington, D.C. with a thorough briefing on the project from USAID at their headquarters, and a meeting to see our team of experts on locusts, pesticides, delivery of pesticides and environmental impacts.

Amazingly, the next step was harder. Because I was going to eight African countries, I needed a visa for each. The only way to accomplish all the visas needed was to hand my passport to a service group. They disappeared for a week, first needing a sheaf of signed forms, photographs and checks, and came back with my passport full of pretty (and big!) stamps allowing me to visit all those places. One of the places I was headed to was Sudan and I had the visa, plus when I returned a stamp showing I had been in Sudan. In today's security conscience world, did that cause a fuss - everything I traveled in subsequent trips I was questioned about my activities in Sudan!

Because the trip was so varied, my baggage included a full camera bag full of telephoto lens, lot of film (yes, it was still back then when no one had yet heard of electronic cameras), and extra filter, etc. It was truly a pleasure to snap away and have a record of all the places on that trip.

The trip was hard work in that we traveled long distances at strange times during the night, had lots of meetings back to back. We traveled in long distance flights (my package of tickets and boarding passes was as thick as a paperback book), and then transferred to lots of car trips (usually in the Toyota vans with massive steel panels on the front and back), and then even to small airplanes (in Mali as I describe below). USAID was very efficient and had drivers meet us at the airports and take us to the hotels and meetings.

Mali

Our first stop was Bamako, Mali, West Africa. It's a pleasant place, with that amazing smell of Africa when you land - a mixture of humidity, cooking fires, and animals and soil that you will never forget. The airport is ancient and customs clearance non-existent as long as you have the USAID person help. Passports were stamped and we headed over to the hotel and then a meeting -after traveling 22 hours through Paris on connecting flights. Thankfully I had made detailed notes of issues and questions for the meeting, so when they asked me for a plan I could answer. We met with the Ministry of Agriculture the next morning. The offices have no air conditioning or fans, but we were meeting with the heads of government, so acceptable dress was a clean pair of slacks and an open neck white shirt. The officials were magnificent in long formal robes, decorated with stitching and made of colorful cloth. We discussed their concerns from locusts and their policies with respect to pesticides. USAID had an office in place in a compound near the offices and we found a variety of pesticides already stored there, along with equipment for dispersing it. (Fig. 5) Interestingly enough there were a variety of languages on the equipment - some of which had come from Italy (in Italian only), France (in French) and the U.S. (usually just symbols for poison). The skull and cross bones for poison were understood there in Mali, but we learned that it could also be interpreted as a sign for an aphrodisiac in other cultures, so that one recommendation was to put warnings in local languages as much as possible. (Fig. 6 picture of the locust from office put here).

- Fig. 5 – Male of the USAID here -

- Fig. 6 here -

We collected lots of technical details on how many farms they wanted to treat, the location of the farms with respect to lakes, organization of the ministry to deal with the materials, etc. Each of the specialists had their own set of questions. For instance, the locust specialist wanted to figure out what species and what cluster of locusts were involved. And I had fun taking lots and lots of pictures.

Coping in the Desert

From Bamako we traveled to meetings in the desert with local farmers.

In order to prepare a programmatic assessment for pesticide use in the locust control report, the initial step in these studies is called a scoping - which in a big assessment - an Environment Impact Assessment - which is rarely done by USAID –is to give the public (everyone who wants to comment) a chance to tell us of their concerns. It was decided that there would be a large public meeting in Mali for this purpose. We flew into the capitol, Bamako, did some initial meetings with officials and planned our brief presentation. Then we drove to the airport and got into a small crop duster airplane, where I was offered a beach chair in the back for a seat. We flew over the edge of the desert to the east and landed on a hard pack area of sand and sparse vegetation. Low and behold next to us was a large tent set up in the desert, with probably 100 seats. Along the edges of the tent a series of air conditioners had been set up and there were a group of generators churning away to power them. The meeting was mostly held in French, although I believe there were some local languages as well. People had a chance to tell us their concerns about use of pesticides to control locusts on their farms. Public officials also spoke. As I remember all the comments were positive, no one worried about impacts on people, animals or plants. They just wanted to be able to use pesticides to control locusts.

After the meeting, we got back into our crop duster plane and once again went over the desert, first to the east to see the situation with crops -- one of the issues was whether other causes, such as drought and other insect pests, were responsible for crop losses. We stopped at a desert research station – with a colleague from one of our team members – to discuss the situation. We were still in a marginal agricultural area – near the desert, with poor looking crops. Lo and behold, at that place I had my first view of locusts and some grasshoppers! (Fig. X). I also got to see the head minor (insect) that was also responsible for many losses. We traveled over the land and got to see Timbuktu, the prime trading town during the 12-16th century (check). Then we headed back west and stopped at the camp of a U.S. researcher, who was studying insects on that region and had a report on his findings for our report. Airborne again, we went to Bamako, safe and sound. Sadly, we heard that the pilot about two weeks later crashed and burned.

Mali was also where I learned about some of the limitations of the desk officer at USAID with respect to languages. We all sat down for lunch at a local cafe and looked forward to the usual French influenced tradition of three courses of some type. We didn't know what was available, so the USAID desk officer (who had traveled in from Washington) asked the waiter for "Le Menu." Very soon after plates of food had started to arrive - looked ok to me, but many didn't want and said that there had been a confusion. If you wanted a menu you ask for "La Carte." If you wanted the special three-course for the day you asked for "Le Menu." Our desk officer hadn't known the difference. In any case it worked out and I found the food to be delicious and safe.

Senegal

We finished up in Mali and headed out to Senegal, which was a short flight away - to the capitol, Dakar. This was my first trip to Senegal, which was soon to become a decade of my work with over 40 visits to come. The operation there was much bigger - Dakar is a booming city with an impressive square with office buildings and broad boulevards. The USAID office was located at the end of the boulevard, but the easiest way to reach it was to head along through back alleys from the very comfortable hotel (which had a great swimming pool) - but too many people were getting mugged that way so we ended up going the long way around. This was my first trip to Senegal - where I ended up visiting over 40 times on other programs during my 15 years of working on the programs. I quickly found a great little hotel on the ocean; at a location with a wonderful chef and always with a room for me. If my driver wasn't around, it was also easy to get a taxi there. Wish I could visit there again!

The meetings in Senegal were memorable for two reasons - they were again handled with pomp and circumstance, with beautiful robes for the official. Second, the Minister of Agriculture (whose name I forget) was from a prosperous family, young and with a reputation for getting things done and not tolerating corruption. We laid out a wonderful program for training, treatment and responsible applications of pesticides. We also developed labeling and safety program, as well as storage of the materials. My team members knew him well and were optimistic on the results. We planned a long-term program - which in government terms was a few years. All came to a crashing halt in the next year when the minister died unexpectedly! We no longer had his support and leadership, so the program languished.

Ivory Coast

We left Senegal for the Côte d'Ivoire (Ivory Coast) and were amazed by what a modern city Abidjan was with a large center city with tall office buildings and apartments. The city had a full range of upscale restaurants, lots of shopping and all the computer repair shops you would want. I needed a special adapter plug for the many devices we were using and it was easy to find along the main shopping street. I remember almost nothing about the trip, because it went so smoothly. I was to return to Abidjan and other parts of Côte d'Ivoire during future activities there with other groups. Subsequently, we had a long program with the African Development Bank that was located there with a very impressive new building. (see Chapter 12). Again, we collected data for our report.

Burkina Faso

We did a brief visit to the capitol of Burkina Faso, with the great name of Ouagadougou (see Chapter 8), even by African standards a very poor country with limited resources. We gathered additional data on their crops and natural resources.

Kenya

From Côte d'Ivoire, we started on a long trip east across Africa, that confirmed the unstable nature of the countries. We traveled with Air Ethiopia, which was safe and reliable, but which stopped many times as we did the trip of over 3000 miles. We stopped in Cameroon (where I would return on a pipeline project – see Chapter 11). Then the fun started. We landed in the Central African Republic to refuel and took off around 5:30 am, just before dawn. A coup had been in the works and apparently we were the last plane to take off before the airport and the country was closed for the next 30 days! So we narrowly avoided that problem and would get to avoid another one later in Sudan.

We next got to Nairobi, Kenya for discussions there. I had been there just about six months before (when I took a vacation/ honeymoon on safari) and it was good to be back. During the previous trip I had done a variety of projects on pesticide safety and training - and had toured the market places where pesticides were sold in piles right next to the vegetables and other produce. Nairobi has beautiful hotels and great restaurants and the headquarters for the

United Nations Environmental Program, UNEP (in a spacious complex just outside), a group I helped to raise funds for and learned that wonderful quote from the head, Mustufa Tolba, "the next war will be about water." Water is managed as it flows between countries and used and polluted in many water that battles over water rights are becoming frequent and more violent. It’s hard to believe that water is a problem during the wet season, but impoundments and river become the lifeblood of a nation during the dry season. Only trees that have adapted with deep tap roots and those that live near water bodies are successful in these climates. But are they successful - some of them grow to 20 feet in diameter and provide wonderful shade. A forest in these areas is so unlike those in temperate climates. Trees tend to space out-- maybe every 50 feet as they each struggle for enough water. With increasing populations of people there is an increasing tendency for only large trees to survive, since smaller ones can be cut down for fuel and charcoal making. As we discovered in other areas (see Burkina Faso- Chapter 8), several types of trees are also becoming very valuable for commercial purposes - such as x trees for skin lotions that are very popular in the west. There are also a variety of nut bearing trees and some fruit trees which are important in commerce in the rural areas.

Obviously the trees are also important for birds and wildlife as sources of food and habitat. The communities of birds are remarkable in West Africa and through the tropics. (some research here) Despite human population growth there are still vast areas with natural populations of birds, with higher concentration near water sources. They are migratory in many cases.

In doing an economic assessment for the project, we looked at the trees that were present in the areas. We looked at the increased value to the farmers of growing vegetable crops, mainly onions, versus losses of trees and other natural products, such as skin oil preparations. Then one has to figure in increased value of economic development in the areas. This was then compared to the economic values associated with crops that could be impacted by locusts, as well as impacts on natural springs by pesticides used for locust control. We also realized that many other types of pesticides were used in these areas, so that the cumulative impacts of the pesticides needed to be considered (see Chapter 20).

Ethiopia

Coming to Ethiopia was, to me, like coming to the Switzerland of Africa. There were tall rugged peaks of mountains, framed by azure blue skies. Unfortunately, the vast mountains had largely been denuded of vegetation and showed deep gullies and other erosion. There was hardly a sign of any green as far as the eye could see. The capital, Addis Ababa, was at 4,000 foot and the air was cool, with a warm African sun. Unlike Nairobi, which was also on a plateau, the humidity in Addis seemed much lower and the air with almost no fragrance of the African soils.

At the time of the visit the political regime was changing from Marxist to a more democratic process. The city was immaculate and there were large banners draped across the streets (printed in languages I didn’t know). As has been remarked so many times, the Ethiopians are a distinctive and extraordinarily handsome people. The literacy rate is high and they were a pleasure to work with.

We had the usual meetings with USAID and embassy staff and then started a tour of farms and natural resources. Ethiopia is blessed with an abundance of lakes and far more perennial water bodies than much of the rest of the countries. The farms and fields in the lower elevations were green and fertile. At least at the time there was no evidence of locust invasions – but there did appear to be a high potential for pesticide to run off from farms into the lake areas. There were also abundant farm animals (particularly goats) that would be using these water resources and therefore might be impacted by pesticides. This information as important in the recommendations we made in the PEA report.

**CHAPTER 4: ADVENTURES IN SUDAN**

The travels in the last chapter then continued to Sudan. It was an amazing multi-cultural experience back before Darfur came into the news, before there was open war, and effectually a peace agreement and separation of the Sudan from Southern Sudan. I had extraordinary fun in more few weeks in Karthum, Sudan. On the first day, for a full introduction to the situation there, I was assigned a driver who spoke good English and was there to drive me to meetings and to visit pesticide dump sites. There was a large compound there, surrounded by a high concrete, mud and brick wall, in which old pesticides were stored. Tons of pesticides that were old and had been allowed to bake in the hot sun for years (there was no roof in that area and on many of the buildings due to the low rainfall), Everyone was worried that they could be used for terrorist activities, since they were, of course, highly poisonous, and, because of their age, highly explosive. To add to the worry, many of them were unlabeled and many were marked with labels that could be misunderstood in other cultures (the symbol for poison could be read as an aphrodisiac in some cultures, as noted earlier).

My driver and I got on well - he was friendly and helpful and knew the situation. He picked me up at my hotel and had a radio and walkie-talkie that he used to speak with other drivers. We started to drive through town to USAID, his radio comes on and he informs me that there is shooting in the street ahead, so we will take another parallel street. I believed him and felt safe and we continued one to our meetings. There was little air conditioning in any of the offices, so the normal routine was to get to the office very early – 6:30 a.m. just after dawn, work until 11 a.m., then take a long break until 3 or 4 p.m. and then work until sunset. In that way we avoided the 100-plus temperatures in the office during the day.

Within a few days we were talking about our families and lives. At the end of week he asked me whether I would like to meet his uncle and I thought it would be fun and interesting.

The Sky

My driver, who had the omnipresent name of Mohammed, picked me up after work. It was pitch black - the sun set exactly at 6 pm. The temperature was still way over 100 F. There were a few street lights, which we soon left behind and we drove into darkness for a while. What I noticed was that there were grey mud/brick, houses along with way and none of them had roofs (nor was there any visible light from them). After a while we stopped at one of these houses and we go out in the dark to meet a very friendly family. There was no door on the house either, but there was a small wooden boat and we were next to the Nile (Karthum is where the White Nile and the Blue Nile come together). We had a pleasant time over a beaker of coffee, which was served in the traditional way with a small long ceramic cup with some straw stuck in the top to keep the grounds in place. The coffee itself was a thick, rich liquid from which a bed of coffee grounds had settled. We discussed his fishing and that it was his means of supporting his family. He offered to take me out on his boat that evening, but as a biologist I knew that wading out to the boat would expose me to lots of diseases I didn't want to deal with (this was part of a much longer trip). I thanked them for a wonderful adventure and was driven back to sleep.

After a few more days the driver reported that his family had enjoyed seeing me and that he wanted me to meet one of his other uncles. Once again he met me and drove me out of the city. This time it became a little worrisome, since we seemed to be driving through dark gray alleys, surrounded by dark stone huts and we kept going and going. Just when I started to think that might be my last ride, we came to a clearing between the houses - it was still too dark to see beyond the headlights.

What happened next I will never forget. The driver opened up what looked like a set of barn doors. Beyond was Shangri-La - a magical courtyard with green plants, a fountain, and a building that surrounded us with balconies. Mohammad's uncle was a pleasant middle-aged man who welcomed me again with coffee. He spoke English well and showed me around. He had gorgeous decorations around the walls, including many ceremonial trays - most engraved with the traditional 100 words of Allah – all, of course, in Arabic.

The green oasis had walls adorned with ceremonial trays, all beautifully decorated. As we sat admiring them my host offered to give me one - of course, in exchange for some money. So we haggled in dollars, Egyptian dollars and Sudanese pounds - and then currency versus traveler’s checks and which transactions were allowed under currency rules. In the end I got a beautiful brass tray encrusted with multi-colored decorations, beautiful folds in the metal and a great piece of decorative art. I proudly carried it home on my return to the US, but did have the luck to have an extra seat next to me on the airplane in order to fit the tray (which was about four feet in diameter). Years later, I was speaking with former members of the U.S. embassy, who told me that my adventure had become a legend among the staff. Would I repeat it today?

The pesticide dump was eventually cleaned up by getting a grant from another government (Dutch) to build a giant incinerator and burning the wastes at a high temperature. Again this became the model for international cooperation.

The lesson learned here is that you can have fun and have a great multi-cultural experience. But you have to be open to the opportunity and, yes, be willing to put trust in your judgment of people. Given the increased incidence of terrorism and now attitudes towards Americans, it is not clear whether this particular adventure can be repeated in a new circumstance.

Figure 5 here. Ceremonial plate/tray

Figure 6 here: Pesticide dump

Leaving Sudan was an amazing experience. I took off during the early morning and had a seat that allowed me to see the ground. We flew up the Nile to Cairo. What an incredible blue ribbon, surrounded by green fields in the middle of sand and desolation!

SHOWDOWN WITH THE UNITED NATIONS (U.N.)

After we finished our visit in Sudan, we headed for a brief trip to Rome to meet with the UN FAO fisheries advisor, to discuss impacts of pesticides on fish and other aquatic organisms. In the small world department, the head of that section was Fran Henderson, who had received his graduate degree in the same department with me. We reviewed the UN recommendations, enjoyed one night in a comfortable hotel and flew back to the US. We prepared our report over the next few months, and came up with general recommendations that included using at least second generation pesticides (i.e., those that did not bio-accumulate) and avoiding a list of banned or limited pesticides including DDT, dieldrin and some other organochloride pesticides (the chlorine molecules in the chemical formulation tend to make them more stable and persistent). As required in Federal law, we didn't consider price of the materials. We did have some consideration of the effort needed to disperse the pesticides -- the second generation pesticides generally degrade in a few days after application - so that it may be necessary to reapply them several times which adds to the cost of the applications.

USAID generally accepted the recommendations and was in the process of implementing them - ordering quantities of pesticides for the programs. They then shared their approach with the UN, which was coordinating efforts from other countries, as well as through UN programs. While USAID was not directly involved in financing locust control programs in Morocco, that became the focus of disagreement. That and strong push from France, which historically had supported Francophone countries, to in fact use dieldrin. Not only did they consider it safe and at a reasonable cost, since it was made in France, but they also wanted to have it sprayed in wide troughs in the north of Africa - in the area of North Morocco, near the Mediterranean, in the Atlas Mountains. The mountain area has historically been a reservoir of locust survival - they stay in a hibernation state for years - sometimes decades- and then proceed south across the desert to fields and green areas near the rivers. The Moroccans wanted to lay down a barrier of pesticides to kill them before they got to the farmland. Their view was that the desert was empty and that it would cause no harm. At least initially the UN supported that position.

I will never forget having a previous discussion with a UN official, during the part of the trip in Mali, in which I asked him to discuss plans for the program. He indicated briefly that the UN had its own policies and there was no need to coordinate with the USAID. He then pulled the usual trump card that he could not discuss it with anyone who didn't speak perfect French. We did get past that point and shared some information about locations of locust problems.

USAID and our team had a very different view of the desert and potential impacts of pesticides such as Dieldrin, not the least of which they were on a list of banned pesticides – including on the list of "black" list pesticides prepared by the UNEP. We then discussed the ecology of the dessert. It was far from empty. It was a major flyway for many birds, including the White Stork, which travels from Europe in a yearly migration on their way to central Africa. It is a revered species, is protected by law in Europe and has a very active society that looks after their welfare. The desert is also home to a wealth of animals that have adapted to that climate. For both humans and animals (including the White Stork), oases are very important as stop over places for water. These areas are actually lenses of water that are at the surface from larger aquifers that unlie the area. If pesticides are sprayed in the desert they would potentially harm plants and animals that are living there at marginal levels and would indirectly affect animals and humans who came to the oases-because the pesticides would be expected to accumulate in these oases (due to their persistence). Thus the environmental assessment would be that spraying pesticides in the desert would do a lot of harm. It was also not clear whether spraying would be an effective way to control the locusts. Incidentally there did appear to be full agreement that spraying in the Atlas Mountains would potentially cause massive harm to the many species that lived there.

The UN eventually agreed not to sanction spraying in the desert and the Moroccans agreed not to use their fixed wing aircraft or dieldrin in the program. Locusts eventually were treated and disappeared, as did the funding for the program. Work shifted to considerations of food security, including the Famine Early Warning System (FEWS) program. (insert to be prepared)

**CHAPTER 5: SOUTHERN SUDAN**

The next adventure in Africa was in Southern Sudan, many years later. This assignment to Southern Sudan, during the time after peace talks and establishment of the new nation, allowed me to see the birth pains and possibilities. But more importantly who can resist a tent on the Nile, looking at crocodiles and lush vegetation to the south and waste lands to the side. By contrast, an open field about 500 yards away is the latrine for the local population - during the dry season it is fairly stable with everything drying up quickly due to the dryness and heat - but during the wet season the flies are abundant and move in clusters to the camp and are the link to many cases of cholera and other water borne diseases. The temperatures in the sun were in excess of 120 F., and there was not a cloud in the sky. Inside the tent - and the better ones had cold running water in a small alcove at the back - it’s probably over 100. Amazingly enough, when night comes and one collapses from the heat into a sweaty sleep, it actually feels cold as the temperature falls into the 90's.

Southern Sudan is a work in progress. There are lots of well-intended efforts that just didn't seem to work. Roads and water were two examples. There was a main road that cut through the middle of Juba, the capital city of the new country. Juba probably had over 200,000 residents and was decimated and in the process of trying to provide water, food and housing to destitute immigrants. Except for oil money - more below - there were almost no resources beyond foreign aid.

With respect to the road, the relief agencies and foreign aid - which are the mainstay for the country - decided to totally repair the main road. As they started they dug down and created steep banks on either side. The plan was to rebuild the base of the road and then do a firm topping - ideally of asphalt. This would allow a long-term solution to the need of a high-volume main road. Before this was done, it rained hard and filled the whole length of road with several feet of water. The only way to get from one side of town the other was to drive down a steep bank, traverse a pond of muddily, disease filled water and then drive up the opposite bank. If you didn't happen to have a good car - one that wouldn't flood out or get stuck in the mud - you were out of luck. Eventually the water went down and the road was repaired.

Speaking of water, there were amazing international politics in setting up a water supply system for Juba the new capital of Southern Sudan- a project that I was only incidentally involved. One of the big debates in water systems (that is drinking water supply systems) is how centralized they need to be. Put another way - how many people do you want to supply with water from a particular source, from one water treatment facility, etc. Normally water is supplied from reservoirs, wells or rivers, treated and then sent out in pipes to homes, offices and factories. In North America, we generally chlorinate the water at the treatment plant and the chlorine stays at a low concentration in the water. This is credited with preventing disease from being transmitted in the water supply. In general terms, this was referred to meeting U.S. Environmental Protection Agency (USEPA) standards. There are similar guidelines that have been developed by the United Nations for projects overseen by their agencies (such as xxx) - referred to as UN standards. In much of the world, there is also a treatment process known as ozonation. Ozone is a triple molecule of oxygen, usually generated from water by electricity that is very effective in killing disease organisms. It is the treatment of choice in Europe and many other countries.

The advantage of chlorine is that it stays in the pipes and keeps on killing organisms that may come in through leaking pipes. The disadvantage is that chlorine combines with some low concentrations of materials (known as organic materials) and forms chemicals that at higher concentrations have been shown to cause cancer. EPA standards show that there is little risk at the concentrations usually found in water. Ozonation, by contrast, does not stay in the pipes and water can become contaminated. However there is no risk of organic/ chlorine molecules in the water supply. Also, in our new age of terrorism, having chlorine around is considered a potential weapon for terrorists, so there is an added expense to protect the chlorine tanks that store the chlorine before it’s used at the water plants.

The water treatment process can be expensive, both to build and operate. And the whole laying of pipes and building distribution systems is expensive and labor-intensive. It is now the U.S. experience that we had put pipes in place in the major cities over a hundred years ago and now they are breaking and wearing out. Cities are finding it too expensive to do more than a small amount each year. There is also a big debate over whether local governments should bear this expense or whether they should have help from the States or the Federal government. There is lots of finger pointing over whether some groups did better maintenance and financial planning for their systems and whether the poorer performers should be bailed out, etc.

In passing, I also want to mention that there are similar debates about the treatment of waste water, which is water containing human waste, dirt from cleaning and laundry and cooking as well as materials that are disposed of in the water (remember pouring that paint or nail polish down the drain). Again, besides issues of the collection of the waste water (how much water to what facility, etc.?), there are issues of re-using the water in a dry climate. In many areas, there are also issues of mixing different types of waste water – for instance, from municipal sources (the human waste), from agriculture (which may contain high levels of unwelcome nutrients and/or pesticides), and from industry (with all its pollutants). All of this raises issues of the best way to treat the waste to make it sanitary, or prevent some environmental damage. None of these were addressed in the present project.

Because of the expense, there is now a debate over whether it’s better to have smaller distribution systems for water. For instance, should there be a series of wells or one central well? If there are a series of wells, presumably closer together than a system with just one well or water source, then there is less need for long, and more importantly, larger pipes to distribute the water. Water also spends less time in the pipe, so there is less chance of contamination. This type of system is also cheaper, because the major expense for a water system is the process of putting the pipes in place. Smaller pipes are less expensive and need a smaller hole for placement. That issue had not been decided.

The last piece of contention was what is an appropriate standard of water treatment for an area like Juba, where there is an extreme need to get water to hundreds of thousands of people. Instead of treating water to an EPA or international standard at a central water treatment facility, perhaps it would be better to just filter the water near the source - to get rid of sand and large contamination, such as insects, rubber, etc. Then send the water to homes with instructions to boil or further filter the water to get rid of bacteria. This approach would allow one to reach a much bigger group of people with less expense. In broad terms, instead of having only enough money for a water system for 10,000 people, with the lower treatment standard (with local instructions), the same money might reach 100,000 people. The money savings is from lower expenses for the central facility - no chlorine or ozone and all the equipment that goes with it. This is, of course, balanced out by the cost of piping systems.

The suggestion to use a lower treatment standard - in order to reach more people who had no water at all (in this very hot climate) - was met with utter disdain by the UN officials, who were in charge of the project. They argued that residents of Juba were entitled to the same water standards as anyone in the developed world. So the system of higher standards were used and up to the time I left, less than hundred households had water supplies from the central system. Thus the old adage of the best being the enemy of the good prevailed. This is a central theme in some many of the projects I have worked on - good intentions of what I call good science or technology results in poor policy decisions. In this case, relaxing of standards for water treatment would have resulted in getting water to desperate people sooner and for many more, but the requirement for a higher standard prevented it. So this was another example of good science leading to bad policy.

The need to find funds for the new nation of Southern Sudan may lead to some other difficult choices. The main reason for my visit there was to determine what environmental consequences might result for the search for oil in that area. There are many aspects of exploration that include, depending on the circumstances, building at least minimal roads through virgin areas, building at least small installations, establishing communication towers, and setting off explosive charges that create reflective signals that are received and analyzed for evidence of oil reservoirs below. These activities have the potential of at least minimal disruption to forests and animal life, but the major analysis is what would be the consequence of putting in oil wells and systems for collections and pipelines for the delivery of the oil. The value of the Southern Sudan ecology is the central question.

Southern Sudan is a very special and mostly unknown case. It has an extensive wetland, which is known as the Sudd. The Sudd is the largest wetland in the world and is the headwater for the Nile. It is formed in an interesting way. A layer of hard mineral, known as iron pyrite, forms an impenetrable layer about 8 or 10 feet below the surface of the ground. Above this area, over the centuries, soil and vegetation has accumulated, which holds moisture and water which eventually flows north to form the Nile River. As the first source of water, Lake Victoria, receives rain during the rainy seasons, water comes down through the Sudd to the Nile. The Sudd has another important function of buffering or smoothing out the water flow, so there is less flooding during the high rain periods and water has also been retained so there is less downstream flooding during the dry season.

For a North American, we know about flooding into our rivers at the end of the winter due to snow melt and due to storms, such as large thunderstorms or even more severe weather. When this happens in North American and European rivers - temperate climate river - water flows faster and faster, the river rises and eventually may come over the banks. So in this system the main trend is the flow of water downstream, with overflow only when it cannot be contained in the banks. The response to this type of river flooding has been the building of stronger and higher containment systems, including concrete embankments, straightening of the channel, building rip-rap structures and other water control structures (including dams).

The situation in Southern Sudan is that of a tropical river. For most tropical rivers there are extensive wetlands (also known as marshes or even swamps) on either side. During wet seasons and flooding the rivers spread out. Water flows are not much faster until there is extensive flooding, and during much of the water precipitation cycle, simply, water spreads out (Welcomme, 1964). Of course, as every school kid knows, the lower Nile in Egypt eventually gets a large amount of water and floods along the agricultural lands and thus keeps the land fertile, since it is providing both water and nutrients to the land. This natural cycle has kept the agricultural economy working well for millennia.

The Sudd serves as this enormous sponge for the Nile and in the process of evening out water flow during floods, it also provides a wondrous rich environment for plants and wildlife. Which brings us to the other amazing characteristic of the area. During surveys of areas south of Juba, along the Sudd and up toward Lake Victoria, it was only within the last five years that huge herds of animals have been discovered. These herds migrate in the area and form wildlife movements that rival those well-known ones in Kenya and Tanzania (to the north and east). Due to their relative remoteness they are thankfully not been extensively effected by the on-going war efforts in Sudan and Southern Sudan.

(Do research is describe these herds and say more about Kenya, etc.).

So the bottom line is that oil exploration in the Sudd, and more importantly, oil development, can punch holes in the pyrite layer that, if extensive, may impact water storage capacity in the area, and in the worst case can effect water flow to the Nile. The second major impact can be oil pollution and that leads to toxic impacts on herds that may be grazing near the area. There is also an old tradition of collecting "bush meat." by local workers in oil installations- that there needs to be monitoring of hunting for workers to save wild life.

The lesson learned is that there need to be a sensible balance between elements in a program. Is the value of high quality water so important that the quantity of water in a dry are will be low and there will be no water for the majority. I submit that this is an example of the best being the enemy of the good- in other words perfectionism prevented the major mission from succeeding. This is another example of a multicultural perspective. Should the U.N. have projected what was good for Juba? Or should Juba be given that choice?

Figure zz here: the Sudd in Souhara Sudan

Figure yy here: Tents in Juba.

As I was developing the final report for Southern Sudan, I had discussed the environmental conclusions with the USAID environmental officer for Eastern Africa. There were some implications for other African programs and Walter decided to fly in from Nairobi, where he was stationed. Apparently the political appointee at USAID had different ideas. Walter had said that he was arriving on a certain plane and that we would discuss matters over dinner in Juba. He didn't show up - and I learned from other staff folks that there had been quite a scene at the airport. Apparently he arrived about the same time as the political appointee at the airport. She saw him and apparently didn't know about his trip (which might have been expected, since that level of detail would not normally be at her level). She saw Walter, questioned his trip and immediately ordered him to take the plane that was idling nearby and return to Nairobi. He and I were old friends and had worked on many, many projects together. We were not to be thwarted - we met in Nairobi as I returned from Juba (the only connection out of Juba was a fairly convenient shuttle between the two cities) and got to have our discussion after all. I don't remember it changing my report, but was amazed to what extent political appointees go to control information.

**CHAPTER 6: SANITATION IN NAIROBI**

A small but highly successful sanitation project in Nairobi stands in strong contrast to some of the World Bank water projects there. All this information came out as somewhat a coincidence that there were two meetings in Washington, D.C.: there was a water week seminar at the World Bank, in which all the aspects of water development projects were discussed and there was a smaller international development conference for non-profit or non-government organizations. At the World Bank conference the projects were varied and impressive in their intention and size. We already discussed the new sewage treatment plant in Fez as an example. There are large and complex programs in place in major river systems, including the Nile, Danube and other systems.

The tiny Dugan fellowship program (the second conference) gives approximately $6,000 to individuals or small groups who want to make a difference. The Nairobi sanitation project was one of these.

Sanitation is always an issue in a city - and the push to improve sanitation in the U.S. cities really only happened with funds that were available under the U.S. Clean Water Act (CWA) in the 1970’s - when the Federal government gave liberal grants to the cities to build new sewage treatment plants to clean up discharges to the river. These became the largest government plans in the nation until they crumbled under the weight of limited funds and purported corruption. Today public bathrooms still can be hard to find in cities - with many private bathrooms in, for instance, restaurants, marked for patrons only. Nevertheless, the CWA is credited with restoring major river systems to health.

In Nairobi the scene was at least as poor. Even public bathrooms at school were not well maintained and students were forced to find relief in some outside area, usually fields.. The Dugan fellowship folks happened upon an ingenious solution. In Nairobi, there were some standalone facilities available, but they were not maintained and were disgusting and, not surprisingly, were almost unused. As strange as it may sound, an entrepreneurial group decided to try to put a candy store in or next to the bathroom facility. All of a sudden people wanted to have the bathroom clean since it was next to a food shop. Then the candy shop was run by a person who brought in other items for sale. The shops became a center of local commerce and people, probably mostly the owner of the shop, took pride in keeping it clean in the bathroom. This model was followed in other locations and wonderfully Nairobi now has clean public facilities. All this for an investment of approximately $6000. It’s wonderful what a small amount of money can do with a big idea!

**CHAPTER 7: MALAWI**

Old idea either die slowly or killed often come back. That is the case with DDT in 2010 \*?) President Obama started the Malaria Eradication (name?) Initiative. Strong parallel efforts are also underway from groups such as the Gates Foundation to try to address with greater funding the surge of malaria in Africa. While the knee jerk reaction in the West is that Malaria is a terrible killer [see insert X, p. 91], and there is no doubt that over 5 million people per year come down with malaria, there is some debate over its importance for several reasons. First, in many polls in Africa, and through my own experience with training programs with the African Development Bank, when Africans are asked to rank the most important problems in Africa, food security and other health problems are ranked far ahead of malaria. The explanation given was that most children recover from the disease. Hunger and thirst, and medical care for accidents were ranked higher than sickle cell. Ecologists point here havea similar position from a difference perspective. If one thinks about ecosystems, the malaria belt through central Africa extends from xx to xxx (paragraph describing. it here). That belt contains a rich array of plants and animals across tropical forests. Much of that system is still intact, although hunting, farming and road building has diminished it. The high level of malaria, as well as other cattle and other farm animal diseases is one important reason that many of the areas have not been exploited (further information here). Ecologists raise the question of whether this is a good thing. Ecosystems have been left alone and humans have gone elsewhere. The question they would raise is whether these areas, if cleared of malaria, would be managed as well by humans as they are operating in nature. Would we protect important species that might be the new source of health products and foods? What about the economic losses from local people not being able to exploit the areas?

Nevertheless, both the USAID and groups such as the giant Gates Foundation have made malaria eradication a major, well-funded priority. To remove malaria one needs to understand the life cycle for the disease. Basically infected people or, in some cases, animals are bitten by the Anopheles mosquitoes, who draw out contaminated blood. This blood contains the complicated and resilient malaria parasite. During another bite to another person, this malaria is transmitted to the second person, thus the mosquito is a vector for the disease. The disease can be stopped by either preventing transmission - killing the mosquitoes - or finding vaccines and treatments for those affected.

Another technique is to separate people from the mosquitoes using devices such as bed nets, which screen people from the mosquito while they (the people) are sleeping. Pesticide treated bed nets have proven to be even more effective. Those of us who have lived and worked in Africa know that you need to take many other precautions if they are available, such as covering arms and legs, avoiding walking outside during early evening and morning when the mosquitoes are more active, and using bug repellant. Experts or consultants who are in the area for shorter periods of time also benefit from anti-malaria drugs, which may be too expensive for local residents (who often don't have enough money even for food), and for some the drugs are unsafe for long term use. Most of these techniques, except for bed nets, are impractical for the villagers.

So what else can be done? The President's malaria commission proposed the spraying of the walls and ceilings of native huts with pesticides in order to kill mosquitoes who try to enter. And guess which pesticide was considered the most important to use? Our old friend DDT, which had been banned in the U.S. for 30 years. Again the argument for DDT was that it was more effective because of its persistence and because it was being used in only a limited way on the huts, it would have little effect on the local ecosystems. It may also be remember that pesticides like DDT are relatively non-toxic to humans, but can have major impacts on ecosystems trough bioaccumulation and its persistence.

Our team was sent to Malawi to assess whether DDT spraying of huts would be effective and safe for the environment. We also looked at other pesticides to determine whether they were the proper selection for use on bed nets and other local operations. The contractor in charge of that operation basically wanted a report that ratified the current situation and had no interest in broader issues, including verifying insect resistance. That attitude conveyed over to the performance of the work.

But first, a quick overview of Malawi. It is one of the poorest countries in the world and a substantial part of the population is malnourished. As we go to press, there are also strong political battles over leadership there. The people are friendly but suffer from a poor infrastructure, including limited schools. As with many places there are more resources in the capitol of Lilongwe, but many of the villages are in dire need. The country lies along the gracious and large Lake Malawi - a 100 mile (check) water body, which is the size of a small great lake in the U.S. and is the second largest lake in Africa. Unfortunately the fish of the lake have been severely depleted from a combination of over-fishing and contamination from pesticides, which apparently has stopped reproduction of many of the species, as well as killed juveniles. The loss of this fishery has contributed to the poor nutrition of locals.

Malaria is such as large problem that world class laboratories have been built next to the main hospital in northern Malawi. The lab is engaged in developing new techniques for preventing and treating malaria and is working in conjunction with international groups, particularly in England. We traveled by car from Lilongwe to the lab to discuss the very important question of how much resistance the mosquitos had developed to the pesticides that were currently being used in the malaria eradication programs. The lab was impressive, with hot steamy rooms used to grow a standard group of mosquitos for research, a variety of testing facilities, as well as a fully equipped chemical lab, microscope lab, freezers and storage facilities. As with any operation there was both close cooperation for some of the parties and severe disagreements which apparently stemmed from the number of people that were "supposed" to be supported by foreign aid programs. Therefore there was the same kind of trend that we observed between private companies in other settings (see Chapter 11) - there was only cautious sharing of information between our team (which was a USAID sponsored team) and the laboratory groups.

After a long discussion, it was determined that apparent changes in gene structure from the mosquitos indicated that they were building up a resistance to the pesticide currently being used. However, the data were somewhat contradictory - reports from one group (transmitted through another health organization) were somewhat older and did not show the resistance, whereas newer but unverified information from the lab indicated that resistance was more recent - which made sense since the use of current pesticides was relatively recent. There was a major policy problem with which set of data could be accepted by the USAID in planning their programs. The implications were very difficult. Nature seemed to be ahead of program planning. The pesticides for the upcoming season, which needed to be distributed and used before the heavy rains, had already been ordered and were in the process of being shipped. It might be that there was too much insect resistance for them to be effective, but it was also too late to change the plans. The type of assessment was called a xxx, a special analysis developed by USAID due to earlier experience with pesticides (see Chapter 7).

The program appeared to have some merit in terms of reducing mosquito populations around the houses and sleeping areas - as long as there was careful application of DDT. The last thing we wanted was more pesticides going into the lake. There was fortunately no evidence that there was mosquito resistance to the DDT, so there had been some learning since the early years with DDT. On the negative side, little DDT had been used yet, so it was too early to tell.

However, there was a major problem with a much bigger question. Reduction of mosquitos would increase survival and decrease mortality for children and some adults in the local villages. This was definably a benefit for quality of life and welfare of the people and a worthwhile humanitarian goal. But the country already had so many malnourished children, that the higher populations that would now survive malaria could not be cared for and would put additional pressure on the problem of security. It appeared to me that there was a need to link the malaria survival program to some family planning services in order to try to slow down the population growth. I wrote that in my report and hit a brick wall. The limited vision company I was working with told me that they were not there to change program direction. They could not change the program by adding or even suggesting some family planning services. I did some research and found that a similar connection between reducing mortality and family planning to reduce population growth had been put in place in the program in Ethiopia, so there was some precedent for it. The slap dash final report did not reflect any of that thinking and once again showed me that the push to lowest price, rather than quality was often the main outcome of the usual contracting experience in USAID.

(research to see how program developed - there is a large web site for it).

The final cultural piece of Malawi was the local decision to only have currency in small denominations. When I went to pay my hotel bill, since I had been issued local currency, it was a major origami exercise in counting the bills and then folding them into piles and then putting the piles together in order to hand a stack - probably at least 1 foot square to the hotel -- and that was for about 2 weeks in the hotel. The room was comfortable as I remember - one had to walk down a long hallway through pretty arches sprouting with plants to reach another internal hallway to get to the room. (Was this the airport that was surrounded by the city - and we had to struggle to get in? Or was that Ouagadougou?).

Coming home was an amazing experience. I took a small plane from Malawi to Johannesburg. It was a bitter sweet decision in that I was probably only an hour from Victoria Falls, which I had always wanted to see. And I missed it for some reason I had to be back in DC or I was not allowed to take a side trip - can't remember. But I missed it and don't know that I will ever get back there. But the substitute experience was well worth it. I first got to see the Johannesburg airport - a project I had worked on back at the home office. We helped to plan the transportation from town to the airport and were also part of the vanguard of treating airports like shopping centers -and there was an incredible range of shops and restaurants that you had to pass to move from one terminal to the next. Judging my own experience, it made a lot of sense for the airport as a spent a significant amount of money on souvenirs, including the usual tourist patches and key chains, but also art and some clothing. It was fun! the fun continued in that I had a great seat on one of the brand new double decker A-38O super jumbo planes, which had wide aisles, a seat that did everything but brush your teeth, a five course meal on real china (after all it was Air France). It was like sitting in your living room for the 10 hour flight from the extreme south of Africa to Paris. In Paris I was given a comfortable sitting room with a shower, while I waited to transfer to a flight back to DC. Everyone trip has its bright lights and that was one of them!

**CHAPTER 8: BURKINA FASO**

Continuing around the continent, another big assignment was in Burkina Faso, formerly Upper Volta in West Africa. On a project for the Millennium Challenge Corporation. The project was one of several new approaches to the funding of international development projects. As we go through the chapters in this section, we will see that there were by the private section, such as the oil pipeline in Chad Cameroon (partially with the World Bank) (Chapter 11) and projects fully funded by the World Bank(see Chapter 15). Other major sources of funding are the foreign aid programs of each country. Many of the developed countries have these programs, including Canada, Germany, France, Holland and Japan. In the US, there has long been the Agency for International Development (USAID). Similar to the process in the World Bank, USAID identifies countries that meet their criteria for aid. These may include humanitarian, social, economic and political factors. “Who do we want to work with and how may it help the U.S. international interests?” would be a key question. After the country is identified, then USAID considers what type of project - health, education, water, agriculture, etc. Than a detailed project is planned and finally funded and contracted to be performed in the host country. The projects are always staffed by American citizens in the principal roles and then local country staff is hired for some of the positions.

It had been argued for years that the USAID procedures involved too much micro-management and did not give the countries enough autonomy to identify and conduct projects which were their own priority. Proponents said, “Ask a country to work like a private sector company and projects would have better results in the countries, ask because they would have a personal stake in the project and be willing to move forward because it was their higher priority.” The answer to this criticism was the creation of the Millennium Challenge Corporation, an independent but fully U.S. (MCC) government-funded group. The procedure adopted for MCC was to ask the countries to identify what they wanted to do with respect to programs and, upon verification by MCC, the country was given a large grant to undertake the project.

The Burkina Faso project for agriculture was one such project. It was intended to be funded at approximately $500 million and was mainly intended to develop agriculture in a region of Burkina Faso which was very poor and need further assistance. MCC assembled a team of 20 experts on economics, agriculture, market and supply chain distribution, environment, water, social issues and crops. I lead the environmental group. The group was mostly made up of French speakers, many from Canada. There were also a number of Africans, French and other Europeans. It warms my heart to think of some of the friendships from that time. One of the soil scientists was an African from Senegal. He came from a small village in southern Senegal - the Casamance region where I had spent almost a decade on another project (see Chapter 13). His family was illiterate, but had been my observation in that region, there was a great respect for education. Somehow he managed to get to a school that got him the basics. Using that education and his keen intelligence, he learned educated French and good English and was able to earn an advanced degree (Ph.D.) in soil science, so, there in Burkina Faso he was contributing mightily to the assessment team. He had a thorough knowledge of the types of soils in the region, and more importantly what sources were suitable for different agriculture and, through the trees and other plants, what other conditions were found in the area.

The team was asked to consider several areas that had been nominated for new, large irrigation projects. There were some other elements, such as fixing old dams and, even more importantly, whether there would be enough water to provide for the project. As with much of West Africa, there was a dry season and a wet, or monsoon season. The problem was always on how to control the water during the rainy season and how to preserve and have enough water during the dry season. In simple terms, irrigation was seen as the answer - rather than rain-fed - in order to have proper drainage during the wet season and to provide water to crops from the rivers during the dry season.

A very large irrigation scheme was seen as the answer to the poor crops and much of the poverty in the region. At the time of the proposed project, growing large fields of onions were seen as an economic boom. Onions were relatively scarce and high priced in West Africa. If part of Burkina Faso could grow enough onions to send them to market throughout West Africa - particularly to neighboring countries such as the Ivory Coast and Ghana, then a project might be self-sustaining and justify the large expense of building the project.

A large irrigation projects has many, many elements. Land needs to be acquired from existing farmers and arrangements need to be made with them to move off the land so that it can be prepared. The construction includes installing proper drainage, creating channels for delivery of the water, creating pumping stations to bring the water from the river and planning roads and access points for the farming. Projects need to consider soil preparation, appropriate seed and plants, and the use of fertilizer and, if allowed and needed, pesticides.

Related to the irrigation project, electricity is needed for the pumps and some other equipment - again with a need of roads for market and supply access both in the wet and dry season. Thinking even more broadly, there need to be trucks and roads to bring the produce to market on a regular schedule, so as to have reliability for the buyers of the produce. Farmers need to have land returned to them and coordination of crops and water needs to be arranged.

With these items in mind the team proceeded to review the sites that the government of Burking Faso had identified. The teams were asked to look at over ten locations. This lead to a fascinating tour of the country. I had been in Burkina about twenty years before on the pesticide project (see Chapter 3). It has, from an American's perspective, one of the most unusual names for the capital - Ouagadougou - the last part "dougou" means village, so there are lots of dougous in the country. Ouagadougou has always been much more prosperous then the rest of this land-locked country. It now had a number of very comfortable hotels with decent internet service. As with most West African experiences, one did need to be inventive to get it to work. In theory we had wireless internet services, but the signal was often weak. I discovered that there was a hard wire to the internet box in the hallway of the upstairs floor of the hotel. I introduced our team to that connection and we happily plugged our computers into a wire connect and were able to function well. Another big improvement was that my use of AOL was no longer a long distance charge as it had been in Senegal (see Chapter 13).

But by far the most dramatic change was the use of cell phones for communication. Land lines were lacking in many places twenty years before. Now there were brand new cell phone communication towers and we saw many villagers using the phones. Within the county the charges were reasonable - although calls from my cell phone to other countries, including parts of West Africa, were very expensive. The ability to communicate by phone made our work for the team much easier (and everyone on the team was given a cell phone) and it was so much to set up meetings and arrange logistics. Villagers reported that it was much easier to get news. What a change!

The key note for much of that region is WAWA - West Africa Wins Again. It is the penultimate rule of unintended consequences. It happens too many times that when you solve one problem, another arises to make a problem more difficult to solve. (good example?) It used to be that when you set up a meeting for “Tuesday morning” there was a confusion of what Tuesday or a confusion over the location or who should attend. With cell phones, much of that problem was solved. However, other issues would arise – about who made the most recent call that might change the agenda, purpose of the meeting, etc. Or a phone call might be misunderstood and someone offended so that some part of the project was not done.

We had some brief meetings in Ougou" - there was a massive group brought together to celebrate the kickoff of our project. There were about 20 members of our team, most of who had just arrived and had jet lag. There were a series of U.S. government officials, officials from the Government of Burkina, and members of companies involved in the consulting effort. In theory, we were given background and an introduction to the program, but all I remember is everyone falling asleep due to the jet lag. There were no team introductions and no overview of the plans to visit the sites, just a summary of the proposed work plan for the large program. Of course, it was all conducted in rapid French with little background materials. I remember that the team, which had only met for the first time that night, was asked to do a work plan by the next day, so that we could start our travels. On my team were a water specialist, a soil specialist, a socio-economic specialist, and a hydro-specialist. We worked closely with an economic team to develop both environmental "costs" of the project, as well as benefits.

Our team set off in a series of cars towards a small town about 2 hours away from Ouga.xxxxxax. The road was paved and smooth and straight. There were light red clay fields all along the way and since it was the dry season they were hard and deeply cracked. It was around 90 deg., but I don't remember it as very oppressive as it becomes from the humidity during the wet season. The most remarkable thing I remember were all the cell phone towers along the road (and I noted that we had good reception on all of our phones).

We arrived at a complex surrounded by a painted wall - with quite an impressive arch at the entrance. Everyone (and remember there were about 20 of us) lined up and the team leader called our names and gave out keys. We went down small hallways to small, but individual cubicles with a bed and a chair and an individual toilet/sink (set off in a small alcove). As time developed, I found that there was enough room in the middle to do yoga - enhanced of course by the 90 degree temperatures - an African version of Birkrum yoga (a form of yoga popular in the U.S. - you do a standard set of poses in a room that has been heated to 100-plus degrees). Most of us had computers and we were able to charge them and do report writing after a day's activity.

I actually look back fondly at our meal times. There was a very large trestle table set out in the middle of the courtyard with a roof and lighting. It was fully "open air". We were treated to grilled meat, stews, and cooked vegetables. I don't remember any special spices or flavors - just that the food was tasty, plentiful and, most remarkable for West Africa, healthy. We had delicious fresh French bread with jam and butter in the morning, had sandwiches for noon meal (while we were in the field) and all had a long meal at dinner - one that was reminiscent of long leisurely meals in France. Many of the conversations were in French, which was also fun.

The biggest downside of that experience was that there were hordes of insects cluttering around the lights. As with most life on the equator, the sun came up at 6 a.m. and went down at 6 p.m., so the evening meal was all under the lights. Since it was so much cooler outside compared to our rooms, we sat around having coffee/tea and exchanging stories about our lives. Unfortunately, it led to major health problems.

All of the team had been in Africa previously and most took pills to prevent malaria. Some, however, knew better, they said. A brilliant economist from Canada (a stubborn Scot who lived in Francophone Canada) had another theory that almost killed him. He said that he had had malaria 20 years before and that he was now either immune from getting it again, or if he got malaria that it would be a minor case. He was wrong.

Apparently he had been infected by the many mosquitoes around the dinner table and by the time we moved camp to another location, he was getting feverish. He said it was a minor setback and not to worry. He got much worse and needed immediate care. Thankfully, Africa had moved ahead in health care. We were in a village of perhaps 700 in a rustic but comfortable hotel. The economist's room consisted of a separate round hut topped with straw and built of mud and straw. Into this room the local doctor brought up to date medicines and a substantial intravenous set up to medicate and keep him hydrated. The doctor indicated that he would have died from fever and dehydration without the care - I was very impressed by how far health care had come in these small villages! At turned out that two other members of the team had also got malaria, but were fine after a few days. I was certainly glad that I strictly took my pills each day!

The backgrounds of the team were extraordinary. I have already mentioned my amazing Senegalese soil scientist, who had been given a good education in his voyage from his small village to an advanced degree, to multiple assignments on missions for agriculture. His command of many languages, including, of course, the highly technical soil science vocabulary, was, to say the least, extraordinary. No less special was a Maine agro-economist who had been a senior official with USAID and who had an amazing perspective on balances between various aspects of the program – science, politics, practical and realistic goals and, probably most important, communications and how to deal with people. Without him most of the team would have not been able to deal with the team leader, a Syrian who now lived in Montreal. While he was a well-trained engineer, he had no interest, and perhaps no ability, to communicate with the team with respect to our logistics, fieldwork and, in the end, the work products needed for the analytical task.

The team was diverse, with a French Canadian woman farmer, an American woman hydrologist who functioned as the team sociologist, an enchanting dam engineer, a young southern French market chain specialist, a European dam expert and, as mentioned earlier, a Scots economist. We spent a fascinating six weeks together – working on the project but also learning about how we all happened to be on that large team together. It was my African version of “e Bridge of San Luis Rey” – an extraordinary novel that brought philosophy, history and religion to the fate of people who were present and then died when the bridge collapsed. It never ceases to amaze me how somewhat unplanned and haphazard is the planning and staffing of these consulting projects. Also, the resilience of people that are willing to have these transitory ex-patriotic lives is remarkable.

So people ask me, what did you really do? We did an analysis of each site by going to the area and writing a description of what was already there. Were their forests, or cleared land./? what types of trees were present? Who was living there? What type of foreign aid or development had been there previously? What type of soil? What rivers or streams were there or nearby? What water sources were available for workers or future farmers? What farmers lived there and were they able to sell any crops? Were there any special wildlife or birds? Were there roads or electricity available? Was there a dam in use? Did it need to be changed?

The answers to so many questions went into hundreds of pages of reports. Much of it was stylized – with a mixture of known, verified data, some assumed or apparent data AND lots of expert opinion about the significance. I often found that we were somewhat “rearranging deck chairs on the Titanic” – by which I mean here that we studied some matters in great detail when that aspect or detail would become totally irrelevant due to some overwhelming “other” facet. For instance, if there was little water – how relevant is a discussion of the types of crops or soils or a discussion of economic benefits – the response might be that someday water might be available –but it didn’t seem likely then or even now.

Trade-offs in Burkina Faso

Whatever one's views about economists (and some have said that an economist is someone who doesn't have the personality to be an accountant), foreign aid projects, and African projects in particular, have a history of difficult tradeoffs in the benefits to residents. Usually something is lost (say original land ownership because a dam causing a large lake to form where farmers had land or in areas where small farm holdings are consolidated into large combined irrigation systems) and in theory something is gained - more crops, more sustained food or water, more power, etc. So many times projects, at least on the face of them, don't seem to add up in the net benefit other projects \_\_\_\_\_\_\_\_\_\_ \_\_\_\_\_\_\_\_\_\_\_ later. For instance, the Senegal Southern Zone Water Management project (see Chapter 12) had both positive and negative aspects (rice versus fish, but also construction management and village participation), as did the Sri Lanka Dry Zone projects (energy vs. land use) (see Chapter 14).

The Burkina project had many tradeoffs and potential positives. The project was designed to build two large new irrigation schemes to allow much greater productivity and sustainable of crops. For instance, if irrigation water was used, with the warm African climate, it was hope that three cycles of crops could be grown each year. This would mean that produce would be available year round. And if the plans to grow onions worked out that would mean much more money for the community. The economists, the environment team and hydrologist looked at the project. The first point was whether the cost of building the schemes was in line with usual costs for other projects. It was in fact more expensive, but might be justified because it would be the beginning of a new development in an impoverished area. I will never forget going with economists to the villages and asking farmers how much they received from selling the crops (part of the before and after analysis). This bright-eyed farmer, with worn and cracked hands and feet, wearing a well-worn shirt and no shoes, said, according to the translator, "we never sell crops we need them all to eat." Then the hydrologists looked at water supply for the irrigation schemes. Again, there might be sufficient water in some years, but we also discovered that other schemes were planned and that in combination not enough water was expected. The result was to look at other areas as well to see if there might be more water available.

The most fatal flaw seemed to be on the social side. Some background. In that area of Burkina, a family plot is owned by the male head of household. The plots are perhaps 2-5 acres in size and are used to grow grains and corn for family food. While Burkina law and custom mandates that a male head of household is the only owner, it works out that widows are also allowed to take on land from the family. The U.S. policy is caught between two positions - that on the one hand we should not interfere with local customs and allow them to be self-ruled, and on the other hand the desire to build rights for women and allow them some equality. The irrigation scheme put even more pressure on these policies because of the plan for land transfer. As planned, all farmers would be removed from an area of approximately 600 acres, the land would be built into an irrigation scheme and then standard size plots would be returned to each family - in that case, with plans only to give land to male heads of household. This would, of course, have left out the widows. Even more importantly it would have left out the essential role of women. Here's why. In the original farm situation, the head of household would turn over a small part of the land to the women of the family. They in turn would use that land to grow vegetables, which were sold and the money was used to pay for the health care and education of the children. It was another useful custom that worked to help the family. However, in the new irrigation schemes there were no plans - and no places - for women to get the land back and to fulfill this role. This problem was identified by the specialized team for foreign aid and was being addressed. So we have another example of unintended consequences of a well-intentioned project.

The review of the project proceeded and it was decided to leave a small part of the team behind, while the other went back home. The small team looked at other potential schemes and made further recommendations. Eventually the full project was reviewed in Washington and a recommendation was made for funding the program. Due to my opposition both because of uncertain water supply and impacts on the women and children I was asked not to participate in the programs further and don't know what happened with it in detail, although I know the project was funded. In a small world story, the internal renew team for MCC projects were the same people I had worked with on pesticides in Africa (see Chapter 3)!

**CHAPTER 9: CAMEROON AND CHAD**

I participated in a large private sector oil pipeline project in Cameroon and Char for a period of four months. It was another example of well-intended science and technology that lead to some poor policy choices. In this case the decisions had a long history of consensus and disagreements between the U.S. public, the World Bank, environmental groups, and country officials. All these issues were centered on plans and construction of a new oil pipeline in these countries.

First, an explanation that the World Bank is an institution that was formed after the Second World War to provide financing between world governments a highly competitive rates. Financing is provided by developed countries, initially the U.S. and Canada, and then later European countries and now other nations and given to developing nations, particularly those in Africa. The African continent contains the poorest nations in the world as measured by per capita income; an average family may have 6-8 members and live on less than $200/year. This is compared to an average of $40,000 xx in the U.S. (check numbers and correct). There is an extensive process for identifying projects, funding them and implementing them. The Bank performs a series of economic analyses about countries and sectors within the country, such as the fishing sector, energy sector, education, health, water and so on. The Bank also has created a long list of policy papers that analyze and set standards for displacement for individuals (who may have to be moved due to a new impoundment behind a dam or an area cleared for agriculture). Impact on woman and children, impact on other aspects of the environment such as air pollution, water pollution, wildlife, religious/historic /archeological and aesthetic resources, etc. There are also a series of guidance documents on issues such as food security, electrification, etc.

By contrast, the largest use of capital for development today is the private sector. Corporations and individuals move what is estimated at over 100 times more money than is done by governments. There are massive institutions involved in energy, transportation, electronics, etc. Even just within one state, say New York State, the main utility Consolidated Edison, receives more funds than does the state. The same is true at the international level, with major companies, such as Total, Exxon-Mobil and others moving trillions of dollars as oil is explored sold and shipped around the world. As discussed in Chapter 14, I was never so amazed when I was in Galle, on the Southern tip of Sri Lanka (formally Ceylon) and looking out into the Indian ocean, and watched oil tanker after oil tanker moving along as they brought oil from the middle east to Asia.

So here we have a voracious desire for western countries for oil, a group of the poorest nations on earth, a group of oil companies who want to make new developments and are willing to do the investment and, voila, a new project is developed. However, it’s large and there is controversy so the oil group approaches the World Bank to be a partner. Thus the Chad-Cameroon pipeline project is born.

Figure A here- World Bank Headquarters

Figure B here- Exxon Mobil Headquarters

Bongone?

DESCRIPTION OF CHAD/CAMEROON PIPELINE

The Chad/Cameroon pipeline was planned as a massive new oil delivery system, starting at oil fields under development in Chad, transported across river systems and desert areas through scrub forests and fields of Cameroon and on to the coast, where an oil terminal is used to load the oil on tankers for transport to users. Oil is a "golden" resource that provides enormous wealth to the owner of the oil and to the companies that explore, transport and sell it.

While oil can be transported by ship when a waterway is available, the most efficient way is to build a pipeline. The building of a pipeline is an enormous investment on land and an engineering feat. The pipe itself requires a vast amount of steel - enough that two factories worked full time to produce the pipe and that the amount of pipe needed for the pipeline temporary changed the price of steel on the world market. Several ships needed to be dedicated to shipping the pipe and a large fleet of trucks transported it inland. The pipes are so heavy that only 6 or 7 pipes can be loaded at a time. I was amazed when I was given a sample piece of the steel pipe. A piece just maybe a foot square seemed very heavy -probably in excess of 20 pounds. The pipe is thick and heavy and must be moved with heavy equipment and for this equipment to work, a road needs to be built -- a road that can support frequent heavy trucks. Bridges must be built over rivers. Routes must be planned with full consideration of terrain, villages and other areas of significance, such as religion shrines.

For the Chad/Cameroon pipeline a work camp of approximately 4000 workers was needed. Therefore a new village - generally bigger than most local villages dash had to be built to World Bank and U.S. standards of housing, sanitation, water supply, etc. Equipment needed to be stored in approved ways - as discussed below. Communication systems needed to be built along the 400 mile route. Construction yards were needed along the route. Trucks, fuel, etc., were needed in large amounts. Thus the technical challenge of building the pipeline was great. It was estimated that the pipeline moved at least six times the amount of material as that moved during the D Day invasion - albeit over a longer time period.

Because of the oil wealth, the Chad/Cameroon pipeline was controversial from the beginning. The context was that there was a serious disagreement about whether oil money would truly benefit those countries. Would the money flow down and improve the life of the people, or would it lead to so many of the other evil that came to be associated with oil money in other countries? Thus, there were issues of distribution of the wealth, corruption and political battles

Figure D- Picture of plan for pipeline….

While all the reasons for dissent were not fully articulated, the Chad/Cameroon pipeline became one of the main targets of opposition against the World Bank. There were protests outside the World Bank headquarters in Washington, D.C., particularly during the annual meetings, with a sizable crowd holding signs to stop the pipeline. Oil money was linked to human rights abuses and hoarding of resources by the rich of the country, along with claims that it did not benefit the average citizen, were mentioned. Critics also pointed to examples of other oil-rich economies that had only benefited a few in a country - and then, in some cases, over a relatively short period of time. Another theme was that oil resources are not sustainable or that most of the revenue went to the oil companies - and thus this was another example of exploitation of Africa by former colonists.

The proponents of the pipeline claimed that it would bring new wealth to two of the poorest countries in the world. For the negative aspects, they claimed that new standards and guidelines would ensure that they would not happen. In essence, the oil company consortium, led by Exxon Mobil, would partner with and abide by World Bank guidelines for social, environmental and health guidelines. And, of course, oil was badly needed by developed countries.

Which is where I came in. I was part of a team that had the function of preparing detailed guidelines for the construction and operation of the new pipeline. Because the pipeline was being built in two Francophone countries, Exxon Mobil contracted with Bouygues - the largest construction company in France. I was asked to move to Paris to work with Bouygues and Exxon Mobil for six months in order to perform those tasks. While I was thrilled to be paid to live in Paris and work there, I had to tell Exxon that I couldn't go unless I could bring my young daughter, our dog and my mother. They agreed and arrangements were made. I flew to Houston for briefings and instructions and then on to Paris - in a very comfortable airplane seat.

Initially, we had to stay in a very fancy hotel while we looked for more permanent quarters. Things only got better as we found a wonderful large apartment with sufficient room for the team and our families. The apartment had high ceilings and tall windows and overlooked a beautiful old street and park in the 16th arrondissement - and therefore was close to shopping in Passy (a neighborhood I knew well from previous trips), as well as near good transportation and tourist areas. I could even walk to a yoga studio nearby!

Everyone should have the joy of living in Paris - especially on a good budget. I had visited for periods of time when I was a student. Then, I was studying near Stuttgart, Germany and my brother was at the Sorbonne in Paris, so I came over to visit a few times. Even then, with a tiny budget we lived well on bread, wonderful French mustard (which I learned later was made in France from Canadian mustard seed) and red wine. I remember well walking around late at night in search of a crepe stand that was selling Grand Marnier or Nutella crepes.

Paris had so many other joys, not the least the beautiful women. As my previous wife had noted, every Parisian woman seemed to wear wonderful shoes - even when they were walking their dogs. Every morning I would walk our new puppy in the park in front of the apartment and there was this beautifully dressed Parisian with her dog and party shoes walking along the partly muddy path. We, of course, lost no time in getting to know each other. I learned quickly that she was single and liked to fly to Miami on weekends to go dancing and partying. She certainly made a visitor to Paris feel welcome.

Many other folks made us welcome. The number one complaint of Americans visiting Paris is that the Parisians are not friendly. While this may be the case for many - and one of my Parisian friends confirmed the culture by saying that a smile is wasted on a stranger, especially when walking on the street - it was not my experience. With a decent knowledge of the language, a young daughter, a mother and a dog, everyone wanted to be our friends. People would gab about America, the neighborhood, upcoming events in the park, schools and life in general. And, of course, about food. At least my experiences led me to realize that Parisians were very much like the expression I had learned in Thailand - "a smile has a thousand faces." They were usually polite and sometimes friendly, but they were pretty cold and didn't share emotions with you until you get to know them quite well. For me it was a joy.

About the apartment: It was a 200-year-old building with a courtyard with a pretty garden in the middle - we looked forward to spending time in the garden and even walking the dog there, but were quickly told that the garden was for viewing only. My 9-year-old daughter was not allowed to play there! There was a sweeping staircase that led up from the entry hall to our second floor apartment. We felt like we were in a castle. There was also a small elevator, which was very temperamental but useful for hauling groceries, etc. It often got stuck and almost always the kids were blamed for pushing the wrong button, etc. Another feature of the apartment was that it had no fans or air conditioning - and as Americans we were always really hot during the summer weather. The Parisians loved it and often complained it was not hot enough!

Another feature was the working hours. If we showed up to eat at a restaurant before 8 p.m., the waiters would look at us like we had two heads. My daughter and 1 (and sometimes my mother) delighted in trying different restaurants - always with at least three courses. Soups, salads and entrees of all types. Our favorite became the three tier platters of sea food with a good glass of wine. Sometimes the most difficult part of the ordering was to get a can or glass of soda for my daughter. Of course every meal had to have some bread and mustard to remind me of my student days. Even when I eat that combination at home it brings back fond memories.

I also delighted in introducing Emily to new foods. Her first escargot (snails in garlic butter) was a big success and she frequently ordered that for her first course. Another time the menu of the day had smoked duck slices presented over a salad of greens. The menu was, of course, in French, so she didn't know what it was and had told me she didn't want to eat duck. I decided to try it on her and ordered the duck salad for both of us and told her it was chicken. She loved it and ordered a second helping. When I told her what we had been eating - I waited a few days - she forgave me and now had another favorite food. There were so many wonderful experiences related to food. We discovered a wonderful sushi (Japanese) restaurant down the road. Besides a wonderful taste of home (a visit to a sushi restaurant is one of our delights each week there), we had the amazing experience of watching some recent arrivals of Russians devour the sushi. They would order a platter of round, tuna filled sushi (Toro Maki), probably 40 pieces to a platter, for six people and then finish it off in a few minutes and order another and then repeat that several times. I guess they really liked sushi. Another time we went to an upscale restaurant and were presented with amazing presentations of squash blossoms and vegetables along the plate in a serpentine pattern with a marvelous cold mayonnaise sauce.

It was perhaps not surprising that living in Paris led me to hear from many friends I didn’t know I had! Our frequent guests enjoyed staying with us, having adventures in restaurants and playing tourist. Friends in all walks of our American life showed up. A friend from the horse stables came with her two daughters, one of which carried Emily on her shoulders as we walked around on Bastille Day and then headed to a restaurant in the Moreau district – thre the picky kids found that French mushroom soup was so good that they talked about it for years. Several of my daughter’s teachers arrived, one of which gave her a lesson in folding her clothes.

With this wonderful setting, I started the work of the project. The World Bank had agreed to sponsor a small percentage of the total project and Exxon Mobil agreed to abide by World Bank standard for the project. After extensive discussion - and lots of additional public dissent - a very thick agreement was hammered out. Part of that agreement was the production of an environmental impact assessment (EIA). In general, environmental assessments are designed to ask questions about the project in order to anticipate in a systematic way what problems might arise with respect to impacts on humans and the environment. An EIA is the most detailed of the family of possible approaches to conducting these analyses - and an EIA is rarely done except for complex, very large or controversial projects. The EIA took about a year to complete and was extensive - covering many aspects of activities. It identified a set of areas that needed detailed guidelines and areas that need special supervision.

In essence, our team of experts in Paris was there to oversee the agreements and put in writing a series of specific procedures to assure compliance. Exxon Mobil had hired Bouygues to implement the road, construction camps and the pipeline, and we were in Paris to help Bouygues set up their guidelines in accordance with the World Bank agreements. Working at the intersection between two giant corporations was fascinating and a little intimidating. There were strict standard procedures. My most vivid memory was that there was an official Exxon office located at the Bouygues coordination office. One day a major report was due from Bouygues to Exxon. Well the report was finished, but the Exxon person did not happen to be in his office, so the report was put on his desk. Over a series of high level discussions Exxon refused to acknowledge receipt of the report since it had not been transmitted formally. It was necessary to assemble a group of approximately 15 people around the table to hash out the acceptance of the report and to change the charge that there had been a default on the contract. At the same meeting the second major issue was settled - English was to be the official language for all activities. Bouygues would have to produce their reports in English, despite the fact that they were a French company and that their employees, who would use the reports, were French speaking. It was also ironic in that I had been hired to work with Bouygues because of my fluency in French. This added another layer of complexity, since Bouygues had hired a series of experts who spoke French only. They now needed to have a group that could speak and work in technical subjects in both French and English.

Work with Bouygues was amazing physically. I worked with the consulting team in a modern office suite at the northern end of Paris. But a few miles away, Bouygues had built a massive new building that roughly resembled the Versailles palace made of glass. It had forests of trees, open seating areas and spacious vistas. The center areas were left open, so that offices around the perimeter overlooked the parks and spaces, all of which were equipped with benches and seating areas.

The facility included a series of coffee shops and restaurants - where we would gather several times a day. To an American the strangest part of the place was, despite careful air conditioning and air filtering, everyone smoked - like a chimney as we used to .say. The air was thick with cigarette smoke and the sunlight coming through the glass walls just showed plumes and clouds of smoke. For Bouygues it was as if they were treating the large interior spaces and parks as places to relax during and between work.

So what were all these environmental and human concerns and what were some of the ironies and unintended consequences? We organized our work along several reports: Safety and pollution prevention, sociology, spill prevention, natural resources protection and construction issues (including the camps), and health issues. Where to begin? I start with some positive accomplishments. There was a strong concern that no toxic materials be used in construction and to prevent pollution. We quickly banned the use of mercury thermometers and other devices with mercury and replaced them with equipment that functioned equally well but that did not have that toxic metal. In a similar manner we got rid of other hazardous substances and to my knowledge had no problem finding substitutes. Next we worried about pollution from oil and gasoline tanks (which of course were used at the construction camps to refuel the trucks and other vehicles). As with most of West Africa, there were periods of heavy monsoon rains that could potentially wash their chemicals into the land. So we mandated that roof structures be built over all tank facilities to avoid having rain wash Of course that was too simple, because it didn't consider any fire safety considerations, so once again we needed to redesign the facility with a pan at the bottom to catch any release of petroleum products and then make the roof wide enough to prevent that area from getting wet. We had many other formal laws to accommodate, such as the storage of hazardous and flammable materials and the storage of waste products, like used oil. All that needed to be planned and built.

One of the most interesting issues that came up was inspecting the facilities and correcting mistakes. The attitude of the American culture was that we had certain procedures, but there would be some issues we failed to anticipate and there would be times when we found violations of our procedures. We planned an administrative process of identifying, reporting and correcting these problems. Our French contractor had a different perspective. They believed that mistakes should not occur and that there was no need for written administrative records of mistakes. Since mistakes did not occur, there would be no reason for reporting. We resolved that and set up a whole administrative structure of assuring compliance with the agreed guidelines for the facilities.

Another vivid memory was over the handling of dust during construction. A road needed to be built across Chad and Cameroon in order to ferry supplies for the pipeline. Remember that the road needed to handle very heavy trucks and even heavier equipment such as generators that would provide electricity for the installation and during construction. It was decided that the dust would be controlled by spraying water from a truck while the road was being built - especially near the villages. So a large boom truck was put in place and a large tank at the back was filled with water for the spraying operation. This procedure was a success and the villagers were protected from clouds of dust during the road construction.

Contrast this operation with villages with yokes and buckets, walking several hours, maybe several miles to get a pail of water. The boom trucks were estimated to use over a million gallons of water while villages toiled for 5 or 10 gallons. It appeared that our perspective didn't jive with the local needs!

Other water issues really were much more massive – the aspect of water associated with oil exploration. The oil fields in Chad, the origin of the oil being transported by the pipeline, contained deposits of oil that also contained vast amounts of water. It had been estimated that for each gallons of oil pumped perhaps several gallons of water were also pumped. They came up the well together and the water was separated out and then the oil put in the pipeline for transport. The question was what to do with the water. Remember that Chad is one of the poorest countries on earth, with ramped malnutrition and very low rainfall for agriculture. During the project it had been estimated that the water from the oil operations could provide sufficient water for agriculture for 30 years - estimates varied but it was anticipated tens of billions of gallons would be available.

So what to do with the water? First consideration was the quality of the water. Was it salty or polluted or excessively hot? It did have some small residue of oil in it, but that apparently was relatively easy to remove. The other characteristics of the water were favorable and meet standards for agriculture. Exxon left it up to the environmental community to decide between the option of using the water for agriculture or pumping it back into the ground. After strong debates with environmental groups, principally Environmental Defense, it was decided to pump the water back into the ground. Their reasoning was that they did not want the country and the farmers to become dependent on a non-renewable resources and that it would also impact local customs and practices. The oil company and other interested parties had the perspective that in 30 years we could develop another source of water or changes farming practices and use that water during that period of time to help poor and starving people. The environmental won and we pumped it back into the ground.

Another consideration was healthcare, which is always a concern. There was a modern and up-to-date clinic established for the construction workers. Related to this were programs for disease control. Of greatest note, for instance, there was a policy of NOT paying truck drivers within country. It was reasoned that if they did not have cash then they would not be able to visit prostitutes and would greatly reduce the spread of AIDS. Thus there was a very strong effort to be mindful of healthcare.

Once again, however, environmental politics intervened in the next step. The oil consortium proposed opening public health clinics for Chad and Cameroon - which would have been a logical step forward and a relatively minor expense compared to the whole project. Once again the environmental groups continued their opposition to the whole project and used the excuse that it would be an intrusion on local government and that those countries should be free to establish (or not establish) their own clinics. Thus no new clinics were built.

The last funny policy disconnect was over alcohol. One can only imagine the French and their flagship company being told that they were not allowed to have wine or any other alcohol. But that was the policy imposed by Exxon Mobil for all their facilities and for their contractors. In fact a violation was grounds for instant dismissal. The French were incensed, although they knew it was part of the contract and of course they could not have a decent meal without at least a glass of wine. At the work camps the policy was made that no alcohol would be allowed within the camp enclosure. So the French had a simple solution. They parked a trailer outside of the fence - and loaded it with a good cellar of wine. And made arrangements to have it with their meals (I have no information on that step).

So life proceeded on that project. One of the major objections to the program was that the new oil revenues in Chad would be used for military supplies for the warring groups there. So one of the provisions of the agreement was that the oil revenues would be put in an off-shore trust and only a small portion given directly to the government. According to news stories, that didn't work out very well and that much of the initial payment was indeed used to buy arms. Once again confirming the bedrock belief that (of environmental community) that oil revenues do not benefit countries.

CHAPTER 10: ENVIRONMENTAL TRAINING IN THE IVORY COAST

In this chapter I will be describing the activities during this project. But equally important, I will be explaining many of the concepts and materials, so that the reader of this chapter can also learn some of this subject area. Many of these concepts then will be used in the discussions on Principles in Chapter 18.

After more than a decade, I got to return to Abidjan in the Ivory Coast; I had been there previously on work on pesticides used in the locust control programs (see Chapter 3). The new assignment was a wide-ranging program to introduce and train all members of the African Development Bank on a full range of environmental programs on appropriate procedures and considerations to practical ideas in developing their programs. The program was again supported by the USAID.

The African Development Bank (ADB) was established by African and some donor countries to provide loans to African countries in their efforts to do development activities. It was modeled after the World Bank in Washington and had many similar features - an imposing building with many, many offices, a complicated bureaucratic structure and a large number of highly qualified staff who fit into categories of senior administration, senior and junior officers and support staff. The staff represented individuals from almost all of the African countries, so that there many different cultures to contend with, and there were a host of languages. Both English and French were considered the official language of the institution. I was amazed at the advanced education of staff, with individuals with doctorates from North America, Europe and Asia.

The major theme of the training was that all projects should consider economic, engineering and environmental aspects of a program. ADB supported a wide range of programs that included agriculture, water and small dams, sanitation, fisheries and agriculture, power generation and distribution and education. Although they had a limited budget they tried to fund programs that met the requests and demands of the member countries, but were under increasing pressure to consider environmental aspects of programs. My team set up training programs over three months to address that need.

As I have described in Chapter 3, Abidjan is a vibrant city with an amazing array of modern facilities. We used to compare it to Washington, DC where we felt that the streets were about the same condition, the climate was about the same in the summer and it had the same number of African (or African/American) faces. Really. Also there was probably the same level of efficiency in government, parking and services. Abidjan is a delight with wonderful food and at that time a strong sense of security. ADB was located in the center of the city and many of the activities occurred at that location. There was a very strict security system - we were issued electronic badges and we needed to use them to come and out of the modern glass building. Apparently at the end of the day they used that system to be sure that everyone had checked out. Ironically, one day the electricity failed and we were ushered in and out of the building with no questions asked.

I had with me a wonderful team of experts in agriculture, energy and education. They were old friends - folks I had worked with for many years. Besides teaching we used to get together just before dark (which was always at 6 pm) and play tennis and then enjoy a pleasant meal. Our hotel was also very pleasant and had its own garden so that we had ample and safe and varied salads with wonderful French cuisine inspired dressings. There was an enormous swimming pool with many different pools, pass-throughs and waterfalls, and it was almost never crowded. The training program extended in a period over the Thanksgiving holiday, so I had my family fly over to stay with me and we had a wonderful time hanging out at the pool - and my daughter Emily had learned to swim very well since our time living in Indonesia (see Chapter 16) and it was a delight to watch her playing the water currents, going over the rapids and through the various connections between the parts of the pool. We had a great time on the variety of foods. It was also the place that I got to increase my collection of wooden African masks. There was a shop at the hotel that had a wide variety of mask and other African art, some of it junky but also some beautiful. I noticed a Fang tribe mask in the beginning of the trip - at the beginning of the training sessions, which extended for several months. I discussed purchasing it with the owner, who wanted far more than I was willing to pay. Over the next few months the mask stayed there and eventually he saw the wisdom of coming down to a reasonable price and I have had the pleasure of that mask in my office now for more than 10 years.

Much of the time at the Abidjan hotel was spent preparing materials for the training and we got to be experts with large tables and training materials for the various courses that we were to teach. For instance, I did a 20 page chart of different aspects of aquaculture development - different stages of the work such as planning water sources, taking care of waste, controlling temperature and preserving areas near the coast, such as mangrove trees, that needed to be protected in the development process. Not only did the technical materials need to be right, but we also needed to display the materials. We tried to be comprehensive in order to provide guidance on issues that might arise when the ADB officer reviewed the project proposals. Other members of the team prepared summaries of issues for power, and agriculture. We tried to cover the types of activities that make occur - for instance building an irrigation system - which has components including soil preparation, water supplies and distribution systems, seed and crop selection, use of pesticides and fertilizers and drainage and treatment of waste water. We also proposed solutions and mitigation. It is a bedrock principle of project assessment that we try to find ways to do a program that are cost effective and have the lowest impact on the environment. If impacts cannot be avoided by making modifications to the project design, then we consider mitigation - finding ways to make up from losses in a project. For instance in a project to build dams, we may destroy fish because they can no longer migrate through the area to feed or reproduce. One might be able to build a fish ladder - a bypass on the side of the dam that the fish can climb to get around the dam or perhaps one can produce new fish stocks by growing them in a hatchery and putting the young fish in the river. (example of chart here)

The thought process of planning a project around economic, engineering and environmental consideration can result in a win-win solution - a project that achieves its aim -providing more crops through irrigation, more power through dams, and more sanitation for people through sewage treatment, etc. while at the same time it helps protect natural resources and other activities. Very often the value to people of a natural resource is not considered or may be undervalued. This is particularly true for functions of the natural system. The most dramatic example of this is wetlands. A tropical wetland usually allows a river to spread out during flooding as a result of the wet season. If the wetland is used for farming a natural consequence will be flooding during the wet season. Depending on the area a wetland can absorb a lot of water - acting like a sponge to capture water at least in the low stages and early stages of flooding. Working with this aspect hydraulic engineering and planners can use contours and other features to direct water where it needs to be - but the capacity of the river to flood to the sides - i.e., flood horizontally - needs to be preserved. Otherwise areas down river may be adversely impacts.

There are a host of other natural functions that are important in wetlands. They act as buffers of materials flowing off farmland. For instance excess fertilizers and pesticides can be captured by the wetland areas before these materials reach the river and cause a problem. It can in turn absorb a certain amount of materials – its assimilative capacity - a second important function of a river’s ability. In U.S. Law this assimilative capacity is measured by the concept of Total Maximum Daily Load (TMDL). (see Chapter 22) If the TMDL is exceeded, then a river or stream can be overloaded, which can lead to the loss of other features. For instance, oxygen can be lost so that fish die.

So, as an example of materials discussed we had a seminar on considerations in funding aquaculture projects. Massive new aquaculture projects are planned along the African coast for growing fish, shellfish and even algae. While these projects can be an important economic development piece for these nations, they also have the potential to cause great harm. For instance, to clear the area they need to remove natural vegetation, the most significant of which are mangrove trees and associated swamp areas. These areas act as important fish habitats and nursery areas - and in fact removing them may lead to the loss of more fish than those grown in the aquaculture facility. It is estimated that over 75% of the fish resources in Africa are associated with coastal habitats (the remainder come from river areas and a very small percentage from high seas fisheries such as tuna). Loss of coastal areas can significantly reduce reproductive areas for fish species. The point is that these need to be considered when planning a new resource.

An aquaculture facility is a massive fish factory - and puts food into the hatchery and generates high volumes of fish and shellfish waste - waste that is often released back into the ocean. These waste water streams have low oxygen and high organic materials --known as Biological Oxygen Demand (BOD) that can turn a whole area anoxic, i.e., deplete all the oxygen in the area and cause additional loss of resources. It can also cause additional disease problems to humans. Again these factors need to be considered.

In a similar way, power generation projects are often needed to provide energy for an area. At the time of the seminars, the only power projects considered were "thermal" power plants - facilities that used oil or coal for fuel. Today there are additional considerations of using renewable energy such as wind and solar as they become more affordable (see Chapter 27). What would be a more likely place for solar than areas lying along the equator with amble sunlight for at least 8 hours per day? Thermal power plants are associated with air pollution, impacts on global warming, and water pollution. Other resources can be lost, such as fish in the water that is taken into the power plant for cooling purposes. Again these impacts need to be considered and avoided if possible and mitigated if not possible. The location of power plants can be very important and we give an example of that from the work in Sri Lanka (see Chapter 14). The design of the power plant intake can also be significant (as discussed in Chapter X on the Hudson River).

Thus in the seminar planning, we tried to present an array of issues to be considered -there is no doubt that a host of projects are needed for economic development in Africa and banks such of the ADB need to consider them. But there is equally no doubt that the projects have the potential to do more harm than good if not well thought out. Besides the types of impacts discussed above, projects can change social and cultural situations. While it can be argued that these changes are needed to lift people out of poverty, it may be possible to preserve important features of a culture and still do the project. We give an example in Chapter 8 on Burkina Faso, where the irrigation schemes have the potential of depriving women of the money needed to provide healthcare and education for their children - because of the loss of land to irrigation schemes (the plots of land had been used to grow vegetables, which were sold an provided the money for those functions).

Again, the point is that if considerations of impacts are assessed then one has a chance to modify a project before the damage is done. There are always unintended consequences of a project and these chapters discuss some of them in detail. However, there are also consequences that can be anticipated and prevented. It seems to come down to risk analysis - whether the probability of the potential consequence can be tolerated because of the potential gain from a program. Years ago I was involved with the U.S. Environmental. Protection Agency (EPA) in planning for the new Toxic Substances control act (TSCA) program, that was designed to regulate industrial chemicals and to protect humans and the environment from unintended consequences from industrial chemicals. We discussed in detail what we called "regulatable endpoints." We meant by this what consequences to the environment should be or can be regulated under U.S. law. For instance, probably few people would worry about the loss of a section of a forest or a section of a stream with a small population of fish. But where is the threshold for damages - how big do they have to get before there is a need or desire for state or Federal regulators to intervene and stop the damage? Is it a whole large forest, a whole population of fish? Or what do you do about more subtle effects such as impacts on predation or reproduction. Finally how do you deal with the tradeoffs - with some effects being very positive (e.g., a new and vibrant onion growing field), with a potential negative - such as the loss of a religious, cultural, historic or aesthetic resource (the latter is considered in U.S. law under the National Environmental Protection act, NEPA)? Some of these are discussed within the context of projects specifically regulated by U.S. law in Chapter 22.

Back to the ADB situation. Since the ADB did indeed try to parallel some of the World Bank culture, it seemed that it might want to follow some of the World Bank guidelines for reviewing and operating projects. Thus besides specific training on specific disciplines, like agriculture, energy and fisheries, we spent a significant time preparing to discuss environmental assessment procedures, environmental economics, and approaches to consideration of paradigms for the earth.

In the latter we discussed the two approaches to exploitation and development - The first was that there are unlimited resources in the world and what we need to do is to develop the resources and, according to mainstream “classical” economics, find ways to redistribute those resources so that everyone has access to them. We would have no problem producing enough buggy whips if we exploited the forests and other resources needed; the price would drop as demand increases and production increases to accommodate that demand. Initial shortages and production failures are the only reason that the goods might not be available to everyone if we only handle that resource correctly.

So we prepared a large number of handouts for our classes - mostly in English, because that was the only language we could write (most of us could speak French). Several examples are enclosed (for aquaculture and pesticides, see Figures 10 and 11). (What can I incorporate from my env. reg, book??). They were meant as reference materials and most of the lectures were intended to be interactive.

(Figure 10 and 11 here)

While the ADB headquarters were Abidjan, most of the work was done at a beautiful new facility in the new capital of the Ivory Coast, Yamoussoukro. We did spend a month in headquarters briefing senior administrators - or rather having a high administrator of USAID speak to the heads of ADB using texts and materials we had prepared. Basically there was a commitment to consider environmental aspects of projects and to bring everyone up to speed in thinking about those issues. Everything was cordial and well-intended. So we proceeded to Yamoussoukro.

When the president of the Ivory Coast - which changed its name to the mandatory French of Côte d'Ivoire, took office in 1989, he decided to create a new capital city, which was approximately 100 miles from Abidjan and located in or near his home village. Other than a regular small African village of probably 1000 people, there was not much in place there. The roads from Abidjan were unpaved compacted soil and wound through a series of small village to get there. Even when we began work in Yamoussoukro, there were maybe two buses a day that connected the two cities - mainly set up for tourists. There were some taxis you could order between the cities as well, but they were old and unreliable. In fact, on one trip back from Yamoussoukro. I hired a driver I knew to take me to Abidjan and then the airport - we left in plenty of time and the day was clear. Less than one hour into the trip we started to limp along - the car could not get up any speed. So he pulled over and looked at the engine and the distributor cap (which are now all electronic on cars), made some adjustments and then the driver decided to push the cap (which was made of Bakelite plastic) with a hammer and, voila, it broke into pieces. Somehow he stuck it back together and limped even more slowly into the next village. There he tried to find a part - not much chance of that. Then he found someone with some glue and stuck it back together. It worked, except we could only drive slowly. So instead of a two hour trip to Abidjan and a one hour trip to the airport, we had a four hour trip that just got me to the airport in time.

In short, transportation between Abidjan and Yamoussoukro was limited - although when we started the classes the teaching team was delivered there in a sturdy van (along with all our materials). As classes started, the students (staff and employees of ADB) had a very nice large bus. In terms of supplies, we found that the hotel, which was luxurious, had few computer and printing supplies. Fortunately we had brought our own portable printer and lots of extra ink cartridges, and we were able to get paper, so we were able to print many copies of materials as they were needed.

The second approach is that environmental resources are limited and we have a duty to control our use of them so that there are resources left for the next generation. We must manage resources in a sustainable way, so that fish remain to replenish a stock of fish, sufficient forests remain to allow deer and other game to reproduce, etc. This extends to the idea that we can't destroy an area through the use of toxic wastes or barreling through a hill side (although as discussed above we may decide to do that, but then mitigate by restoring the area). Sustainable development does not mean development, it just means asking questions in a systematic way in order to see if a project can be improved - or in fact whether it makes sense at all.

Two other concepts:

1. It is much cheaper to prevent a problem then fix it later. The easiest example here is that it might cost in the U.S. $30,000 to keep chemicals from a factory out of a landfill area. But when we dump those chemicals without treatment, particularly in any area that has not been prepared for the dumping (no bottom to the pit, etc.), then it can cost millions to fix, as we see from the chemical waste sites, know in the U.S. as "superfund" site.
2. The best cannot be the enemy of the good - it is worth trying to address an issue, even though it may not be an ideal fix. There is often the feeling that we should wait, because we don't have the perfect answer and perhaps we will have a better answer in the future. Cleaning up nuclear waste is the most dramatic example of that, in which the U.S. is struggling to decide how to dispose of nuclear waste from weapons and power plants - after 20 years of study for disposal -- in site such as Yucca Mountain in Nevada - there is still strong disagreement on what to do for disposal. The system is essentially paralyzed by the need to have the "fight" decision.

So what is the proper approach in an African scenario - when the poorest nations on earth are in Africa (dig out statistic), an area where previous exploitation has lead to so many bad results (diamond mining, and oil exploitation -- discussed in detail in section on Chad and Cameroon). So many projects have had initial success, but failed to be sustainable - which raises issues of whether proper capacity was put in place, whether host nations could have supported them better, whether it was the proper project in the first place, and whether the donors were responsible for pushing a program that was more in their interest than in the host nation's. To address that aspect we also discussed project assessment - what constitutes the success of a program, how to you measure its achievements and failures and what can you learn for the future about that outcome?

It can also be argued that private development is preferable to public, donor involvement because the private areas can be more flexible and entrepreneurial.

There was no text book and only an overhead projector that allowed us to show transparencies of materials. It was important to show the new vocabulary because there was no backup text and because much of the class did not have English as their first language. We were overjoyed by the luxurious large "auditorium" which resembled a large government meeting room, of, for instance, a senate, with desks rapping around the room, microphones for questions, good lighting and a gracious podium in front. This served us well during the next two months of teaching.

Yamoussoukro was a rebuilt new city. Its main features were the extraordinary cathedral, a conference center and a five star hotel. These features dominated the landscape, which otherwise had mostly one story buildings usually masonry with tin or straw roofs. From the top of the hotel (probably 12 stories) one could see lush forests, almost unbroken by any farming or villages. In some ways it was an oasis, in other ways it was a major work in progress. Near the hotel was another government building that was used for cabinet meetings - top government functions. The working administrative offices remained in Abidjan.

What an incredible site was the cathedral! It is listed as the third or fourth biggest one in the world and to cost $30 million when built in the 1970s. To build it, there were remarkable designs created by Italian craftsmen in marble and local stone. The paneling was all African hardwoods. Most remarkable was the space - wonderful round center amphitheater with seats for 800 or 900. An aisle surrounded the whole area and one had the feeling of a wide open space. Everything was luxurious - beautiful woods, carefully details carvings, wonderful chandeliers. I felt like I was in the calm understory of a forest, with soft lighting overall, but good detailed lighting in the pews. It was all air conditioned and very comfortable.

Outside the cathedral was an even large plaza that could accommodate thousands of people. Amazingly, the sides of the cathedral could open to make it one long plaza that looked to the center podium, which was also spectacular. Thus thousands of people could be accommodated for special occasions and holidays. Even more remarkable, the air conditioning had been planned so that even with the panels open, the cathedral stayed cool (shades of the air conditioning in the tent in the desert in Mali for meeting on pesticides; Chapter 3).

So the question that always arose was what was a poor country like Côte d’Ivoire doing with such a luxurious cathedral? The cost of the cathedral was approximately the same amount as foreign aid received each year at the time of the construction. The president’s response was that it needed to build a model of the modern country he was building. And he replied that the English had built St. James cathedral when they were poor and the French had built Notre Dame before they were rich - so that he was simply in the normal development pattern for countries. In any case the cathedral was finished and used on occasions, but normal attendance was only a few hundred people on Sundays.

It also served as an important tourist destination - and was included in tours of the countryside tourists were also treated to a very fancy hotel, with world class rooms and service. It has a good pool and tennis courts and large meeting rooms (including the ones we used).

Which brings me to one of my favorite cultural awareness moments. I was teaching with an African from Ghana - a Ph.D. professor of business development. He was highly educated and well-spoken and had traveled fairly extensively internationally. I will never forget the moment that we were standing at the elevator lobby on the main floor and waiting to go upstairs to a higher floor. So I pressed the up button to call the elevator and tell it that I was planning to go up. Well my African friend pressed the down button. I asked him why he had done that and he said it was because he was asking the elevator to come down to get him. Certainly we were both totally correct in our thinking, but had completely different cultural orientations to those matters. I could not help thinking of the wonderful elevator scene in the book, "Hitchhiker's Guide to the Galaxy."  The protagonist in that book was standing in front of an elevator and wanted to go upstairs. He asked (there were no buttons) the elevator, who could talk and was existential, to go up. The elevator started a long dialogue with him by first asking him whether he had considered going down, as there many interesting things to see downstairs. He said no that he was going up and the elevator urged him to consider other choices in life and not be tied to the idea of just going up. So much for a stubborn elevator.

We had developed a teaching schedule - with different groups coming in for two week sessions, during which we covered the main issues in team teaching. Our general format was to cover a specific topic - for instance, agriculture or fisheries with an introductory lecture and then assign a working example. We would discuss ways to approach an analysis of a proposed project, give the class a group of our reference materials and ask then to consider potential impacts of a project in a working session and then discuss this with the class. We sometimes had a lunch break between the assigned materials and the afternoon discussion. This worked well with most groups and the student evaluations were positive.

Even a good teaching model can have unintended flaws and gaps. One of the two week groups was given the same teaching experience, with a lecture and a discussion session. I believe we were looking at a hypothetical project in which we built an agricultural processing factory in a rural location. So we discussed potential impacts, handed out the assignment, agreed to go to lunch and meet in the afternoon. The assignment had been phrased as we would like to see what you, the students, think would be issues in doing the program as proposed.

Did we get our heads handed to us, probably, for a cultural misunderstanding! After lunch we went back to the classroom and started class. Most of the students were missing. It had happened before that students were delayed at lunch or that they had some work from the office to finish and came in after class started. We waited and no one came in. I asked the few students present whether they knew the situation. Well, I was told, our assignment was wrong. "We want you to give us the answers (the students). You are the expert and it is wrong for you to ask us to give you the answers. We think you are not doing your job and are boycotting the class until you fix the problem." While it was helpful to know the perspective on this, I explained that it was a working exercise to see different views on potential problems caused by the proposed project.

This led to a wider discussion the next day about teaching approaches in Francophone versus Anglophone environments. the students, who had almost all been educated in France or in a French system, wanted to be given all aspects of a problem and answers, so that they could memorize them and repeat then in exams and in work problems. They were uncomfortable with having to think through a problem themselves, for of course, the professor had the answers and need to teach it to them. In general, the Western world teaching is divided into the Socratic Method, in which a teacher poses a problem, perhaps based on a text or story/problem presented. A typical example would be a philosophy class in which we ask what is the sound of one hand clapping or does a tree falling in a forest make a sound when there is no one there to hear it? The opposite, generally called a Napoleonic approach, is to give the students long, extensive lectures in detail on a topic and expect them to memorize it. A traditional place to do this might be, for instance, in medical training. The thought was that there was only one right answer and the students would be given it by the teacher.

The students accepted this explanation and decided to return to the class for further discussions. Another surprise with that group came when we discussed one non-controversial and one, to them, controversial topics. The first topic dealt with impacts of projects on water quality and water supply - two key topics in Africa. We discussed that water was contained in large underground lakes, known as aquifers and that they had become polluted in Europe since the 15th century, so that one could not drink untreated water and had to resort to bottled water in most cases. In African, much of the pollution was still associated with surface water - pollution and sewage running off the land into streams and other water bodies. But we needed to be concerned in the future with groundwater pollution.

That word “groundwater” set off an enormous intercultural discussion. The term groundwater is used extensively in the U.S. and Europe refer to all the water in the aquifers and underground (beneath the land; not surface water). Many of the U.S. laws, such as Resource Conservation and Recovery Act (RCRA) discuss groundwater and have a large set of regulations on how to protect the water through special handling of waste site, run-off from factories, etc. (see Chapter 18).

The concept of "groundwater" was confusing to the Francophone students. We had a wonderful opportunity to look at approaches to technical concepts and ideas in English and French. The Francophone students wanted us to be more specific - did we mean "subterrerian water"; “L'eau subterrean" or deep water;"L'eau profunde" or water in the root zone for plants - "L'eau de Nappe"? Or some other meaning? I explained that the intention of the English term was to cover the whole group of these types of water.

This kind of difference between French and English was seen many times. For our classes, there was one segment where we asked the class to break up into sessions and prepare a hypothetical evaluation report on a topic assigned (which had been discussed in class). We had sessions that we conducted in French as well as sessions in English. We asked the class to restrict their essay to one or two paragraphs. Was there a difference in the French and English classes! The French essays were usually 50% longer than the English ones, even though they covered the same material. The reason was that the French language was much more precise in expressing ideas and therefore took more space. There were also differences on how students approached the problem - the French trained students were much more methodical in covering the range of issues - which in this case meant they discussed what they were not going to discuss as well as the topic in hand. It was a different approach to learning and one that a teacher needs to be aware of.

The controversial topic was in the context of international development. We had discussed with the class the two approaches to work views (discussed on two world paradigms in Chapter 7) and was defining that one approach was that there were limited resources and we had the responsibility to husband resources for the next generation in a sustainable way. An implication of that was that we needed to limit population because population growth put increasing demand on water, food and other resources. At that point did we hit a sensitive subject! Several students stood up and started shouting that this was a typical attempt of the west to hurt the African people. Several said that the Koran required them as a good Moslem to have as many children as possible. They also said that they needed more children to work farms and do manual tasks.

I explained the concept of a demographic leap and the controversy around that concept. The general theory is that as civilizations become more industrial and shifted from farm economies, that there is no longer a need for the large families to work the land and that factories need fewer individuals. The demographic leap worked well in Europe, America and Asia - who reduced the family sizes dramatically. (see worldwatch book on subject). This was credited with reducing demand on resources, although today per capita consumption (the amount of resources for each individual) has also increased dramatically, so that the average American uses more resources than perhaps 8 Africans.

For a number of reasons that are hypothesized, the demographic leap has not worked in Africa, and family sizes are still high - around an average of 8 children in East Africa and slightly smaller in West Africa. The reason suggested is that industrialization has come too late in a world cycle - that there are so many other industries in full swing in other countries that it’s hard for Africa to compete and grow their own industry. They are stuck in an earlier stage of the cycle, where they still need large numbers to "prime the pump." Other reasons given are that there was so much disruption in these societies that it’s hard to establish a reliable industry - and that is blamed on colonialists - and now China - that take resources without growing industries in the local country. Thus, mineral ores are exploited and shipped overseas, but there is no factory built to process them or turn them into finished goods.

These ideas are controversial and not completely accepted, especially in Africa, where there is a mixed feeling over what needs to be done. The idea that large families are required by cultural or religious beliefs has been proposed, but does not seem at the root of the issue, since many other cultures have a tradition of large families -and yet they have been able to change to smaller families. One last aspect proposed is health care. Western countries certainly had improvements in infant survival and treatment of a wide range of diseases; they also were able to prevent many waterborne diseases and insect vectors (i.e., many swamps and wetlands were drained to eliminate mosquitoes and the associated malaria). It can be argued that health care has lagged in Africa and that there is still a very high infant mortality rate. If this factor proves to be important, health care is much better now (as discussed in Chapter 8), although AIDS continues to ravish the populations (again health care measures, such as not paying truck drivers in country in Chad/Cameroon, Chapter 10, have tried to slow down the increase/incidence.

So, in summary, family planning is a very sensitive subject, but we felt that it was appropriate to discuss within the context of protection of natural resources. Which is related to the whole question of how much one values a natural resource. The African participants accepted that these resources have value and that they are a major asset in Africa. They disagree on the priority for its protection. They argue that with a lack of food security that at any cost people must be feed and have good water. They will do the protection later. In fact, the protection of the environment is a luxury of the West - they didn't protect the resources until industrialization and good growth in their economies, so why should the Africans. So following the example of the west, they will get around to environmental protection in a few generations. the Western perspective, is that we know that it true around the development curve but they have now learned enough that they can help Africa from making the same mistakes and that they can work together to find win-win solution as (as discussed in Chapter 18). There must be ways to help Africa make the transition to lower resource use, they would argue, and help them to preserve cultural and religious value. It doesn't always work as discussed in the Chapter 8.

Another aspect of this discussion is the history of so many of these countries in which they were colonized and cut up into new nations that in some cases put warring or at least different tribes together. Then in many cases there was a history of freedom and national building, accompanied by democratization. Unfortunately that was then followed by a scouring set of dictators, who took out major resources from the countries. We now appear to be in a new stage when there is again an attempt at democratic nation building. It has been argued that other regions have not had to go through these types of upheavals and this again has delayed development and associated growth from industry and slowing of population growth.

Yet another aspect has been globalization of resources, which has increased competition in many industries. While there may be some value in goods produced locally, if they can be obtained cheaper and transportation is improving to provide them then again local industry may not prosper. A related issue is financial. It has been argue that there is a strong need for major changes in banks, as well as a need to generate more income. Components such as micro-banking to jump start local entrepreneurs who are poor might help, since they have had a great track record in India and Indonesia, for example. Other techniques have included cancelling World Bank loans or doing "nature debt swaps” exchanging for instance forest for relief from high debts and or debt payments. These have been done (do research on success of land set aside, etc.).

The other aspect of this is new financial resources derived from oil and other resources. As discussed in Chapter 10, there has not been a good history of good use of new wealth - the poster child for this has been Norway, which is almost totally dependent on its oil revenues. But with a homogenous population of a limited size, it appears that has been sustainable. But other nations, such as Nigeria, have been struggling with corruption, wealth inequity and political debates for regions. It is the general consensus that the average citizen has not benefited from the new oil money, despite the fact that resources there are huge. (more research on Nigeria situation). The new wealth has led to terrorism, atrocities and immense corruption (one of my colleagues told the story of one of his former students who was able to get all the money for a tanker load of oil - corruption at a new level).

Thus, we had a very good discussion on this topic, but almost none of the participants accepted that there was a limit to resources. The solution was more development of natural resources, more energy and electrification, and more help to emerging economies. One of the checks and balances to the plans for greater investment and development is, as mentioned earlier, that the World Bank and the private sector both have a role in the funding of those projects (as they did in the Chad/Cameroon pipeline) and that under regulations of groups like the World Bank, there must be environmental reviews conducted to try to form a project with fewer consequences. One of the benefits of the review process is to look at alternatives to a program to see if there is a better solution - or one that has fewer environmental consequences. As mentioned earlier that is intended to be a balance between environmental, economic and engineering aspects of a program and formal review can help this process (see greater details on Chapters 17, 18 and 19).

We finished the workshops with four groups of students - each with their own perspective on conducting the work. The processes were then put in place by the bank. But then "life got in the way." Political turmoil in the Ivory Coast had a severe impact on Abidjan and the ADB was moved to Ethiopia. One of the marks of improvement in Côte d’Ivoiree stated by one wit was that when the bank moves back to Abidjan we know that the political and security situation has improved.

CHAPTER 11: SENEGAL

The longest project I was involved in was in Senegal, where I visited over 40 times in the course of a 10 year project. The project was sponsored by the USAID, a foreign aid agency of the U.S. and was called the Southern Zone Water Management Project. As I have mentioned earlier, West Africa has enormous variations in precipitation, from no rain for about half the year to intense rain during the monsoon season. The project was designed to try to even out the availability of water by building a large number of small dams to catch the water and hold the freshwater for crops of rice. That said there were many complicated issues that needed to be resolved.

The project was conducted in the southern part of Senegal, known as the Casamanche region because of the river by that name. Generally it was a humanitarian project - designed to help people have more food, but it was also political. Senegal is essentially divided into two different regions in the north and south and with upcoming elections and other issues the government of Senegal was interested in having support from locals and hence this very large project, a project that was the largest USAID in Africa at the time. The country in the north is predominately Muslim, which the south is generally Christian, with a very strong tradition of education and learning in the south.

The two parts of the country are also physically divided by a long finger of the Gambia in between them. The only land connection between the two parts is a road on the extreme east of the country (to avoid the Gambia to the West). While the border is generally open through the Gambia, we found that we needed to take major supplies and materials through the eastern Senegal route due to issues with customs in the Gambia. Many times through both routes we drove the 10 hours over bumpy, pot-holed, dusty roads, through villages with farmers and trade, past fishing villages and driving straight through hoping that the dogs and goats would stay out of the way. We never hit any of the animals in the ten years in and out of the area, but the drivers were delighted to hit a grouse, which was taken home for dinner. We also stopped on some occasions at a fishing village and the driver would buy a string of fish, which he hung on the front hood and let dry or "season" for the day while we were driving. The air was as always hot and humid, but the air conditioning in the vehicles was almost none existent, so we kept the windows open and had the pleasure of a draft like a hot stove for the trip.

A few lucky times we avoided the drive by taking one of the two Air Senegal flights from Dakar, the capital in the north, to Ziguinchor, the main city in the South. This was also an amazing experience. The flights went only once or twice a day and were always full. The old plane held perhaps 50 people are could take very little baggage, and what it took was not checked, but just loaded into a space at the back when you entered the plane. I actually saw crates of chickens and even a young pig being placed at the back. The flights were usually uneventful and took an hour, and the one flight attendant would bustle up and down the narrow single aisle giving us juice or water. The flight was in other ways also unpredictable, since this was only one of two planes -and it was occasionally taken by the government to do other functions such as mail runs. Things got even worse after about 5 years when one of the planes crashed, killing many tourists and leaving only one plane to do the route. Once we arrived at the Ziguinchor airport, we also had an interesting experience. The arrival time for the flights was uncertain, so residents of the town, including our team, would wait to hear the plane arriving overhead and then go to the airport. Once we arrived there was the usually sorting out of the baggage that had been put in the storage area and wading through the ancient terminal (which consisted of one room) to the area outside, where hopefully your driver was waiting or waited taxis wanted to help. Of course all this was done in French or a variety of tribal languages, with only occasional English (which was quite rare in that region). But it was always like coming home from the many previous trips and the air had that special pungent tropical feel of humidity, cooking fires, animal and soil and vegetation. This coupled with pounding rain, if it was that season.

Visitors and regularly visiting consultants stayed at the one hotel in Ziguinchor, and we were old friends as the project went on. I had the same big wooden bed with large head boards and foot boards of local wood and a very comfortable bathroom with a shower - which was used several times each day. I had a shower in the morning before stepping out into the languid humidity. We came back for lunch around noon and had at least a one hour nap and shower, then back to work and a shower before dinner, which was usually outside on a tree shaded terrace. The sun set promptly at 6 p.m. and we had light from a few electric bulbs. The food was French, but due to the heat, I ate little, and usually had a plate of rice and butter or a simple omelet for dinner. Occasionally we had other items such as roast chicken (with a simple sauce) and very occasionally lamb chops. No salad was safe, due to contamination but strong efforts to do some variety of French cooking. We occasionally had chocolate mousse or some fish dishes.

When the missions got longer - I would spend maybe a month on each visit - we were lucky enough to stay in a house and we had our own wonderful cook! I say we, because I dragged my wife and one year old daughter to the mission - and was that an adventure. With baggage for the usual baby supplies, including diapers and some baby food. But most importantly a big supply of baby toys, including silly putty, clay and stuffed "Barney" toys. Of course, there was no TV or video games or tables, so play time was either running around in the yard, which was safe and big, but very, very hot with lots of bugs; or staying in the house in the cooler temperatures and creating clay versions of favorite animals and TV characters from the U.S. Our darling daughter, Emily, was very exacting and if we put the wrong number of toes on the Barney sculpture, we were admonished severely to fix it. Clay sculptures of cats and dogs were also suitably and closely watched to be sure that tails, whiskers and legs were attached and molded properly.

But back to our wonderful cook. He had been a top chef for a church group in the Casamanche, but for some reasons that group moved on. The leader of the team I was working with knew of him through his grapevine of information and we made arrangements to hire the cook for our stays there. I will never forget the car trip we took to pick him up, one in which we loaded his stove, tanks of propane, cooking supplies of pots and pans and utensils on to the back of the car - with the stove dangling off the back and we drove through the usual bumps and pot holes for several hours to deliver him to our cooking kitchen, which was a small stone building behind the main house. He happily set up his equipment and cheerfully prepared many, many happy meals for us. His first job was to go to the bakery to get many loaves of French bread. The French culture has thoroughly convinced much of the Senegalese that this bread was the staple of meals and there were several wonderful smelling bakeries in town. . The trick was to get to the bakery before they were sold out and also to get enough supply to allow for spoilage. As hard as we tried, it seemed impossible to keep bugs out of the bread. We would wrap it many times in plastic, but still open the bread at the end of the day and find a thorough colony of insects. The final solution was to put the bread in the freezer, which sort of defeated the idea of fresh bread for dinner. But our cook always seemed to be a master in having it thawed out, sliced and beautifully presented.

But that was only the beginning. The chef was very careful with the sanitation of produce and gave us wonderful salads every day. He scraped the cucumbers to within an inch of their life - with no sign of cucumber skin, all seeds totally gone and perfect slices on a plate, with similarly well-prepared tomatoes and onions. All accompanied with a tangy vinaigrette dressing and, of course, plates and silverware for the first course; accompanied, of course by a glass of red wine. He would then prepare roasted vegetables, such as beets, potatoes and local root vegetables, sautéed meat with butter sauces. He also used the local tradition of peanut sauces to yummy results. Then he would amaze us with a variety of local fruit for dessert - pineapple, papaya, and mango. Sometime we even had pudding or crème Brule. We were delighted with "Joseph" as he liked to be called, and our culture within a culture there was a great adventure. My daughter Emily still remembers all the times there. Besides the food Emily remembers being tortured (when she was older on later trips) with malaria medicine. The adults took pills, but because of her age she needed to take a liquid form of the bitter medicine. Every night we had a ritual of her battle with us. She got to sit in a chair, while we poured a few teaspoons of liquid into a long spoon shaped like a hippothermus. We then held her mouth open, pinched her nose closed and poured the icky medicine in the back of her mouth and waited for it to be swallowed. The reward was some water or Fanta to get rid of the taste. All was successful and we stayed healthy with that regard.

We were not so lucky in other things. Before we go to Ziguinchor we stayed a few nights in a hotel in Dakar while I did some work with USAID. An interesting feature of the hotel was that it was frequently visited by U.S. African-Americans who wanted to see some of their roots; they also celebrated with big meals of local lobster. Emily and my wife Nancy happily played in the swimming pool, which was large and very well attended. Too well, apparently. Soon after we left and went to Ziguinchor, Emily was crying and complaining that it hurt. After a little inquiry about what hurt it turned out to be an ear infection from the pool. Again I was amazed. We were sent to a wonderful, French-trained doctor in town (who happened to be the cousin of one of the men working on our project). Previous to that we had been told by our local driver to push a leaf from a local plant into her ear and she would get better. That was in progress when we went to see the doctor, but it did not seem to be helping. The doctor examined Emily, declared that it was indeed an ear infection and Voila! - produced a bottle of current antibiotic, which fixed the problem. This was the beginning of my familiarity and respect for the level of training in tropical medicine for both the French and the Senegalese!

Speaking of diseases, one of the habitual problems are "bad" tummies. All manner of digestive problems crop up from not being used to local food/water to mostly waterborne diseases. On our travels with the family we typically brought one suitcase with clothes and personal items, one suitcase full of papers for the project (books, etc.), and another full suitcase of medicine This included a pile of items for over-the-counter, such as Alka Seltzer, Pepto and Tums; and then more serious items such as a few bags of oral hydration fluid. Most stomach ailments pass after a few days, but the greatest danger, especially to children, is dehydration. So oral hydration fluid is a mixture of electrolytes (including salts) that used to come pre-mixed with water (because there was a concern that local water might be contaminated if it was used for mixing). Later on we could also get it in a powered form, which was much lighter in our baggage. By the way we also had a good supply of prescription pills in case things got much worse - which didn't happen). I brought the bottles of dehydration fluid to the house and left them there for future trips - why carry the heavy bottles back and forth to the U.S.? I had an interesting insight into "normal" conditions in West Africa from Terry, who was the team leader for the project in one our phone calls. He thanked me for the dehydration fluids and said he had used it. I asked whether they had had a problem with their stomachs. He said they always had a problem and that was the regular situation, but things had got particularly bad and he had to resort to the fluids to help. So that was normal life even for a long term resident there!!!! It would probably be too impolite to go into greater detail, but there certainly times on my many trips that I stomach problems were excruciating. They lived up to the old Mexican saying that there were two types of stomach problems, the ones you died of and the ones you wished you died of.

We had many trips to Ziguinchor as a family and it was fun getting the family to speak French and see new folks. To this day my daughter has the travel bug and wants to get back to at least Europe and maybe Africa. Life in Ziguinchor was never completely comfortable, but it was very livable, with the local chef, a real house and a dependable car. Even the Internet worked reliably, although it was an expensive landline call to Dakar to connect with the outside world. Not unusually, the most expensive part of our life was water - with water typically costing $5 for each quart bottle; more expensive than soda or beer and comparable to wine. So what do you think we drank the most of?

Over the years the political situation kept changing. During the early years there were a good number of tourists who came to enjoy the pretty brick and ceramic resorts along the coast of the ocean, near to the outlet of the Casamance River - actually just north and south, since there was an oil depot at the mouth of the river that left the water contaminated and the air smelly. The resorts had beautiful colored tile in the rooms and the bathrooms. I remember the wonderful big shower with an arched entrance and no need for a curtain - and big spray. There were pools and colorful dining areas in and outdoors. This unfortunately came to an end as the civil situation became more violent and we were told to stay away from that coast area. One of our groups was in a jeep that received rifle fire, so we took it seriously. In a subsequent trip we had to stay in Ziguinchor and then as things got even worse we had to be evacuated in a later trip to an area about three hours east into the southeast desert area, into the town of xxx. These trips, in which I needed to be in that town were, to say the least, interesting.

There were at least two I remember. In the first, I was with the family again and we lived in a big old hotel with large spacious rooms. We were the only car in the village - the car would pick me up in the morning, we would drive maybe two hours to our work activity, do what we could and then return back before dark, since the roads were considered dangerous. In fact, the number of traffic fatalities in West Africa is horrendous and no safe blood is available. Meanwhile, Emily and her mother hung out in the big hotel and played. Sometimes they would walk around the village and play. I have wonderful photos of Emily playing on dirt piles with local kids. They managed to have a great time playing, even though they had no common language! The kids didn't speak French - only a local tribal language and she didn't know anything but French at that point. Everyone would run up and down on the streets, hide behind huts and run in and out of houses. They would also sit around cooking fires and help pound food, clean vegetables and seemed to have a wonderful time. We did worry that the water wells were open holes in the ground and had no protection. A kid could have fallen in easily and it still gives me chills - why didn't the put a top on the well or a small fence? That still bothers me. I never found out why, but also never had a report that a kid actually fell in.

But my second mission to that town was horribly memorable. I mentioned before that we had a suitcase full of medicines for stomach problems. Also mentioned that Emily had to take malaria medicine from her hippopotamus spoon, while we adults had to take medicine by pills. I, of course, was one of the people who did that regularly because of my many trips to Africa. In fact, because of the large amount of time I spent there I started out by taking a quinine-based medicine, sublimated by another medicine because of quinine resistance malaria. But the doctors told me that I could only take about 100 months’ worth of that before there was a danger of eye cataracts. And in the meanwhile they had a new, better medicine called Lariam. So I started to take Lariam, which had a number of known side effects. But the conventional medicine line was that the side effects, which were mostly psychological, only occurred with people who were predisposed to psychological problems. I was told, but need to verify, that the chemical makeup of the medicine was not dissimilar to LSD. In any case, the major side effects included funny dreams, hallucinations and mental confusion. I was one of the lucky ones who got those side effects in a big way.

I was in that little town, in that big hotel, by myself with none of my team around me. I awoke in the middle of the night feeling really strange with terrible stomach pains and total confusion. All I could do was get dressed and go out to the concierge and say, in French, that I was sick. I imagined I was having a heart attack or something, although everything seemed to be working. Eventually Terry showed up - it must have been a few hours at least. He took me for a long car ride to a local medicine clinic, where the only doctor was a woman gynecologist. She listened to my complaints and said immediately that it was the malaria medicine and in fact the French did not believe in it due to the large and strong side effects. She told me to get off that medicine and within a few days I should be ok. To protect against malaria she recommended a combination of two medicines - a combination not approved in the U.S., but which I could easily get in France and West Africa - and that became my standard medicine for the next several years in Africa. I did get better soon but was swept up in standard protocols for USAID. I was flown back with a private plane to Dakar and then checked in with the lead consultant on the project. I had to call Washington, D.C. from Dakar over the regular phone line and reported that I felt better, but was still ordered to come back to the U.S. for a checkup. What I remember the most about that call was that it lasted perhaps ten or fifteen minutes and that I had a charge for about a thousand dollars on my bill!

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So back to the project itself. It was a huge program that covered much of the Casamance River - a distance of hundreds of square miles - and probably hundreds of villages. In each case there were analysis and plans for each stream or small river that flowed to the Casamance to see what could be done for the farmers. We examined whether a small or even medium sized dam could be used to capture the water during the wet season. The Casamance itself was tidal and was fairly salty even upstream at least 50 to 100 miles and therefore didn't work for agriculture.

So, in summary, the SZWMP had as an objective to build a series of small (low-head) dams that would capture fresh water during the monsoon (rainy season) and retain the water so that it could be used to grow rice crops. Normally it would not be possible to grow crops after the rains due to dry conditions. Besides several serious technical issues on hydrology and soils, there were a series of social issues. The latter were settled by working with village chiefs, to help determine which fields would receive the fresh water – which was a balance between being flooded, just the right amount and too little – depending, of course, how close the field was to the dam, how high the water was maintained behind the gates of the dam, and at what stage of the rainy season was occurring.

The soil issues became a major multicultural debate between the American and French experts on the team (as well as experts back at the home office). The key question was whether to flood the fields with SALT water during the dry period in order to keep the soils wet. The French engineers believed that it was necessary to have the soils wet at all times in order to prevent irreversible chemical changes in the soil. If these changes occurred, the consequences would be that the soils would become too acid to grow crops. They recognized that the salt water would also make the soil unusable, but the remedy would be to “wash” the soils with the first amounts of fresh water during the beginning of the rainy season. By contrast, the American engineers believed that there would NOT be irreversible chemical changes when soils became dry and that there was no need to flood them with salt water. This led to research on the issue, but in practice it was not fully resolved in the project. Both techniques were tried, but there was no clear difference in the rice yields in the fields.

As dam sites were identified the next major phase was to build the dams (after they were designed) and to maintain them. The plan was to build them with heavy equipment and have the villages do the maintenance. So the first phase of the project was to train villages in construction management and maintenance. This phase was highly successful and many villages learned how to organize and operate a construction company, including taking care of the equipment and do the necessary training. To this day, these groups are some of the mainstay of construction work in the region.

The dams came in many shapes and sizes, but due to the heavy rainy season they all had to be reasonably sturdy. Generally, they were earthen structures with gates to release water – and the policy was to have the gates made of local materials and of a size that could be managed without mechanical equipment. I have many pictures of the dams that varied between three and ten feet in height and were from about 30 feet to hundreds of feet in length. Of course, there was also a need to have access to the dams, so small earthen roads were also built. There was a strong effort to organize village committee to ensure that the village would participate in helping to build and maintain the dam. This also seemed to work quite well and there was wide-spread agreement that this aspect of this very large project (which had a budget of over $18 million) was a success.

USAID was concerned about environmental effects of the project. Their guidelines required that there be a review of potential impacts of a project. In general, environmental regulations have become more complex than those of the Internal Revenue Service on taxes. USAID regulations were struggling with how to assess this large project, which was large both geographically and financially. The project was also long, with a projected period of at least 8 years. The environmental review was divided into a Programmatic Environmental Review that conducted all the formal elements of a review. I have already described this type of assessment in Chapter 3. The first step was to ask the questions of what potential impacts would the project have on the environment and human health. To answer this we assembled a multi-lingual, multi-national team to conduct reviews on such issues on impacts on forests, fisheries, human health and, more importantly, social and economic systems. We had a full session in the Casamance with the local farmers and officials to see what concerns they might have. By far they wanted to know what the program would do to benefit them and how it would avoid hurting them, as many earlier programs had failed to make a long term difference. What would be the effects on the fishing villages, rice farmers and other aspects of village life?

The team went to work to do a survey of these impacts by having a team meet in the Casamance several times, gather information and prepare a report. The report became a model for reviewing assessments and resulted in a major USAID publication on lessons learned from this type of assessment. (Cooper, 1994)

So what was learned? We raised the question of whether the project would result in an increase in food for the region. The terminology used today is whether it would improve food security. To assess this we had both economic and environmental reviews. The economic analysis was resolved fairly quickly with a comparison between food lost from reduced fish into the streams and rivers (because they would be blocked by the new dams) and the increased rice production (because of the availability of more fresh water). The assessment that there might be a substantial loss of fish for the fishermen and the project proposed the establishment of a fish growing program - known as aquaculture. That whole program of setting up fish enclosures at the mouth of the rivers and stocking them with local fish (mostly tilapia) and getting them maintained by local villagers was a major planning process and we were able to have a specialist work on that (and we consulted an expert in this by visiting my friend and graduate school colleague, Fran Henderson, in Rome at the UNFAO). Some of the issues were that the fishermen involved spoke a different local language -Mandink - from the village officials, who generally spoke both French and another local language, Waloff. But that got resolved and poles were driven into the river bottom, nets strung between the poles and fish planted into the enclosures. River flow was used to provide oxygen and food and cleaning to the enclosures. After a growing period of a few months (fish grew quickly in the warm, food rich area), fish were harvested and distributed within the village. As I remember the organizational system that had been set up for the construction was also useful in sorting out work responsibilities and those who would benefit from this project.

Another and major aspect of the food production question involved education, training and research. The decision was made to treat the food production question as a scientific hypothesis that needed to be formulated and tested. Basically the question became “does the project, which blocks rivers and streams, have a significant impact on the blocking of stream and rivers compared to previous construction in the region and does this result in a reduction of fish production?” This overarching research question became one of two major the focus of an 8 year research project (the other focus was on social impacts). The USAID entered into an agreement with the Senegalese government to further fund ISRA - translated and The Senegalese Institute for Agriculture Research. ISRA had been set up earlier as a research center, with a laboratory, computer area, housing for researches and with electrification and other infrastructure pieces. . The researchers at ISRA were impressive, with advanced degrees from excellent colleges, with excellent command of science, English and local conditions. It appeared to be an ideal marriage -sorting out issues on this large international development project, doing further training of local capacities to do this type of research, and providing needed equipment and supplies for the largely unused facility.

The ISRA project occupied me for the next 8 years as we developed the planning, implementation end review of the program. The decision was made to have the program directed by the overall team leader for the project and then to have the project planned in detail from the US, with visits to the Casamche at least 4 times per year. It was a wonderful opportunity and a rewarding long-term project that introduced me to so many aspects of international development.

The first task, in this early age without GPS systems, computer Graphic Information Systems (GIS), internet or on-line data systems, was to figure out how many streams went to the Casamance River and how many of them had been previously impacted by the building of other dams, bridges, docks, or any other obstructions. A junior staff person had the task of using an engineering program - called CAD (computer automated design) to take maps and other information and create a map of the Casamance River Basin and all of its tributaries. We then took maps and other information and created a key that showed which systems were now blocked. Finally we looked at how many streams would be blocked by the Southern Zone Water Management Program. This effort took months to finish. The result was a massive map that was printed on an engineering machine intended for blue prints and large engineering construction drawings. There were many, many streams and not surprisingly many of them had already been blocked or manipulated by construction - mostly road building. The good news was that the new planned project did not appear to have a significant impact, as measured by the number of areas and streams that would be affected. The bad news was that so much of the fish production areas had already been blocked and the food lost.

These blockages were partially exacerbated by the Bignona River dam. That river was a major tributary flowing into the Casamanche River and contributed major water volumes. Because it was relatively upstream from the mouth of the Casamanche, tidal impacts were low and it was seen as a good place to capture lower saline waters; in fact, if a dam were in place it might be retained as a mostly freshwater river. In turn, this would provide water for crops.

The new proposed dam on the Bignona River raised a major philosophical question – what is the best way to control a policy – any type of policy? Two approaches considered are: 1) Can you work within an organization or relationship to make changes? Or 2) Should you work outside of an organization to make changes? In the case of Bignona River, the USAID was asked by Senegal to fund and build the dam. They declined because they determined that the dam would have serious environmental consequences; for many fish and other aquatic resources would be lost by blocking that major river. Thus, they decided NOT to work within the USAID organization to possibly alter or mitigate plans for the dam. They also decided NOT to work with Senegal to try to change their approach – perhaps to NOT build the dam. In any case, it appeared to be a reasonable decision at the time and certainly USAID came forward with the main stages to the SZWMP to support in a major way development in Senegal.

The second approach – of working outside of an organization or relationship – of trying an external influence – unfortunately did not work either. Senegal entered into an agreement with China, who built the Bignona dam without any environmental assessment or consideration of any form of mitigation (which, you will remember, means finding ways to address and compensate for negative environmental impacts). Irrespective of whether the dam was a “good” decision, it illustrates the hard choices of whether it may be more effective to work internally or externally to arrive at decisions on development. This concept will be revisited in the consideration of political or policy decisions in Chapter 18.

That larger question of the loss of fish production throughout the Casamanche basin was not addressed, but it did put even more pressure on the SZWMP project to help increase rice production to provide more food security to the area. It also gave me the opportunity to start what would become a lifelong working relationship with Walter Knausenberger, an USAID official who was in charge of environmental aspects of this project, who would become the official for all of west African projects and who I would work with again through locust projects in eight African nations (see Chapter 3), do training projects for Dar Es Salaam in Tanzania, and then a dramatic project in Malawi. Our careers interacted in so many ways.

With the analysis finished we moved onto another task of planning and equipping the ISRA lab to do water quality analysis - to determine what impacts might occur from changes in nutrients, chemical contamination, etc. These impacts were potentially both negative and positive - would there be more nutrients available to help crops, or would there be a need to add fertilizers, which also might have impacts. Again the larger picture was that we hoped to help the project and also build large and lasting capacity for Senegal to address its own environmental issues. The decision was made to use the substantial budget to set up a decent environmental testing lab at ISRA. Based on the planned experiment of testing the hypothesis that the SZWMP would not have a major impact on aquatic resources of the Casamanche, we put together an equipment and supply list and started the process of getting it re-viewed by ISRA and USAID. We planned on a full range of automated equipment, as well as all the reagents needed to perform the tests (shades of the lab set up programs I was doing with Indonesia at a similar time in setting up BAPADAL labs – see Chapter 16).

Finding the equipment and putting in the orders was fairly straight forward. But the packing and shipping became an amazing eye opener. There was not enough equipment to fill a full metal shipping container and in any case it was not clear whether the Dakar port could handle a regular container. So we had our shipping department build a wooden crate and pack the materials. We then transferred the crate to an international shipping group that was certified to handle USAID shipments - with all the issues of custom clearance, tax-free inter-government transfers, truck transfers and, of course, ocean freight. Which lead to another problem. We had in the shipment a substantial number of concentrated acids and bases. They had to be separated, since we were not allowed to send them on the same ship due to safety regulations. So we had the shipper do the separation. Problem solved except for big lists of inventories.

The plan was to send off the shipments, have them received in Dakar (in about six weeks as I remember), then transfer them to a truck big enough to handle the wooden shipping containers. Then, because of other customs issues the truck would need to go all the way around the Gambia, through eastern Senegal to reach Ziguinchor. It was also planned that I would be in Ziguinchor to receive the crates end officially transfer them to ISRA. Amazingly, all went smoothly. I went to Ziguinchor and worked on the project planning for other aspects, and low and behold, a truck arrived with the crates and we were able to transfer the materials to ISRA. The lab was ready with space for the equipment. It might be added that we wanted a full service lab, so we also shipped office equipment, such as photocopy machines and all the supplies needed for them. There were plans for many reports and we wanted them to be able to do copies of the reports that would be prepared on the several computers that we were also supplying.

I mentioned earlier about WAWA - West Africa Wins again, and this happened in many ways in our plans for the lab and the training. The computers were installed in a new air conditioned and dust free room. And we were able to use them to do a full training program on CAD and other computer software at the time (we brought in a computer specialist to do the course - another interesting character who I mentored for years on that project - he had worked on the CAD mapping of the streams and would work on many other aspects of computer software and analysis in the future). After we finished the setup of the room and after we used the room for the first CAD training we left ISRA and felt very self-satisfied that we had accomplished that task. Upon my return about three months later, it was a disaster; the computer room was hot and totally full of dust. ISRA explained that the air conditioning bill was too high and that they either didn't have electricity, because they had not paid the bill, or that the decision had been made to turn off the AC to save money! We had a similar experience with the photocopy equipment. We had provided paper, extra cartridges, etc. for the equipment. But we were told that they could not make copies because they didn’t have supplies and no one knew where the supplies were! WAWA!

We dealt with those issues and proceed to the next task, of organizing the social studies of the program. Perhaps as a student of wines might know, the French culture has developed the concept of Terroir - improperly translated as territory, by meaning the whole environment around, in that case, the grape vines. The social team for SZWMP was examining the terroir around the villages before and after the construction of the new low-head dam structures. They created massive databases on which villages would be affected, directly and indirectly. That already was a big list. Then they did a subset of the villages to look as aspects from cultural, economic, and other social perspective.

We had long discussions on the methodology for data collection, data compilation and analysis - discussions that took over two years for the program. Of course, there were interconnections and deadlines on-going for the main project of SZWMP villages were being organized for dam development and there was some urgency to get the before and after data collected. We had many, many meetings, separated over three months between field visits. Results were mixed and prepared in draft final reports to USAID. The reports themselves became big discussion points. I remember long discussions of how to properly translate some of the terms in the French documents into English. Not just differences in terminology but large cultural divides on who to interpret responsibilities and obligations -were things "required" or "encouraged" or "mandatory" or "informal". These discussions lead to delays on "deliverables" - government language for reports. I remember being in Indonesia on the BAPADAL project and being summoned back to the consulting office in New Jersey and then being rushed back to Senegal and the Casamanche to resolve issue on the report and breach of agreements on getting reports into USAID, from ISRA and then to Senegalese officials (who were, of course, very involved in the large SZWAP project). It was so reminiscent of the large "getting things settled" meeting between Exxon and Bouygues on the oil pipeline study for Chad/Cameroon (see Chapter 10), and for similar meetings on pesticide use in Africa in the project for locust control that occurred between the United Nations, USAID, and the agricultural ministers from Africa (see Chapter 37).

The long-term benefit of the ISRA components of the SZWAP project is not clear - it certainly provided support for an important function and helped to do useful employment for some well-trained and well- intentioned Senegalese. The studies became a good model of environment and social studies - similar to the wide range of studies that had been performed on the Senegal River by the University of Michigan and Suny Binginton. Another major function for the ISRA study, shifting back to chemistry, was to try to resolve the major issues on soil chemistry between the French and American engineers. There were a number of publications produced about the SZWMP – lessons learned on environmental assessments and on balancing environmental, economic and engineering considerations. (Cooper, 1997, 2001)

CHAPTER 12: MOROCCO

Going to Morocco is like going to another continent than that of East and West Africa – it is so different! While French is similar, much of the formal work is done in a Moroccan Arabic, which is extinct enough that other Arab speakers can’t understand. The ocean and coast is an emerald green and the sun shines hot and bright. The country is still an absolute monarchy and nothing gets done without the approval of the king. In fact all ideas originate with the king through an elaborate process. Morocco is undergoing a remarkable economic boom and in many areas does not exhibit the extreme poverty of black Africa. Morocco is an arid country, but one that is also blessed with large river systems, particularly the Sebou that flows in the north through Fez. Much of the country receives water from dams in the northern Atlas Mountains.

My adventure in Morocco actually started in Washington, D.C. where I had an assignment with the World Bank to help them plan the next five years of investments in the country, with a particular emphasis on environmental issues. The reason the adventure started there was that as soon as I walked through the door of the Bank, into the Department called EMENA (Europe Middle East and North Africa), the whole team was Francophone and also all the work was in French, led by an incredible leader Terry Baudan (who later moved on to a major role in French industry). One has not lived until you had to use an advanced French /English dictionary to translate Gazelle and so many other animals. In the spirit of on-going Bank policy I was imbedded in an operating department, instead of the central Environmental Department in order to share environmental knowledge and training with the staff. As with so many Bank personnel, they were multi-lingual, well-educated and experts at their particular discipline. But they knew nothing about the idea of considering environmental impacts along with engineering. Of course, economic aspects of a project were one of their expertise. I will never forget two of the senior staff stating to me that irrigation projects could have no environmental impacts and therefore the discussions were a waste of time. They soon learned to consider the many impacts of these schemes and that became policy for the Bank for the past 20 years (and into the future).

The Bank had been asked to support the building of new dams in the Atlas Mountains, so it was a logical place to begin by considering the water cycle in Morocco; scientists refer to this as a “mass-balance” approach. Where are all the inputs and outputs into the system? Where did water come from? How was it used? Where were the gaps in knowledge for choosing new investments?

Water is primarily used for municipal use, industry and agriculture. We looked at these three aspects. Water is available from canals that are connected to dams in the Atlas mountains and from rivers, with the Sebou River in northern Morocco as the main source in the north. The river flows through the city of Fez, with its many textile, dying, agricultural and leather industries. So besides a large load of municipal sewage, the river is heavily polluted from industry. In fact its pollution loads have been so heavy that the water is unusable for drinking, even after treatment and it is also almost unusable for many industrial uses. At the time, at the beginning of the study, the solution proposed by Morocco was to increase water supplies by building more dams in the Atlas Mountains. A second major use of water was the agricultural sector, which was heavily subsidized for the price of water. Again new dams were proposed to keep up with water demand. Other sources such as drilling groundwater or desalination had been rejected as too expensive, although there was some research to use wind power for desalination. Thus all solutions to input were seen as new, expensive dams.

While there were some potential impacts on wildlife and fisheries if more dams were to be built in the mountains, in this case the economic considerations were probably the ones driving the process. What we found was that making two changes, which were expensive but still cheaper than a dam or dams, would preclude the need for new dams for several decades. These changes were to use the water more efficiently and wisely. First change was to raise the price of water to the farmers - the water tariffs - by a few percentages. It was calculated by the economists that this would cause the farmers to use much less water - much of it that appeared to be wasted.

A second major solution was to clean up the Sebou River and make the water more available for both municipal and industrial use. This aspect of the project would consume another 10 years of my work - interspersed with the many other projects. In a separate study the World Bank had decided to fund a new sewage treatment plant for Fez in order to reduce that large source of pollution to the river. Not only were there health and sanitation issues, but also the waste assimilation load (BOD or Biological Oxygen Demand) was so high that the water had no oxygen and could not even assimilate further waste, let alone support fish or other aquatic organisms (for more explanation of this, see Chapters 22 and 24). So plans were in the works for a large, new water treatment plant.

A huge additional obstacle was the industrial waste - waste that was high enough that it was estimated that it would disrupt the operation of the new sewage treatment plant. So in another set of trips to Morocco (in fact funded by U.S. Trade and Development, or USTD), I was asked to look at American technologies that could be useful in addressing the many problems of pollution in Morocco. That was probably the most hectic trip I have ever had in that I traveled all over Morocco, probably ten trips up and down the coast between Casablanca and Fez. Fortunately, I had a wonderful student from Morocco who was studying environmental science at George Mason (where I was a professor) and who understood many of the technical, as well as the cultural issues there. His ability to manage the phone and railroad systems there were invaluable. This trip resulted in the funding of new projects and further work on the Sebou River.

After review, the solution and plan were presented to the World Bank and the Kingdom of Morocco and accepted - through many meetings above my level. Meanwhile back at the Bank, the work we did with the white paper became a standard approach to bank operations. Many years later, at a meeting at the Bank - called water week - it was clear that the procedures and policies we had put in place in the bank were standard protocols. Even irrigation projects, let alone dams and other issues, were given a full environmental consideration along with the economic and technical issues. Interestingly enough, I can no longer work with the bank because they generally do not employ or contract with folks older than a certain age. The dams were not built and massive plans were put in place to deal with pollution in the river.

In order to address the pollution issues, we looked at a wide range of U.S. technologies. For the trip, we had discussed a range of programs that might be of interest to both Morocco and the U.S. trade and Development - and we were instructed to look at water and energy projects. The general approach was to plan one or more pilot projects in the range of $50,000 to possible $1 million, although for these types of water projects the range was probably closer to $300,000. I was asked to identify appropriate projects; one’s that would efficiently utilize American technologies and coordinate with other projects in Morocco. Many projects were considered as we set up maybe 8 meeting per day for almost a week. We shuttled between Casablanca and Fez and several locations near them. All the energy projects were much too large for the present budget, as were several water supply and treatment facilities associated with agriculture. But helping on the Sebou seemed ideal.

There were many sources of industrial pollution to the Sebou - but a key problem appeared to be from the olive oil industry. If the World Bank finished the new sewage treatment plant, the high BOD pollution from that industry would probably disrupt the operation of the plant. In the industry, olives are picked and then need extensive processing to make them edible. They are pickled in lye or heavy salt to take off the outer husk and soften them. Then the processed olives are pressed to remove the oil, which is the valuable produce for world consumption. What is left is the waste from the pressed olives. For decades the farmers have brought this waste near or to the Sebou river and dumped it - causing massive pollution - both from the salt and lye and from the very high BOD - very high solid waste that overwhelmed the ability of the river to assimilate it.

What could be done? We had an ideal American solution - bring the olive waste (what is special name in French for it?), to a facility where the tank would be sealed and the waste destroyed by bacteria - this was in a tank without oxygen, an anaerobic digester. This anaerobic digester is at the heart of all sewage treatment plants in the Western world. The trick was to find an anaerobic digester system that could handle the high salt/lye and very high percentage of solid-waste for this type of material. Again there were good examples of American systems that were working with similar wastes.

The digester had other advantages as well. The product of the digesters was Co2 and methane gas. In fact methane from facilities such as sewage treatment plants and landfill sites are a major source of methane in the U.S. and the methane is used as an ample sources of power for heating, power plants and manufacturing. A full sized digester in Morocco would provide ample methane for power. In turn, this methane gas and the revenues from it would provide the incentive for farmers to bring their waste to the facility. Certainly it was conceivable that there could be a law that required that they participate and bring in their waste, but if there was a positive economic benefit from them, as opposed to avoiding a fine or jail, then the system might work even better. It was a classical win-win solution to this type of environmental problem and the third major benefit was that it would prevent disruption to the new sewage treatment plant in Fez.

While we also presented perhaps 20 additional projects that used U.S. technologies, the U.S. trade representative and other staff at the embassy had little interest in them, but the digester gained traction. The next step, we thought, was to develop the project idea into a formal proposal and then a document that would be used to solicit bids from people to do the project. That part was relatively easy - we prepared all the technical requirements, budgets, and timelines that might be appropriate. But then the real maneuvering started.

The Moroccan debate

After discussions within Morocco after the decision was made to do the anaerobic digester, things really got interesting. There are at least two official groups working on cleaning up the Sebou River. There was a Sebou River Coordination Commission, a more or less local group working within a municipal structure in the area near Fez. We visited their office and were impressed by the expertise and focus of the staff. Their offices were in a shabby old building that they shared with the town hall offices in a city north of Fez and a police substation in a city north of Fez. They did have working computers and office equipment and excellent maps of the area, plus good summaries of pollution issues and other funding. They were also familiar with the issues related to olive oil waste. They wanted to be the Moroccan Agency that implemented the project - which was now slated for about $350,000.

The second official group was an arm of the National government in charge of natural resources and issues related to pollution. Their offices were much more substantial and located in Casablanca. While they didn't have dedicated staff for the Sebou, they were interested in combining this program with other efforts. And of course they wanted to be the one to implement the project.

After discussions with everyone and our team we determined it would be best to have the Sebou River Coordination Commission oversee the project because of their dedication and focus. Through my student, who interpreted from the Arabic and from various phone calls, we had a message that the national group wanted to meet with us near Fez at a particular time. However, a second phone call to the Sebou River group said that the meeting was in a different city at a different time. It turned out that they were correct, and in fact either through subterfuge or mistake, we were being sent to a location at a time that would have meant that we missed the planning meeting - and a meeting where we would make a final decision. Without the local coverage we would have missed that meeting and would be told that the national group had made the decision by default -since we were not available. In hindsight, we felt that the project would have not succeeded because our program would become intrined with other ongoing national programs. The national group was disappointed, but realized that a decision had been made and agreed to support the Sebau River group. It was a close call, but thankfully good local information saved the day.

The politics were far from over. We returned to Washington and did a de-brief with the USTD folks and the project was put on the roster for review. It was approved and a RFP (request for proposals) was released and eventually awarded to a group that I did not know - and after a phone call to them with an offer to help they wouldn't discuss anything with me. To this day I have no idea what they completed or whether the full scale multi-million dollar program was eventually built.

But a much bigger perspective arose. I was asked by the Moroccan government to become a member of the Sebou River Planning Commission, which I was happy to accept (and it was without compensation). This lead to an amazing perspective. It turned out that there was a massive planning effort to clean up the Sebou River - a total project that included the full length of the river and which needed funding of over $200 million. The World Bank sewage treat plan and our little anaerobic digester were the only project that involved the US. I was invited to attend a sumptuous and high level meeting of the government - which might have the king and had ALL of the high officials of the government. It was held in a glorious hall and the participants were dressed in their most handsome flowing robes (yes, I don’t believe I saw any women in the group!). The hall was decorated with flags and the highest level of pomp and circumstance.

I informed the USTD and USAID and State Department of the event, but was told there was no funding for the U.S. attendance. As a former head of the Hudson River Foundation and a member of the Sebou River Planning Commission, I felt that it was important to be present and determine some of the politics. I flew in, and was told that I needed to stay in the nicest hotel just outside of the walls that surrounded Fez. It was an amazing view of the city and the surrounding hills. And the room was a wonderful memory forever: flowing fabrics, sitting areas, living room, bedroom and sumptuous bathroom. At a very reasonable cost, I might add. Just the process of arriving at the event was fancy, with a ride from a local consultant that I knew in his best car - of course, he had on robes; as a Westerner I wore a good suit.

My next surprise was that we were ushered into the large hall and most of us, except for the highest officials, were placed in large seated balconies overlooking and amphitheater. Then the event started and it turned out such an august event meeting that everything was in Arabic - not a word of French was heard. The biggest player in the event was the French - who had committed millions in funding to the components of the project. I had learned many years before in other projects in Africa that one of the ways that the French had obtained and retained power was to give very attractive financing for projects wanted by the countries. They showed that power in spades in the Moroccan meeting with many French construction and other firms being given large parts of the project. There were some speeches describing that of which I didn't understand a word but the local consultant gave me a clue. Then they decided that they would like to have me give a word about the anaerobic project -- that piddingly little project compared to all the other ones - but at least a place holder for U.S. interests. Not only did I not speak Arabic, but there was no way I was going to do a speech in French with such a group. Fortunately, the local consultant translated my English directly into Arabic and all was well received. The meeting established the 10-year plan for cleaning up the river - and remember, it was already ten years since the World Bank report on the water budget and identification of the need to clean up the river.

What would be such an event be without a feast! We were ushered into a beautifully tiled courtyard with colorful awnings and sat at round tables of maybe 15 people each. The weather was glorious – warm but not too hot, low humidity and clean breezes. Out came platter after platter of gorgeous food - salads, dips, breads, fancy finger foods - all with different wonderful flavors of citrus, spices, honey and nuts. I happily dug in and had a few plates full of the glorious food - I had never had anything like that and with the company, which was interested in discussing other river systems, America, other work in Africa, American elections and business. But was I fooled. The platters were taken away and I imagined, except for a few speeches, we were done. Not in the least. Beautiful big platters started to arrive - targins with lamb with dates, chicken and meat with tangy lemons, vegetables with wonderful fragrant spices and nuts - all beautifully presented and set in front of the guests. It was an exotic panorama for the mouth and the eyes - it was served with all kinds of rice and breads. And then came all the courses with fruits and deserts and, ah so satisfying, wonderful Moroccan mint tea. I could have burst with happiness! And so unexpected.

This event finished and I returned to Washington to other work, but stayed in touch with the Sebou River group - and through events at the World Bank learned something of the cleanup efforts on the river. Was all the money sufficient to do the deed or were there a need for new regulations and for strict instructions from the king? I don’t know.

So what did we learn from Morocco experience? First we learned that protection of water resources is cheaper than cleaning it up - a much smaller investment several decades earlier would have been much cheaper than the $200 million plus needed to clean up the resource. The promising news is that the problem is now being addressed. While it may seem obvious today, when the problem of cleaning up the river instead of just building another dam was discussed, this was not the solution 20 years ago when the Morocco water balance paper was prepared. While it’s not clear how the idea was promulgated and eventually proposed by the Moroccan King, over the last 20 years that idea has become mainstream. Perhaps part of that was the realization that cleaning up the river would be a cheaper alternative to building new dams and aqueducts. Certainly millions of dollars in foreign aid and public capital were saved in the present plans. Perhaps another aspect is that a strongly controlled government, as that of the King in Morocco can direct changes more quickly - thus a democratic but centrally controlled economy can be responsive to changes needed.

SECTION III ASIA

CHAPTER 13: SRI LANKA

Sri Lanka, the former Island of Ceylon, is magical, with tall mountains in the center, covered with lush forests and tea plantations, dropping to snow white beaches and the azure Indian Ocean. The people have a very high literacy rate and are friendly and helpful. The island is full of wonderful historical sites, from water "tanks" (cistern) that are almost 1000 years old (see Figure X), shrines and temples, internationally recognized forests and palatial old British hotels and other buildings. The air sometimes has pollution and humidity, but the ocean breezes generally keep it feeling clean and fragrant.

(Figure X here)

There have been many USAID and other foreign aid projects over the last 30 years to try and help the development of this lovely place. In order to try to understand the mission in which I participated we must go back to a series of earlier, massive projects - the Mahaweli dam projects in the north of Sri Lanka, a river that lead to the Trincomalee Harbour. The harbor its self was very deep and served for many years as suitable deep draft vessels, including military ones. The dam projects were intended to store fresh water for hydropower, as well as have a dependable source of fresh water for rice and other crops.

As discussed in the book, "Much Depends on Dinner," humans have been changing the planet for at least 1,000 years to provide sufficient water for growing rice. This magical crop alone has been responsible for organization of social systems in order to assure an orderly availability of water. For instance, those fields situated higher on a slope or mountain would use water and then release it for lower level farms. And in order to make that happen, systems of cisterns, aqueducts and canals were created to channel the water. In Sri Lanka it is possible to see stones with carvings of cobra and other animals that guard over 500 - 1,000 year old "tanks". (picture of tank and other quotes from book).

(Figure 4 here)

Another feature that is relevant is the civil war that started between the Tamal people in the north of Sri Lanka, a people whose religion is Hindu, and the Sinhalese people in the south, who are Buddhist. That war raged for 20 years and was just settled in 2013, although there are now on-going investigations and allegations of war crimes and atrocities. These battles were just starting when I arrived in Sri Lanka for a series of trips over a period of three years.

Why did the war start? - there are several theories, but the most prevalent is that it was due to the Mahaweli project. The two groups had lived peacefully side by side for hundreds of years, with each content to stay in their own geographic area and each to have their own language (Tamil and Sinhala). When they decided to amalgamate as a country a decision was made to have English as the common language (check English history), due to the English colonialism. Thus each group kept their language and used a third neutral language when together.

Sri Lanka became an independent nation after the English left in xx. Foreign aid programs began, including the large Malawi program. As with any large foreign aid program there was an environmental assessment conducted and reviewed. The conclusion of the assessment was that the project would be beneficial and allow the power and water control options to proceed without any major environmental concerns. The exceptions were of socio-economic concerns. There was a strong warning that doing the project in the north where the Tamil people lived, would bring a large number of Sinhalese from the South to work on the project (which was intended to benefit both groups), which could lead to friction and other interactions that could impact the future relations. For once, at least, an environmental assessment proved to be true and this interaction was at least partially responsive for some for the later war.

A second factor that was cited was that the Sinhalese majority in the country lead a movement to adopt Sinhalese as the common national language and to remove English, which was a symbol of colonialism. (history?) Apparently that decision was not acceptable to the Tamil, who shortly after formed the Tamil Tigers and attempted to secede as a separate country in the North. Whatever those factors the war that broke out eventually put an end of most of the foreign aid projects.

I came to Sri Lanka as a scientist to perform an environmental assessment for another project - that of a new power plant planned for an area along the coast, north of Colombo, the capital. It was my first trip to Sri Lanka, but we had a great team made up of other specialists on social issues and fisheries, and a great local team, well -educated and knowledgeable about the country.

There were really two issues. First to decide on an appropriate site for the new installation, and second to analyze possible environmental impacts. Thus, we were trying to balance engineering and environmental considerations, while considering economic aspects. For the first stage we also had a group of engineers from Kansas, who looked at features such as suitability of sites of building (good foundations, etc.), ease of supplies of coals from ships and creating a connection to the power grids. It was fascinating for me to learn about these very complicated and practical issues for a new power "station."

We went around the country looking at a large number of potential sites - actually up and down the coast from Colombo We looked at a few sites to the north, ones that were large enough for a power plant and appeared to have good sites for new ports for coal ships.

We traveled down to the southernmost tip of the island, to the city of Gaul and stayed in a beautiful old hotel that had been built by the British and featured heavy dark wood and large rooms. All the beds were covered with bed nets to protect against mosquitoes, but there was no air conditioning and the rooms were hot and steamy even with ceiling fans. There were beautiful views of the Indian Ocean. Looking straight out had two amazing features: First, if you looked straight out to the south you were having a view of the ocean that didn't stop until the Antarctic coast. But, second, more amazing was that there was a constant line of oil tankers passing by as they went from the Middle East to Asia. One after another, about 10 miles out, they passed, probably no more than a few miles between each one. Truly a physical picture of the huge change in global politics and transfer of energy to Asia.

The dining area for the hotel was a very large room with a long common table. In the corner, near it was a steel frame with a hook. At the beginning of our stay, the owners hung a huge mackerel from that hook. Our main meals were mackerel steaks, wonderfully fresh and rich-tasting with a vegetable curry and rice. Each day for part of a week, the mackerel would get shorter as they cut off steaks for meals. By the third or fourth day it started to taste a little fishy, but not unpleasant! The third remarkable piece of our visit was, for at least the men there, that Playboy magazine was doing a photo shoot with a gorgeous nude model. She told me that catching the sun's rays first thing in the morning made her skin look luminous and they valued that shooting location for that reason. She was German and shared several meals with us and revealed that Scientology was her guiding light as well.

As we gathered up all our data from the different power plant sites, the engineers were delighted; they had found the perfect spot to the north, with a large flat area, good building characteristics and easy access to ships for coal. The second choice, a site to the north was rockier and needed more infrastructure - probably at an added cost of at least 10% compared to the first site. On my side, I developed a scoring system that considered loss of natural resources of different types, cultural resources, social resources and potential impacts of pollution on target areas (such as air pollution from the plant on local villages or cities). That scoring system revealed that the first site was, in fact, a bird sanctuary and that building in that area would have much greater impacts than building in the second site. We presented a simple picture to the Sri Lankan government. The cost of environmental protection, if that was what they wanted, would be about 10% more to build the power plant in the second site. That choice was never made, because the civil war intruded.

A second power issue in Sri Lanka was truly fascinating. We looked at the relationship between air pollution from the proposed power plant and the growing of tea and were truly amazed at what we found. There was, of course, a great concern that any new power plant might hurt the tea crops, which were the main foreign export from Sri Lanka.

The Tea Plantation/Estate

The new power plant planned in Sri Lanka, as well as a number of new super-sized plants planned in India, just not in west across from Sri Lanka, raised major concerns about the effects of air pollution on the tea crops. The first step in conducting that analysis was a trip planned to a large tea estate. Again it was an experience of a life time. I accompanied several of our local consultants in an easy car ride from the humid and hot coastal plan near Columbo up into the mountains, past cascading waterfalls (Figure 2 pictures here), lush green hills, with carefully constructed terraces along the steep slopes, occasional wooden houses. The tea fields resembled vineyards, except that they were perennial and much more lush. Everything looked carefully tended and orderly. Apparently human rights and working conditions for the tea pluckers are not good and there are movements to improve these situations. But I-seldom saw the workers, who were hidden among the tea vines, which towered over our heads.

(Figure 2 here)

We arrived at the main compound for the estate, probably at around 6000 feet above sea level and saw a magnificently build mansion, with beautiful wood beams, large rooms and airy open windows. And what a change in temperature - it was probably 30 degrees cooler and delightful. The air feels cool and fragrant and inviting. I was given a very comfortable bedroom for the evening. In the evening we sat down to a simple but wonderful meal of curry and rice. The Sri Lankan curries use much more coconut milk and much less butter than Indian curries, so that they are lighter meals. In a new transcultural moment, I was the only westerner in the group. Everyone dug in with enjoyment. I had been in Sri Lanka several times before and had become somewhat experienced with their cuisine. Apparently I was now accepted as one of the group, and got the "normal" experience, which in this case was a curry hot enough to burn rubber. I normally might have had some yogurt or fruit juice to help with the hotness. But all we had was a glass picture with water (and a few flies floating in it). It would have to do and I just it to quince my thirst and went on to enjoy the meal. Technically, we learned from the tea experts that tea leaves were not especially sensitive to air pollution – NOx and SOx. It also did not appear that any pollution would travel to the heights of the most important tea estates. We did learn most significantly that tea needed to be cultured with the addition of goodly quantities of sulfur, applied along their roots. So ironically they craved sulfur for growth and flavor! The experience we had at the estate would lead to amazing solutions to some major issues in Colombo, as well as a further trip to Thailand to explore other research on the relationships between tea cultivation and air pollution.

A chapter on Sri Lanka would not be complete without some discussion on tea. The teas there thrive on the cool air and rick volcanic soils in the mountains and is world famous for its flavor. I learned that it is picked by hand and then sent for processing in which it is dried and sorted. The tea ends up in 20 grades, from #1 grave (the best) to #20. Much of the tea we get in U.S. grocery stores is near #20. But finer teas are up to #1 grade. Fortunately that was a grade available in Sri Lanka for a very reasonable price (as I remember, less than $2/pound). It made the most remarkable afternoon “meal”.

Sri Lanka still maintained the British tradition of afternoon teas and our hotel in Colombo put on a wonderful event. The finest teas were of course at the center. It was a meal unto itself – full-flavored with a range of amazing subtle layers – with absolutely no hint of bitterness. Even the fully brewed tea was subtle and interesting. It was an amazing contrast with U.S. tea bags! This wonderful beverage – or I shall say again that wonderful meal – was served on beautiful china in the British manner – with a pot of brewed tea and a pot of hot water. It was served with beautiful sugar cubes, rich mild and plates of small sandwiches.

Returning to our discussion of environmental matters, the insights from knowing about the need for sulfur for tea crops lead to an amazing win-win situation in which air pollution, economics and tea cultivation could be improved - the kind of integrated solutions that environmentalists are always seeking. We have already discussed the first feature, that tea needs sulfur for cultivation. What we learned next was that Sri Lanka was spending millions each year to import sulfur for that purpose.

We then discovered a third important piece by next looking at the power plant near Colombo and air pollution in that city. Economically, Sri Lanka trades tea for oil from the Middle East. What they get is an oil with a very high sulfur content - it’s not generally acceptable for the western markets, so the Sri Lankans get it fairly cheaply. The problem is that when it is burned in a power plant, or in other applications such as machinery, it results in large releases of sulfur; in the form of SOx to the surrounding air. There are technologies to control this release, but they require a significant amount of energy form the power plant to clean out the emissions, and a fairly sophisticated technology that must be maintained on a regular basis. The power plant in Colombo was not equipped with these features. In power plants in the US, the first approach is to use a lower sulfur oil to avoid the problem; in fact, many plants have switched from oil to natural gas to eliminate most of the need for these pollution controls and the associated loss of power from the plants.

Besides air pollution, a second major impact from the high sulfur oil was the operation of the plant itself, one that had led to shutting down the plant when I was there. The high sulfur in the emissions turned into the formation of acid products, particularly sulfuric acid (which had formed from the water vapor in the humid air common to Colombo). This can be controlled if the operation of the plant is kept sufficiently hot, known as stack temperatures were high. This apparently had been a problem and there was some major corrosion that leads to a stoppage of operations of the facility.

So we had the three associated problems: 1) of the cost of sulfur for the tea plants; 2) the air pollution in Colombo when the plant was operating; and 3) the closure of the plant due to sulfuric acid corrosion. Putting the three items together led to a viable and somewhat obvious answer. The Sri Lankan government would apply for a grant to put in an oil washing facility, one that would remove the sulfur from the oil. The sulfur would then be used for the tea and the government would avoid the expense of buying the sulfur. The lower sulfur oil would then be used in power generation and we would avoid much of the air pollution and the corrosion in the plants. This ingenious solution was proposed to the government and the World Bank, who looked favorably into it. Then the civil war intensified and nothing further was done with the matter. Sic Gloria Mundi. The trips to Sri Lanka were incredibly productive in terms of environmental issues. We had developed a clear set of options and choices about locations for a new power plant and had tied together other power plants issues into local solutions that would save money and improve environmental conditions. As with any war - and this was a war to protect the environment and improve living conditions in Sri Lanka - the operational or military solutions must be supported and lead to a political solution. So we were only able to go so far. Hopefully, now that the civil war has ended, we may be able to return to these solutions. Or perhaps take advantage of the abundant sunlight to go with solar and other renewable solutions.

I end this chapter with the story of a very close call. I had been making repeated trips to Sri Lanka from New York. Sri Lanka is exactly halfway around the world from New York, so sometimes I went west through California, maybe Hawaii, Singapore and then Colombo. Other times I went east through Europe or the Middle East, usually India and then Colombo. Fortunately in those days, the client was willing to pay for a business class ticket on such long flights – it generally took at least two days with stops. One time when the plane broke down in Belgium it took five days.

After I finished my mission in Sri Lanka on a trip in 1987(?), I was planning my return flight to New York. I had booked a flight on Pan Am (which was still flying in those days). I also knew that there were major tensions in the Middle East and that the U.S. was a target of anger and possibly terrorism. So I change my flight to Royal Dutch Airways. My caution was well founded – the Pan Am flight was the one blown up over Lockerbee!

CHAPTER 14: CHINA

No adventure was as strange as a trip to China to work on water protection issues for the Asian Development Bank and the China Central Committee. A combination of transportation issues and cultural traditions accounted for that. The story started when we were invited to go to China to review a proposal to perform environmental planning for a new set of water control structures in southwest China, in an area known as Guyane City. This area represents to the Chinese something similar to our old Wild West in the US. It is near the Vietnam border and is occupied by many minority groups, groups that have many different traditions compared to the majority Han people. The area is generally poor and has a reputation as one of the centers of drug trade - something that is relatively rare in the rest of China. It is far even by air from Beijing and has come under focus by the China Central Committee as an area that will receive extensive economic stimulation. One of the projects considered included was the potential for a new dam system. There had been significantly controversy over the Three Gorges Dam and the Chinese wanted me to consider other infrastructure that might not be so controversial (they acknowledged the controversy but did not accept that there was any problem with their planning).

The trip started with an endless trip from Washington, DC. We took a plane from Washington to Chicago, in order to catch the direct flight to Beijing. It was not to be, as we arrived in Chicago on time and were about to board the China flight when we were told that there would be a delay. As we found out later, the plane had been bumped by a truck, so a second plane was brought in. Then that plane developed mechanical problems, so in the end we were brought to a hotel for the night. We got up the next morning and started the trip to Beijing - note that we are now about 24 hours into our trip. The flight was approximately 16 hours and as always with the time change and the long flight, I arrived tired. I was met promptly by our Chinese counterpart and his assistant. I found out that the person l was to meet there, Ted, was on a flight that would not arrive for a few hours, so we waited. The restaurant at the airport, a place that I got to know very well that day and from previous visits had very good food, so we ate and waited. Ted arrived several hours later, but needed to go fix this ticket before leaving, so we waited a few more hours for that to happen. We then needed to travel via bus to Sezechuwwang, the capital of the next province of X. The bus was leaving soon, so we jumped on for a trip of approximately 10 hours. It was pitch black and the bus appeared to be speeding along recklessly, and because of the rush all we had for food was a bag of trail mix that I shared with my two companions. I think the biggest oversight was that we had no water. So now, according to our body clocks, it was maybe 48 hours since the trip had started and we hadn't much rest for the past 12 hours. We arrived in S. and were greeted happily by Ruopong, our local office chief - he had been a translator and spoke perfect English. It was now about 3 a.m. local time. Ruopong insisted that we could not arrive in his city and near his office without an official banquet. So we went to a large restaurant and the staff did not seem to feel it was unusual to serve a dozen dishes at 3 a.m. - along with a few gallons of rice wine. The dishes were lots of fun as I remember - eggs and meat and fish and vegetables.

So pleasantly full and slightly tipsy from the wine, we went back to our hotel - now about 5 a.m. We checked in and again the hotel didn't see it strange that we were coming in at that time. I went up to my floor in the hotel and as I walked down the corridor, low and behold, an Orthodox Jew with full formal clothes was also coming down the corridor. I am from New York and instantly recognized a lantsman - a country man. Of course, he was from New York and of course, I had to go down to his room for a snack and a drink. All this happened in the middle of the night in a provincial city halfway around the world from New York. He had a factory there and was on a business trip (he made hats). So finally, 56 hours later, I got to bed.

As might be expected I didn't make it to the 7 am meeting - I did stop for a wonderful breakfast at about that time, but went back to bed.

Finally, mid-afternoon we had a meeting to discuss the planning for the new project - we needed to gain agreement from the Chinese government to include the proposed Asia Development Bank project on the list of project that involved endangered species and protection of natural resources. Next, we needed to travel to a meeting with the Chinese government in Guyang City. We hooped on a series of Air China flights and had a marvelous travelogue of China. We flew over the Great Wall, then over rugged plains and then mountains as we ventured to the west. We landed in Guyang City, which was rather shabby and had a reputation for a high crime rate - so we were told not to walk alone.

As instructed, I put on a good suit for my meeting. A member of the Central Committee had arranged a meeting with us. We were ushered into a formal room with two high back chairs and I sat in one and the official sat in the other. Next to us were two seats for translators. Ruopong translated for me and the official had a young translator, who, according to Ruopong, was incorrect and often exactly giving the opposite meanings in her translations. We discussed the policies and technical considerations for the program and the need for ADB approval as well as listing for the Chinese government.

So here we were sitting in a ceremonial room, discussing the government's policies with respect to water and protecting endangered species. The first thing we were told was that the Central Committee was committed to spending many billions of dollars in economic development for the region, a region that had lagged behind the rest of Chinese prosperity. Therefore the idea of developing water resources while being mindful of environmental matters was attractive. Another official at the Chinese embassy (a very high official who had responsibility for many issues related to economics and finance) had also confirmed that the government would like to be more aware of environmental issues – one was there because we were seeking together win-win scenarios - economic development with environmental awareness of sustainability. So we agreed that we would try to move forward together.

The next key road block was the Chinese insistence that there be some co-funding for the project. Even though they could afford it, they felt that there should be "leveraging" in all projects - a way to increase their funds using someone else's, at least in part. Therefore we were back to the idea that the Asian Development Bank should fund part of the program. ADB had already expressed interest in that program, so that didn't appear to be impossible. Were we wrong! We arranged to talk with ADB about the program, which meant a quick trip to Manila, Philippines. So we flew all the way east again to Beijing and arranged to go to Manila. We already had many contacts there, including a Filipino who would work on a number of projects with us in the future. He arranged to meet me in the Manila airport. He was concerned about security and insisted that we have TWO guards with us at all times. In fact, one guard actually slept on the floor in the bedroom! While doing visits, we would load into the car, one guard would stay with the car and the second one would accompany me at all times through the buildings and offices.

We started our meeting with the ADB and discussed our previous meetings in Guyang and the Chinese interest in the project. At the time ADB was considering perhaps 30 projects in China and this was one they were willing to fund. But here comes the rub. The Chinese government was given the choice of which ten projects they wanted to complete as part of an endangered or threatened species program. Only ten. So it was up to the Chinese to decide. Either they didn't understand this or they didn't know (or worse) in China. So back we went to China to talk with the officials, who were now in Beijing (which meant that my translator had to travel from S. to Beijing). We explained the ADB position to them and they went to do some inquiries. The results were not good. The Chinese government, in considering the 40 projects from ADB, had decided to NOT include the Guayang project in the top ten. So it would not be approved by APB. And that was the end of that round of discussions. I left China with the knowledge that we had a lot to learn and that there were many reasons why a project didn't proceed - in this case because of a category of funding!

CHAPTER 15: INDONESIA

The Indonesia project was a large effort under the World Bank to basically set up their version of the U.S. Environmental Protection Agency, what they called BAPEDAL. The specific objective of my responsibilities was to: 1) Organize cooperation between the 21 provinces of Indonesia and the Federal government; 2) establish standards for water quality and pollution prevention across the country; and 3) organize a series of environmental testing laboratories that would be used to detect pollution and enforce the new standards. It was a massive effort, but one that let me use the expertise I had gained while working with the USEPA in Washington, D.C. in the new Toxic Substances Control Act (TSCA), which was designed to control pollution associated with industrial chemicals. In the case of Indonesia we were combining parts of the regulations that were applicable to what is known as the Clean Water Act, parts of the Resource Recovery Act (RCRA), as well as TSCA. These are discussed in great detail in Chapter 22.

In order to do the project I have to start with the whole process of winning contracts for such international programs. The World Bank made it the responsibility of the Indonesian government to do the selection process and I was alerted by a consulting group that I was working with that the Government of Indonesia was looking for bids on hat large BAPEDAL project. I started what would become a long series of trips between New York and Jakarta on the program. So, with relatively short notice I did the two-day trip to attend a bidder’s conference, in which we were introduced to the Indonesian officials ans were given their understanding of what they wanted to achieve. Besides the work I was looking at, there were other related proposals on training of Indonesian personnel (there were probably less than 100 folks in Indonesia trained at the time to do this type of work), another group on writing and enforcing the regulations. In passing, I note that the group who won the regulation piece was well-known and well-respected and led by a former congressman. But they crashed and burned. They had proposed a set of pollution regulations that were similar to those in the U.S. – what we call permits associated with the discharge of pollutants (see Chapter 22). Well, they were told in no uncertain terms that Indonesia did not believe in permits – their system was a code of conduct program (again, see Chapter 22). So Indonesia rejected that approach and their response was to ask that group to leave the country! They should have known that most Asian countries work with the code of conduct approach.

So there I was at a large conference table in Indonesia at the bidder’s conference. They outlined a series of steps, which included submitting a preliminary proposal on what should be done and, of course, a price (however the budget was largely known). We would then be asked to come back after the proposals were reviewed for an interview and then a selection would be made. So I returned to the U.S. to prepare a proposal, at a time that was very difficult for me, because my twin brother was in the process of dying. Perhaps because I knew the subject matter well, or perhaps as a distraction, I whipped out a proposal that encompassed the principles and proper steps to perform the tasks. To my surprise the Indonesians said that the proposal was so good that they were changing the process and awarding the work to the consulting company, with the requirement that I lead the group! I agreed to go if I could bring my family – which included my daughter, who was almost three.

It worked very well. I was able to arrange to have a house sitter and someone to take care of all the cats and dogs at home, got a large apartment in Jakarta, and made travel arrangements. We packed many, many bags for what was expected to be over a year. Fortunately again, I had so many frequent flyer miles that I could get three business class tickets for the family. We did have a minor problem on the flight in that the airline informed us that they would not give business class meals to a young child (even though she had a regular ticket), but of course, my ever vigilant daughter noticed right away that her food trays were smaller than her parents. But after some bargaining, we got that okay. My wife had brilliantly planned distractions on the trip by giving our daughter some of the wonderful new games, known as Poly Pockets, and she spent hours absorbed in them! But there is only so much you can do with a three-year-old and we could not get her adjusted in any way to sleeping during the day part of the trip – she spent quite a lot of time running up and down the aisle during the flight. The stewardess also fortunately had seen some of that before and spent a good bit of time with here doing origami.

Well, about 18 hours later we arrived for a night stopover in Tokyo. Everybody was so tired that we did get some sleep and also very much enjoyed a sumptuous breakfast of Japanese and Western food. Then we got on another long flight to Jakarta and once again Emily slept during the “day”, which her body felt was night. When we arrived in Jakarta, we got on a long line at customs and had Emily in her carriage as we tried to move down a long staircase. To do this I had to stand below the carriage on the staircase and her mother took the handles above, so that we could lift the carriage and carry it down the stairs. That upset our daughter and she started to cry. Low and behold, the wonderful people at the customs counter looked up – perhaps past a row of 50 people – and said where is that baby currying and come right to the front of the line! All went very smoothly and we were picked up by our new car and driver and taken to our beautiful new apartment.

The apartment had several bedrooms, with marble floors, two large marble bathrooms, and a large living room. There was a large dining room next to the kitchen. It was a very beautiful place and it had a view of much of the city. I could even see my office in the distance. Two things struck me about the apartment, however. First it had a large balcony off of the living room, but there were almost no railings! It was totally unsafe for a child and probably for an adult. So we barricaded that door for protection. Second we had a very large propane gas tank next to an oven. When in use the oven got very hot on the outside and the tank was sitting right next to it – however, we never heard about an accident and did survive!

Other features of the apartment were also intriguing. The windows overlook a large open space, which we later learned had been a graveyard and was in fact the scene of a portion of the movie, “A Year of Living Dangerously”. Looking in another direction we could see along a wide boulevard that led to downtown and my office. At most times you could not see down that way because of the air pollution. However, during the period of our Christmas holidays, the air cleared because there was also a Moslem holiday, the Ascension of Mohammed to Heaven. This was a period when most of the population of Jakarta left to see family and there was little traffic. Therefore, the pollution dropped and the air cleared! Normally, we also saw that kind of pollution in our apartment. We had an air filter there, and it turned black every week or so, due to the air pollution.

We had a live-in cook, who prepared wonderful meals. Our favorite was chicken porridge, which consisted of a whole chicken cooked and boned and then put in soup containing noodles and oatmeal. Yum! We also had great fresh goods, fruits of all types. My daughter insisted on eating mostly Western food, and there was one such supermarket in town so we spent a good bit of time there. Alternatively, she and my wife liked to go most weekdays to the local Pizza Hut. They were so well known there that when they walked in the pizza was brought over automatically to them!

The working team was organized with several chemical specialists from Indonesia and me as the Western lead. We had many interesting task. First we were putting together standard protocols on how to test water for pollution, including nutrients, pesticides, heavy metal and other organic materials. While there was no official legislation in Indonesia, they asked us to assume that the same standards as those used in the U.S. would apply. Therefore, we were able to take many of the USEPA protocols for that purpose. The materials ran to many volumes and had to be modified as appropriate for Indonesia. For instance, there is a test for fecal coliform bacteria – that is performed in the U.S. at 20 degrees C. That would not work in Indonesia with the warmer climate and we found acceptable protocols that used a higher temperature to get an appropriate response on local bacteria.

Next the team needed to work with Indonesia to define purchases that would be made for a new water quality lab, one that was paid for by a large grant from the Japanese government. We needed to define the equipment that would be sued to perform the protocols selected, particularly those measuring low quantities of materials such as pesticides. The Indonesians had built a beautiful new building for the lab but it was at that time empty. Once we had selected the equipment, we then needed to coordinate with the training team to assure that there would be individuals who could perform the protocols.

Another aspect of our work was to organize ways for the provinces to coordinate with the center, Federal government to share technical information, as well as data that would be sued for enforcement – as you will remember the enforcement would come when a facility or group failed to honor a code of conduct and released too much pollution.

The last and perhaps most interesting aspect of our work was to try to identify major sources of pollution for major rivers and streams. In the U.S. there are formal programs to assess the amount of pollution in a river for a standard set of pollutants, there are permits to use to identify which facility may be releasing the materials and there are goals for having the river get cleaner in the future. In Indonesia, there was no baseline for the present state of the river with respect to any of the pollutants. Nor were there capabilities to get these data. So we decided to try to estimate the pollution indirectly, by looking at tax and other data for each facility. This would tell us how much material was produced by the facility (chemicals, pain, metal, etc.). We then could use some standard measures for a facility of that type (the appropriate industry, materials possessed, etc.) and could do a crude measurement of the pollution load to a river. In that way we could get a rough mass balance of the pollution entering a river.

The team was inexperienced at this type of work, but eager and spent a lot of time collecting information and discussing the results. We had regular team meetings – also a somewhat new concept to them. One of the most fun times during the week was when the team leaders got together – and that was when I got to know the head of the training team, who has remained a lifelong friend. His family played with mine in much of the time in Indonesia and we played tourist together as well. Eventually, they moved back to Bristol, England (and I returned to the New York area), but we visited each other in our respective homelands.

We were able to make good progress in the work and to gain approval from the Indonesian government and the World Bank and were even given an award for efficiently finishing our aspects of the work. I was able to leave the project in the hands of another eager scientist. He became well-known in Indonesia because he traveled to all the 21 provinces (for the coordination of work) and took a remarkable set of pictures that was a brilliant travelogue in the country.

Section IV Principles and Technical Discussions

CHAPTER 16: PRINCIPALS OF DEVELOPMENT

To use the old military distinction, in the previous chapter I have discussed strategies for successful international programs – frameworks on how to approach them within the policy and paradigms of various world views. In this chapter, I look at tactics for successful programs. What elements do we need to incorporate in order to have a successful program? I had suggested that as the reader reviewed the previous chapters that he/she consider things that perhaps were done correctly and those that might be improved.

I have divided my approach to successful tactics or principles into the two categories of planning principles and technical analytical principles (Table X).

**Table X. Checklist of Principles**

I. Planning Principles

A. Aware of multicultural perspectives?

B. What aspects address and/or meet political concerns?

C. How are shifting priorities/concerns handled in project?

D. What measures of success are appropriate to gauge progress and outcome of project?

E. Has the project clearly and explicitly coordinated with other projects, either in that discipline or another relevant field?

F. How are overreaching issues such as population growth, gender issues and climate change handled or analyzed?

G. Has there been a balance between economic, environmental and engineering consideration?

H. Does the project funding have a role of providing initial funding for a comprehensive project?

II. Technical/Analytical Principles.

A. Has the project used a programmatic or similar device to identify or consider win-win solutions?

B. Has the program conserved some form of a mass balance analysis – one that considers all inputs and outputs to the projects to assure a net benefit of the project? Alternatively, has it considered explicably all trade-offs on which some things are lost and other things gained?

C. How are issues related to natural resources or food security considered?

D. Specifically, how are water, energy, and transportation resources considered?

E. What consideration is given of issues related to cities and large urban areas?

F. Is this project preventing a problem, or is it only fixing one that has become substantiated?

G. What are the roles of new or future technologies in leap-frogging earlier technologies or possibly avoiding problems earlier encountered in developed countries?

H. Is the project utilizing appropriate technologies for this stage of development for this country?

I. Will developing large budgets or planning large-scale projects necessarily solve the development issue?

J. Is the “Best” the enemy of the “Good”?

I. Planning Principles

I.A. Multicultural perspective.

A multicultural perspective is essential. Many projects have been “transplanted” inappropriately. For instance, I have seen projects that worked well in Asia, planned and funded in Africa, but missing essential elements. For instance, rice projects – not included putting fish (such as Gambrusia) in the flooded patties to eat insect larvae – used in Asia, were duplicated in Africa without the fish. This then resulted in the potential for increased malaria cases or the undesirable alternative of using pesticide to control the insects.

A related and important point is which perspective is best – should projects be planned by the donor because they “know better” and have lots of experience (which in general is the USAID approach), or should the donor just provide funds and take the lead on priorities and approaches from the receiving country (basically, the Millennium Challenge Corporation approach)? Both perspectives have merit. Again, in general, the best of the donor perspective is that it may better consider long-term issues – such as deforestation, long-term sustainability, gender issues, population control or global warming. It may also better consider global economic issues and macroeconomic issues related to the project.

The developing country perspective considers local political and economic issues, and might be expected to give higher priorities to immediate issues, such as food or water security. When a country is facing abject poverty and lack of food, it is difficult to keep people from using up all the forests or food supplies. Thus, at least one consideration is that international development will help people to get past a crisis stage.

I.B. Political Concerns

Donor nations and organizations all have political agendas. These can include considerations of funding projects that are high priorities for the people of the donor nation. Hence, for instance, funding of an “Africa” fund by Congress due to political concerns that Africa, and America’s African-American citizens, see attention to their concerns. It has also been a principle that the U.S. will support projects in “friendly” nations and projects that support the development of democracies. The inverse also works, in that the U.S. will deny aid to nationals not seen as avoiding repression, etc.

Another consideration is the funding of projects that are required by treaties and other legal agreements. The prime example are the Camp David Accords, that have guaranteed that Egypt will be provided aid in an equal amount that is given to Israel. There are many similar agreements in place form Mexico, other Americas, Africa and Asia.

In a similar manner the political acceptability of projects when the developing country must be considered. Is there a preference for large infrastructure projects over education or health programs? This must, of course, be coordinated with Principle I.A.

The biggest political concern is, of course, war. In many places, war “gets in the way”. In this case, Sri Lanka is the prime example, although civil unrest in Sudan/Southern Sudan and in the Ivory Coast have changed funding perspective.

I.C. There is a continual shift in priorities in the programs. The U.N. has recently identified a few (see newspaper insert article and other Internet research). Projects in the 80’s tended to be large infrastructures – dams, irrigation, large agricultural. More recently, not documented above – update? does included Malawi health, where is a shift towards education, health programs. There is also a shift in scale and input from local countries as seen by Millennium Challenge’s attempt to let the country lead the way – to avoid what had been charged that USAID is micro-managing projects, as generally is the World Bank.

I.D. Measures of Success

A huge field has developed in assessing a project. At each stage – from project inception to completion. In the initial stage, the availability of funds, donor and receiver nation priorities, as well as lessons learned from successes and failures are considered. Unfortunately, due to change in administrations and staffing, there is often a lack of “institutional memory.” There is not a clear method for capturing the precious information and applying it to new programs. In fact, there is often a desire to put a new imprint on a program with each organizational change (see also I.C. issues above – on shifting priorities).

There is also a steep learning curve on what is a reasonable measure of success. The easiest example is confusing actions with outcomes. For instance, a measurement of how much pollution is cleaned up (for instance, pesticide dumps) is not as good a measure as determining how many people are healthier or protected (the outcome) as a result of the actions. A measure of the installation of new dams or new water supplies is nowhere as useful as a measure of how many people now have food or water security. Unfortunately, the outcome models are often the most difficult to measure – and its often difficult to determine causation due to a multiple of the factors (e.g., changes in rainfall, climate, migration of people and natural diseases). But projects need to try – and use of technical factors like mass balance can help. Economic assessment is also important (see example insert enclosed)

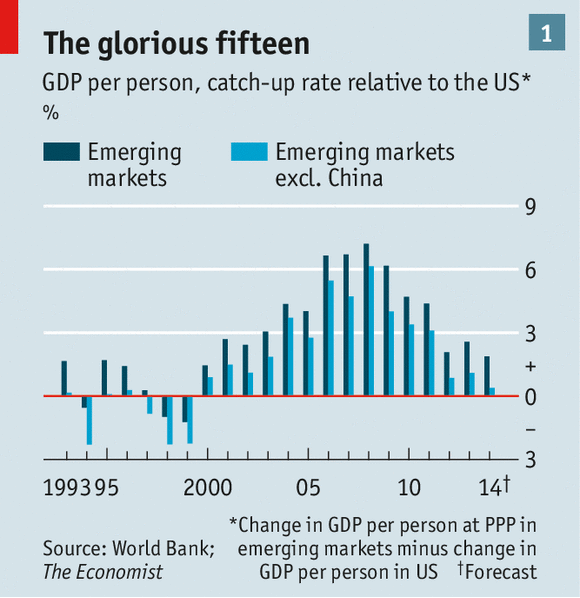
**Briefing** Economic convergence

**The headwinds return** (The headwinds return, 2014)

NOWHERE are the consequences of different rates of growth clearer than on a trip up the Pearl River Delta in southern China. At the river’s mouth sits Hong Kong, a city in which average living standards exceed those in most rich European countries. Travel farther north and you pass the container ports of Shenzhen, behind which new skyscrapers tower over a sprawling melange of housing and factories. Since its establishment as a special economic zone in 1980, Shenzhen’s economy has grown at a frenetic pace, and incomes there are now just over half of those in Hong Kong, which is similar to what you would see in southern and central Europe.

Farther north and west sits Guangzhou, capital of Guangdong province, with its newly constructed motorways and tower blocks among the rice paddies. Average incomes in Guangdong are just a quarter of those in Hong Kong, equivalent to Algeria or Costa Rica. Finally, toward the western edge of the watershed, the tributaries reach across Guangxi into Yunnan—provinces where the people have yet to get into the flow of China’s voyage of development. Incomes there are but a tenth of those in Hong Kong, on a par with those in Angola or the Republic of the Congo.

Over the past 15 years the currents that take people from such hinterlands of poverty to the broad open reaches of wealth have been flowing at an unprecedented rate. When adjusted for living costs, output per person in the emerging world almost doubled between 2000 and 2009; the average annual rate of growth over that decade was 7.6%, 4.5 percentage points higher than the rate seen in rich countries (see chart 1). As a result of that difference the gap between the developed and developing worlds narrowed quickly.



This burst of growth struck an extraordinary blow against deprivation. The share of the developing world’s population living on less than $1.25 a day (the international definition of poverty) has fallen from 30% in 2000 to below 10%, according to an estimate by the Centre for Global Development, based on new data published by the World Bank in April. Such progress nurtured hopes of more to come. Were the emerging world able to maintain a 4.5-percentage-point growth advantage over the rich world, then other things being equal its average income per person would converge with that in America in just over 30 years: scarcely a generation. Such a convergence would represent an historic change rivalled in its scope only by the extraordinary industrialisation that opened the global gaps between the rich and the rest in the first place, and completely unprecedented in its pace.

Alas, those hopes are now slipping away. An analysis of data on GDP per person which takes account of new estimates of living costs released in April by the World Bank’s International Comparison Programme (ICP) suggests that convergence has slowed down a lot.

Since 2008 growth rates across the emerging world have slipped back toward those in advanced economies. When the new ICP estimates are applied, the average GDP per head in the emerging world, measured on a purchasing-power-parity (PPP) basis, grew just 2.6 percentage points faster than American GDP in 2013. If China is excluded from the calculations the difference is just 1.1 percentage points. At that pace convergence with rich-economy incomes happens over a period of time more like a century than a generation. If China is included, emerging economies could expect to reach rich-world income levels, on average, in just over 50 years. If China is left out, catch-up takes 115 years.

The most recent 2014 growth projections from the IMF suggest the outlook is darkening further. They put the difference between the growth in emerging markets other than China and growth in the developed world at just 0.39 percentage points this year. That would put off full convergence for more than 300 years—indistinguishable from never as far as today’s societies are concerned.

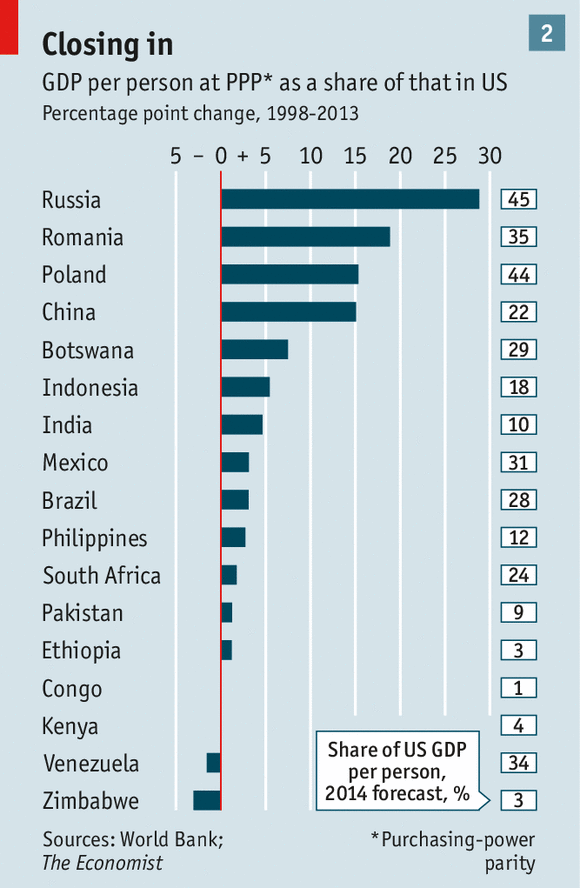
**It used to be harder**

To get the rate of convergence back up to what it was a decade ago would seem as great an economic boon as the world could wish for. But the things which made that period exceptional cannot be replicated easily, if at all. From now on simply keeping up with the rich world will prove a challenge for many. Gaining ground will require reforms that look less achievable by the day. The great expectations raised over the last half-generation look increasingly likely to be dashed.

In 1997, just before the great catch-up got into its swing, the World Bank’s senior economist, Lant Pritchett, described a widening income gap between rich and poor countries as “the dominant feature of modern economic history”. Its dominance was rendered particularly galling by the fact that orthodox economics struggled to explain it. Theories of economic growth like the one published by Nobel-winner Robert Solow in 1956 predicted that, over time, poor economies should catch up with rich ones.

In the Solow model economies were poor because their workers had access to less capital. This capital shortfall implied that the return on investment should be high, so capital should flow from rich countries to poor ones, leading the two worlds to converge on similar levels of productivity and income. The fact that the richer countries would themselves grow while this was going on complicated matters, but not too terribly. Their long-run growth, Mr. Solow reckoned, was driven by new technology which, once developed, could be adopted by poorer economies too. Indeed, the poor could potentially learn from the missteps made by the rich, and leapfrog directly to more productive ways of doing things.

The model seemed to apply well enough to the histories of then-rich countries. Thanks to its trailblazing industrial revolution, British GDP per person soared above that in other countries in the 19th century. By 1870 Britons were 30% more productive than Americans and 70% more productive than Germans. Yet this advantage disappeared as rivals improved upon Britain’s successes. By the early 20th century America had already surpassed Britain; not long after the second world war [sic] most of western Europe had caught up.



But what was true for Europe and the colonies it had created in temperate climes did not apply elsewhere. Prior to the late 1990s poor countries growing faster than rich ones were rare, and doing it persistently was rarer still. From the mid-1940s to the mid-1990s less than a third of developing economies were growing faster than the rich world at any one time. In any given economy one decade’s gains were often reversed in the next.

Some Asian economies proved to be exceptions. Japan, already industrialised in the first part of the 20th century, grew to be the world’s second largest economy. South Korea, Taiwan and a smattering of city-states like Singapore and Hong Kong also got rich. But promising bursts of growth in Africa and the Middle East in the 1960s and 1970s petered out. Crises repeatedly punctured bubbles of enthusiasm in Latin America. This dismal performance left dismal scientists feeling appropriately dismal. Writing in 1987 another Nobelist, Robert Lucas, noted: “The consequences for human welfare involved in questions like [getting poor countries to grow faster than rich ones] are simply staggering: Once one starts to think about them, it is hard to think about anything else.”

Economists tweaked their models, deploying new notions such as that of human capital to try and explain the persistent divide. Perhaps, they reckoned, it was only economies with comparable levels of investment and worker skills that converged to similar incomes, a phenomenon dubbed “conditional convergence”. Other segments of the profession explored different possibilities. Some reckoned institutions were the key. In the tropics, European colonial powers tended to impose institutions distorted by the overriding interest in extracting natural resources to which the interests and rights of the general population were secondary. Since these institutions were persistent, the legacy of past misgovernment continued to hold down incomes. Still other economists focused on geography and climate. Remoteness from economic centres and hot, disease-prone conditions could retard development.

Even as these debates continued, the world shifted beneath economists’ feet as growth in the developing world shot up from the end of the 1990s. A great deal of this was due to the rise of China as a manufacturing superpower, but that was far from being the whole story. In 2006, before the effects of the financial crisis slowed rich-country growth, emerging economies were achieving catch-up rates of more than five percentage points even if China was taken out of the mix. The catch-up experience was far more broad-based than it had been in previous growth spurts.

That is not to say the benefits were evenly spread (see chart 2). In eastern Europe and East Asia economies closed the gap at a remarkable clip, though for many eastern European countries a significant part of that growth simply reversed the contraction that followed the fall of the Soviet Union. In 1998 GDP per person in Poland was just 28% of that in America, while China’s was just 7%. By 2013 those figures had risen to 44% and 22%, respectively. Other countries made less progress. Brazil’s GDP per head was already 25% of America’s in 1998 and scraped forward just three percentage points over the next 15 years. For very poor countries even quite high growth provided little catch-up; in Ethiopia, GDP per head rose from 1.3% of that in America to 2.5%. Venezuela and Zimbabwe fell further behind.

**A perfect lack of storms**

The quality of governance and the introduction of market reforms deserves much of the credit for better performance in some countries than in others. But that pattern is superimposed on the effects of a confluence of helpful tailwinds.

One of these was a benign macroeconomic environment; in the 2000s interest rates were low and capital flowed freely. Another was rapid growth in commodity prices; many emerging economies rely heavily on natural resource exports. But the biggest push—which was not unrelated to the commodity-price boom—came from global trade. From 1980 to 1993 global trade grew at about 4.7% per year on average, or a bit more than the 3% rate of global growth. Between 1994 and 2007, however, trade grew at almost twice the rate that the world economy did. Goods exports soared to about a quarter of global GDP.

The lion’s share of this growth was due to China. During this phase of what Arvind Subramanian and Martin Kessler, of the Peterson Institute for International Economics, call “hyperglobalisation”, China’s trade became so important that it was critical not just to its own economy but to that of the world as a whole. The only previous economy of which that could be said was 19th-century Britain’s. But trade went up across the board, too.

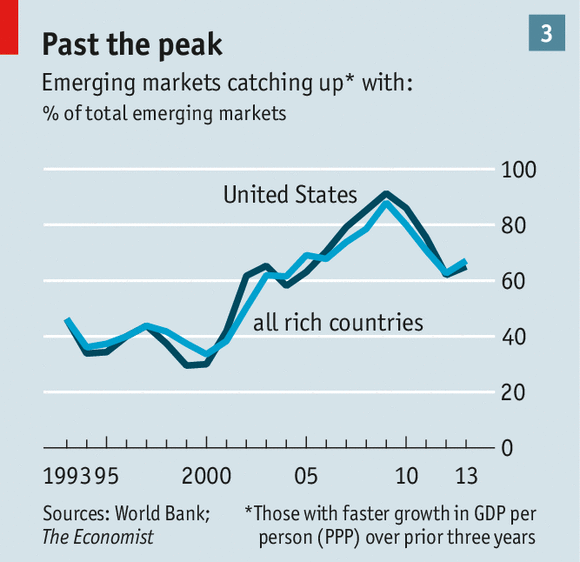
Two broad factors drove that change. Years of trade liberalisation culminated in the establishment of the World Trade Organisation in 1995, with China acceding to it in 2001. At the same time technological improvements made possible longer and more complex supply chains. By the 1990s container shipping had made transporting goods around the world easier and cheaper than ever before, and the new ports needed to add trade capacity could be built quickly and easily. Better communications, and the development of computer-based design technologies that allowed precise details of components to be easily sent from place to place, and to be changed on the fly, mean that the range of things to be shipped increased. Cheaper and easier international trade allowed supply chains that had been segregated within countries and regions to expand across the globe.

This allowed for a much faster pace of catch-up. Where Japan and South Korea needed to build industrial and technological capabilities from the ground up, more recent sprinters needed little more than a supply of cheap labour and the regulations and infrastructure required to move products quickly in and out of factory towns.

**The things manufacturing can’t make**

Since the peak of the convergence era in 2008 these tailwinds have flagged—a becalming that can be seen in the number of developing countries catching up with rich ones, which has fallen sharply (see chart 3). Chinese growth has dropped from a peak of above 14% in 2007 to just over 7% now, and this has had a knock-on effect on commodity prices. Capital flows have become more fickle over the past year as rich-world central banks reduced their interventions in the economy. Trade, which tumbled in the global financial crisis, briefly roared back in 2010 but has barely kept pace with output growth for the past couple of years.

There are also fears that rapid catch-up might have meant shallow catch-up of a sort that could never be sustained. The factors that made industrial capacity easy to build did not encourage the development of the physical infrastructure and the capacity for things like design and marketing which, when they grow up alongside manufacturing, help to anchor it in the broader economy. China and some other emerging markets used the heady catch-up years to develop underlying technological and managerial capabilities and invest in infrastructure. Others made less progress.



Growth driven entirely by manufacturing brings particular worries. Dani Rodrik of the Institute for Advanced Study in Princeton points out that, over time, the share of employment in industry at any given stage of a country’s development has declined; middle-income economies today employ fewer people in manufacturing than did middle-income economies in the 1960s or 1980s. And the income level at which an economy typically enjoys the peak share of employment in industry has fallen by almost half.

While the manufacturing sectors of developing economies can quite often come to match the labour productivity of rich-world economies, the distance towards rich-world levels of wealth that an economy can travel simply by developing its manufacturing has been falling. With manufacturing as a proportion of the total economy peaking earlier and at a lower level, emerging economies can now find their catch-up more likely to stall at disappointingly low levels of income.

The last wave of convergence may also have come close to exhausting the potential created by reform-minded and capable governments. The labour-intensity of manufacturing in India has fallen over time, despite its rock-bottom labour costs, according to an analysis from the International Growth Centre, a think-tank. That may reflect in part the continued constraints of strict labour laws, which undermine the competitive advantages of low wages. Many of the economies that benefited least from the most recent convergence wave are economic “hard cases”, where infrastructure is least developed, government is most corrupt, and basic security is a constant concern.

**Difficult, again**

There could be ways forward for those willing to take them. A new round of global trade liberalisation focused on services could touch off a new wave of globalisation. As industrial employment declines in importance around the world, development increasingly means shifting workers from agriculture into urban service occupations. Expanding the range of services easily traded across borders could enable more developing-economy workers to participate in sectors with rising levels of productivity and wages. But trade in services remains highly restricted. A club of mostly rich countries has made efforts to negotiate a Trade in Services Agreement to update an accord reached in 1995. But there has been little progress.

Efforts to simplify global trade regulations and invest in infrastructure in the world’s poorest economies could also reduce barriers to participation in global trade in places like sub-Saharan Africa. Such measures were a necessary component of the “trade facilitation” agreement negotiated within the World Trade Organisation last year. Yet that agreement is also foundering thanks to Indian opposition to agricultural rules included in the deal.

No such efforts look likely to yield anything like the commodities boom and hyperglobalisation of the turn of the century. In the absence of such stimuli, history suggests that catch-up will be a long, difficult grind, built on slow improvement in institutions and worker skill levels. The past 15 years have changed perceptions regarding just what is possible. But they also deceived people into thinking broad convergence is the natural way of things. It looks like the world is now being reminded that catching up is hard to do.

I.E. Coordinated Projects

Project coordination is generally an administrative issue and is often caused by “stove-piping” or lack of communication between administrative units. This can occur at all levels – from bureaus and offices, across units of government and between nations, as well as within donor organizations. The pesticide overlap chapter is one example, as is the dam building in Senegal and the infrastructure development in Southern Sudan. Another example is the coordination of projects on the Sebou River in Morocco – in which a well-intentioned sewage treatment plant in Fez might be disabled due to the release of waste into the river (e.g., olive oil waste).

I.F. Overarching Issues

Some issues are of stratospheric concern compared to the particular project or group of projects being implemented. These include issues such as population growth, gender issues and climate change. In some cases environmental law or other laws at least require the consideration of these issues as the project is planned and analyzed through an environmental assessment. For instance, in many cases the carbon footprint of a project needs to be considered. For other aspects, such as that of gender there are a host of specific policies within the major funding groups that require their consideration, as discussed in the work done in Burkina Faso. Population growth is almost the third rail of a project and is almost never considered – in fact, it can mean the end of a consultancy as discussed for the Malaria project in Malawi.

Climate change is an important emerging concern that can be highly beneficial to a project. If a way can be found to meet the aims of the project – better education, new infrastructure, more food security, etc., then many aspects of climate change consideration can improve a program. During the 1960’s and 1970’s there was a big push for energy efficiency – President Carter described it as the next major war to gain energy independence and efficiency. While there were many negative reactions to the idea, and the ways in which it was implemented, several years’ later industry recognized that it has helped them to identify energy inefficiencies in an operation. In the end, investments in more energy efficient operations improved their financial bottom line – and also improve what is now also recognized as a bottom line of being better corporate citizens with respect to the environment (the triple bottom line). Certainly there is the continuing concern that a push for energy efficiency or, in this case, for help with aspects of climate change, can add costs to an operation – costs that might be used for other aspects of the program. As discussed earlier, the proper role for government, it can be argued, is to help bear the higher expense in the short term in order to recognize savings in the long term. And since these projects are often government supported, or even in the cases where they are private, this seems a proper role.

Climate change issues go far beyond energy efficiency. There have been major debates over other aspects, including preserving or planting new forests, changing agricultural practices, and limiting per capita demand, through many programs such as mass transit, low impact development and other programs (discussed further in the section on Cities). Therefore, consideration of issues such as climate change meets the criteria of balancing environment with economic and engineering considerations.

I.G. Balancing the three E’s: Economic, Environmental and Engineering considerations

A major theme throughout the book has been an attempt to balance economic, environmental and engineering considerations. On the face of it, this seems a somewhat obvious consideration today – given that there has been a major focus on adding the environmental considerations to a project. It should be remembered that environmental in this context also means human aspects of health, socioeconomic concerns, living conditions and even transportation. This kind of consideration can also be, of course, a strong aspect of a project aim. The difference, or particular aspects of this consideration, is that it may require a project to look more deeply into the root cause of a problem. For instance, will a road project really solve a transportation issue? Or is there a strong need to tie in consideration of production? Where are natural resources and people located? Is there already congestion in the area? Several years ago, for instance, we looked at a new fishing project in Vietnam – and it seemed straightforward to support the fishing industry, which was already a strong section in that culture. But if the fishing port had no refrigeration, processing facilities or transport to market, it would not work. Going even deeper, what is the likelihood that there would be sufficient stocks of fish to justify the expense of building these facilities? Would aquaculture be a better project? Should the project be located in a new place? What would the project do to the socioeconomic structure of at least that region?

Thus, a balanced approach seems a vital part of project planning. We have already seen many aspects of times that it was not considered – for instance, the Bignona River dam in Senegal. Or times when gender issues (that were connected with education and health of children) might lessen the success of a project in Burkina. There were also success stories, such as improving basic construction skills in Senegal, looking at many aspects of pesticides use in 8 countries, and attempts to balance massive water pollution control projects in Indonesia.

Environmental economics is also important in trying to balance short-term and long-term costs associated with a project. What projects have been successful in lifting up poor people and providing better food security? Certainly adequate health programs are important – but they need to be balanced with concerns about how there will be adequate resources to support these populations (see I.F.). It is my impression that some of the greatest success – as measured in terms of “bang for the buck” has been the many grassroots programs, such as the Nairobi sanitation. Other remarkable examples have been the success of micro-lending programs that have encouraged the growth of textile industries in Indonesia, as well as the many programs supported throughout India and Pakistan.

Economic considerations would not be complete without mentioning the debate about who to support within a country. Traditionally, much of the foreign development money has gone to the government of a nation, which would then oversee the project and disperse the funds. Alternatively, a project was implemented on behalf of a nation by the donor, who would provide their own team – or at least management – of the project. By contrast, non-government organizations (NGOs) or non-profit groups have been making grants to other NGOs. In some cases there have also been crossovers. While it is not clear which approach is the most effective, it certainly should be considered when planning an aid program.

Within the realm of engineering considerations, I have illustrated at least two examples of how integrating the three E’s can potentially lead to remarkable results. In the work in Sri Lanka, by asking the global question about how sulfur was used in the country, we were able to identify ways in which there could be a win-win solution of cleaning up sulfur in oil (and avoiding associated problems), saving money in foreign balance of payments (by not needing to buy sulfur in the work market), and avoiding the need for new power plant construction (by better maintenance of the existing facilities). In the second case we discussed how a consideration of the mass balance for water in Morocco saved the expense of new dams in the Atlas Mountains, and also led to better use of water in the major river of Fez, as well as some better control of water use in the agricultural section. The time it took to develop these analyses resulted in savings of potentially tens of millions of dollars or more on an annual basis.

The balance between these aspects may be important, but the implementation of this idea is not always obvious. These are difficult analyses, and may take some careful consideration. This cries out for the use of specialists or even creation of an office that is responsible for helping to think through the issues.

I.H. Role of Project Funding

This consideration is of increasing importance, as there is an increased need to leverage funds. Both through my work in private industry and with government projects, it is clear that one of the real gaps in funding of projects are the initial funds needed to get a project moving. In many cases there is the worry that the money may be wasted on an untried project or approach – but I submit that this is a risk worth taking if a project seems reasonable within the framework of the donor group. One of the strongest insights I gained as a person responsible for supporting over $ million/year in research projects is that it’s almost impossible to predict which projects will lead to long-term successes. This is also clear by looking at the awarding of Nobel prizes, when it was not at all clear that a certain line of research started thirty years’ ago would lead to a major breakthrough in science, economics or medicine. Therefore, it appears appropriate that at least some of the project funding budget of an organization be used to support somewhat speculative or uncertain projects – especially if they are relatively low budget.

The major criticism of this type of funding is that they are hard to oversee – an old rule of thumb was that a manager could only oversee about a million dollars in projects – or perhaps now more than six or seven groups. While this may be true, the use of project evaluation teams, developing public-private partnerships and many other aspects can help to leverage the resources needed to oversee these projects.

And other criticism is that if budgets are spread too thin they lose cohesiveness and not much progress is made in certain research areas. This is valid and needs to be protected by having realistic program objectives – the distinction that was already made in measures of success. Projects that specifically address these objectives then have a great chance of success.

Finally, another important consideration is the review of proposals or potential projects – which is typically done by committee in an organization. This is often supplemented through a peer review process. While there is not enough space to go into details in this, it should be noted that there are increasingly big concerns about that process. On one hand they are not seen as avoiding project frauds and improper data (ref), while on the other hand they are seen as usually employing groups of “old boy clubs” that want to fund traditional projects along the lines used in the past, and avoiding projects that are in areas unfamiliar to them.

II. Technical/Analytical Principles

II.A. Programmatic assessments.

There has already been extensive discussion of this topic in previous chapters and it is hoped that there has been adequate explanation of both the technique and the success of its application. The reader is specifically referred to the discussion of programs in the Ivory Coast.

II.B. Mass balance.

Mass balance has been a major concept discussed in many pervious chapters, particularly on Morocco and work in Senegal and the reader is referred to these chapters.

II.C. Natural resources and food security.

From my perspective, tools such as mass balance go a long way towards helping to define issues related to the sustainability of natural resources and to help decide whether a project will indeed improve food security. As discussed in previous chapters on rice production in Senegal, for instance, many projects that are intended to improve productivity of agricultural resources can lead to a decline in food productivity from aquatic resources or other trade-offs (such as natural resources as discussed in Burkina Faso). These trade-offs may be direct – in draining a wetland that is a nursery to fish resources or indirect, in taking water from a system and using it for irrigation and reducing water in rivers. None of this is intended to be a value judgement – just a piece of information that is designed to inform the project designer of making decisions in terms of priorities in a project. We also saw this type of trade off, discussed in the chapter on Sri Lanka, when the government was given a choice of two locations for their power plants – one that was cheaper and better from an engineering and perhaps economic perspective, but had environmental issues; and a second site that avoided the environmental issues but was more expensive. In that way, a clear choice could be made about how to move forward with a project design.

In a similar way, there are so often indirect impacts associated with a project and there is a need to consider whether, for instance, building a new school complex (which appears to be benign environmentally), can add new population pressures that could result in deforestation. But if, to the perspective we add the dimension of how deforestation is considered, and, for instance, it may be due to the production of charcoal, a project might add another component of giving available or making available in another way charcoal and then the project becomes a win-win solution.

Some of the most difficult trade-offs with respect to natural resources are power projects. We have already discussed in great detail some of the considerations in designing traditional power projects versus renewable programs. Again, the major consideration is whether the project designer and user are comfortable with new technologies – and see a benefit from moving in a new direction.

Finally, the reader is reminded that food security comes in cycles. The green revolution in Africa, in which new types of grain were introduced, allowed rapid growth of populations and a wonderful improvement in food availability for impoverished people. However, sooner or later, population size catches up to this technical fix. In order to have a sustainable food security both the availability of food (and water!) and the demand for this – from either growing populations or increased per capital demand/consumption (i.e., the need for more resources per person) need to be considered.

11.D.Water, energy and transportation resources.

While this factor can be considered a subset of 11.C., above, these resources are so important that I have called them out separately. It is suggested that there be an individual consideration of each of these factors to be considered and then there also be a second, higher level analysis of how these factors are related. There are many interrelations in all three areas – in fact, transportation, for instance, may utilize as many resources as energy or water programs. And, of course, transportation is vital for economic success of projects to bring goods to market.

II.E. Balance between resources to cities versus rural areas.

As for much of the world, there has been a huge shift of populations from rural areas to large cities. Despite this, in so many of the international development projects there is a policy emphasis on improving underdeveloped rural areas. Very few projects have been focused on the particular problems in the cities. Again, if this is a conscious policy decision, and it meets with the goals of the user nations, it only needs to be considered explicitly. However, it appears in many ways that there has simply been the inertia of how projects have been done in the past, rather than considering whether this policy needs to be revised.

If one considered the bang for the buck arguments, projects in cities have the potential to improve the lives and food security for a large number of people. At the same time one needs to consider a balance in both approaches. Perhaps mid-sized villages are the optimal size unit. Certainly in the developed countries the small business (which may be in the city and also in other locations), are the strongest forces behind economic growth. Thanks to new communications, particularly cell phones, there is, of course, the potential to have seed projects cross-fertilize between large cities and more rural areas much more easily.

II.F. Preventing problems.

While it may seem naïve, the idea of preventing problems by facilitating relatively cheap solutions to emerging problems can be so much more cost effective than some other projects. There are so many opportunities, such as in health projects to avoid serious diseases before they develop from more minor ailments. The same is true in avoiding the overuse or inappropriate use of pesticides in agricultural projects. In water projects it can be the balance between where water is sued and places where it may be needed. There are, of course, no illusions that there are sufficient water resources in locations in Africa, at least over an annual cycle, but again, the prevention-based projects are generally much cheaper and are good candidates for a project mix.

II.G. Role of new or future technologies.

Technology is almost always seen as the solution to development issues. If only there were more power, more water, more natural resources that could be reached with new technologies, the economy of a country might be improved. However, in a global marketplace technologies must compete on a global level. So there are many good economic rationales for using newer technologies in international development projects. The argument against their use is that they may not be appropriate for the developing country to maintain the new technology, and there may not be a workforce trained to sue them. In addition, some argue that low technology solutions are more than adequate to address the base level problems in these countries. So obviously there is the two-pronged solution of combining education and job development aspects of a project with the introduction of potential new technologies. These types of hybrid projects certainly have the potential for a large payback.

Another aspect of this issue is that older technologies, such as relatively low efficient energy devices, including older cars, simply add to the future problem of cleaning up the air and water pollution associated with them. And they demand much greater availability of energy to support them. Once again, it might be argued that the policy aim of the international development projects would be to balance the funds available to overcome the short-term expense of introducing the new technologies and training the workforce.

The cultural aspect of one country telling another “trust me, we have been there and made this mistake, and want to help you avoid this” is often rejected as closeted colonialism and interference with national independence. We have already visited this question in great detail with respect to population issues. The same can be true in so many agricultural and health programs. When a case is made not to use a specific pesticide, for instance, the receiving country may argue that it may not be an ideal solution, but it is needed badly and is all that is available (shades of best being the energy of the good!!!). This kind of response can be frustrating for the donor. The key to the issue is communication and dialogue, to see if both perspectives can be accommodated. Certainly it can be argued that the donor represents a person who is putting a gun to the head of the receiving country and saying either take it on my terms or not at all, so there needs to be a way to deal sensitively with the issues. There is also the danger that a project may be funded by a different group that may be more sympathetic to the receiving group and that the new donor may be less concerned with the problems identified by the first donor – and we are back to the issue of whether it is better to try to find a good solution to a problem by working within an organization (for instance, mitigate potential issues) or whether to push externally.

II.H. Use of appropriate technologies.

Again, I have chosen to specifically call out this factor, which I have discussed within the context of water and transportation projects (II.C.). Thus, if an infrastructure project is envisioned, there is the full consideration of appropriate scale projects. For instance, in the Senegal project, one of the big issues becomes, with respect to the low head dams, was what size gate to put on the dam. Should it be a local material gate and one that can be managed at the local level (not too heavy, need too much maintenance)? Or should we take advantage of larger gates that would allow more control over the structure? In a similar vein, in the Senegal project, we provided up-to-date computers for the program and there were people who were well-trained to operate them. And we offered a set of seminars to show new software. But that part of the project failed because there was not enough electricity to keep the computer room air conditioned – and avoid the dust that disabled the computers.

Another major aspect is the total size of a project. There has often been a preference to develop large-scale projects in the past for infrastructures, and more recently for health and education. But so many times small-scale projects, or large projects broken into smaller components can be so much more helpful to economic growth of a country. These smaller components may also need less capital-intensive equipment. And so many times a large scale project may not be manageable within the capacity of the host country. As with Indonesia, for instance, there were so few trained people in environmental chemistry and operation of equipment that these technologies needed to be scaled back and there was the need for a large training component.

II.I. Best not enemy of good.

As a last factor to consider, it is a common tendency to try to define the best project possible for a situation. Then projects may be constrained by budgets, political considerations, and a host of other issues. Very often international development projects involve coordination with other donor groups and the important consideration of political and economic issues in the host country. For instance, the Morocco projects on the Fez river involved a sewage treatment facility funded by the World Bank, a host of dams and clean-up projects funded by the French and a much smaller project on olive oil waste funded by the U.S. In each case, in a manner of speaking, the first project was funded on faith that the next project would work. It was clear that there would not be perfect coordination – and in fact, the World Bank project would not work well unless the pollution associated with the olive oil waste would be controlled. But it might be agreed that at least a “good” project was in place – it was moving forward, included need elements and was an acceptable program for all the involved parties. It was also a good example of a multi-national cooperation project.

By contrast, in the short term, the South Sudan water project decided to sue an international standard for water to be delivered to households. This was the “best” standard – it is agreed that this is the ideal “best” standard for assuring healthy water. But, in my opinion, it was an unrealistic standard under what was essentially an emergency situation. Hundreds of thousands of people needed water – at least some delivered to their area in Juba (the capital city). I refer to this as the “good”. Using the international standard, perhaps, at “best”, only a thousand folks could get water. While it can be argued that the policy was right, and people in South Sudan deserve the same health standard as people in the developed countries, this “best” standard was indeed the enemy of the “good”. Too many people were left without water at all, so that a small group could get the best water. I submit that this was not a good trade-off.

The concept of the best being enemy of the good often leads to a paralysis in project design and implementation. We all want the best project, but more typically we have to design the best project we can under the circumstances and within the constraints at a particular time. Thus, we try to make the best decision we can at the time under the real world situation. When in doubt, it may indeed be best to at least start the project tin a smaller pilot scale, rather than abandoning a project or program just because it cannot be done in an ideal way.

CHAPTER 17: PARADIGMS FOR ENVIRONMENTAL POLICY

I have already mentioned that the goal of international development is to balance economic, environmental and engineering considerations in projects that benefit the recipient country and satisfy the political and other concerns of the donor country or group. One of the bedrock principles is to try to assure that the project contributes to the long-term sustainability of both the project and the receiving country. There has been much written on the concept of sustainability and many might say that it is an overused word at this time. For instance, how is sustainability of measured? Over what period of time? How do you account? Is a period of 30 years too short to be sustainable (for instance, the water associated with oil in Cha/Cameroon). Or do we just need the potential for a project to be able to continue on its own after an 8-year period of cooperation and training (see Senegal dam and rice project)? How do you take into account the rapidly changing technology that might make a project obsolete very quickly?

Probably most importantly, who gets to decide about priorities in the development projects, given that the donors want to have the sustainability, but the developing countries not the acute problems with abject poverty, lack of water, food security and poor healthcare. How can you address these matters while putting them into a long-term planning context that considers sustainability? On top of that, at least for Africa, is the question of pressure on resources due to rapidly growing populations (as we discussed in the context of the Ivory Coast project).

We have also discussed in the Ivory Coast chapter the idea of two world views – that of the first that considers that there are plenty of resources, but that they need to be better distributed – most basically through better economic management. This is often called the Cornucopian approach. The second view, sometimes called the Malthusian view, sees that resources are limited, and the policy is to use only what is needed for the present generation, and leave sufficient resources for the future. This leads to the idea that forests, water, energy, etc., should be managed in a sustainable manner – which might indicate the use of renewable resources (as discussed in upcoming Chapter X). But donor nations note correctly that all of the developed nations used resources in a non-sustainable manner in order to become developed and that all those resources might be needed to allow Africa to move past these acute stages of development. It has been said that sustainability is the luxury of the rich countries and cannot work in the developing country.

So how do we reconcile these different paradigms – the need for perhaps rapid results, directed perhaps by the needs and desires of the developing country, but the hindsight observations of donor nations and organizations on the need for sustainability? How do we adjust priorities, within a limited economic situation? One group has attempted to do that (see topic example by Mr. Ridley) and claims that a discreet set of projects can be the most effective “bang for the buck”. Their top three of to reduce malnutrition, tackle malaria and tuberculosis, boost pre-primary education, provide universal access to sexual and reproductive health and expand free trade. They dispute that some topics like renewable energy, many agriculture programs or XX are appropriate. They also leave out what I observed to be a primary building, that of better communication systems, not the least of which has been all that wonderful cell phone technology. I applaud this type of approach to try to put in place lessons learned on what has worked and what has not worked – and how we can do better in the future. Perhaps these types of projects are the proper answer, but there are so many details that need to be considered as well – I saw corruption at all levels of the programs, less than stellar management from both the donors and the receivers, and that yawning gap between the upper group of the societies and the rest. I have also mentioned misgivings that solving a problem in malaria areas may mean that people attempt to manage natural resources in a better way than nature (see Chapter 3).

Each donor group will have to consider within the text of their priorities, capabilities and budgets and within the appropriate political framework, what programs work for them. The Ridley pieces do an excellent job of linking issues such as family planning with disease control and perhaps indirectly food security. It is inevitable, and perhaps appropriate that donors will put considerations on their funds. But then again, perhaps working closely with the recipients (working internally) on a program together can be more effective than fighting actions that may be taken by that country in receiving funds from groups that do not have the same policies and/or procedures and, as we see it in the U.S., the same concern for balancing environmental, economic and engineering considerations. One thing is for certain, that at a time of global economics, that there is a far quicker and sometimes Draconian response to changes in the developing countries and there is even a great need to coordinate efforts.

In another context, Chapter XX, I discuss as an example the lack of coordination on the use of pesticides for agricultural and health concerns. Within the chapter we have the same kind of problem on a much bigger stage – there needs to be much closer coordination between donor nations or organizations. I have seen that the major area, say Asia, Africa. The Americas and Europe do not seem to coordinate their answers and share their results with each other – certainly that was my experience in seeing rice production projections that worked in Asia, transplanted to Africa without appropriate changes. (For instance, incorporating the growth of fish in the rice paddies to eat the insect disease vectors.)

So I leave the reader with the challenge on how to best consider within their organization how to do the most good for the most people. We all seem to be able to agree on some of the problems, but often disagree on the solutions, due to political and policy considerations. It should also be noted that I see much of this as art as a science. Artists have typically been instrumental in moving a society forward, making them aware of major concerns and issues. As leaders ponder these matters they might also consider inviting a broad spectrum of views on what is best – views that certainly consider the economists, scientists, engineers and environmentalists, but also art, faith and culturists

Smart Aid for the World’s Poor

How can rich countries best help poor ones? Matt Ridley identifies five priorities that provide the biggest benefits for every dollar spent. Mr. Ridley is the author of “The Rational Optimist: How Prosperity Evolves” and a member of the British House of Lords.

In September next year, the United Nations plans to choose a list of development goals for the world to meet by the year 2030. What aspirations should it set for this global campaign, to improve the lot of the poor, and how should it choose them?

In answering that question, U.N. Secretary-General Ban Ki-moon and his advisers are confronted with a task that they often avoid: setting priorities. It is no good saying that we would like peace and prosperity to reach every corner of the world. And it is no good listing hundreds of targets. Money for foreign aid, though munificent, is limited. What are the things that matter most? And what would be nice to achieve but matter less?

The origin of this quest for global priorities goes back to 2000, when Mr. Ban’s predecessor, Kofi Annan, picked a set of “Millennium Development Goals,” eight challenges to be met by 2015, which were adopted by world leaders. Although some of these goals were woolly, the very brevity of the list and the deadline itself meant that they really did catch the world’s imagination and force the aid industry to be more selective.

Most of the original Millennium Development Goals will have been met or nearly so by 2015. Since 2000, for example, the number of people living in extreme poverty and hunger around the world will have been cut in half – an astonishing achievement. Other goals included universal primary education, gender equality, reductions in infant mortality, improvements in maternal health, progress against HIV and malaria, environmental sustainability and (most vaguely) a “global partnership for development”.

The lesson, surely, from this first round of setting development goals is the need to be even more ruthlessly selective next time. A list of eight goals is too long for most outsiders to remember. When I asked several of my colleagues in the British Parliament, they remembered only three-to-five. Several development experts I spoke to say that the new list should have just five discrete, quantitative, achievable goals.

Only Mr. Ban can make that happen, says Charles Kenny, a senior fellow at the Center for Global Development in Washington, D.C., who observes that you should “never ask a committee to write poetry.” Mr. Kenny told me: “There is one person who can bring the poetry. The U.N. Secretary-General has to edit down with an axe, not a scalpel. Without strong intervention from Ban Ki-moon, there is extremely limited prospect for simplification.”

So far, however, the process of deciding on the 2030 goals is short on poetry. There is not just one committee on the job but several – the most prominent of which is called the Open Working Group, or OWG, which has already been meeting off and on for more than two years. The OWG “stream” – and keep in mind that other U.N. groups are also producing streams of their own – has so far managed to whittle its list of possible targets down to 169. It is an absurdly long list, and each time the results of its deliberations are published, every pressure group checks to make sure its favorite goal is still in there and makes a fuss if it is not.

What Mr. Ban needs is an objective way of paring down the list. In doing so, I would recommend to him an unlikely ally: Bjorn Lomborg, a T-shirt wearing vegetarian, Danish political scientist who shot to fame in 2001 with a book called “The Skeptical Environmentalist”, which infuriated those who support environmental protection at all costs, including the welfare of the poor.

Mr. Lomborg is the founder of an international think tank called the Copenhagen Consensus Center. He has invented a useful method for dispassionately but expertly deciding how to spend limited funds on different priorities. Every four years since 2004, he has assembled a group of leading economists to assess the best way to spend money on global development. ON the most recent occasion, in 20012, the group – which included four Nobel laureates – debated 40 proposals for how best to spend aid money.

The goal was simple: to create a cost-benefit analysis for each policy and to rank them by their likely effectiveness. For every dollar spent, how much good would be done in the world?

The Copenhagen Consensus Center process has won worldwide respect for its scrupulously fair methods and starling conclusions. Its 2012 report, published in book form as “How to Spend $75 Billion to Make the World a Better Place” came to the conclusion that the top five priorities should be nutritional supplements to combat malnutrition, expanded immunization for children, and redoubled efforts against malaria, intestinal worms and tuberculosis.

Their point wasn’t that these are the world’s biggest problems, but that these are the problems for which each dollar spent on aid generates the most benefit. Enabling a sick child to regain her health and contribute to the world economy is in the child’s interest – and the world’s.

The numbers produced by this exercise are eye-catching. Every dollar spent to alleviate malnutrition can do $59 of good; on malaria, $35; on HIV, $11. As for fashionable goals such as programs intended to limit global warming to less than two degrees Celsius in the foreseeable future: just 2 cents of benefit for each dollar spent.

Nor is this just about the cold tabulation of dollars and cents. The calculus used by the Copenhagen Consensus also includes such benefits as avoided deaths and sickness and potential environmental benefits, including forestalling climate change.

The Copenhagen experts use strips of paper on which are written different priorities along with cost-benefit ratios, and they are invited to move them up and down as they debate the academic evidence. In setting priorities, they also take into account the feasibility of scaling up interventions and the risk of corruption.

Of course, when the U.N. is contemplating its choices for the next set of global development goals, cost-benefit isn’t the only criterion. In South Africa, for instance, HIV is a much bigger problem than malaria, so different regions will have different concerns. But ranking the interventions does concentrate the mind.

Surprising as it may seem, the global-aid industry has rarely done such cost-benefit analysis. People in this line of work generally recoil from such rankings as a heartless exercise implying discrimination against still-worthy global goals. The aid industry often seems implicitly to take the view that funds are unlimited and that spending on one priority doesn’t crowd out spending on another. But this is patently not the case: The problems are far bigger than the available budget and will remain so even if the world’s rich countries ever meet their 35-year-old goals of spending 0.7% of their GNP on development aid.

In December last year, Mr. Lomborg came to New York to address the U.N. Open Working Group’s ambassadors directly. He handed them his strips of paper and asked them to put them down in preferred order. It was an eye-opening exercise in a place where people are accustomed to saying, in diplomatic earnest, “Everything is important.”

Then, over eight days in June, Mr. Lomborg got a group of 60 leading economists to work through all the OWG’s putative development targets for 2030 (there were more than 200 of them at the time), making a quick assessment of which were good value for money. The result, now available online, is a document that assigns a color code to each target: green (phenomenal value for money), pale green (good), yellow (fair), gray (not enough known) and red (poor).

At the conclusion of this process, the group had 27 “phenomenal” green values and 23 “poor” red values, with all the rest in-between.

Champions of aid aren’t used to having their homework marked in his stark fashion, and some didn’t like it at first. As Ambassador Elizabeth M. Cousens, the U.S. representative to the U.N. Economic and Social Council told Mr. Lomborg, “I really don’t like you putting one of my favorite targets in red.” But she added, “I’m glad you’re saying it, because we all need to hear economic evidence that challenges us.”

Having gone through this useful document myself, I found myself in full sympathy with those forced to choose among them. But at least this sort of analysis provides some rigor and direction.

What would my own list of five 2030 goals look like, based on the work of the Copenhagen Consensus Group?

1. **Reduce malnutrition.** When children get better food, they develop their brains, stay in school longer and end up becoming far more productive members of society. Every dollar spent to alleviate malnutrition brings $59 of benefits.

**2.** **Tackle malaria and tuberculosis.** These two diseases debilitate huge populations in poor countries, but they are largely preventable and curable. In the most harshly affected countries, two people of ten do one person’s work because one of them is sick. Benefit to cost ration: 35 to 1.

3. **Boost pre-primary educations,** which costs little and has lifelong benefits by getting children started on learning. 30 to 1.

4. **Provide universal access to sexual and reproductive health,** which would save the lives of mothers and infants while enabling women to be more economically productive. It would also lower birthrates (when fewer children die, people have fewer children). Benefits could be as high as 150.

5. **Expand free trade.** This isn’t considered sexy in the development industry, and it may seem remote from humanitarian issues, but free trade often delivers phenomenal improvements to the welfare of the poor in a surprisingly short time, as the example of China has demonstrated in recent eyars. One of the discoveries of the Copenhagen Consensus process is that incremental goals such as expanding free trade are often better than supposedly “transformational” goals. A successful Doha Round of the World Trade Organization could deliver annual benefits of $3 trillion for the developing world by 2020, rising to $100 trillion by the end of the century.

The development goals of least value, according to the Copenhagen process, include the self-contradictory call for higher agricultural productivity with less environmental impact. Other bad investments are less obvious but would actually hurt the poor. For example, equal access to affordable tertiary education may sound good in principle, but in many developing countries, it amounts to a policy of having the mass of poor people pay for the college education of the rich. Other goals – such as “sustainable tourism” – are simply too narrow and ill-defined to merit consideration on a list of urgent priorities.

One much-favored goal in the list generated by the U.N.’s Open Working Group comes out especially badly: the idea of providing gender-disaggregated data to help women. Not only do we already have much of the data (and it is very costly to gather more), but how, say the Copenhagen experts, would you define the gender-disaggregated value of a cow owned by a family of five?

Those who fear that the rankings reflect Mr. Lomborg’s own prejudices will be relieved. He convened the economists, to be sure, but they are the ones who did the color coding.

Mr. Lomborg accepts the basic conclusions of today’s climate science, but he is known to be skeptical about many current policies to avert climate change. Still, the experts he brought together conclude that phasing out fossil-fuel subsidies as a “phenomenal” value. They also find excellent value in programs meant to develop resilience and adaptive capacity in response to climate-induced hazards.

But they judge it poor value, for the world’s poor, to attempt either to double the share of renewable energy in the global energy mix or to hold the increase in global average temperature below a certain level in accordance with international agreements. This is because the experts think that allowing emissions to rise initially while investing in rapid advances in energy technology is a much better idea than trying to limit emissions now with today’s expensive renewables.

Indeed, one of the world’s most pressing health problems, and the one most conspicuously missing from Mr. Annan’s original development goals in 2000, is the annual death toll of more than four million people due to indoor air pollution. This enormous, abiding problem is attributable to the fact that so many of the world’s poor lack access to affordable (that is, fossil-fuel-generated) electricity and therefore cook over burning wood or dung.

This most recent exercise by the Copenhagen Consensus was, Mr. Lomborg admits, “quick and dirty,” intended to catch the attention of the Open Working Group before it wraps up its work for the summer. But in the coming months, Mr. Lomborg’s group will publish thousands of peer-reviewed pages, describing costs and benefits for all the most important U.N. targets. With the help of three Nobel Laureates, the group will produce a definitive report with ranked priorities and deliver it to the U.N.

Figuring out the best way to help the world’s poor isn’t like solving a math problem. There are not right and wrong answers. But there are better and worse answers, and the only way to assign those priorities is to set aside our sentimental commitments and do the hard work of assessing costs and benefits.

See some of the Copenhagen Consensus Center’s rankings of global development goals at WSJ.com/review.

CHAPTER 18: ECONOMIC ASPECTS

(TBD)

CHAPTER 19: PESTICIDE OREG LAPS

This chapter is a highly technical discussion on the use of pesticides in foreign aid programs in Africa. It gives the reader an idea of the level of detail and the amount of research that may be required to develop environmental policy and make decisions about financial contributions to a program. While it may be too detailed for many readers, who are then invited to continue on to the next chapter, I believe its main point may be clear. The programs developed to control insect pests on crops, and the programs developed to control disease vectors (which are usually insects) have not been coordinated and result in an almost constant rain of pesticide applications in the places documented – the lands of Mali and areas near the Niger River. Each of the programs are well-meaning. The agriculture programs are trying to prevent damage to crops from insects and weeds. More specialized programs also attempt to eliminate more occasional pests, such as locusts and grasshoppers. The health programs are targeted at some specific diseases, such as River Blindness (Onchocerciasis) and malaria. Depending on the specific types of villages and the specific types of crops, spraying of pesticides appears to occur almost monthly.

Their impacts are not well-documented. Given the types of materials used it would be expected that there can be severe impacts on ecosystems, and perhaps loss of many resources in the aquatic systems. This may or may not be justified by gains in the terrestrial systems. Certainly, improvements to human health have been dramatic with the Onco programs. Malaria control is less certain. And the overall goal of improving livelihoods still lacks documentation, although growing populations would indicate improvements in food security.

(Maps and texts of rest of chapter will be inserted from separate manuscript when available)

Unedited old manuscript follows:

**PATTERNS OF PESTICIDE USE**

**IN MALI, WEST AFRICA AND**

**ITS ENVIRONMENTAL IMPLICATIONS**

[Pesticide patterns in Mali]

by

Patricia Peckham and Jon C. Cooper[[1]](#footnote-1)

Keywords: Africa, pesticides, protected resources, agriculture, population risk

**ABSTRACT**

Mali is an example of a nation with concurrent use of pesticides, where there is little or no coordination between the various agencies which use chemical pest control. Pesticides are used both in internationally-sponsored and national agricultural programs including agricultural programs, pest control programs for special problems such as locusts and grasshoppers, and insect vector control in health programs. This study examines overlap of pesticide use into environmentally sensitive areas. These areas, already stressed from natural pressures of drought and desertification, are especially vulnerable to the additional pressure from the toxic effects of pesticides.

Mali has increased its productivity by more development and irrigation projects and an increased yield on already cultivated lands. Pesticides are used in irrigation projects to help control insect borne diseases. Pesticides are used to combat agricultural pests, particularly cotton, ground nuts, millet, sorghum and rice. Rice is considered a moderate to high user of pesticides, and cotton production requires both large quantities of pesticides and frequent applications; this trend of pesticide consumption for cotton is increasing and is expected to continue.

The regions of Mali most affected by the use of agricultural pesticides are the south central regions of Mopti, Segou, and Sikasso. Pesticides are generally applied during the wet growing season of June through December. Irrigated areas may encourage dry season application for their off‑season crops. Pesticides are used without regard for the seasonal vulnerability of the non‑target biota. Pesticide application during the‑early life stages, breeding, and reproductive seasons of nontarget species can have a negative affect on their populations.

Mali also uses pesticides for grasshopper/locust infestations. About 15% of all agro‑pesticide consumed in Mali are for this program. Organized under the umbrella of the Crop Protection Service of Mali, many international donors help with this campaign. The zone of grasshopper infestation runs centrally west to east across Mali, from the 14th to the 17th parallels The cercles (political divisions) with the highest concentration of pesticides wed for the campaign year 1989 were Mopti and Niono. The four cercles with the most hectares sprayed were Nioro du Sahel, Yelimane, Gossi, and Mopti. The application of pesticides for grasshopper/locust control is from May through December.

Another special agricultural program which uses pesticides is for granivorous bird control. This program is located primarily within the cercles of Niono, San, and Nioro du Sahel. There have been reports that the spraying of roost sites for the pest species have resulted in kills of nontarget birds in the area as well as secondary poisonings among the predators.

Insect borne diseases to humans are controlled by pesticides in Mali, including the Onchocerciasis Control Programme (OCP) in southern Mali; pesticides are put into the river systems to kill the blackfly larvae. The OCP has an environmental monitoring program which has been monitoring the effects of its program on a regular basis. Other vector borne disease endemic to Mali are malaria, schistosomiasis, and trypanosomiasis.

Sensitive areas affected include the important habitats of the Inland Delta of the Niger River, an important habitat for both residential and migrant birds, the national park system of Mali (through agricultural activities). Pesticide overlap appear to occur in these areas. For instance, the Mopti region within the Inland Delta is sprayed for pesticides from both the agricultural programs (primarily through the high pesticide use in the cotton crops) and locust/grasshopper programs. Pesticides used for vector control are also present.

Mali is an example of a developing nation facing choices as it struggles to improve itself. The problems from the impact of pesticides should not be separated from the other ecological problems of desertification, son loss, loss of biodiversity, drought, and its growing population. Establishing national guidelines for pesticide use might mitigate some of the stress upon Mali's environment. A national policy on pesticide use would provide guidelines to mitigate the toxic effects of pesticides on the ecosystems of Mali. No policy can be implemented if there is a lack of coordination among the pesticide programs.

**1.0 INTRODUCTION AND BACKGROUND INFORMATION**

**1.1.1 Introduction**

The objective of this paper is to document the patterns of pesticide use in Mali, a developing country in the Sahelian region of West Africa. We then examine the implications to environmental impacts and public policy for this country, especially as they affect the overlap of pesticide use into environmentally sensitive areas.

The Sahel, located on the fringes of the Sahara desert, has a fragile ecosystem which has been increasingly stressed from both natural and manmade influences. Since 1968, every seasonal rainfall has been below normal and severe drought has occurred periodically (IUCN b 1989) . Populations in this area are increasing and the nations must plan to develop ways to improve their agricultural yields and improve the health conditions.

Pesticides are used in these nations for agriculture, health, and special programs (such as control of locust/grasshopper and granivorous birds). These chemicals are usually controlled by different international and national agencies, often with little or no system of coordination between them. This thesis has gathered the available information from different agencies which use pesticides in Mali. Data on applications of pesticide include which chemicals are used, where they are applied and when they are applied. From this information, the geographic and temporal concurrence of pesticide applications as well as any geographic overlap into environmentally sensitive areas may be examined. This is a first step in understanding the effects of pesticide use on a country's environment.

**1.1.2 Organization of study**

Section 1 begins with general information and continues with a description of Mali's physical and climatic background. Sections 2, 3 and 4 are collections of information from the use of pesticides in the agriculture, special problem programs, and health programs respectively. Section 5 describes Mali's protected areas and the problems of these areas which are intensified by pesticide use. Section 6 concludes the paper with some recommendations.

The mapping done for this thesis is based on information available and should be considered only in a general sense. For example, two IUCN maps, one dated in 1986 and one in 1989, showed slightly different shapes for the Boucle du Baoule National Park. A third map of the protected areas, by Warshall et al (1988), included another park( called the Banifing Reserve) in the Sikasso region not shown at all by the IUCN maps (and therefore not included here). However, the basic ideas are illustrated by the maps which show any overlaps (or potential overlap) into these areas by pesticide use. Equally important to any geographic overlap in pesticide use is the temporal overlap. The concurrence of pesticide applications with seasonal Vulnerability of non‑target species is potentially damaging to populations. The calendars illustrate the possibility of these overlaps. Acronyms are shown in Appendix 1.

**1.1.3 Mali as a Case Study**

Mali was chosen as a case study for this thesis for several reasons: Mali is an example of a nation with concurrent use of pesticides for agricultural programs, insect vector control, and special problem programs including a major pesticide consumer, the locust/grasshopper control programs. Almost all the pesticides used in Mali are donated by other countries or international organizations, and most programs are controlled by these agencies. The international nature of the pesticide programs facilitates the collection of data.

Like other Sahelian Countries, Mali's ecosystem is threatened by pressures from excessive population growth. Although most of Mali's biotic zone is desert or semi‑arid, within its borders is the important Inland Delta of the Niger River. This seasonal floodplain is an economically important fishing and agricultural center for Mali. It is also a major habitat for birds, located on the flyway for European migrating birds, as well as intra‑African migrants and its own residential birds. Mali's protected areas are suffering from the encroachment of people migrating into them looking for food, water, and wood. As Cultivation increases, the use of pesticides increase. As irrigation and development programs work to increase production of arable lands, the use of pesticides tends to increase. These trends of pesticide use in Mali increase the need for the government to coordinate their use.

**1.1.4 Trends of Pesticide Use and Causes**

Worldwide trends of pesticide use are reflected by the trends of their sales. Sales of pesticides increased worldwide from $2.7 billion in 1970 to $11.6 billion in 1980 and are projected to reach $18.5 billion in 1990. Sixty‑two percent of the worldwide insecticides are applied in developing Countries (WRI,1988). These trends are predicted to continue especially within the countries with agriculturally based economy. As populations increase, there is more demand on the land for agricultural output. More land needs to be cultivated and existing cultivated lands are pressured for increased yields. For acreage to increase production, pesticides are used to combat the pests which produce crop and harvest loss. Increasing arable hectares means irrigating lands and opening up forested areas. Pesticides are necessary for disease control for insect vectors are found in underdeveloped areas.

**1.1.5 General Effects from Pesticide Use**

Pesticides are often non‑specific poisons, poisonous to non‑target as well as target species. While effects of mortality, toxicity, persistence, etc are known from lab data, the impacts from chemicals in specific ecosystems are not well known. Pesticides are often seen as the solution to a seasonal crop pest, however pesticides must be Viewed with their impact on the ecosystem rather than a seasonal Solution to a problem. Unfortunately long term effects on ecosystems are difficult or impossible to assess. However it is known that negative pressure on a non‑target organism's population can effect the ecosystem as a whole. For example, pesticides may effect non‑target species in the soil system's fauna and unbalance the soil chemistry. Soils depend on these organisms for their fertility and anything affecting this level of the ecosystem will effect the entire system.

In 1980, the World Conservation Strategy recommended that general surveillance of the environment should be taken where pesticides are used and that the levels of pesticides should be reduced to those which could be tolerated by ecosystems and the species concerned. Protected areas and habitats of economically important species especially need a reduction from the stress of pesticides (Balk, 1984). The most recent accepted approach on pest control is Integrated Pest Management (IPM) . This is a combination of natural, biological, chemical, and cultural controls designed for a specific pest problem (Miller, 1985). Even with the increased implementation of IPM, chemical control remains a part of any farm program, and the monitoring of its use is an important issue.

**1.2 General Background Information**

**1.2.1 Mali: Physical Characteristics**

Mali is a landlocked country located in West Africa between the 10′ and 25′ North latitudes, and 12′ west and 4.15 east longitudes (Figure 1). It covers an area of 1,240,000 square kilometers. Its climate is arid or semi-arid with savanna-type vegetation covering 43.7% of the country. Seasonality exists as rainy or dry (ALIC, 1980).

The length of the dry season varies from 9 months in the north to 5‑6 months in the south, with rainfall varying between biotic zones. December and January are the coolest months and April and May are the hottest. Yearly temperatures average from 26°‑30°C. The seasons are dominated by the southwesterly monsoons and the northeasterly trade winds. A relatively cool wind called the “alize” blows from the Sahara from November to January but is then replaced by another northeasterly wind, the “harmattan”, important as it brings with is hotter temperatures and dust from the Sahara. The “harmattan” blows until June when the monsoons bring rain up from the southwest. The rains are heaviest in July and August (Naylor, 1987).

**1.2.2 Biotic Zones of Mali**

Mali can be divided into biotic zones; those described here are illustrated by the IUCN’s classification of West and Central African biotic Communities (Figure 2) (Warshall, 1988). The southern edge of the Sahara Desert stretches down into northern Mali and includes several desert regions. In the farthest north, is an area of dunes and desert devoid of vegetation. Regs (gravel deserts), hamadas (stony areas), and wadis (dry valleys with temporary Vegetation) predominate just south of the absolute desert. Woody vegetation, either Tamarix or Acacia, can grow only in the wadis. Ergs (dunes with an erratic annual bloom) occur in a portion of this northern zone. Rainfall in this part of Mali averages 100 mm/year. There is no cultivation here although some nomadic grazing may occur. oases ln this region offer water and resting places for migrating animals and birds (ALIC 1980) .

The Sahelian zones form grassland and shrubs at the edge of the wadis. The more northern Sahelian zone, just north of Gao, is primarily nomadic grazing land. Animal breeding is an important use of this area due to the ability to move from one pasture to another. The southern zone between Gao and just north of Mopti and along the Mauritania border, is the zone where cultivation begins. The crops grown here are primarily subsistence agriculture of millet, with pockets of cotton. The growing season lasts from June to September and rainfall averages 267 mm/year. Vegetation is transient and discontinuous depending on the weather. Acacia wooded grassland and deciduous bushland comprise the vegetative cover (ALIC, 1980).

The Sudanian biotic region, often called “savanna”, has an average rainfall of 750‑1250 mm/year. The growing season here lasts from 75 to 179 days as you travel north to south respectively. Crops grown in these regions are sorghum, peanuts (groundnuts), cotton, sugar cane, tobacco, and rice. The Sudanian region varies from north to south, progressing from Savannah to thin forests. The natural vegetation divides into the more northern Sudanian Undifferentiated Woodland and the southern Sudanian Isoberlinia Woodland (ALIC, 1980) . The natural species which require more water are disappearing due to the seasonal decline in rainfall over the last twenty years. The ground cover is made up of hardy grain species and annual grain Species. This zone provides more Vegetation and water than the Sahel, and is consequently more active for agriculture. Much of the original forests have disappeared. Centuries of civilization has influenced these regions as Cultivation, wood cutting, grazing, and grassfires have deforested this area. This deforestation is leading to loss of habitat for wildlife and a general loss of soil fertility for the country. Mali has 4,085,000 hectares (ha) of open forest and 500,000 ha of closed forest. In the 1980's, the average annual extent of deforestation was 36,000 ha/yr, a rate of 0.5%/yr (WRI, 1989) . The Inland Delta of the Niger River can be considered separate biotic zone. its seasonally inundated floodplain can cover 40,000 square kilometers. Trees are widely spaced and edaphic grasslands form dense stands of up to 3 meters high. Semiaquatic Vegetation is prevalent. This is a valuable area for fisheries, and agriculture. Crops grown here are rice, cotton, sugar cane, and subsistence crops. Pastoralists follow the receding floodplain to graze their herds (ALIC, 1980).

**1.2.3 Mali's Agricultural System**

Politically, Mali is divided from largest to smallest into divisions called regions, cercles and arrondissements. The regions are from west to east Kayes, Bamako, Sikasso to the south, Segou, Mopti, Tombouctou to the north, and Gao to the east. (Figure 1) The agricultural system in Mali is under the auspices of several organizations. The Crop Protection Service, Service de la Protection des Vegetaux (SNPV), is the governmental agency overseeing the subsistence farmer and the cereal production. They also work with the international agencies on problems such as locust/grasshopper control (Alomenu, 1989). Inaugurated in 1932, Office du Niger is one of the oldest development projects in Mali. Funded by the government, it has irrigated many hectares and bunt dams and canals. Rice and sugar cane are the principle crops under their programs. The Cotton Development Board, Campagnie Malienne pour le Developpement des Textiles (CMDT), with the help of the World Bank is growing cotton and cereals in the southwest region near Sikasso. USAID's Operation Haute Vallee (OHV) promotes integrated rural development, primarily millet, tobacco, sorghum and groundnut farming. Cotton is also a product being developed by the OHV . The OHV operates in the regions of Bamako and Sikasso ( Naylor, 1987, Warshall, 1988).

Subsistence crops of sorghum, maize, and millet are grown throughout the arable regions. Cotton and groundnuts are the most important agricultural exports. The periodic droughts and decreased rainfalls of the last twenty years have created shortfalls in agricultural production. However, according to the Famine Early Warning System (FEWS) harvest report of 1989, Mali was nationally self‑sufficient in cereals and grains . However, on a regional basis, this was not always the case. Grasshoppers, locusts, granivorous birds, drought and flood levels Contribute to lost production within local areas (FEWS, 1990).

The Inland Delta of the Niger River provides 90% of the fishing industry of Mali, with the Senegal River the other 10%. The fisheries average 110,000 tonnes of fish each year. Domestic consumption is more than 65,000 tonnes/year. About a third of the annual production is exported to neighboring countries as smoked and dried fish. It is a primary source of protein for both Mali and the West African region, therefore any contamination would have a large impact on the population (ALIC,1980).

**1.2.4 Protected Areas of Mali**

There are 4,633,300 hectares in seventeen protected areas in Mali (Figure 3). Most of these are located within the biotic zones of heaviest agricultural use, the Sahelian‑Sudanian areas and three are within the Inland Delta region. Mali's administration of its protected areas fall under several agencies. The ministry responsible for the parks is the Ministry of Natural Resources and Animal Husbandry, Ministere des Resources Naturelles et de l'Elevage. The Forestry Service is responsible for the management of classified forests. The National Parks Department, Direction des Parc Nationaux, is supervised by the Department of Water and Forests, Direction Generale des Eaux et Forets (MacKinnon, 1987).

Classification of protected areas in Mali falls into six categories. The strictest category is the National Park where all human intervention is prohibited except management and visitor access. The Reserves de Faune forbid hunting but allow grazing, cultivation, and forestry. Reserves Naturalles are areas where human intervention is minimum and strict control is required. Reserves Speciale or Sanctuaire are areas set aside to protect or conserve Certain Species or Communities and all other activities are subordinate to this. Zone Cynegetique are where the Department of Water and Forests facilitate hunting width camps and tracks. Hunting is forbidden in Classified Forests.

The National Park, Boucle du Baoule, is a Biosphere Reserve when it includes the Faunal Reserves of Badinko, Kongoss Ambougou, and Fina. It is located 200 km northwest of Bamako and includes three biogeographical zones, the sudano‑guinean, sahelian, and the riverine forest along the Baoule River. There is a large diversity of fauna here although poaching and brushfires have reduced the populations. This reserve contains one of the last two populations in the world of the ungulate grant eland. This reserve has been selected as a pilot biosphere reserve in arid/semi‑arid lands by the Netherlands/Mali project on Recherche sur l'Utilization Rationnelle du Gibber du Sahel (RURGS).

The Reserve de Kenie‑Baoule is a Managed Nature Reserve in the Koulikoro Province. Mammals include buffalo and unconfirmed reports of the giant eland. Disturbances to this reserve are poaching, forest exploitation, and agriculture (MacKinnon, 1987).

Bossofola Forest also reports grant eland and buffalo. There is a proposed Bafing National Park near the Manatalli Dam on the Senegal River to mitigate the effects of the dam. The status of this park is unknown (Warshall, 1988).

The Farimake Reserve is west of the Niger floodplain . This reserve qualifies Mali to adopt the RAMSAR wetlands convention. It's centered on the Cercle of Youvarou where three multiple‑use protected areas were established (IUCN, 1990).

**1.2.5 Population**

In 1980 Mali's population was 7.7 million, and in 1990 was estimated to be 9.4 million. Density is 8 people per sq. km. However, most of northern Mali is essentially uninhabited so for arable and irrigated land, the density increases to 293 people per sq km. Except for a few nomadic groups, most of the population is in the southern part of the country. In the most humid southern part of Mali, the diseases of trypanosomiasis and onchocerciasis has prevented settlement. However, the control of these diseases is improving and settlement into these areas is increasing the spread of population into these areas is creating a loss of habitat for the wildlife which lives there (IUCN 1989b, FEWS 1990).

Transhumance, migrations of people, is an important part of Mali's culture. population in the Niger River areas change with the flux of the floodplain . The pastoralists bring their cattle to the floodplains, following the receding waters to eat the rich grass. The fishermen also follow the diminishing waters to remain near the best fishing areas (IUCN 1989b).

As populations increase, there is increased pressure on the lands for increased yield. In its Global 2000 report, the FAO estimated that in order for developing countries to feed themselves, the necessary growth rate of agricultural production needs to be raised by 4% per year. Expansion in most of West Africa of arable land can only account for 27% of the needed 4% increase. Therefore the land already under Cultivation must produce more to sustain its own population (Balk, 1984).

These lands are already experiencing increased stress. The drought of the last twenty years, and the intensive grazing from growing herds have caused diminution of seed stock in the Sahelian soils. Certain trees have died off and in some cases, the soils have lost their microbial community and are considered sterile. The fragmentation of the forests has resulted in a loss of pollinators — certain birds and mammalian browsers. The drought has dried up watering holes within parks and increased pressure on farmlands from wild animals and people have reciprocally pressured protected areas for water and wood (Warshall, 1988).

**1.2.6 An Overview of Pesticide Consumption in Mali**

Pesticide Consumption in the 1990's is expected to be four to five times higher in Mali than in the mid 1980's. This is because the Sahel self-sufficiency program as determined by CILSS requires a 50% increase in groundnut and cereal production, a threefold increase in rice, and a doubling in cotton production since 1984 (Balk, 1984). Within the West African countries, Mali is one of the highest consumers of pesticides because it is the largest producer of cotton in its region and there are frequent outbreaks of locusts and grasshoppers. According to a report to the FAO, of the total agricultural pesticides used in Mali, the locust/grasshopper control program uses 15% and the cotton production is responsible for 709 Other pests such as the quelea bird, and the armyworm have chemical control programs, and food crops also use pesticides. Insect vector control programs uses pesticides in various health programs including the Onchocerciasis Control Programme in southern Mali (Alomenu, 1989). Important consumers are listed in Table 1.1.

**1.2.7 Pesticide Distribution**

The distribution of pesticides are managed by both state and private companies. The pesticides distributed by the government are usually free or at a low cost to the farmers. However, these state subsidized chemicals are sometimes in short supply and the farmers may need to buy them on the open market. Although the subsistence farmers receive their pesticides free, the cash crop farmers of cotton, tobacco, and groundnut pay prices 15-20% higher than the official prices. Open market prices fluctuate from 75-200% over the recommended prices.

The SNPV distributes its pesticides from the main depot in Bamako to out stations according to the determination of need. Farmers are given pesticides at the beginning of their agricultural anti‑pest campaigns and are replenished according to need. The CMDT distributes directly to the farmers in their development zone. The Office du Niger, and Operation Haute Valley distribute to the farmers under their management. General merchants and small traders have networks through the villages. It was reported that a substantial quantity of pesticides are imported unofficially across borders and causing adulterated, expired and toxic pesticides to be found on the market (Alomenu,1989).

Mali depends on the pesticides donated to them by outside nations or organizations La Societe Malienne des Produits Chimiques (SMPC), a parastatal company in Bamako mixes and formulates pesticides under contract for the SNPV, CMDT, Office du Niger, and International Aid agencies. About 75% of the total pesticides are imported. Some are imported directly through international relief agencies as for locust control and others import indirectly through multinational companies. The SNPV accepts donations from aid agencies, but also buys on a national budget through local agrochemical companies as do other government services. (Agrochemical Companies are listed in the Appendix 3). The SMPC is not affiliated with any one maJor multinational company but Imports its products from Senegal and Ivory Coast. It has a store in Bamako where it sells repacked sachets of Pesticides to the small buyer, often with no labels (Alomenu,1989).

**1.2.8 Recent Pesticide Consumption**

Recent pesticide consumption has been by the SNPV and the CMDT as shown in table 1.2. This table should be considered an illustration of pesticide trends in Mali, as it is does not reflect total consumption of all agencies and applications involved..

**1.2.9 General Background on Pesticides**

There are four major groups of insecticides which are used in Mali: organochlorines, carbamates, organophosphates, and pyrethroids. The chlorinated hydrocarbons present a high risk and impact to the environment because of high persistence and their tendency to bioaccumulate in the food chain. The other groups have generally replaced the organochlorines, although some of the relatively non‑persistent organochlorines such as lindane and endosulfan are still in use. Dieldrine, an organochlorine considered unsafe, has not been used in Mali for locust control since 1985, however there are reports that it is still used for insect vector control (SNPV, 1988). There is much variation within the carbamate and organophosphate groups as to toxicity to nontarget species . The organophosphates and carbamates interfere with the cholinesterase system and the pyrethroids also affect the nervous system . Table 1.3 describes some of the characteristics of the most common pesticides used in Mali.

**2.0. PESTICIDE CONSUMPTION IN AGRICULTURE**

**2.1 General Information**

Agriculture is the major business of Mali's economy, with 90 percent of the population involved in agriculture and 99% of all exports being agricultural products. Subsistence crops of maize, millet and sorghum are grown throughout the country and are an important part of the Malian diet. Mali's cash crops are primarily cotton and groundnuts. Cotton accounts for 57% of the agricultural exports, groundnuts 18%, and live animals are 14%. Fish, cereal, fruit, vegetables, and leather make up the rest of the earnings. Rice is also an important cereal grown in Mali especially in Inland Delta area (Naylor, 1987).

Although the Sahelian countries have had severe drought and problems with famine within the last twenty years, the most recent harvests in Mali have been sufficient to feed the country. In 1989, the national harvest had enough surplus to al low the 8% grain export taxes to be dropped. However, on a local scale, there were arrondissements unable to feed themselves. According to the 1990 FEWS report grasshoppers damaging crops was the cause for harvest loss in almost all of the arrondissements. Some areas were damaged by other problems such as drought and the ensuing low flood levels. Pockets of drought in the Youvarou and Tenenkou cercles and in parts of the Douentza cercle prevented crops from completing their cycle. Mopti and Segou's rice production was decreased by low flood levels (FEWS, 1990).

Pesticides are used in Malian agriculture to control the various pests which contribute to harvest loss. Although grasshoppers are endemic to Mali, they are considered to be among migratory pests like the locust, and certain bird species. in the west African region, international organizations (OCLALAV, CILSS, IFAD) have been set up assist in the problem of locust and grasshopper infestations. Since 1986, the Malian SNPV has been the umbrella agency responsible for control of migrant pests within its own borders .

For the purposes of this report, the locust/grasshopper infestation problem is considered separately from the rest of the agricultural use of pesticides. These migrant pests require control which is relative to their development and invasion patterns rather than the development of the crops invaded. Most of the pesticide use in agriculture is dependent on the crop which is being protected‑ its growing season, its specific pests. Pesticide use to the locust/grasshopper problem is discussed in Chapter 3.

Mali's agriculture system is set up under state and parastatal organizations. These development projects are generally in different areas of the country and handle different crops. All of the agricultural development projects use large amounts of pesticides. In the south of Mali, these organizations are the CMDT which heads the cotton and some cereal production primarily in the Sikasso region, and the Operation Haute Valley in the Bamako and Sikasso regions of Mali which has an integrated agricultural program including tobacco, millet, cotton and groundnuts. Office du Niger, which is in charge of irrigation projects and rice, is near the Niger Inland

Delta. The OMVS on the Senegal River in western Mali has irrigation and development projects. Mali is the highest producer of cotton in the West African region (Alomenu,1989).

Mali has approximately 2,073,000 hectares under cultivation. Cereal production has risen recently from 274,000 metric tons in 1986 to 510,151 mt in 1989. Of this, rice production in 1989 was 75,729 mt for paddy rice and 20,820 mt for other rice. fillet, maize, sorghum, and wheat totaled 323,152 mt for 1989. Animals approximately number cattle 4,705,000, sheep and goats 10,433,000, chickens 14 million, pigs 55,000, horses, mules, and asses 611,000, and buffalo and camels 230,000 (WRI, 1989, FEWS 1990).

For a comparison of how the land is used, harvested land breaks down into crops the following way. Total arable land 1980 was 2,047,000 ha. Cereals totalled 1,711,000 ha (83.6%) including rice 160,000 ha, maize 90,000 ha, sorghum and millet 1,400,000 ha . The cash crops of groundnuts and cotton were 200,00 ha (9.7%) and 109,000 (5.3%) ha respectively. The lesser crops are tobacco at 500 ha, roots and tuber at 11,900 ha, pulses (broad bean, pigeon pea, kidney bean, cowpea, mungbean) 30,000, sweet potato 4,000, cassava 6,500 ha, vegetables 1,870 ha, and 10 mt of fruit. From 1980 to 1989, the land under cultivation has increased to 2,073,000 ha with 8% under cotton (Balk, 1984, CMDT 1989).

**2.2 Pesticides and Associated Crops**

Pesticides are used on agricultural crops in West Africa are used in very specific ways in West AFrica, so that , for instance, rice receives a large number and therefore high level of pesticides. Other crops ar more selective. Table 2.1 reflects the pesticides generally used on some specific crops in West Africa.

**2.3 Pesticide Requirements**

In order to evaluate what quantities of pesticides will be used on the land, several factors need to be considered. First, establish which crops are grown where. Secondly, evaluate the pesticide to crop requirement as high, low, or moderate. By mapping where the crops are grown, one can establish which areas will require a high, moderate, or low input from pesticides. These steps are followed for estimating the pesticide requirements in Mali. According to FEWS, 1990 the following regions had a net production (mt) of these crops in 1988‑89 (Table 2.2).

The cotton production for 1989 in southern Mali according to the CMDT totalled 233,300 mt. Based on a regional breakdown, the cotton production is described by Table 2.3. The CMDT figures reflect a breakdown according to their own sectors. The region used in the table is the political region or cercle (CMDT 1989).

Although these figures reflect the two years prior to the FEWS table, a general trend for where the crops are grown can be established. The Bougouni, Koutlala, and the Slkasso sectors are within the governmental region of Slkasso. The San sector is within Segou. The OHV cotton production is primarily in the Sikasso region. Highest cotton production is therefore in the Sikasso, Segou, and Koulikoro regions. Pesticide requirements vary between crops. The FAO has projected as estimated range of pesticide requirements in West Africa for use by the year 2000 as described by Table 2.4.

From these tables it can be inferred that the areas with the highest applications of pesticides will be those where rice and cotton are grown. These regions are primarily Sikasso, Segou, and Mopti. Most of the Inland Delta is within this region. It should be expected that the pesticides will have an impact upon this wetland.

**2.4 Cotton**

Cotton is one the highest consumers of agricultural pesticides, using 70% of the total. The CMDT is in charge of the major cotton production in Southern Mali and their system includes a crop rotation with millet, sorghum, and maize. Its zone is from the southern border to the 14th latitude' north. It covers 96,000 km2 and is 8% of the national territory (CMDT, 1988).

Cotton is treated with pesticides sometimes as much as 8 times per growing season. Insecticide use on cotton has steadily increased over the last fifteen years. In the early seventies, the money spent on insecticides was approximately 450,000 CFA but it combed steadily to 5,693,000 CFA in 1988. Similarly, the amounts of pesticide used increased. From 1983‑84 growing season to the 1987‑88 growing season, the numbers of liters of pesticide increased from 1,069,466 to 1,737,840. This is could be due to the increase in hectares cultivated from almost 100,000 ha in 1983 to 180,000 hectares in 1988. The land under the CMDT was generally treated an average of 4 treatments at 3/liters /treatment during the growing season in these same years, 80%‑82% of the cultivated lands used 4 treatments and 30‑37% of the land were treated 5 times (CMDT, 1988).

In 1988‑89, 80.75% of the crops were treated 4 times and 19.25% were treated more than 4 times, sometimes as many as 8. The dosage of insecticides per treatment was 2.36 liters to 3 liters/treatment., although this is an average and the dosage diminishes with increasing treatments. The areas which were treated 8 times used 1.62 liters/treatment. At a liter/hectare basis, the number averaged 10.75 l/ha. According to the CMDT, 100% of their regions used pesticides (CMDT, 1989).

The actual chemicals used by the CMDT were not specked by the CMDT report, but according to Alomenu and Balk, the cotton industry uses the chemicals fenitrothion, cypermethrine, fenvalerate (Sumicidin), dimethoate, chlorpyrifos‑ethyl(Dursban), permethrine, deltamethrine. Neither the regional nor the quantitative use of these chemicals were available (Alomenu 1989, Balk 1984).

**2.5 Timing of Application of Pesticides**

When pesticides are applied depends on the seasonal occurrence of pests, diseases, and the growing season. Most are applied during the wet growing season, June through December. However, off‑season crops due to irrigation and floodplain recession encourage the use of pesticides during the dry season as well. Herbicides are applied before crop canopy closure to insure against competition from weeds. Their application varies temporally crop to crop depending on the speed of canopy closure.

Pesticides used during the wet season cover a wider range and consume a larger quantity of pesticides than the applications during the dry season. However even the low input during the dry season can be hazardous because of the low dilution capacity of the aquatic systems. Therefore the biota that is exposed during the dry season is exposed at a higher Concentration then during the wet season. Additionally, during the dry season, irrigated crops serve as a refuge for many animal species and consequently more non‑target species are affected by pesticide application at this time. Application of non‑selective pesticides in isolated habitats such as oases or riverine forests in savanna areas can be hazardous to species using these places as refuges to recover their populations. In countries where the dry season is severe, like Mali, theses reservoir functions of oases and riverine forests are important. The bird populations are more Varied during the dry season as both Contra and inter African migrants as well as residential birds concentrate at available water sources. Seed dressings at this time will have a large negative affect on birds. Fish are also vulnerable during the dry season when fishing pressure is already high, the dilution capacity of the water is low and natural mortality is also high. Larval fish are present at the end of the dry season and the beginning of the wet (Balk, 1984).

Below are crop calendars for crops in West Africa and a pesticide use calendar for three of the major crops grown in Mali. Cotton was not included in the calendar but as most of the cotton is treated four or more times per season, it can be assumed that pesticide application is steady from June to November, which is the rainy season in Mali. The pesticide use calendar shows the overlap of herbicides with seed dressings and pesticides to control stemborers and midges during this time. Floodplain sorghum and the double cropping of irrigated rice have growing seasons during the dry season. As explained above, the impact of pesticide use during this time can be significant.

**2.6 Summary**

Agricultural pesticide use in Mali is concentrated in the southwestern part of Mali where the cotton is grown. The subsistence farmer who plants primarily sorghum and millet depend on the state and parastatal organizations to give them pesticides and the pesticide use on these crops is low to moderate. Rice is a moderate to high consumer of pesticides and is grown extensively ln the Inland Delta regions. Groundnuts, an important crop to Mali, is a moderate user of pesticides. Using the steps outlined above, the areas most at risk from pesticide use are the inland Delta region, and the Sikasso region (Figures 4, 5, 6, and 7).

It can be assumed that where there is agriculture, there are pest controls used. The trend for chemical control has been increasing and without a national policy on its use, this trend will probably continue.

**3.0 SPECIAL CONTROL PROGRAMS**

**3.l General Information on Management of Locust/Grasshopper Campaign**

Mali uses pesticides to control the locust, grasshopper, and the granivorous bird infestations. These pests are considered separately from the normal agricultural processes and their control involves international organizations as well as national commitments. The locusts and grasshoppers may breed within one political boundary but migrate and damage crops in another country. Thus it is an international rather than national problem. The organizations involved in Controlling Mali's locust/grasshopper problem for the Sahellan region are coordinated by the UNFAO and under the management of the SNPV nationally. Countries that donate aid to Mali for control of the locust/grasshopper infestation include France, US, Japan, Algiers, Canada, and Norway. Other organizations which donated aid in 1989 are the Bank Afrique de Development, the European Development Fund and Mali's Ministry of Agriculture (Appendix 6) (SNPV 1990) .

The USAID's role in the locust Campaign is emergency control of locust grasshopper plagues. USAID demands that there be a pesticide donor coordinating committee within each country chaired by the FAO (UN Food and Agricultural Organization). it also has extended its AELGA (Africa Emergency Locust and Grasshopper Assistance) support to Countries like Mali who have completed a supplementary environmental impact assessment. USAID follows the US laws which state that pesticides used must be registered by the EPA and used by people trained in the handling of chemicals. USAID only supplies pesticides that have been screened for minimal toxic effects. If other donors supply environmentally hazardous chemicals, the USAID has threatened to remove its support (Gaudet, 1990).

The regional organization, OCLALAV (Organization Commune de Lutte Antiacridienne et de Lutte Antiaviare) consists of nine Sahellan Countries (Burkina Faso, Cameroon, Ivory Coast, Gambia, Mali, Mauritania, Niger, Senegal, Chad ). it has ben involved in bird and locust control in this region since 1966, although it has not used any pesticides against birds since 1985 (OCLALAV, l990). The regional Campaign against the locust is coordinated by the FAO's ECLO (Emergency Locust Control Program), which estimates the financial, pesticide, and manpower requirements for each country and presents requests to the donors. It also reviews the strategies used in pesticide application and in plague prevention. In Mali, the Crop Protection Service (SNPV) oversees all of the efforts of the locust/grasshopper campaign. In Mali and most of the other Sahelian countries, where subsistence farming is a major part of their agriculture, the plagues are devastating to the farmer at the local level, and the locust/grasshopper problem has warranted a lot of attention from the international community (US Dept of State, l990).

**3.2 Zones “At Risk” from Locust/Grasshopper Infestation**

Locusts and grasshoppers affect the natural Vegetation by eating the grasses which are most abundant in August and September. This is not a threat to the general biomass but does add hardships to the pastoral grazers in the rural populations (SNPV 1990).

In Mali, crop losses due to grasshopper/locust damage impact regionally more than nationally. In 1989‑90, the nation as a whole lost only 15% to these pests, but for example, the Mopti region lost 42% of their total hectares planted. The SNPV has identified a zone at risk for the primary grasshopper nuisance species, the Senegalese grasshopper *Oedalous senegalensis* (OSE) and the *Kraussaria angulifera*. This zone is from the 14th to the 17th north parallels and 1′ to 12′ west longitudes. Sectors noted for the OSE are Kayes, Yelimane, Nioro du Sahel, Balle, Dilly, Mourdiah, and Douentza. Within these zones, annual loss of production is estimated at 37% (FEWS 1990).

The grasshopper/locust infestation varies monthly as well as by area. In 1989, the highest infestation occurred in October over an area of 1,200,000 hectares. The infestation remained in an area of over 100,000 ha from August through the end of November. The severity of attack is greatest in September just prior to the harvest of most crops by the 15th of October. At this time the crops are at their fullest. The rates of damage also vary between regions within the “at risk” zone and the highest rates are shown in this table. The figures are adapted from the Mali Crop Protection Service (SNPV). These represent estimations as it is difficult to be accurate with either agricultural productivity and/or crop loss. The methodology used by the SNPV is unknown (SNPV, l990)(Figures 8-12).

**3.3 Pesticide Use in Locust/Grasshopper Control Is Escalating over the Last Several Years**

There has been a dramatic increase in the use of pesticides to control the locust/grasshopper infestation in Mali since 1980. Whereas between 1980‑1984, the total land treated each year never exceeded 100,000 hectares, in 1985 almost 200,000 hectares were treated and in 1989 over 700,000 hectares were treated. It is not clear whether this increase is due to more infestation and thus more need or whether the increase is due to a more thorough program (Figures 9 and 10) ( SNPV, 1990).

Total pesticide application in 1988 was 441,840 ha, with ground application of 400,000 ha. Approximately 30,000 ha were treated by farmers with dust or backpack sprayers of 3% and 5% fenitrothion EC and ULV formulations. The primary objective of ground application is the early intervention to destroy hopper bands (young grasshopper/locusts before they swarm). In the Segou Diabinta region alone, treatment of 400 ha by farmers eliminated early instar hoppers over 120,000 ha. The early intervention by farmers in 1988 probably prevented the expansion of infestation of 10,000 ha. Aerial application in 1988 resulted in treatment of 41,840 ha. (Appleby, 1989) .

The total hectares treated in 1989 was between 712,000 and 736,614 ha. Ground application resulted in 319,937 ha and 416,677 ha were treated by air, almost ten times that of 1988. The following tables display the 1989 pesticide use for locust/grasshopper control by region, first by method (land and air), secondly listing the breakdown of liquid or powder formulation.

Locust infestation tends to be cyclic and linked with the amounts of available rainfall and therefore hard to predict, but grasshoppers are endemic to Mali and a constant threat to their harvest. Therefore the regional locust control authorities have developed a two phase plan for 1990, as described by the OCLALAV (OCLALAV 1990). Phase I stresses the destruction of the eggpods within the identified areas of risk. This phase plans on treating between 75,000 and 250,000 hectares during the months of May through August. For Phase i, the OCLALAV has determined that 700 tons of powdered pesticide and 90,000 liters of liquid (fenitrothion 50 ULV) is sufficient. They have available as of April 1990, 100 tons of powder and 170,000 liters of liquid allocated for Phase I. This Phase is primarily application via ground treatment.

Phase II, from September to January 1991, includes an intensification of intervention within the zones at risk. The attack is directed towards the migrations of the locusts and grasshoppers from the north toward the south. Most of this is an aerial application and assumes treatment of 800,000 ha using an available 220,000 liters of pesticide.

Although this is an escalation of pesticide use from 1989, the emphasis is on the Phase I destruction of eggpods and not aerial treatment, an environmentally unfavorable treatment where drift from the spray can impact non‑target species and habitats. During a meeting in April 1990 coordinated by Lukas Brader of the FAO/ECLO, eight Sahellan Countries reviewed their protected 1990 campaigns. Donor Countries and regional organizations (OCLALAV, CLISS, IFAD) were present as well. The delegation supported FAO's suggestion that pesticide use be minimized through early season ground control rather than late season aerial control. Post harvest spraying (after mid‑October) was suggested to be avoided altogether. Other suggestions by the FAO included improved pesticide management practices including safety, training and constant onsite supervising (US Dept of State 1990).

**3.4 Pesticides Used, Description of Chemicals and Where Applied**

The pesticides chosen for use against the locust/grasshopper pest include those chemicals with a quick “knock‑down” effect, banner sprays, bait formulations. Bait formulations were to be tested in the 1989 campaign but there was some fear that livestock would eat the bait. Rice bait using carbaryl was suggested by the SNPV.

In 1988, the SNPV's chemical of choice was fenitrothion due to its availability and its efficiency. Malathion is recognized as being less hazardous to the environment and is the pesticide of choice considered by USAID for the Mali campaign. Generally, the organophosphates are preferred, but their short persistence time is a drawback. For example, some breeding sites are sprayed as much as seven times in one campaign. Propoxur dust was the main chemical used by the farmers for the ground control . it has a short shelf life however and sometimes produces poor locust kills because of this. The FAO recommended mixing malathion or fenitrothion with a pyrethroid insecticide to produce a rapid knock down and kill. Mali has on stock dieldrin, lindane, and BHC (Benzene Hexachloride), and DDVP. These chemicals were not requested, but donated by France, Algeria, and the OCLALAV. Although immediately impounded, the Malian government may use these chemicals in a crisis situation. Particularly the lindane and dieldrine would be used as a last resort insecticide. There is some thought to use dieldrin in the desert as a barrier spray. This could severely impact the lenses of water (groundwater which comes to the surface in low areas) which supply refuge for migrating birds and other animals. Mali has not used dieldrine for the locust/grasshopper campaign since 1985 although there have been reports of its use as a vector control insecticide (TAMS 1989, Appleby 1989). Cercles with the most land treated is in the following order: Nioro du Sahel, Yelimane, Gossi, Mouth Mourdiah, Niono, KaYess Gao, Bamako, San.

It can be inferred from these tables that the cercles with the highest concentration of pesticide use for the locust/grasshopper campaign are Mopti and Niono which both lie within the Inland Delta region of Mali.

The following pesticides used in Mali have these characteristics (TAMS 1989, SNPV 1988):

1. Fenitrothion: low cost, low rate of application. weak toxicity for mammals (673 mg for rat), presents low risk to worker, sufficient selectivity, highly toxic to birds, less toxic to fish. recommended by the PEA to be used only near aquatic environments where fisheries are threatened; widely used in Africa. habitats to be avoided are bird nesting and aquatic/wetlands.

2. Malathion 96% ULV: malathion is a weak risk for man ( except for its isomer which was responsible for a group intoxication in Pakistan‑2800 cases) it is efficient with a relatively low persistence, low cost, the standard pesticide for locust/grasshopper control provided by USAID, toxic to bees, but has a long history of use in Africa without reportable unfavorable environmental effect.

3. Diazinon. low toxicity to mammals, suggested by PEA that aquatic habitats be avoided.

4. Dursban (chlorpyrifos‑ethyl): rated among the top four pesticides in terms of efficacy in realms 1987 tests. High toxicity to non‑target organisms, recommended as a banner spray or bait because of its rate of persistence.

5. Ficam (bendiocarb): high toxicity to mammals.

6. Carbaryl: high persistence (up to 21 days in the US), relatively low In toxicity in birds, very expensive, UL\J formulation requires 4:1 dilution with diesel fuel which adds to the cost. needs almost double the application of either malathion or fenitrothion.

7. Propoxur dust: (Unden) highly toxic to birds but low toxicity to nontarget invertebrates. bird nesting habitats should be avoided.

8. Fastac, Ripcord (cypermethrine): inconvenient, and tends to bioaccumulate, habitat to avoid is aquatic/wetland.

9. Sumicombi Association: sumi‑fenitrothion, obtains synergistic action, less risk and precaution with exposure.

10. Lindane: highly toxic to mammals.

11. Dieldrine: very toxic to fauna, highly persistent and the USA has banned its use for international programs.

12. Karate (lamda‑cyhalothrln) :should avoid aquatic/wetland habitats.

**3.5 Species and Habitats of Locust/Grasshopper Pest in Mali**

The following is a list of the grasshopper and locust pests which effect Mali. The Desert Locust (*Schistocerca gregaria*) feeds on a wide variety of Vegetation, Including millet, sorghum, maize and cotton. The African Migratory Locust (*Locusta migratoria migratorioides),* is a particular problem in the Niger Inland Delta area, but invades most of Africa south of the Sahara. The Tree Locust (*Anacridium menanorhodon*) eats the valuable Acacla tree in the Sudano‑Sahellan regions, and its habitat stretches across Mali.

The most damaging grasshopper species is the Senegalese grasshopper, *Oedaleus senegalensis* (OSE). Its habitat is between the 14th and 17th parallels and 1′ to 12′ west longitudes. Other minor species of grasshopper which affect Mali include *Hieroglyphus daganensis* which is associated with the Niger River Basin, the *Kraussaria angulifera* which occupies the same zone as the OSE. Another pest of the Inland Delta is the grasshopper *Diabolocatantops axillaris* and the *Cataloipus cymbiferus* also effects Mali (TAMS 1989. SNPV 1990).

**3.6 Granivorous Birds**

The major species of grain eating birds effecting Mali's crops are the *Quelea quelea* the *Quelea erythrops* and the *Passer luteus*. The areas effected by the granivorous birds in Mali occur mostly in the regions of Yelimane, Nioro du Sahel, Nara, Niono, San, Mopti, and Gao. Data of areas treated specifically for the birds include only Niono, San, and Nioro du Sahel. Reproduction of one species, *Quelea erythrops* is restricted to 40 hectares near Dalla (in the cercle San) in September. All species of the Quelea are a serious menace to the crops and in some cases the peasants are obliged to harvest before term. This happens especially within the cercles of Mopti, Tenenkou, Douentza, and Youvarou (Warshall 1988, SNPV 1990).

The anti‑bird campaign is usually managed in August and September within the sectors of Nioro du Sahel and Niono. In October, with the decline of the anti‑grasshopper activity, some of the pesticides are used in the anti‑bird Campaign (SNPV 1990).

In 1989, the total land treated for birds was 4,122 ha with 11,250 liters of Fenthion 1000, 840 liter of Diazion, and 640 kg of explosives. The spraying of birds is done primarily at night and Via air. It has been reported that the spraying of the roosting sites of the Quelea has had lethal consequences for other birds which roost in nearby areas. Herons, egrets, swallows, sand martins, yellow wagtail, are all species which are located near these habitats. When to earner years, parathion was used to kill the pest birds, secondary poisoning occurred as predators such as eagles, storks, kites preyed on the animals killed by this chemical (SNPV 1990, Balk 1984).

**3.7 Waterbirds as Pests**

Waterbirds are considered pests especially where rice is cultivated. The major Species and their favored foods are in Table 3.9. These birds create the most damage when the fields are planted late or counter‑seasonally because the ripening coincides with the return of winter migrants. This Condition often occurs when irrigation makes off season planting possible. As the recent trends of lower rainfall continue, the natural wetlands decrease With a subsequent depletion of habitat. Traditional techniques such as scaring, establishing artificial wetlands, and planting Varieties which mature before Waterbirds return, successfully limit damage to crops. Still the use of seed coating with pesticides is used with negative impacts both to the birds and to their predators (Warshall, 1988).

**3.9 Other Special Problem Programs**

Another pest is the rodent, *Arvicanthis niloticus,* which is found in the Office du Niger region Molodo, Niono, Diabali, Kolongo, Kourama, and N'Debougou. In all, 2,491 ha were treated with 15,430 kg of the poison bait Chlorophacinone.

For the control of storage pests, the Grains Marketing Board (OPAM) uses phostoxin and detia as fumigants, and as insecticides, permethrin 25%, pririmiphos‑methyl 40%, fenitrothion 50% (Alomenu 1989, SNPV 1990).

**4.0 PESTICIDE USE FOR INSECT VECTOR CONTROL**

**4.1 General Information**

Pesticides are used in Mali to help control four major health problems. These are the vector borne diseases of schistosomiasis, malaria, trypanosomiasis, and onchocerciasis. These diseases affect the health of the population, and where prevalent, retard the development of arable lands. Onchocerciasis, which is endemic in the riverine areas in southern Mali, has especially been a deterrent to cultivation of these areas.

The majority of pesticide use to Mali is to the agricultural and locust/grasshopper Campaigns. However, since most of the pesticides used in vector control are applied to bodies of water and because some organochlorines are still used, the environmental effects should be Considered .

**4.2 Schistosomiasis**

Schistosomiasis is a disease caused by the parasitic worms *Schistosoma mansonoi* and *Schistosoma haematobium*. Snails are an intermediate host for the disease and because they live and breed in standing waters, humans may contract the disease as they bathe and drink from the infected waters. Although schistosomiasis is endemic to parts of Mali, irrigation and man‑made dams and lakes have increased the prevalence of the disease. The creation of the man‑made lakes provides excellent breeding grounds for the snails and the periodic distribution of water helps to spread the disease into the drinking and wash water systems (Brinkman 1988b, Balk 1984).

Mali has been trying to control schistosomiasis since 1978. Control began as part of the dam budding project in the Bandiagara district and continued in 1982 when a national program was created. The program slowed during the drought and famine of 1983 to 1985, but remained active and has since had some success in slowing the prevalence of the disease. The program has been active to the districts of Bandiagara, the Office du Niger, the Haute Valee Baguineda irrigation areas and the Selingue dam area. Control was by both mollusciciding water inhabited by snails (contact site areas) and by treating afflicted humans with the drug praziquantel (Brinkman 1988b).

Mollusciciding controls snails by periodic application of chemicals to the sites of contact. Usually three applications are used, one at the end of the rainy season, another six weeks into the dry season, and a third time during the dry season. The molluscicide generally used in West Africa was niclosamide which is toxic to fish and other aquatic organisms. In Mali, mollusciciding occurred from 1980‑1986, but was generally discontinued in 1987 because it was proving expensive and too much of an environmental risk towards non target organisms. Special studies to the Office du Niger legation zones and to the district of Bandiagara have continued “focal mollusciciding” in order to evaluate its effectiveness. The main strategy to control schistosomiasis is mass chemotherapy to the individual with praziquantel (Figure 13) (Balk 1984, Brinkman 1988b).

The target of the National Schistosomiasis Control Programme was a 50% reduction in prevalence of the disease among 6‑10 years old children. After ten years, the results were varied. As of 1988, the parasite was almost completely gone from the villages in the Bandiagara and the Baguineda irrigation zone. In the Office du Niger area, the results of the program were poor but bad hygienic Conditions are thought to have an impact on this. The primary method of control is by mass chemotherapy rather than the mollusciciding and therefore the environmental effects from the control of this disease are generally minimal. The areas of focal mollusciciding are ln areas where agricultural pesticides are already used and entry into the water systems there may impact the environment at these locations (Brinkman 1988a).

**4.3 Malaria**

Malaria has been traditionally controlled with applications of the DDT. However, resistant strains of mosquitoes to DDT have increased as well as resistance to dieldrin, HCH, organophosphorus, and the carbamates. In the late 1970's, malathion, fenitrothion and propoxur were considered as suitable compounds for house spraying to kill the adult mosquito vector (Balk 1984).

To control the mosquito larvae in West Africa, chemical products such as temephos, chlorpyrifos, malathion, parathion, and fenthion are used. WHO has also been studying newer insecticides chlorphoxim, pirimiphosmethyl, phoxim, and jodfenphos. The insect growth regulators methoprene and diflubenzuron are also considered for potential against the malaria vector.

The carrier of the protozoa Plasmodium, the Anopheles mosquito, breeds in forest areas as well as in all collections of water. The trend towards larviciding to control this mosquito should be considered an environmental risk to aquatic habitats. The organochlorine dieldrine has been reportedly used in Mali as an anti‑vector product since 1985. Specific data on where, when, and quantities of pesticides used for the anti‑malaria campaign within Mali was unavailable (SNPV 1988).

**4.4 Trypanosomiases**

Trypanosomiases affects both animal and humans in Africa. The vector, the tsetse fly, occurs in the southern part of Mali within the biotic region of the Sudanian Woodland zone. There are three types of the fly, the riverine (also found in man‑made lakes ), the savanna, and the forest. The riverine species affect primarily humans, whereas all three species transmit the disease to animals. For livestock agriculture to develop to these areas, the control of the tsetse fly has become important. Since 1979, WHO and FAO have been cooperating in a long term program called Programme for the Control of African Animal Trypanosomiasis and Related Development.

The only tsetse control programs in southern Mali are along the Niger River . The FAO governed over applications of endosulfan and deltamethrin. Generally these applications occur during the dry season. A major problem with tsetse control is reinvasion of the vector after an area has been cleared. There was little or no data on specific amounts of pesticides used (Balk 1984).

**4.5 Onchocerciasis**

Onchocerciasis, or river blindness, is a disease in West Africa which has been a major deterrent to development of the riverine areas. The black fly. *Similium damnosum*, is the vector of the disease and inhabits the southern riverine areas of Mali.

Attempts to control the vector began in 1949, and between 1949 and 1967 the method of control was adulticiding the gallery forests with DDT, HCH, and lindane. However, the black files would quickly repopulate the area . They are strong fliers flying up to 15‑18 km/day and have been known to travel as far as 120 km from their breeding places . Adulticiding is now limited to control of reinvading flies, to complement larviciding where there are outbreaks of resistance to the larviciding chemicals, or to isolated breeding sites which make larviciding too costly (Garms 1987, Kurtak 1987).

In 1974, the World Health Organization (WHO), began the Onchocerciasis Control Programme (O.C.P.) . The program was designed for a twenty year period, with 764,000 km2 under control in seven west African countries and a western extension of 445,000 km2 into Mali and Senegal proposed for 1986. Before the inception of the OCP, 1.5 million out of 2 million inhabitants were infected With the disease With more than 100,000 people band. In hyperendemic villages, 80% of the people had the disease and 25‑50% of the adults were band. The object of the OCP was to reduce the vector populations to a “tolerable” density, an effort to control rather than eradication. As of 1984, there was a 97% reduction to occurrence of infection among children in 90% of the treated area. In addition, in the country of Burkina Faso, there was resettlement of 20‑32% of unoccupied arable lands (These figures all refer to the total OCP area and include Mali) (Philippon 1987).

The long term strategy of control includes chemotherapeutical research, a territorial extension of activity, and a more selective, cost-effective approach. This means extensive research on parasite and vector identification, vector behavior, man‑vector relationship, resistance, insecticides, vector‑control relationships. An independent ecological survey group has monitored the effects of the pesticides used. Sampling was done routinely several times a year on fish and invertebrate populations. After ten years, no detectable effects of the compounds used were discovered on fish and only slight but reversible impacts were found on invertebrates. It was discovered that sometimes the effects from agricultural pesticides surpassed the impact from the health control programs (Philippon 1987).

The OCP 's primary method of control is larviciding. The black fly larvae suspends itself from substrate in fast moving water. Because they are filter feeders, the chemicals are sprayed into the water and are ingested by the larvae. The advantage of this is a minimal amount of insecticide can be used for selective results. The chemical products were chosen with the

guidelines of no acute or long‑term effects on fish or crustaceans with an adequate safety margin, and a minimum toxicity to mammals of oral LD50 1000 mg of formulation/kg.

The chemicals used are the organophosphate temephos (Abate) which has a maximum reduction on non‑target invertebrate populations of 25-30%, chlorphoxim which is more toxic to nontarget species, and B. thuringiensis H.14 BtH14 is a biological control agent, which has been used against strains of larvae resistant to the organophosphate chemicals. The selectivity of BtH14 is better than the other products, but much more expensive as 3‑6 times more product is required at each application and its use is limited to slower flowing waters. Permethrin has also been used but it is limited to high waters because it is more toxic than either temephos or chlorphoxim to nontarget invertebrates. Water conditions can influence the effectiveness of the insecticide, as large amounts of algae can neutralize permethrin and reduce the effectiveness of BtH14. BtH‑14 and the chemical insecticides are alternated to ease pressure on non‑target species and to retard resistance to the insecticides (Cummins 1990, Kurtak, 1987).

Treatment of the insecticides is to the fast moving parts of the river systems at weekly intervals throughout the year. In the river basins, treatments are suspended seasonally, with 18,000 km of river treated per week in the wet season and 8,000 km of river treated during the dry season. In 1980, it was estimated that 270,000 liters of insecticide was used in the program area. The river systems in Mali treated this way include the southern Niger, the Bani with its tributaries the Baoule, Bagoye, and the southern Senegal with its tributaries the Baring, and the Bakoye (Balk 1984).

**4.6 Discussion**

The map enclosed Illustrates the geographical areas which are under vector control programs. Also important is the temporal distribution of the application of the pesticides. The following calendar illustrates this periodicity. The majority of the continued use is during the wet, growing season. When considered along with the agricultural and locust spray programs, there is a temporal overlap . There was little to no specific data on amounts and type of chemicals used. Specific geographical information was also unavailable. The lack of data and the difficulty of obtaining data supports the idea that there is a need for Coordination of the pesticide use in order to minimize environmental impact.

**5.0 PROTECTED AREAS**

**5.1 The Role of Protected Areas**

Mali has set aside some of its land as protected areas. Other regions are also environmentally sensitive but not protected. Some general background information on protected areas is described below. Protected areas conserve the natural resources of a country and benefit it's future by increasing the information about its ecosystem.

The IUCN has established seven roles for protected areas (IUCN 1989b).

1. Preservation of genetic resources in arid and semi/arid zones: Plants have evolved to tolerate drought, heat, and salt; research into these genetic resources could benefit cultivated plants under the same stresses. Some plants produce toxins against environmental stress which have been beneficial in cancer research. These plants are representative of small and isolated families with unique biochemistries which may be beneficial in presently unknown ways. Conserving them gives Society a potential base to improve agricultural techniques and provide for medicinal research.

2. Provide for ecological research. The studies of how an ecosystem functions, the linkages and relationships between communities, the regeneration of indigenous species, combine to provide a record of the ecosystem which has little or no influence from man. Long‑term development planning requires the background of the natural system in order to determine whether the changes in the environment are due to regional environmental shifts or man's influence.

3. Scope for tourism, education, and associated employment. This area has been successfully implemented by some African nations and is generating income for the country while preserving its natural systems

4. Conservation of renewable and harvestable resources. Local communities use plants for ropes, fruit, medicine, building poles and the wild meat for food especially in times of drought. The wetlands are important as a source of water for both livestock and humans as well as fisheries. Protection of animals such as turtles and crocodiles could lead to farming of these species and become a source of income .

5. Stabilize water run‑off from watershed systems. A good vegetative cover and deep soils will absorb rainwater which will be released onto the systems during later dry periods.

6. Protect soils from erosion; a natural vegetation cover maintains the soils stability and fertility.

7. May contribute to climatic stability through the maintenance of the natural vegetation cover. It is thought that the general trends of transpiration, evaporation are influenced by vegetative cover, and that the rainfall deficits ln the Sahel are finked to overgrazing and an increase in cultivation.

**5.2 Mali’s Protected Areas**

Mali's attention to protected areas began in 1969 with its Hunting Act, which provided for the establishment of national parks. The definitions of these followed the 1968 African Convention of Conservation of Nature and Natural Resources. Mali has three wetland sites west of the Niger Inland Delta which enable her to ratify the Ramsar Convention on Wetlands. Mali's fourteen reserves includes one of international significance, the Boucle du Baoale, which is part of UNESCO's Man and the Biosphere project. UNEP had recommended that 10% of a country's total land be established as protected areas. Mali's protected areas are only 3.2% of her total area. In Mali, overpopulation and drought have put increasing pressure on its protected areas. Encroachment on these lands by farmers, hunting, and wood cutting has made management of these lands even more difficult (MacKinnon 1987, Warshall 1988).

Most of Mali's protected areas are in the Sudanian woodland region. One reserve, the Asongo‑Menaka is in the Sahelian zone. There are no protected areas in the Sahara regions, although there are endangered species living there. An area in need of protection are the Spartan forests. These gallery forests along the rivers provide habitat for many species and are used as a refuge in times of drought. The area south of the Manantalli Dam on the Senegal River is an example of riparian forest being destroyed by the dam. There is a proposed reserve along the Bafing river which would compensate for the loss of these forests. The Inland Delta of the Niger River, an internationally important wetland, is largely unprotected except for three Ramsar sites and the Elephant Faunal Reserve which includes part of the eastern Delta (Warshall, 1988).

The Boucle du Baoule is a national park, part of the international UNESCO Man and the Biosphere project. It's core park is totally protected, with partially protected “buffer zone” reserves around it . The designation of a Biosphere Reserve implies several important ideas. It means that the park is a standard for measuring long‑term changes in the ecosystems and provides facilities for education and training. Its purpose is to conserve the diversity and integrity of the biotic communities, and their genetic diversity within the ecosystems. A priority “A” rating was given to this park by IUCN, which means it is of global importance with major wildlife resources and unique examples of its ecosystem (MacKinnon, 1986).

Mali has been able to ratify the RAMSAR Convention on Wetlands with three sites Within the Niger Inland Delta. This is an international policy to provide wetland protection throughout the planet. The three Inland Delta reserves have been established as multiple use areas. IUCN has been working in the Delta under the Mali National Directorate for Forests and Water (DNEF) along with the World Wildlife Fund and the West German Ministry for Economic Cooperation (BMZ). The project, called the Inner Niger Delta Conservation Project, is designed to develop a means of sustainable utilization of the wetlands while conserving the natural resources. The three sites are at Lake Debo) Lake Horo, and Seri (IUCN 1990). The Elephant Faunal Reserve is primarily in the Sudanian biotic region, but it does include some of the Inland Delta. Although only partially protected, this area is the second protected area in Mali which has been given a priority “A” rating (MacKinnon 1986).

**5.3 Problems of Protected Areas**

The use of pesticides which overlap into the environmentally sensitive areas of Mali impact on these areas which are already under great stress. To fully understand the implications of the possible toxicity caused by the pesticides, the other impacts on Mali's environment are discussed. Mali has been under tremendous environmental stress since the drought of 1969‑73 and again when the rains failed in 1982, and 1984. The protected areas became sanctuaries of water, firewood, food, and grazing. The farmers allowed their animals to migrate into the parks for water and food. In some cases, such as the Boucle du Baoule National Park, trees were killed by Moors resulting in subsequent settling and farming of groundnuts. Hunters and poachers often enter into the protected areas and are a constant threat to wildlife. The drought also has encouraged wild animals to wander out of the parks in search of water and food and they have been shot by farmers as pests (Warshall, 1988).

Loss of habitat is another major problem for wildlife. Mali's population increase has led to destruction of woodlands for firewood, the overgrazing of livestock on already stressed rangelands, and migration onto previously unsettled lands.. Human settlement in Mali has largely remained in the 400‑800 mm rainfall zones and the Niger River Delta. In the drier northern lands some nomads exist. In the more humid southern areas, the diseases onchocerciasis and trypanosomiasis, have been a major deterrent to development, and Wildlife was largely undisturbed here. However, with the increased control of disease and consequent settlement of these zones, there has been a resulting loss of wildlife habitat (MacKinnon 1986).

Despite Mali's severe restrictions on hunting, it continues. In the Sikasso, Mopti, and Bamako markets the following were noticed for sale as late as 1988: monkey and baboon skins; chimpanzee hands; civet and serval or leopard skins; antelope skins; crocodile, monitor lizard, boa, and python skin pieces; two crested crane heads; turtle shells and other reptile parts. The Malian government gave permission in 1988 to shoot one of the last two giraffes in the Asongo‑Menaka Reserve essentially leaving the giraffe extinct in Mali. The large carnivores have been killed off as well as the large game species (Warshall 1988).

The environmental consequences of the loss of the large mammals are to increase the desertification process. The large seeded legumes require the game species for seed dispersal and growth stimulation. With the depletion of the game species and subsequent decrease in the plants requiring them there is an increase in habitat loss and a decrease in the carrying capacity of the land. The loss of large carnivores results fin penetration of the thicketed areas by cattle. The loss of these forests is a loss of drought fall‑back foods. The tramping and soil compaction due to the overgrazing reduces the groundwater infiltration rates and promotes loss of soil (Warshall 1988). Another problem for wildlife in Mali is their inability to survive in small sanctuaries. The protected areas in Mali do not consider the migratory habits of the animals. Although a series of parks adjoin each other, no ecological survey has been done of corridors and migration routes. The slant eland, the chimpanzee, and the elephant need safe‑passage corridors established. These animals travel out of the parks into the unprotected areas where they fall prey to poachers, or are shot as agricultural pests (Warshall 1988). Mali is a poor country trying to feed and employ its people. A major problem of the protected areas is the conflict between people and wildlife using the land. The increasing population demands that conflict resolution be a large part of the management of the protected areas. Multiple use areas and ways to encourage sustainable conservation and development are increasingly important and practical. The Malian government has interest in restoring the environment and the best environmental education in West Africa is the Walia magazine and school programs of Mali.

**5.4 Species List**

The mammals threatened in Mali include the elephants, of which a herd of 100 remains, and the hippopotamus which is on the verge of extinction with only 6‑8 living within the Cercle of Youvorou in the Inland Delta. The warthog and the manatee are although they are still considered threatened are beginning to gain in number. As of 1986, the preservation of the West African manatee along the Niger in Mali was considered a conservation action priority by the IUCN. The Dama gazelle is vanishing as well as the lion. The giraffes, hit hard by the drought and hunting ,are drastically reduced in numbers and virtually extinct in Mali. There is a band of chimpanzees near the Guinea border although they are unprotected. The slant Eland is represented in Mali and Senegal but these are the last remaining herds. Other ungulates, including the addax in the Sahara, and the oryx are considered threatened (IUCN 1989a, Warshall 1988).

Although there is some consideration of establishing Crocodile farms in Mali, as of 1989, this has not happened. Hunting, although officially banned, is still a primary threat to all animals in Mali including the crocodile. Birds species in Mali are represented by species endemic to Mali, intra‑African migrants, and European migrants. The Inland Delta serves as a refuge for these birds which congregate there. Therefore the composition of the species vanes during the year. The number of palearctic bird species wintering is West Africa is estimated at 175. The Sudanian region has 319 species of passerine birds and the Sahellan region 211. Four habitats are important to the birds of Mali: the Inland Delta, the enclosed valleys from Monts Mandiques to Adrar; the cuff faces; the temporary or perennial ponds within the Sahel. The enclosed valleys are extensions of southern vegetation and contain undisturbed forest habitat (due to inaccessibility). The ostrich in Mali, although not included below by MacKinnon, is vulnerable to extinction because its eggs are collected for sale (Balk 1984, MacKinnon 1986, Warshall 1988). The birds regarded as threatened in the Sudanian and Sahelian regions are shown in Table 5.4.

**5.5 Water Resources**

**5.5.1 The Senegal River**

The Senegal River flows through Mali, Mauritania) and Senegal. The OMVS (Organization pour la Mise en Valeur du Fleuve Senegal) was created in 1972 by all three countries. It is responsible for the development and projects which use the resources of the Senegal River Basin (SRB). Its plans have included a navigation system up‑river to Kayes, Mali, a dam at Diama Senegal and a dam at Manatali, Mali. Since these dams have been bunt the river is in an extensively modified condition.

The variation in river flow rate has disappeared resulting in a depletion of the fish populations whose breeding were triggered by river flux. Fish populations which required lateral migration into floodplain pools for breeding have also been harmed. There is a reduction in floodplain grazing and flood recessional agriculture., until the irrigation agriculture develops. This is thought to be a fifteen to twenty year period. The nutrients brought into the area by the river will need to be replaced by fertilizers. There is an expected impact from fertilizers, pesticides, and sediments. The switch to counter seasonal rice will increase the problems of waterfowl destroying crops . The two season rice cultivation will attract the birds Just before they leave for spring migrations. The floodplain forest has been reduced and is unprotected. These forests are sanctuaries for birds during times of drought. The OMVS has not acted on developing artificial estuaries to increase fish species stock (Warshall 1988).

The irrigation canals are expected to increase the diseases schistosomiasis and malaria . As of 1980, malaria was responsible for a mortality rate of 10‑15% to children under two in this area. Insecticides are expected to be used in controlling these problems (ALIC 1980).

**5.5.2 The Niger River and Inland Delta**

The Niger River flows for 1700 km southwest to northeast and then southeast again in a great arc. It is divided into two navigable stretches by a waterfall over sandstone outcrop below Bamako. The flow Just above the falls is managed with canals and barrages. From Koulikoro to Samsanding north of Mopti, the river is in a valley and flooding is restricted. There are numerous water management schemes here and this area is highly cultivated. The next area is the Inland Delta region and is managed by the Office du Niger with a dam at Sansanding and a network of irrigation canals (see maps 14, 15 for development areas). The river divides at Diafarabe and rejoins at Lac Debo. From Lake Debo to Kabara, the riverport of Tombouctou, the Niger flows in a network of streams and lakes. Above Kabara the Niger becomes a single stream again and turns southward at Bourem creating the Niger Bend (ALIC 1980, Moorehead 1989).

The Inland Delta is the largest floodplain in West Africa. It is one of the most important wetlands in Africa and its rich ecosystem relies upon the seasonal flooding and the rainfall. During the period of high water, the inland delta can inundate up to 40,000 km2 (Moorehead, 1989).

Cattle, fishing, and crops of millet, sorghum, rice, peanuts are the primary agricultural activities in the Delta. The floodplains are especially Important to the pastoralists who follow the receding waters with their cattle. The fisheries are some of the most productive freshwater fisheries in Africa yielding 90,000‑110,000 tons a year. About 500,000 people live in the delta area. It is estimated that 150,000 live from fishing and farming, 200,000 from farming and herding, and 75,000 from full time herding. Over one million cattle and two million head of sheep and goats use the floodplain each year (Moorehead, 1989).

This area has also been troubled by the drought. In 1984‑85 the actual area inundated by the flood had been reduced to 10,000 km2. Similarly the cereal productions, fish, and livestock figures all fell 35%‑75% from 1977-1987. This narrowing of the resources has put increased pressure on the delta including a developing market for wild products. Wild grains, dried pasture, wild fruit, waterfowl and forest products for fuel have all been commercialized (Moorehead 1989).

Another problem related to the ecosystem of the Delta is the changing in the flood regime by the upstream dams (Selingue and diversions to the Canal du Sahel). These diversions lower the flood peak and change the timing of the floodwave. The slight changes in river pulse can have major economic effects as slight increases in river level disproportionately inundate acres of grassland and floodplain agriculture. The Selingue Dam (1982) has favored upstream production over the inner delta. Release timing has not been set to maximize flood height, duration, or area within the delta which would increase fish production. The IUCN has proposed an examination of river basin management to mitigate this situation (Warshall, 1988). The Inland Delta supports some 130 species of fish, 350 of birds including 108 of the major migratory species. The Ramsar sites are important zones for these birds. These sites, the lakes Walado and Debo(1031 km2), Seri (400 km2) and Lake Horo (190 km2) make up 5% of the total Inland Delta region (IUCN 1990, IUCN 1989a).

**5.6 Pesticides and Protected Areas**

**5.6.1 Estimating the Effects of Pesticides**

To estimate the effect pesticides may have on an area, a stepwise procedure should be implemented similar to the procedure used in the agriculture chapter. First, the seasonal vulnerability of the species should be established. This would include breeding and reproductive seasons, periods of mounting fattening for migrants, and early life stages. Next an overlap of activities in the area, and an estimation of when the pesticides are applied (from previous chapters) and whether it is a crop with low, moderate, or high pesticide requirement. Table 5.5 is a calendar of the reproduction of some of the birds living within the Delta (IUCN 1987)

If this calendar is compared to the following calendar of productivity in the Delta area, there can be an estimation of pressures upon the birds by agricultural pesticides (Moorehead 1989p). (Rice is a crop which uses a moderate to high amount of pesticides).

Table 5.7 depicts another calendar Comparing the activities of the region is as follows:

Most of the vulnerable stages for the birds occur from June through January or February. This is also the time of highest pesticide application. Therefore on a temporal basis at least, the implications are that the pesticide use will have a negative effect on the birdlife in the Delta.

**5.6.2 Fish and Aquatic Systems**

Most fish species in the tropics are adaptable to the changing environment of the wet and dry seasons. Spawning generally occurs at the beginning of the flood season and at the edge of the floodplain. Various species migrate with the seasons, sometimes with the young fish and adult fish of the same species living in different areas and becoming parts of different communities during the wet season. As flood waters recede, fish populations become concentrated in the residual pools. Under these circumstances, pesticide exposure is severe (Balk, 1984).

When fish are stressed either by pollution, fishing pressure, or environmental disturbances, the trend is towards the smaller, faster growing, shorter lived species. However the preferred food species are the larger slower growing species. Therefore attention needs to be paid to fish life cycles, and principles of closed seasons would be considered with regard to pesticides. Spawning sites should be respected and the reproductive and early life stages considered for the closed season.

Pesticides enter the water systems via agricultural run‑off, drift from aerial spraying for locust/grasshopper, and directly by health control organizations. Operational procedure for the locust control program prohibits treatment adjacent to water bodies. If pesticides are applied directly to standing bodies of water the effects are more harmful than if applied to the fast moving waters of streams and rivers since these may be repopulated from other areas (Balk 1984).

Species of fish vary greatly in their toxicity to pesticides and not much study of African fish has been done. The few species that have been tested, the cichlids and the tilapia, do remain within the same toxicity range as North American species. Toxicity to fish and to the aquatic Invertebrates vary greatly (Tables 1.4 and 1.5) (TAMS 1989).

Pesticides can affect ecosystems directly or indirectly. Food chain transport can transfer the toxics from prey to predator and the concentration may increase as it goes up the food chain. This can be a problem for predators such as birds or humans when eating the contaminated fish. The aquatic system can de indirectly affected by exposure from pesticides. The chemicals may settle or adsorb to the sediments, concentrating the contaminants. This poses a risk to the organisms living or feeding near the sediments. Pesticides may affect the ecosystem Indirectly by creating a loss of food organisms, shifting the competitive balance by weakening the prey species, or changing plant growth which affects the light penetration.

Pesticides applied near the floodplain area may be inundated into the floodplain system. Buffer zones of “no spraying” must occur outside the general floodplain of a river to avoid exposure. Recommended buffer zones are 5 km for borders of wetlands and 16 km for the area of origin and outlets. In some cases however, crops are planted up to the water's edge so buffers may not be possible. Rice paddies in the Senegal River Basin have been known to have been sprayed directly for grasshopper control. It would be expected that most of the fish would be killed as well as most of the invertebrates (TAMS, 1989).

**5.6.3 Birds**

The birds in the savanna habitat include the residential species, the intra‑African migrants and the intercontinental migrants (Figures 14 and 15). Some of the intra‑African birds migrate southwards in the dry season and follow the rains northward, others appear seasonally from the equatorial zones. Many species from Europe winter in the Delta, including European ducks and waders. During drought entire populations of Waterbirds from all over the Sahellan region may congregate at the Inland Delta (Warshall 1988).

Very little data is available on bird mortality from the use of pesticides in Africa. However, in 1980, thousands of storks died after locust control. It is not known whether the storks died because of the pesticides used or due to the loss of locusts as a food for the storks . it is reported that locust control also has effected the Captors Montagu's Harrier (*Circus pygargus*), Red‑footed Falcon, some herons, the cattle Egret, shrikes (*Lanlidae*), rollers (*Coraciidae*), bee‑eaters (*Meropidae*) and some small birds such as the European Whitethroat (*Sylvia communis*) (Balk, 1984).

The spraying or coating of seeds with pesticides may have contributed to the deaths of seed eating birds. Ducks, the black‑tailed godwit, and the ruff are considered pests in rice growing regions; they will eat seeds and often trample the seedlings. Out of season crops planted on irrigated fields are attractive to birds and seed coatings have been used to prevent them from damaging the crops. The use of insecticides fin the rice fields has decreased the populations of fish and insects upon which some birds like the herons depend. Contamination of the bird's habitat, and depletion of the food organisms are the most relevant effects of pesticides on birds (Balk 1984).

**5.7 Sahara**

The Sahara desert in Mali is unnecessarily unprotected. Within it there are the endangered species the addax, the oryx, and the scimitar horned gazelle. There are also important watering areas. Both oases and temporary lenses of water are necessary for the nomads and their livestock as well as wildlife. It is assumed that migrating birds use these resources as well.

The spraying of pesticides over the desert has been considered for two reasons. One is to use as a barrier spray against the hopper bands of locusts where they may be crossing before they swarm. Another purpose of spraying pesticides into the desert is to deplete the stores of old, expired, and/or banned pesticides. However the theory that these pesticides are "diluted" by the desert does not consider the effects on the lenses of water. In the sandy soils, the chemicals become concentrated in these lenses., Furthermore many of the old stocks are of dieldrin, a very persistent organochlorine. The effect of this Contamination for wildlife and humans should not be ignored (Cooper 1990).

**5.8 Summary**

Pesticide use appears to overlap with environmentally sensitive areas and even with protected areas. Although there is a no spraying policy for the national parks, the encroachment of agriculture onto these areas suggests the use of pesticides as well. The Inland Delta of Mali is a particularly important wetland for the entire West African region. Although there are some areas set aside for wetlands conservation, the Inland Delta is a primary agricultural center. Rice cultivation uses pesticides. Development projects and irrigation create health problems controlled by pesticides. For these reasons, this wetland is most likely to be impacted from the use of pesticides.

Referring to the maps of the Inland Delta (Figures 14 and 16), it is clear that many of the bird habitats are not within the Ramsar Sites. Additionally, development projects are adjacent to major bird habitats. This suggests that pesticides will pressure these areas.

The national parks of Mali are located fin the crop growing regions of groundnuts, sorghum. The maps suggest a low to moderate use of pesticides in these areas. There does not appear to be much relevance between the areas sprayed for locust/grasshopper and the protected areas, except for the possibility of spraying over the Sahara which would impact an unprotected but Sensitive region.

**5.9 Impacts of Pesticide Use on the Environment**

Mali’s environmental problems are intertwined with the pressures of feeding and employing a growing population. As people encroach onto any available arable land, there is a consequent loss of forest and wildlife. With the decline of the natural balance in the ecosystem, its resilience to stress decreases. Additionally, the natural stress of the periodic droughts which occur in the Sahel intensifies desertification. in order to feed its people, Mali must both expand its arable land and amplify the productivity of the land under cultivation. To this end, the trends in Mali's agricultural systems have been to increase the use of pesticides over the last ten years. predictions by the FA02000 are that these trends will continue for the next several decades (Balk 1984).

As described by Balk and Koeman, the land has four essential functions of material value to mankind. These functions are production, Carrier, information, and regulation. Production functions are supplies of material or energy from the environment to societies, such as water, agriculture, wood. Information reservoirs of biota offer potential benefits from genetic resources, research, and education. The environment acts as a carrier of human activities, for example recreation, building and construction, waste . Regulation functions include the ability of the environment to purify water and liquid waste processing, filter dust from the air. Other important regulatory features of the environment are the stabilization of climate, the properties of water and its influence of the ecosystems and the son (Balk 1984).

Pesticides impact these functions. By depletion of non‑target groups such as pollinators, parasites, and predators, there is interference with the production function. Loss of attractive species will decrease its economic value for recreational purposes. Loss of species interfere with the information function, and toxification of natural systems will negatively effect the regulation functions. The setting aside of protected areas is an important but partial solution. As pesticide use appears to be an increasing and integral part of the agricultural system, guidelines for their use should be implemented in order to minimize their effects on an already stressed environment.

**6.0 GENERAL RECOMMENDATIONS AND DISCUSSION**

**6.1 Impact of Pesticides in Mali**

Based on the available data we are able to make the following conclusions.

There is little to no overlap between the vector control pesticide use and the pesticide applications from the locust/grasshopper control. The health program's applications do occur geographically and temporally with the agricultural pest control programs especially to southern Mali where most of the cotton is cultivated. However, the environmental risks from the vector control programs such as the OCD are closely monitored for any ecological significance. By using target‑specific pesticides and improving application techniques (e.g., computerized applications from helicopters), these risks have been minimized. The Onchocerciasis Control Program has found that the agricultural pesticides have had a greater impact on the water in their areas than its own insect control pesticides (Cummins).

There does appear to be an overlap ln pesticide use between the locust/grasshopper programs and the agricultural use of pesticides. The areas with the most overlap lie within the grasshopper “at risk” zone between the 14th and the 17th parallels. Referring to maps six and eleven, the greatest occurrence of overlap is in the rice growing Delta area around Mopti and in the cotton growing region of Nioro du Sahel. The areas south of Bamako and east towards Sikasso where most of the cotton is grown (and therefore the area of highest agricultural pesticide input) has little to no need for locust/grasshopper control. This Section of the country is impacted primarily from the agricultural pesticide use.

Control efforts against locust infestations and the control efforts against grasshopper infestations have generally been considered as one campaign but they should be considered separately when examining their environmental effects. Locust plagues are cyclical and depending on the strength of the invasion are treated accordingly. Conversely, grasshoppers, especially the Senegalese Grasshopper, are a constant threat to Mali's Cultivated areas and theft control is on a more regular basis. Map 11 describes the locust/grasshopper treatments for the year 1989. The trends for locust/grasshopper control are for an increasing use of pesticides. Although USAID recommends a buffer zone of non‑chemical use around bodies of water, there are reports of pesticides used in the rice fields of the Senegal River Basin for grasshopper control. Negative effects on fish and invertebrate species should be expected fin these Circumstances (TAMS 1989).

The occurrence of pesticide use overlapping with environmentally Sensitive areas is demonstrated by maps three, thirteen, six and eleven. The locust/grasshopper control programs seem not to overlap with Protected areas, except for the applications Within the Inland Delta area which should be considered a risk to that wetland. The health control programs do not appear to affect the official protected areas of Mali. However, wherever development and therefore man made bodies of water exist, there is the potential of vector control with pesticides. In a similar way, where there is no agriculture, there is no overlap of pesticide use with the protected areas. However, as the population grows, there is a spread of cultivation into these areas, bringing with that the chemical pest control.

The area in Mali which seems to be most at risk from pesticide use is in the Inland Delta area, especially near Mopti. This internationally important wetland his a critical habitat for bird and animal species as well as an agricultural center. Rice, groundnuts, and cotton are considered high pesticide consumers by the FAO and these are primary products of this region. Therefore it can be assumed that this area will be an area of high to moderate pesticide use. The locust and grasshopper controls have also sprayed in parts of the Delta. Insect vector control is generally necessary where irrigation and development schemes have created man‑made bodies of water and the resulting use of pesticides needs to be monitored. Migratory and residential birds have been negatively affected directly by seed dressings, and indirectly by loss of invertebrate food sources, and loss of habitat (Balk 1984, Warshall 1988).

**6.2 Discussion**

In Mali, overlaps in pesticide use do occur. Environmentally sensitive areas, already stressed from drought, are placed under greater stress when pesticides are applied to them. There is a trend towards increased use of pesticides in Mali, because of an increase in cultivation and a growing trend towards chemical control of pests. There are many separate programs using this type of pest control with no national policy on pesticides or their application. There are many vulnerable areas in Mali, some are protected by the government and others are not.

Mali is an example of a developing nation with complicated environmental problems. It is impossible to simplify the impacts of pesticides Without trying to understand the other pressures which are involved. Solutions can be attained with careful and comprehensive planning. However this type of planning can only be achieved with reliable data and statistics. It is important that a national policy on pesticide use be implemented so that the impacts from pesticides be minimized on this already fragile ecosystem.

**6.3 Recommendations**

1. Mali needs a national policy on pesticide use. At the present time, the use of pesticides are in the hands of different international and national agencies. There is no national policy on pesticides nor guidelines which could be followed. There needs to be a national list of approved chemicals. At this time, most pesticides are donated and accepted by Mali without reservations. Legislation on pesticide application should be developed. Buffer zones of non‑chemical use need to be installed near bodies of water, human settlement, and protected areas. Likewise temporal “buffer zones” should be established to protect the seasonal Vulnerability of species; for example breeding, reproductive, and early fife stages of fish and birds. The principles of IPM should be accepted and adhered to whenever possible.

2. A national coordinating body should be organized to gather statistical data from pesticide consumers and make it available to land‑use planners. To date there is no national coordination of pesticide use and no accumulation of statistical information on the usage of pesticides. Different national and international groups from agriculture, health, and locust activities all use the pesticides without coordination. The burden of gathering data could easily rest with the responsible agency since the average farmer obtains his pesticides through his particular development agency (e.g. CMDT, Operation Haute Valley).

3. A system of environmental monitoring of the impacts from pesticides should be implemented. Individual programs are monitoring the environment for example the WHO's Onchocerciasis Control Program which monitors the effects from its pesticides on a regular basis. Also, the Netherlands has a research team ln Mali working an the Boucle du Baoule National Park. This project, the Recherche sur l'Utilisation Rationnelle du Gibier du Sahel (RURGS), began in 1977 to study the utilization of the natural resources for the local population and to improve population build up among the wildlife. The Dutch also have a six‑year environmental anti-locust pesticide study in the neighboring Sahelian Countries of Senegal and Mauritania whose results could be relevant to Mali. At the request of USAID, the American company Dynamic and the SNPV conducted testing of eight pesticides used in the locust grasshopper control programs and their impact on the Sahelian environment in 1987‑88. However the largest consumers of pesticides in Mali, the cotton and rice producers, do not have a system of monitoring the effects from the agricultural pesticides (Appleby 1989, MacKinnon 1987, Stanley 1990).

. An assessment of the present and future hazards from pesticide use should be developed. Planning land suitability for crops will indicate which areas are likely to use high amounts of pesticides. The IUCN has recommended the following approach to assess the hazards presented by pesticide use. The geographical areas where “substantial” amounts of pesticides are released should be identified and compared to areas which are of ecological value. The uses and types of pesticides which could damage the biota should be identified and, if possible, avoided. A calendar of pesticide use should be compared to the seasonal Vulnerability of species and ecosystems in these areas. Alternative control methods should be considered especially where unacceptable damage would occur (Balk 1984).

5. Protected areas and critical habitats need to be carefully mapped and the recommendations of the IUCN acted upon. In Mali, the protected areas have been mapped by the IUCN both to 1986 and again an the Sahel Studies 1989 report. However the maps did not always coincide exactly. There are other unmapped critical areas which may be important when studying the impacts of pesticides. These areas mentioned by IUCN were the forests near Sikasso, the forests with chimpanzee populations near the Guinea border, the enclosed valleys of southern forests (an important habitat for birds), the elephant migration routes, and the wetlands of the Inland Delta. In this thesis, the protected areas map show only the elephant migration routes and the areas mapped by IUCN (MacKinnon 1986).

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Some Organizations had excellent data, notably the Malian Government SNPV's grasshopper/locust campaign report (obtained through USAID) and the WHO's Onchocerciasis Control Programme. Others had little to no statistics on the pesticide use. The CMDT (Cotton Development), funded by the World Bank, uses 70% of the agricultural pesticides in Mali and has no environmental monitoring program. Although they had general information on amounts of pesticides used, they did not have available to this thesis a detailed breakdown of which chemicals were applied where. Different agencies (Pesticide Action Network, World Resource Institute, USAID) trying to collect data on pesticide use had similar responses to their efforts — little to no hard statistics from many of the different agencies.

I am grateful to Ron Stanley and Walter Knausenberger, both of USAID, who were very helpful. Several documents were invaluable, especially the IUCN's Ecology Paper #6 by Ir. F. Balk and Dr. J.H. Koeman and the Opportunities for Sustained Development by Peter Warshall et al. I should also mention a report for the FAO by Herbert Alomenu which contained vital information.

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**APPENDIX 1**

**ACRONYMS**

AELGA Africa Emergency Locust and Grasshopper Assistance

BMZ West German Ministry for Economic Cooperation

CILSS Comite Interetat pour la Lutte contre la Secheresse au Sahel

CMDT Campagnie Malienne pour le Developpement des Textiles

DNEF National Directorate for Forests and Water

ECLO Emergency Locust Control Program (FAO)

FAO Food and Agriculture Organization (UN)

FEWS Famine Early Warning System

IPM Integrated Pest Management

IUCN International Union for Conservation of Nature and Natural Resources

OCLALAV Organisation Commune de Lutte Antiacridienne et Lutte Antiaviare

OCP Onchocersiasis Control Program

ODIK Operation Integre du Karte

OHV Operation Haute Valley

OMVS Organisation pour la Mise en Valeur de Fleuve Senegal

OSE Senegalese grasshopper (*Oedaleus senegalensis*)

RAMSAR Conventlon aimed to establish worldwide wetland protection

RURGS Recherche sur l'Utilisation Rationelle du Gibier du Sahel

SMPL La Societe Malienne des Produits Chimiques

SNPV Service de la Protection des Vegetaux (Mali's Crop Protection Service)

SRB Senegal River Basin

UNEP United Nations Environment Programme

UNESCO United Nations Educational Scientific and Cultural Organization

USAID United States Agency for International Development

WHO World Health Organization

**APPENDIX 3**

**AGROCHEMICAL COMPANIES**

Agrochemical Companies Involved in Importation and Distribution of pesticides to Mali.

UNIGOCE Representative of Rhone Poulenc Chemical of France

UMIMEX Agent of Shell Chimie

SODEMA Representative of Comeco, UK

RECOMA Agent of ALM International

SOPIAC Agent of Mitsui Co. and Ciba‑Geigy local office

Societe Representative of DOW

MAMADOU SADA DIALLO

(source Alomenu)

**APPENDIX 4**

**PESTICIDE AND LOCUST CONTROL PROGRAM DONORS FOR 1989‑1990 ‑**

Algeria

17,600 liters dichlorvos

1. gas/oil

Banque Africaine de Developpment

CFA for the acquisition of pesticides, equipment, and operational costs

Canada

10,000 1. pesticides

logistical equipment worth 5,292,315 CFA

FAO

208,965 1. pesticides

funds for pesticides, helicopter costs, operational fees

European Development Fund

l. of pesticides

ECUS for spray equipment and vehicle parts

France

6,000 1. of pesticides

vehicles, equipment, personnel

Switzerland

1. of gas

Norway

100,000 1. pesticides

helicopter hours

USAID

609,000 US$ for pesticides, laboratory equipment, fuel, two vehicles

(Rapport d'Activities, SNPV 1990)

**APPENDIX 5**

**IUCN RECOMMENDATIONS FOR MALI'S PROTECTED AREAS**

**A. Extend the Protected Areas System**

1. Establish the proposed national park at Faya. This area includes chimpanzees, elephants, giant eland and dunker.

2. Establish reserves to protect the species rich forests near Sikasso.

3. Establish a reserve to protect the remaining forest on the Guinea border an area with good chimpanzee population. A national park in the Bafing Makana region would mitigate losses from the Manantalli Dam.

4. Consolidate the proposal for Asongo‑Menaka partial Faunal Reserve, an area of Sahelian fauna (giraffe, ostrich, three species of gazelle) now threatened by poaching and encroachment from livestock.

**B. Improving Protection and Management**

1. Protection and management is poor in all protected areas in Mali. Poaching, brush fires, and encroachment by farmers and livestock threaten all reserves. Improved management will require increased numbers of trained personnel funding, equipment, transport, and other resources for all reserves.

2. Remove human settlement from within reserves or establish enclaves to exclude them from park lands. Disallow grazing of cattle an livestock within the reserves, even in times of drought.

3. At present, the Elephant Reserve does not give adequate protection to Mali's elephants. Olivier recommends that the existing reserve be redefined as a multiple use area covering the majority of the Gourma elephant range and that within this one or more sanctuaries be established as critical habitats.

4. Prepare and implement management plans for all major protected areas.

**C. Other Conservation Action**

1. Develop land use plans and programmes taking into account the needs of rural communities living adjacent to protected areas.

2. Study migration routes and patterns of elephants to determine the best protection and conservation measures for the elephant population.

3. Protect critical floodplain habitat.

4. Protect migration routes and habitats of the last herds of oryx and addax which migrate between Mali and Mauritania.

(MacKinnon 1987) 1986, IUCN 1989b)

TABLE 1.1. PESTICIDE CONSUMERS in Mali.

Pesticide Consumers Use

Cotton Development Board (CMDT) cotton

Crop Protection Service (SNPV) cereal

Operation Haute Valley tobacco, groundnut

Office du Niger irrigation

Operation Development Intergre du KARTA

Government Agricultural Service small farmer

Public and Animal Health Control disease control

World Health Organization onchocerciasis

SNPV (umbrella agency for programs) locust/grasshopper

(Alomenu, 1989)

Table I.2. Pesticide consumption for recent years by two of the major consumers in Mali.

Year Organization Insecticide Herbicide

liquid (liters) dust (tons) (liters)

1986‑87 SNPV 208,034 558

CMDT 1,579,970 146,930

1987‑88 SNPV 114,898 79

CMDT 1,429,400 113,256

1988‑89 SNPV 246,032 460

CMDT 952,320 166,700

USAID 300,000

1989‑90 SNPV 567,781 416,813 (kg)

(Alomenu 1989, Appleby 1989, SNPV 1990)

Table 1.3. List of chemicals used in Mali in recent years, their chemical family and their general purpose.

Chemical Family Use: Locust Bird Agriculture Health

Fenitrothion 1 X X

Cypermethrine 2 X

Fenvalerate 1 X

Dimethoate 1 X

Chlorpyrifos‑ethyl 1 X X

Permethrine X

Deltamethrine X

Malathion 1 X

Propoxur 3 X

Diazinon 1 X X

Bendiocarb 3 X

Endosulfan 4 X X

Dieldrine 4 X X

Lindane 4 X X

Fenthion 1 X X

Sumicombi 1 X

Lamda‑cyhalothrine 2 X

Pyrimophos‑methyl X

Dichlorvos 1 X

Gamophele X

Bromophos 1 X

Ofunack X

Carbaryl 3 X X

Chlorphoxin 1 X X

Temephos 1 X

Acephate 3 X

niclosamide X

DDT 4 X

l‑organophosphate

2‑synthetic pyrethroid

3‑carbamate

4‑chlorinated hydrocarbon

(Alomenu 1989, SNPV 1990, Stanley 1990 )

TABLE 1.4 RELATIVE TOXICITY TO NON‑TARGET ORGANISMS as estimated in USAID studies.

Chemical Persistence Bioaccumulation Toxicity

Fish Invert Bird Mammal

Dieldrin H H M M H H

Lindane M‑H H M M M-H M

Chlorpyrifos M‑H M‑H M H — M

Diazinon M M M H M-H L

Fenitrothion L M L H H L

Malathion L L L L M L-M

Bendiocarb M M M M M M

Propoxur L‑M L‑M L H L-M M

Cypermethrin M‑H H H H — L

Lamda‑cyhalothrin M H H H L H

L=low, M=moderate, H=high

(TAMS,1989 pg E‑56)

Table I.5, Recommended use of pesticides on different ecosystems by the TAMS 1987 Programmatic Environmental Assessment.

KEY:

Y=yes, used with caution,

N=no should never be used in ecosystem indicated,

C=caution, should only be used with proper mitigative measures, Snot around bees,

2= not around bird nesting sites,

3= testing and data very limited

Pesticide Aquatic Terrestrial

Carbaryl Y Y,1

Diazinon C,2 C,2

Dieldrin N N

Fenitrothion C,2 C,2

Lindane N N

Malathion C Y

Propoxur Y C

Bendiocarb Y,3 C

Chlorpyrifos C C,3

Cypermethrin N Y

Lamda‑cyhalothrin N Y

(TAMS,1989, exsum‑38)

TABLE 2.1 PESTICIDES ASSOCIATED with specific CROPS

Pesticide Crop

Fenitrothion rice, tobacco, cowpeas, sugarcane

Cypermethrine rice, cotton

Fenvalerate(sumicidin) rice, cotton

Dimethoate rice, cotton, groundnuts, cowpeas,

Chlorpyrifos‑ethyl rice, cotton, cowpeas, sugarcane, fruit

Permethrine cotton

Deltamethrine cotton

Malathion rice, groundnuts, tobacco, sugarcane, fruit sorghum/millet

Diazinon rice, sugarcane, fruit

(adapted from Balk, 1984, Appendix 6)

TABLE 2.2 NET CROP PRODUCTION (MT) BY REGION 1988‑89

Region Millet Sorghum Corn Rice Fonio Total

Segou 274,920 133,952 17,454 69,864 9,865 506,055

Sikasso 132,453 127,937 90,059 5,133 3,111 358,693

Mopti 268,269 21,554 -- 44,513 - 334,336

Koulikoro 138,564 146,213 34,366 1,061 1,900 322,104

Kayes 9,633 111,828 29,494 - 3,290 154,245

Tombouctou 26,019 28,773 - 13,167 - 67,959

Gao 62 1,308 - 13,061 14,431

Total 849,920 571,565 171,375 146,799 18,166 1,757,823

(FEWS 1990 Appendix B2)

TABLE 2.3 PRODUCTION OF COTTON, 1986‑87,1987‑88

Cercle Ha Cultivated Production (kg/ha) Production(mt)

86‑87 87‑88 86‑87 87‑88 86‑87 87‑88

Koulikoro 35,297 35,012 1,406 1,473 49,634 51,582

Bougounl 10,546 14,537 1,302 1,334 13,735 19,393

Sikasso 32,580 32,089 1,417 1,456 46,170 46,729

Koutiala 59,048 51,536 1,285 1,210 75,882 52,380

San 8,276 9,048 1,129 1,051 9,342 9,512

OHV 5,506 6,562 1,251 1,416 6,890 9,291

Total 151,253 148,784 1,333 1,337 201,653 198,837

(CMDT 1989 Table 27)

TABLE 2.4. COST PER HECTARE FOR PESTICIDES PER CROP

Crop Dollar per Hectare

Cotton 22‑140

Rice up to 10

Sugarcane 18‑26

Millet/Sorghum up to 7

Maize up to 5

Groundnuts up to 5

Tobacco up to 8

(adapted from Balk, Figure 7)

TABLE 2.7 CROP CALENDAR

fly sheet

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Crop | E | J | F | M | A | M | J | J | A | S | O | N | D | J |
| Millet  Sorghum  Sorghum(floodplain)  Rice  Rice(irrigated‑double crop)  Maize  Groundnuts  Cotton  Sweet Potatoes  Cowpea |  | · | ·  ·  · | ·  ·  ⮙ |  | ⮙ | ⮙  ⮙  ⮙  ·  \_  ⮙  ⮙  ⮙ | ⮙  ⮙  ⮙  ·  ·  ⮙ | °  ▪ | ⮙  ·  ·  ·  ⮙ | ▪  ★  ·  ·  ·  · | ·  · | ·  ·  · | ·  · |

Planting ⮙ Planting bulk of crop \_

Flowering ▪ Flowering bulk of crop 🞎

Harvest · Harvest bulk of crop °

Transplanting from seedbeds ★

Source: Future Hazards from Pesticides, Appendix 4

TABLE 2.8 PESTICIDE USE CALENDAR

fly sheet

Crop June July Aug Sept Oct Nov

Sorghum 3‑5 mo ⮙ ⮙ ▪ · ·

2 mo until crop \_ \_ \_

canopy close s ★ ★

Army Worms

Shootflies 🞎 🞎

Stemborers

Sorgho Midges 🞎 🞎 🞎

Seeddressing 🞎 🞎

Maize 70‑80 days ⮙ ⮙ ▪ · ·

until canopy closure \_ \_ \_

Army Worms ★ ★ ★ ★

Stemborers 🞎 🞎 🞎

mildew ° ° °

seeddressing 🞎 🞎

Rice 5 mo until ⮙ ·

canopy closure \_ \_

Stemborers 🞎 🞎 🞎 🞎 🞎

Rice Gall Midges 🞎 🞎

Planting ⮙ Herbicides \_

Flowering ▪ Insecticides 🞎

Harvest · Fungicides °

RES VAR resistent varieties ★

Source: Balk, 1984

TABLE 3.1 RATES OF DAMAGE OF GRASSHOPPER/LOCUST

Rate Cercle

60-100% Koro, Douentza, Nioro du Sahel, Diema

20-60% Dilly, Mourdiah, Nord de Segou

(Rapport d'Activities campagne 1989‑1990)

TABLE 3.2 HECTARES INFESTED AND TREATED MAY‑DECEMBER 1989

Month Ha infested Ha treated

May 500 371

June 8,000 2,156

July 20,000 8,267

August 189,000 89,483

September 650,000 387,432

October 1,200,000 656,507

November 100,000 710,579

December 20,000 722,492

(adapted from SNPV, l990 graph #2)

TABLE 3.3 PRODUCTION REDUCTIONS DUE TO GRASSHOPPER/LOCUST

INFESTATION 1989‑90

Region Cercle %of Normal Estimated 1989‑90

Production Production (mt)

Kayes Nioro 19 48,229

Yelimane 3 6,388

Koulikoro Banamba 13 48,353

Nara 10 38,980

Segou Segou 38 167,330

Macina 12 51,916

Niono 5 21,122

Mopti Mopti 12 49,618

Douentza 5 21,600

Koro 10 41,690

Youvarou 31 4,052

Tenenkou 20 78,429

Tombouctou Niafunke 54 43,245

Total 630,952

(adapted from FEWS 1990)

TABLE 3.4 HECTARES TREATED WITH INSECTICIDES BY CERCLE

Cercle Area Treated (ha)

Ground Aerial Total

1. Nioro du Sahel 110,254 103,625 213,881

2. Yelimane 32,264 100,225 132,489

3. Gossi 14,791 91,080 115,871

4. Mopti 41,415 57,496 98,951

5. Mourdiah 66,997 22,760 89,757

6. Niono 26,657 8,550 35,206

7. Kayes 12,723 14,250 26,973

8. Gao 3,280 8,300 11,580

9. Bamako 10,898 — 10,898

10. San 650 350 1,008

Totals 319,937 416,677 736,614

(adapted from SNPV 1990 Tables 6 and 8)

TABLE 3.5 QUANTITIES OF INSECTICIDES USED BY CERCLE

Cercle

1. Nioro du Sahel

2. Mopti

3. Yelimane

4. Mourdiah

5. Niono

6. Gao

7. Kayes

8, Gossi

9. Bamako

10. San

Totals

Powder (kg)

172,000

72,675

58,500

35,398

37,000

—

32,000

—

480

3,400

411,453 kg

Liquid (l)

97,025

114,100

87,145

70,261

66,800

76,924

19,246

25,640

9,650

1,090\*

567,881 liters

\*this number refers to pesticides against granivorous birds only

(adapted from SNPV 1990 tables 6 and 8)

TABLE 3.6 QUANTITIES OF INSECTICIDES USED 1989‑90

Pesticide amount #of cercles

Unden 2% (pp) (propoxur) 259,530 kg 7

Dursban 5% (chlorpyrifos‑ethyl) 129,830 kg 2

Fens ou Sumithon 3‑5% 22,093 kg 3

Fenitrothion 50% ULV 230,520 liters 9

Dursban 24% ULV 147,370 l 7

Malathion 96% ULV 75,950 l 8

Karate 4% ULV

(lamda‑cyhalothrine) 24,325 l 2

Lindane 320 ULV 23,115 l 2

Diazion 90% ULV 18,310 l 3

Dichlorvos 300 ULV 17,400 l 3

Fenthion 1000 11,320 l 2

Ripcord 12 ULV(cypermethrine) 6,221 l 1

Fenitrothion 1000 ULV 5,000 l 1

Ofunack 30 ULV 4,400 l 1

Fenitrothion 50 CE 2,500 l l

Ficam (bendiocarb) 1,300 l l

The total amounts used in 1989‑90 were 411,453 kg of powder, and 567,781 liters of liquid pesticide. In 1988, approximately 300,000 liters were used.

(adapted from SNPV 1990 Table 6).

TABLE 3.7 CHEMICALS USED IN EACH CERCLE

NIORO DU SAHEL: Unden, Fenitrothion 50%, Malathion, Dursban ULV, Karate, Ficam

YELIMANE: Unden, Fenitrothlon 50%, Malathion, Karate, Fenitrothion 1000

GOSSI: Fenitrothion 50%, Malation, Dursban

MOPTI: Unden, Feni ou Sumithion, Fenitrothion 50%, Malathion, Diazion, Dursban ULV

MOURDIAH: Unden, Fenitrothion 50%, Malation, Dursban ULV, Ripcord, Ofunack

NIONO: Unden, Fenitrothian 50%, Malthion, Dursban ULV, Diazion, Fenitrothion 1000, Fenthion 1000, Dichlorvos

KAYES: Unde, Fenitrothion 50%, Malathion, Diazion, Lindane, Dichlorvos

GAO: Fenitrothion 50%, Malathion, Dursban, Lindane, Dichlorvos

BAMAKO: Unden, Fenitrothion 50%, Dursban

SAN: Feni ou Sumithion, Fenthion 1000

(adapted from SNPV table 6)

Table 3.8, Campaign against birds for 1989‑90.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Zones | Hectares Treated | | | Pesticides (liters) | | |
| Air | Ground | Total | Fenthion | Diazion | Explosive |
| Niono  San  Nioro du Sahel  Totals | 3,650  350  —  4,000 | 20  —  102  122 | 3,670  350  102  4,122 | 10,160  1,090  -  11,250 | 840  -  -  840 | -  -  640 kg  640 |

(adapted from SNPV 1990)

TABLE 3.9 WATERBIRDS AND THEIR FOOD

Bird (common name) Food

Ruff lodged rice with invertebrates

Black‑tailed Godwit cultivated rice, wild rice, tubers, seeds

Fulvous Tree Duck cultivated rice, wild grass, wild rice, water lily

White‑faced Tree Duck tubers, rice, water lily, wild grass

Garganey wild grass, water lily, seeds

Egyptian Goose na

Spur‑winged Goose standing rice in Senegal

Knob‑billed Goose prunes young rice, causes mire and sprout death

Glossy Ibis immature rice

(adapted from Warshall, 1988 Table II.A)

Table 3.8, Campaign against birds for 1989‑90.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
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Egyptian Goose na

Spur‑winged Goose standing rice in Senegal

Knob‑billed Goose prunes young rice, causes mire and sprout death

Glossy Ibis immature rice

(adapted from Warshall, 1988 Table II.A)

Table 4.1 calendar of events

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Vector | J | F | M | A | M | J | J | A | S | O | N | D |

Mosquitoes ------------------------------------------------------

Snails ------------------------------ -- -- -- ------

Blackflies -- -- -- -- -- -- -- -- -- -- -- ------------------------------------------------------ -- --

Tsetse flies ---------------------------------------------------- -- -- -- -- -- --

Agricultural ----------------------------------------

------------------ continued use

use in interval

(adapted from Balk 1984)

TABLE 5.1 PROTECTED AREAS IN MALI; VEGETATION, SIZE

Name of Area Vegetation Type Area (ha)

National Parks (T)

#Boucle du Baoule 29a 350,000

Faunal Reserves (P)

#Badinko 29a 193,000

#Fina 29a 136,000

Kenie‑Baoule 29a 67,500

#Kongossambougou 29a 92,000

Partial Faunal Reserves (P)

Asongo‑Menaka 43, 54a 1,750,000

Gourma Elephant 29a, 64 1,200,000

Wetlands (RAMSAR)

\*Lac Horo 64 18,900

\*Seri 64 40,000

\*Walado Debo/Lac Debo 64 103,000

Forest Reserves (P)

Banfing Baoule 29a 13,000

Bossofola 29a 12,000

Faya 29a 80,000

Nafadji 29a 92,000

Talikourou 29a 37,600

T = Total Protection White's Vegetation Type

P = Partial Protection 29a = Sudanian woodland

# = Biosphere (or part of) 43 = Sahel acacia

\* = RAMSAR site 54a = Northern Sahel semi‑desert grass

64 = Edaphic grassland, semi aquatic

(adapted from IUCN 1989b. MacKinnon 1986, Warshall 1988)

TABLE V.2 MAMMALS FOUND IN MALI

Common name Scientific name Status

roan antelope *Hippotragus equinus* vulnerable

Defassa waterbuck *Kobus ellipsiprymnus*

Giant eland *Taurotragus derbianus* endangered

eland *Taurotragus oryx*

hartebeest *Alcelaphus buselaphus* endangered

oribi *Ourebia ourebi*

warthog *Phacochoerus aethiopicus*

giraffe *Giraffa camelopardalis*

elephant *Loxodonta africana* vulnerable

hippopotamus *Hippopotamus amphibius*

lion *Panthera leo*  vulnerable

leopard *Panthera pardus* vulnerable

cheetah *Acinonyx Jubatus* vulnerable

chimpanzee *P. troglodytes* endangered

olive baboon *Papio anubis*

vervet monkey *Cercopithecus aethiops*

patas monkey *ErythroceDus patas*

manatee *Trichechus senegalensis* vulnerable

addax *Addax nasomaculatus* endangered

scimitar‑horned oryx *Oryx dammah* endangered

slender horned gazelle *Gazella leptoceros* vulnerable

hunting dog *Lyscaon pictus* vulnerable

Dama gazelle *Gazella dama*

(Warshall 1988, MacKinnon 1986)

Table 5.3 THREATENED REPTILES FOUND IN MALI

Green Turtle *Chelonla mydas* endangered

Hawksbill Turtle *Eretmochelys imbricata* endangered

Nile crocodile *Crocodylus niloticus*  vulnerable

African slender‑snouted crocodile *Crocodylus cataphractus*  indeterminate

African dwarf crocodile *Osteolaemus tetraspis* indeterminate

(adapted from MacKinnon 1986)

TABLE 5.4 THREATENED BIRDS IN MALI

Common name Scientific name Status

Northern Bald Ibis *Geronticus eremita* endangered

Shoebill *Balaeniceps* of special concern

River Prinia *Prinia fluviatilis* insuff. known

(adapted from MacKinnon 1986)

TABLE 5.5 SEASONAL REPRODUCTION OF SOME BIRD SPECIES IN THE INLAND DELTA

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Scientific Name | Months | | | | | | | | | | | |
| J | F | M | A | M | J | J | A | S | O | N | D |
| *Phalacrocorax africanus*  *Ardea melanoceophala*  *Egretta alba*  *Egretta garzetta*  *Ardeola ralloldes*  *Threskiornis aethlopica*  *vernacular:*  *Anhinga*  *Heron cendres*  *Aigrettes intermediares*  *Herons noirs*  *Garde‑boefs*  *Bec‑ouvert*  *Spatule d'Afrique* | x | x |  |  |  |  |  | x | x | x | x | x |
|  |  |  |  |  |  |  |  |  |  |  |  |  |

(adapted from IUCN 1987)

TABLE 5.6 CALENDAR OF PRODUCTION OF INLAND DELTA

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Resource |  | | | | | | | | | | | |
| J | F | M | A | M | J | J | A | S | O | N | D |

(Drylands) Rains

Crops

Crop residues (millet)

Wild Food

Pasture

Forests

(Wetlands) water levels

falling low rising high

Crops

Crop residues

Wild Food

Pasture

Forests

Fisheries

(adapted from Moorehead 1989)

TABLE 5.7 CALENDAR OF ACTIVITIES WITHIN THE INLAND DELTA

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | | | | | | | | | | | |
| J | F | M | A | M | J | J | A | S | O | N | D |

rains (500mm)

agricultural

sedentary birds breeding

Intra‑African migrants

Palaearctic migrants

wintering

moulting, fattening

(adapted from Balk 1984)

CHAPTER 20: STANDARDS OF UNCERTAINTY

There is a huge discrepancy between disciplines of science, law and economics as far as the acceptance of uncertainty. Within science, statistical tests and other measures often strive for a confidence limit of 95% or greater - which as a measure of uncertainty would approach 5%. This limit is used to determine whether a hypothesis has been accepted or rejected, and in experiments it is designed to lead a researcher to the next stages of experiments - having determined that the first steps appear to be established sufficiently. This has major implications for the fields of medicine, for instance, when a drug is under trial - and of course has major cost implications as well.

Within environmental science, these kinds of standards are used to establish safe levels for chemicals in food and safe use of pesticides in agriculture. Again these standards are considered rigorous and high levels of certainty are demanded. However these kinds of standards are generally only possible in laboratory experiments, and in some limited field studies. Often, because of limited sample sizes or incomplete data, a lower standard is required - and hence begins a debate over what is an acceptable certainty. It is often said that the U.S. population is uncomfortable with risk (see chapter x on risk earlier) and wants a high degree of certainty when it comes to public policy. Areas to be considered include how safe is a drug (or a vaccine), how safe are electric power lines near, say school houses, or how safe does a car need to be, it may be that regulators and the American public will accept a lower level of certainty in some areas, but requires a very high level in others. (see EPA study on risk tolerance - for instance, people are much more worried about nuclear waste and chemical waste sites than they are about air quality and perhaps global warming). In a world with better and better communications through public media and the web, one anecdote about a safety problem is sometimes enough to set off a worry to the public on a particular level - so issue is what is the proper role of government - get back to that. Oak communication is also a big item - how that is given to the public - on nuclear waste a session said that it is more likely to be bitten by a lion than to he hurt by nuclear waste - that was not an acceptable analogy in a public session and there was a fire storm of protest.

In general terms, the public is much more concerned with risk they are exposed to that is involuntary - chemicals, drugs, safety hazards, etc. that they feel that they are unaware of and which it is the government’s responsibility to regulate. They are much more comfortable with voluntary risk and at least three - alcohol, nicotine and caffeine are probably responsible for a majority 6f risks. If you add drug use - both illegal and overuse of prescription drugs and it has been estimated that 90% of all regular risks are present. Leaving aside concerns about certainty on the voluntary risks (do you really want to know?); it is the certainty on involuntary risks that are the focus of public concern and the push for regulation.

Inevitably involving government and regulators introduces the element of law. The standards for law are much different than those of science. Within the law, there are criminal civil cases, where the standard of proof - the standards for uncertainty are "preponderance of the evidence" - some would say at least 51% certainty. In criminal cases the standard is highly - beyond a reasonable doubt (did I mix these up?) - which is higher than 51%, perhaps up near 90%, but undefined. Most people would probably say it is not as high as 95% required in science.

In public policy, it is often impossible to reach the 95% certainty in science. If the issue is so big or of great cost, but the data are not yet available or there is a strong debate on the significance of the data, then a decision has to be made whether an interim level of certainty can be accepted. Generally this is pushed by those in favor of the precautionary principle - if we wait to make a decision on some important policy - the current one of concern is global warming - then maybe it will be too late -- we will be beyond the tipping point and will not be able to make a difference. So the urge is to act now, rather than wait, even if there is some risk -or even high risk - that we may be wrong on our expenditure of resources - and there will have wasted money. We get into these debates all the time in government -should we cut down in the number of fish taken in a fishery to preserve the fish -or is it just another cycle and nature will take care of it later. Is global warming just a natural cycle that we have no control over or have humans contributed to the phenomenon?

So often there is a disconnect between the certainty demanded by the law in a case involving scientific data. Judges and juries are uncomfortable about science - especially when science is discussing probabilities and indirect relationships. And especially when it involves the use implicitly or explicitly of models - based on assumptions scientists may develop a prediction that may or may not be correct. Of course, forensics and crime scene investigators relay on these types of models. A DNA and blood analysis relies on probabilities for matching. It wasn't long ago (see book on DNA in the courtroom) that DNA data and probabilities were considered too speculative and not allowed. In the opposite situation, the courts determined that there was a high risk and therefore awarded high damages over breast implants, although the data indicated that there was a low correlation in those cases - there was a high certainty that disease and implants were not related.

In the environmental area, there has been a strong push to establish science courts to sort out issues in science for the courtroom. Xxx More on roles of models - and math as the language of science. Maybe bring in some information on cyber security and terrorism.

Old notes from other book:

Notes for uncertaintity book

I. Previous materials for course on division between science and non-science

Characteristics of science vs. non-science

Science Non-science

math Prose

use of uncertainty,correlation determinism

use of models Practical links

designed to study problems Needs to make firm decisions

Hypothesis testing other deductive and inductive reasoning

Looks at two sides one-sided advocacy

II. How we make decisions

A. Crises-driven must events. We have to make quick decisions in light of limited data. The reliability of the data is usually unclear as well. We look at the credibility of the data provider. Greenspan, for instance, has been around a long time and has precided over a prosperous time few missteps to his credit, so we tend to believe him. Similiarly those in public office because of their positions often have high persuisive value. Cult figures? Religious leaders?

B. Time versus credibility. Increased data results in increased reliability, less uncertainty. Increased time allows for the development of those materials. Toxicology literature shows that as we develop more data on the risk of toxic chemicals we improve the reliability of our information figure from tox text.

C. Nature of decision needed interim, to be revisited, versus one with permanent effect. Irony is that court decisions, which are intended to be permanent, are made on a predominance of the evidence say 51%. Science decisions, which are generally made based on 95% confidence limits, are by their nature changeable as the field changes.

D. Voluntary vs. non-voluntary assumption of risk. We dont worry about nicotine, caffeine or salt, but that world of risk problems with chemicals commands large expenditure of regulatory resources. Look at EPA risk report of what interests public is not what the experts say about risk. Superfund and nuclear a large concern, while experts might pick air pollution or water pollution.

E. Wellmans comment in ethics class how do we convince someone why do we belive them. His answer was essentially on credibility and trust. Look at world of ethics issues.

F. Trust varies over time desparation of times, leads to reaching out for leadership. War is a prime example looking to Roosevelt for new deal. Decision-making in the face of terrorism.

G. Are economic decisions a special case we make decisions about the US economy based on very sketchy data.

H. Is poor data worse than no data making a decision based on limited data seems to be harder than making one based on pure speculation.

I. Decisions are also based on systems of rules legal rules, economic rules, scientific principles, religious basis good oppportunity to look at Jewish, Christian and Muslem cultures.

J. Why is the environment often last to get decisions make about it?

K. Decisions based on policy we make a decision which we know will result in an injustice in the name of a higher policy option. Cover up of a murder on a military base to protect the institution. Policy concepts allocation of resources for what society thinks is best. Get out old philosphy text greatest good for the greatest number, verus the Visit (Der Bersuch den alten Dame) in which the loss of one life will bring prosperity to all but will they then lose their moral direction.

L. Role of freedom in decision making need to think about determinism vs. free will. Classic reconstructionist view is that God makes the rules, but mankind has the freedom to apply them. So we choose good or evil (famous Deuteronomy).

Can science be instructive in helping to make better decisions. Ecological decision-making text tries to make that case get it out and look.

Legal decision making based on strict rules, policy changes, **very fact specific**

Do we make decisions in music?

Learning from others, versus having to learn for ourselves.

Get out science in the courtroom book on fisheries and look at comments there.

Gina Kolata article on uncertainty a few years ago.

Decision tools? What is a decision? Ommission vs. Commission

Law teaching texts on science and decisions making.

Jim Gillette recommendations on fellow in Colorado on issue.

International aspests?

What is my objective to show the irony of how things work or dont work. Vision for the future?

Role of compromise again issue of what we mean by decisions.

Paradyms shift that literature?

Role of science in decision-making. What is thinking of scientific mind vs. others.

Unexpected results in science pesticide Good Science, bad policy vs. Bad Science, good policy. Junk science stuff?

Liscensing of drugs.

Instincitve decisions how our senses make decisions. Our eyes fool us, our olfactory sense smell rarely does. Fooling taste has been basis of much of diet industry sugar substitutes, etc.

Touch? Horses find way home by feel of ground.

New notes for book

Science is often a surrogate for policy issues that cannot be resolved. Saying that the science is inadequate implies that there is too much uncertainty in order to make that decision. While the science side of this may agree (the information has not yet reached the 95% plus confidence level yet), it is in reality the science policy side that is uncertain. Public policy is the allocation of resources in accordance with a society’s values and it is a leap of faith (a policy decision) to establish a specific direction. Acid rain was early example under Ronald Reagan. The global warming debate under Bush is another. Clinton struggled with ….

As I sat at my desk, on my horse, as I lay on my yoga mat, as I watched the bare trees when I walked through the park, or even as I waited in traffic, wrapped in thought about a future in work and romance, still grieving for the loss of my mother, quietly enjoying the joy of tranquility, delighted in the raising of my daughter life seems to be passing me by. There is just not enough time to do it all – different careers, earn money, sleep with lots of woman, progress in accomplishment in music, scholarship, yoga, and maintenance (or improvement!) of health. Surrounded by a secure home -- familiar, filled with personal objects and memories, and in a neighborhood where that is home, yet split between different worlds. Split with New York, which is really just recreational now. Split in the Jewish/other world. Split in the man/woman worlds, split in the personal/business world. Split in the geographic – US versus France, Chad, Senegal, Indonesia, England. Surrounded by silence and beautiful music, or the sounds of a daughter or a pet in the house.

City of Girls

Girls on Horseback

They are all girls

I should have married a dog

Hug in the wind – raising a daughter

Kvetching and Conversations.

Convergence of religious thought, scientific thinking and legal reasoning – how do we believe something.

Welman may have been a good link. In ethics, I asked how do I convince you of something – he said that you tell him something and then he thinks about it and then believes or doesn’t believe. It would appear that there are several layers for this –

Information – through actions, body language, written and oral communication

Data – codified information, such that it is testable in some way – the classical hypothesis based information that a scientist craves

Character – the reputation and personal attributes of the person making statements of doing actions

Stature – place in society of the person making statements – Director of program, President, Priest or Rabbi, winner of Nobel prize (Famous story about Linus Pauling, winner of Nobel prize in Chemistry – also in Peace, making fundamental errors on phosphorous chemistry with respect to DNA)

Paradigm of the receiver and of a time in history – are we willing to believe in environmental destruction or are we in a exploitation phase of development. – we can get into discussion on neo-malthusian vesus cornucopian worldviews. For an individual, information must often fall within the realm of experience or value systems (political, abject poverty, business, religious, etc.)

Other notes from NCSE meeting:

Ray Anderson’s ringing affirmation that industry must support sustainable development. The Rio conference lead to speeches that progress and environmental protection are not incompatible.

[Where are my files on science in the courtroom? – especially law review article on courts/judges not being comfortable with probabilistic thinking] DNA in courtroom example, Breast implant example. New Junk science decisions?

Comments on battle of scientists – can’t be sorted out very well.

BIG ISSUE IS WHO IS MY AUDIENCE

Choices: decision-makers/politicians

Scientists

Lawyers

Environmentalists

I want to bridge the gap between science and law and get better decisions about environmental policy.

Combine with good science/bad policy discussions – pesticide registration process as so expensive as to drive broad spectrum pesticide development, instead of limited. This was partially address in FQPA – easier methods for registration of orphan/low use pesticides. Water policy too?

Combine with environmental adventures around the world.

What about using this as a book to train the next generation?

Combine with some science and tech materials for lawyers. For scientists, it will be a look at factors that we take for granted, but we need to know in order to see how the rest of the world sees us. For lawyers, insights into materials they will have to deal with and give some basis for understanding as well as managing the process.

More notes:

Battle of scientists (inconclusive hearing)

“Objectivity”

Knowledge is not value free

Neutrals/conservatives need to work together

How to judge

Prinipals and values

Vs. economic growth

Human rights and environmental protection joing together

Humility – CFCs were judged great in the 1970s, now bad

Decision in the fact of uncertainty “ Dennis Hayes

One can own decisions, but not own facts. One can even own valudes

“Role science plays in enviormntal plicy is minimal.

Complexicity is ubiguious, not about just two sides.

Comes down to values/humor. Easier to make intellectual mess than clean them up.

Trade off queston between gloval warming vs. nuclear waste vs. security.

Prior rights and economic interest need to be bought out.

Principles – decision not just made in science, but Ag lands fleeing to cities

Quality of life issues – that effect children and greand children crises drives catosphtrophy

{Taylor Stuff Environmental Regulatory Reforms of the 108th Congress}

Environmental protection policy disagreements are not about what to conclude from the available scientific knowledge; they represent a struggle for political power among groups having vastly different interests and visions for society. In this struggle, science is used as a means of legitimizing the various positions. Science is a pawn, cynically abused as may brcynically abused as may suit the interests of a particular protagonist despite great ignorance concerning the problems being addressed.

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CHAPTER 21: DISCUSSION OF LAWS AND INTERNATIONAL TREATIES

International environmental laws and treaties have generally been modeled after the laws that were passed in the U.S. during the 1970 and 1980's, with some exceptions. At the base of all the laws, is the grandfather of all environmental laws, the National Environmental Policy Act (NEPA), which, among other items requires a systematic examination of potential impacts of a proposed program or project. This simple concept has led to a culture around the world of asking these types of questions and using them to plan programs and projects. (Cooper, ref). While the details of these laws and regulations differ, they are all designed to look at potential alternatives to one or more aspects of a program. For instance, is there a different place to run a road, locate a power plant, or build an irrigation scheme? As discussed previously they are intended to help achieve a balance between engineering, economic and environmental aspects of a program.

Two aspects of an environmental or other law are transparency and enforcement. In this there are vast differences. In some countries, especially centrally planned economies or those lead by Monarchs or other high ranks, information may be restricted and in fact there may be no right for most people to the information. This is opposed to U.S. NEPA regulations which require interested parties, government officials and adjacent property owners to be notified of the availability of an assessment, which will include all the data considered in doing an analysis (article from William and Mary law school). In a similar manner there is a wide range of enforcement from none to a dedicated force implementing the law.

As a basic principle each government is sovereign and are left to create and enforce their own laws. This implies that no one can force another nation to follow rules or regulations against their will. In the concepts of international treaties, nations have voluntarily agreed to be bound by a common regulation or law. The exception to this are 1) acts that harm or destroy the environment of another nation - which would include pollution in the air or in trans-boundary waters, and 2) actions that have been found to be "wrong" in the international Court of The Hague. While there are attempts to come to agreements (expand and research this section), this is one of the more contentious areas - not only because some nations feel that some of the pollution is a necessary side effect of economic development, but also because of other aspects of trade agreements. Under the Gap 2 treaty (on goods and services between nations), over 100 nations have agreed to have open trade of goods and are agreed to remove all "non-tariff" trade barriers. Many environmental regulations have been interpreted as these types of barriers and have lost power to regulate in that way. Only voluntary treaties can solve that issue.

Many of the treaties and regulations have come through the United Nations, which has the United Nations Environmental Program. These treaties have included regulations on the shipment of hazardous waste to other countries, banning chemicals that contribute to ozone depletion, implementing trans-boundary waste pollution and banning the trade of products from endangered species. Many of these regulations have been effective, but are also increasingly controversial due to charges that they inhibit-economic development. For instance trade in ivory is banned, but some countries have large elephant herds and want to sell ivory for international funds. (add names of laws, etc.)

A third basis for environmental regulations comes through the funding of international projects. Embedded in the regulations of the World Bank, for instance, is the Pelosi Amendment that requires all projects, due to the participation of the ITS in funding the Bank, to abide by and use environmental laws. Thus a project in Africa must consider environmental aspects under NEPA and must look at regulations on air and water pollution. Other laws, non-US, by the World Bank consider important issues such as transfer of people from land (e.g., moving them to make way for agriculture or water impoundments). This is a major issue around the world. In a similar manner projects funded by many counties, - the US, Canada, Japan, Germany, Holland, etc. - require consideration of similar aspects of programs. Examples of these include consideration of pesticide use, health of villagers, and protection of natural resources (special forests, migrating birds, etc.). As discussed in other chapters, the USAID regulations have led to major assessments of projects in Senegal, etc.

U.S. Regulations

I discussed in somewhat broad detail the U.S. laws and regulations related to the environment. It has been noted that these laws and regulations are now more extensive than the often ridiculed tax regulations. As new environmental regulations have been put in place, there has been little opportunity to revise and coordinate them into a consistent framework, so that there are continually contradictions and inconsistencies in them. The regulations have also often been broken up into “silos” so that one group, say, on water pollution or industrial chemical pollution, may not coordinate with natural resource protection laws, such as Magnuson Stevens or the Endangered Species Act.

The granddaddy of all U.S. environmental regulations is the National Environmental Protection Act (NEPA), which has been discussed briefly in previous sections, particularly within the context of environmental impact statements and programmatic assessments (Chapters 3 and X for instance). This Act requires that all major projects of the U.S. Federal government and, for legal reasons, projects funded indirectly by the U.S., such as the World Bank and the U.J. – that all projects prepare an environmental assessment – because of the world view discussed in the preamble that it is U.S. policy to preserve the environment for future generations. The general rules for doing the assessment have been assembled in a special set of regulations by the Council for Environmental Quality, a group that reports to the President. Among other considerations the assessment is to consider all potential impacts on the environment that occur through direct, indirect and cumulative impacts. The NEPA has been considered highly successful in changing the approach to environmental considerations worldwide and perhaps hoping to tailor and plan the work of government and private industry (see Chapter XX – Chad/Cameroon)

There are a group of other environmental laws which have been identified as “media” specific – they deal with water in the Clean Water Act and with air in the Clean Air Act. Both acts are extremely complex and specialized, but they have some legal and scientific features in common. First, they require that anyone putting pollution into the environment to have a permit for that purpose. Under the Clean Water Act, these are known as National Pollution Discharge Elimination Permits (NPDES) and under the Clean Air Act they are known as National Ambient Air Quality permits (NAAQS) (correct exact language). What they do is to be sure that the polluter has accepted that they can only release a certain amount of material from their pipes or smokestacks and it allows the government to monitor and enforce those considerations.

These permits for “source” generation of pollutants – a guide to where the pollution is coming from. There is a related, second approach. Both laws considering the area where the pollution is going. IN the Clean Water Act, the receiving water body is assessed for its water quality – and classified and an assessment is done on how much pollution is entering from all sources and what can be done to control that pollution (the Total Maximum Daily Load Assessment). In the Clean Air Act, the country is divided into regions and many approaches are taken to try to control the air pollution from homeowners, mobile sources (such as cars and trucks and also their parking areas), and power plants. These regulations are highly complex but include carefully mass balance assessments of where the pollution is coming from and where it is going. They also attempt to add many economic inducements to change some behavior and operations, as well as classical U.S. approaches known as carrots and stick 0 putting in place fines and other punishments for offenders. Somewhat specific to U.S. laws, they also have provisions that avoid many legal problems with enforcement, such as the use of so-called Citizen Provisions that give, in many cases, anyone a right to sue because of improper pollution.

A third group of laws deal with chemical pollution, especially old waste sites (Superfund or Comprehensive Environmental Regulation and Liability Act, CERCLA), new waste and groundwater protection (Resource Conservation and Recovery Act, RCRA), industrial chemical pollution (Toxic Substances Control Act, TSCA) and pesticides (Fungicide, Insecticides and Rodenticide Act, FIFRA, as amended). Each of these acts attempts to set standards on appropriate safe levels of chemicals in the environment sets rules on the release of these materials after appropriate permits and testing and also describes how these materials should be cleaned up from a waste site. I also add that RCRA addresses recycling and other efforts.

Finally, a fourth group of acts consider the protection of species and other conservation. The most important of these is the Endangered Species Act (ESA), which mandates total protection of designated species that are considered threatened and/or endangered. There are a host of other conservation acts that are designed to protect specific species, such as marine mammals (Marine Mammal Protection Act), forests (Forest Protection Act), rangelands (Taylor Grazing Act, etc.) and other resources.

Thus, all these acts combine techniques from law and science in order to try to protect human health and natural resources. They are designed to tell people what is permitted and what must not be done. It also specifies rewards and punishments for activities that are now legal or illegal. The problem is that they are so complex that it is often difficult to do the correct things. The laws are major subjects of legal challenges, and at least in the case of CERCLA it is estimated that the majority of the funds have been used on legal battles rather than improving environmental pollution. Nevertheless, rivers and air are cleaner, waste sites have been identified and cleaned up and many of these laws have led to preventing pollution rather than spending money on cleaning up situations.

The main reason for this discussion is to have international developers consider appropriate factors when designing projects and in their search for a balance between engineering, economic and environmental considerations.

CHAPTER 23: FATE AND EFFECTS OF PESTICIDES

This is another detailed, technical resource chapter that may assist the planner of international development projects and may provide additional background for some of the materials presented in earlier chapters. Again, it can be bypassed.

Pesticides and toxic materials are of concern because they can have negative impacts on the environment – they can affect human health, kill organisms and alter ecosystems. At the same time, they are seen as useful in agriculture and through the chemicals that are used to produce the many materials wanted in today’s society.

The process of assessing the impacts and behavior of these materials in the environment is known as toxicology. The science of toxicology considers: the effects on organisms (including humans, known as an effects or hazard assessment), or how the materials move or are distributed in the environment (chemical fate or transport assessment).

Thus, the general equation for assessing toxicity, known as a risk assessment is:

Risk = effect x fate.

What that means is that a chemical must have a specific effect – such as it causes death at a certain concentration AND it must be present in the environment such that it comes in contact with an organism. A chemical that is very, very toxic is of no concern at all if it is totally isolated and does not come in contact with an organism. WE have all seen those science fiction movies where an alien substance has the potential to wipe out the earth, but is, for most of the movie, totally isolated in a lab.

By the same token, a chemical that has little or no effect is of little concern if it is in contact with an organism – the simplest example is plain water – except for physical issues, like drowning, it is chemically of little concern since it is non-toxic. Other materials that do not move around or come into contact with humans, such as a lump of plastic, are of little concern.

So then we put it together – chemicals that have some toxic effects and which come into contact with organisms are a concern – the extent of the concern will be how toxic they are – can, for instance, a very low concentration or low dose kill or maim a person or kill an organism – and how they move around in the environment. In this movement – again, known as the chemical fate of a chemical – does it reach the air that people breath? Does it reach a lake or river where fish live? Does it reach the soil or roots of plants where they grow? All of these factors go into a consideration of how big the risk of a chemical is to the environment. Again, it should be noted that we introduce some chemicals on purpose, such as pesticides, to kill insects and weeds; produce chemicals for sanitation, to render some chemicals less toxic (such as removing chlorine from water to avoid death to aquatic organisms.

So a risk assessment is a tool used to predict what impacts a chemical will have on the environment and to predict a level of how big a concern it may be. It also provides a guide to how to avoid some impacts – keep away from water, household pets, or keep an area well-ventilated maybe be familiar to the reader.

As with so many materials, there are trade-offs with using chemicals for purposes needing and causing some harm. A sanitation agent may cause some skin irritation, while killing the disease organisms that are of concern. A pesticide may kill organisms on corn or wheat crops, but can lead to health effects of surrounding populations or the death of fish in nearby streams. The risk assessment tool is one measure of how to be aware of these trade-offs and to allow the user or regulator to be aware of how to consider the matter.

SECTION IV: AFRICAN VILLAGES AND CITIES

CHAPTER 23: AFRICAN VILLIAGES AND LANDSCAPES

The villages in West Africa, irrespective of their sizes, have been changing from simply a collection of huts arrayed around a central plaza to communities that have a source of central clean water, cell phone service and in many cases some kind of store that sells water and other basic commodities (which for visitors may be soda and candy), and more frequently health clinics of some type. There is a central street usually occupied with hand carts of carts pulled by donkey or bullock, but automobile traffic has increased in many areas. When I was in southeast Senegal, in a tiny town of perhaps 500 people, our car was one of the few during the day. With my wife and three-year-old daughter, we could wander the street with little concern for traffic. We did worry a lot about the open water holes that could plunge a kid down a narrow shaft perhaps 20 feet. There is usually no electricity and cooking is done over small cooking stoves or, in more prosperous places, with stoves fueled by propane. Due to the heat the woman wear simple shifts and the men often only have a pair of baggy shorts. Most of the people are barefooted. It was often disturbing that farmers would be hoeing in their fields with steel hoes- very strong ones due to the heavy clay soils – in bare feet and no protection of any type for their feet.

The air has a special smell of wood fires, animal dung, and drying straw and mud from the houses. Occasionally there is the smell of cooking, but many meals are roast corn or peanut stews of vegetables, people, families?

Emily running around with kids, with no common language, but jumping on piles of direct argun running around houses and playing with the camp fires. They also go pieces of fruit.

Larger villages and small towns had repair shops for cars, and even places for farmers to buy fertilizer and pesticides.

CHAPTER 24: HELP FOR THE CITIES

Trends in improving economic conditions and environmental quality in American cities may provide some useful information in addressing problems in African and Asian cities. There are many similar problems. In the poor areas and ghettos of large American cities there are extensive food derts desserts - areas where good quality food at affordable prices are unavailable. In middle class areas of cities food is found in abundance at large chain supermarkets as well as specialty stores; in many areas "large box" stories also provide discounted food. Because of this abundance, the price of food and the percentage of the American budget spent on found has declined (ref.).

This is not the case in the poor areas. There is a severe shortage, or in many cases a total lack of general food stores or supermarkets - and there are generally only a few small shops that have few fresh ingredients, and what they have are generally much higher priced than the same goods at a regular supermarket, let alone a large box store. The problem is a combination of few stores (with the high prices and low inventories) and transportation - there are often poor bus or other mass transit connections for people to shop or bring back materials in any convenience. This is even exacerbated by the inability to get food stuff in bulk, which presumably will also be cheaper. Finally, the foods available are often of the fast food variety -that that people reach for potato chips instead of, say, fresh carrots. Which brings us to yet another problem, that even if fresh ingredients were available, in many cases people do not know how to prepare it - the cooking and preparation steps have not been taught, perhaps indeed because the ingredients have never been available for the cook.

It is unclear who much poverty is at the root of these problems. Certainly many of the families have very limited resources - have to feed an extended family on a very modest income. Putting aside the issue of helping these people to get to work or, in the American model, receiving welfare or pother public assistance, the issue is how to utilize the income - to get the most nutrition possible. So that's an economic structural issue - to make more higher quality food available and an educational issue - of showing them how to eat better. Several studies have shown that it is possible to eat healthy on low income budgets but it requires extensive planning and the ability to utilize inexpensive ingredients in creative cooking ways. It is NOT, for instance, cost-effective to buy pizza, cold cuts or chicken wings. By contrast, buying a whale chicken and roasting it can provide a nutrition meal for a family at perhaps 1/4 of the price.

The healthy diet is recommended to include quantities of vegetables. As noted before these are often not available, and if they are, people don't know how to prepare them. Techniques such as eating vegetables in season when the prices are low could in principle help. Encouraging farmer's market to bring produce to these food desserts is one solution.

The farmer's markets are a good solution if the farmers can be convinced to locate near these impoverished areas. Unfortunately they have the idea that people don't have enough money to buy their produce. Which is partly true. At least in some of the markets in the big cities, farmers need to be able to accept welfare checks and other public assistance funds, which are often on electronic cards. Alternatively they need to accept some forms of credit like debit cards, since people may not feel it safe to carry cash. This is far different from markets in wealthier areas, where people routinely pay in cash. So again, healthy eating needs to be linked to banking and financial instruments.

The final approach, which is now working well in the city, is to encourage folks to grow their own food. In the most successful examples of this, not only are folks successful n getting healthier food but, probably most importantly, the projects bring the community together with a sense of hope for the future. People in many of these situations have been told no so many times they have given up or there have been many promises that have not been fulfilled. It has been my experience that most of these folks want to work to earn an income, but there skills - including planning and even minimal executive skills have not been taught or learned. So once again the elements are providing a proper economic base and some types of incentives (which may be health related - everyone wants a healthy family) and education. The economic piece may be to provide some startup funds, free labor on some projects and some materials. Of course, growing your own vegetables has many, many elements. First there needs to adequate space and sun. This can best be provided in community gardens, church plots or areas in public spaces near housing developments. This has been done in two locations in Anacostia and Washington, DC.

How Land Use Planning and Zoning Can Protect and Conserve Water Resources:

A Guide for Local Governments

All communities must guide development so that public water supply is protected and replenished.

This can be done through revision of local planning and zoning ordinances to encourage the use of low impact development (LID). It may be necessary to first update the local comprehensive plan to set a goal for open space and conservation planning and design. LID design integrates stormwater management and erosion and sedimentation control into natural systems that keep rainwater on site. This is different from traditional development that uses pipes and drains, ponds, and storm sewers to move water quickly off site and into streams, rivers, lakes.

Why is Low Impact Development Important for Water Resource Protection?

* In an undeveloped area, over one-third of rainfall flows to the groundwater, replenishing it, and supporting the local environment.
* When development occurs, that amount is reduced to 15% or less because hard surfaces and movement of water through storm sewers prevents water from seeping into the ground.
* The flow of water on the surface increases from less than one percent to over 30%. This reduces water going into the natural system, increasing the risk of flooding and erosion.
* Rainwater washing over hard surfaces picks up pollutants that pollute surface and groundwater. This contaminates water sources and increases the cost of drinking water treatment.

What are the Impacts of Traditional Development on Water Resources?

* Flooding
* Erosion
* Stream channel alteration
* Environmental damage
* Groundwater depletion

What are the Benefits of Low Impact Development?

**Prevents pollution**. Lid removes common urban pollutants including nutrients, metals, and sediment in addition to protecting groundwater. LID preserves and improves environmental quality and protects public health.

**Protects groundwater replenishment**. LID allows stormwater to seep into the ground where it is naturally filtered and replenishes groundwater.

**Saves money on construction**. LID allows communities and developers to spend less on constructing pavement, curbs, gutters, piping, and inlet structures. The Center for Watershed Protection found that construction cost savings are between 11% and 66%.

**Saves money on public works budgets**. By not building pipe and drain systems to manage stormwater and by building narrower roads, communities have lower maintenance costs. The reduced direct flow of stormwater to streams decreases the risk of flooding.

**Improves the tax base**. LID creates a desirable product that often sells faster and at a higher price than equivalent conventional developments, increasing property values and tax bases.

**Enhances quality of life**. Increased natural landscapes and open spaces augment recreational opportunities and reduces flooding on private and public property.

What Issues Should Be Included in Planning and Zoning Ordinances to Protect Water Resources?

**Site Planning**. Best site planning practices minimize impervious surface, alteration of natural vegetation and topography, and unnecessary development expenses.

**Landscape Design**. Landscape design integrates natural features into the footprint of a parcel under development. Effective landscape design ensures that water resources are protected and supportive of plants, animals and people who use the land.

**Erosion and sedimentation control**. Erosion and sediment control is important in reducing the amount of soil that wears away and into local waterways. The most important erosion control practice is to minimize clearing and re-grading on a development site. In LID, clearing is done in phases to minimize the amount of bare ground at any one time.

**Stormwater management**. Natural and vegetated stormwater management systems such as swales, constructed wetlands, and bioretention cells can be used to manage stormwater and comply with federal and local stormwater regulations.

Second, water needs to be available. Ideally water can be located from roof tops into barrels and cistern - again with the need for planning and some basic materials. There are a variety of organizations that make rain barrels available at a minimal cost (ref). Other clean containers can work, such as barrels from supplies (but not used pesticide barrels!).

Third, the soil must be non-toxic and rich enough for the crops planned. In many areas, soils have become polluted from lead deposition from the air, oil product disposal, sewage (which can be ok as long as the crops are cleaned of any harmful bacteria), and even pesticides and herbicides. If the area is near a road it may also have rubber asphalt. Or even basic soil issues, such as the presence of many roads or other debris, may exist. Aside from these contaminants, the soil needs to have a proper balance of nutrients - potassium, nitrogen and phosphorous. While these nutrients are normally added to soils via fertilizer, some of the more imaginative programs are combining waste, such as leaves and vegetation or even manure to provide a free and healthy source of nutrients. Making these materials available are again an economic as well as logistical issue.

Fourth, there needs to be a suitable choice of plants - a balance between crops that people will consider eating - cucumbers, squash, lettuce, carrots, potatoes, ethnic crops and spices, green peppers and tomatoes are some common choices. There are good complimentary additions to a meal that may involve diary (e.g. milk), meat or fish (e.g., the roast chicken again) or a vegetarian option (lentils, beans, rice, etc.). (Get back to subsistence fishing and props and cons)

Fifth, if possible a controlled environment such as a Quonset hut or "hoop house" can provide the focus for a program. In these areas there is protection from cold or freezing in the early and late season, shelter from high winds, they provide some measure of security from vandalism and they can protect from heavy rain, hail, etc. For some crops they also provide some relief from the sun.. It has been our experience that such structures can be built cheaply, constructed quickly and can bring together the community in the ways mentioned earlier.

Then there is the organizational and educational elements. Groups or families need to learn to work together, do regular schedules of activities (such as waterming) , and learn to plan and anticipate needs for the system (i.e., don't forget to order the new hose we will need, or get the transportation needed to more some fertilizer, etc. As with any farming skill, individuals and families need to learn about the five elements discussed above. A variety of curriculum have been developed in this area -describe here.)

CHAPTER 25: IDEAS ON HOW TO APPLY TO AFRICAN CITIES

In some ways, applying these ideas in African and Asian cities may be easier than in temperate climates - with temperatures above freezing and usually green spaces available. Also, at least some of the residents have a familiarity with farming. The crucial elements that need extensive planning are water during the long dry seasons, adequate soil preparation (including removing toxics), and organization and training. Minimal supplies and materials may also need to be provided to get the programs started. (Remember to discuss raised beds as a way to avoid bad soils). Just as the Nairobi project brought people together to improve the community, and at minimal cost, city-based community gardens and other activities can be very useful.

There plots are NOT useful for crops requiring large acreage - such as corn, soybeans, wheat and millet. But the basic vegetables, such as onions, potatoes, beans, cucumbers, tomatoes and squash can be done very successfully.

examples of model programs:

xxx

Water Management in the City

Within temperate areas, the biggest issues are pollution associated with the runoff of water from the areas within a city. This can result in high nutrients that pollute large areas, such as estuaries and bays, as well as rivers. Therefore there is a strong push to control this runoff - again beyond the scope of this work, but there are law s and regulations designed to control runoff and pollution from factories and other "point source" - (i.e., pipes, etc.). There are also increased efforts to control other run off from areas such as parking lots, roads and farms. The solutions in many cities are referred to as Low Impact Development (LID), which means that water runoff is controlled through the addition of holding ponds, water barrels, etc. (ADD a lot more on LID here).

Within the Tropical cities, the two biggest issues are handling the sewage and ensuring a consistent water supply for the city gardens. Solutions are no somewhat divided. As discussed, for instance, in the Southern Sudan city of Juba, there is a push and pull over quantity versus quality. The Western principle of centralizing facilities appears to be too expensive, so that a variety of decentralized approaches need to be considered. So, how to consider this within the various cities?

Is there any appeal to community gardens and other plots? Certainly some crops such as onions are quite expensive in Africa, so locals do want to grow them. And bringing over some other traditions, such as having the women crop vegetable crops to sell n use of health and education for the children (as was done in Burkina Faso) might be brought as a tradition to the city. Communities working together to provide fresh produce might also work. The role of the city government might be to help with some essentials such as water management making supplies of fertilizers available, and perhaps regulating the use of pesticides in such situations.

WATER FLOW FOR THE CITY

Water Management is a huge concern for cities. The major issues are water supply for residential use - drinking, cooking, cleaning, etc., water supply for sanitation, and flood control. To this mix there are increased efforts to use water for growing crops in gardens. WE have already discussed efforts to build water capacity in Juba, Southern Sudan. Efforts to provide the water supply needed for cities was discussed for Fez, Morocco as well.

Water is a major resource and it has been said that the next war may well be over that of water. Water flows from rivers, a resource that is often shared between countries or regions within countries. Of course water flow will vary with season (particularly due to the rain/drought cycles in Africa), as well as water cycles (long term) as precipitation varies over years. In many parts of West and Central Africa, there has been a shift in water, as rain lines (isopleths of precipitation) have shifted further south leaving areas to the north will scarcer rains. Thus the more distant issue of climate change is becoming a reality in the north of Senegal, for instance. The water flow is also influenced by the presence of dams, and controversies over the placement of dams that may keep water from flowing to a region or another country. As discussed in the treaties section, there are mechanisms through the UN and between countries to set trans-boundary issues of these matters, as well as international courts to adjudicate between them. Besides the water supply there are a boat of other issues that can be associated with the flow from these rivers - impacts on fisheries (as discussed in the Senegal section) and the release of water from these dams – known as conservation flow, as discussed in the Sri Lanka section). The quality of the conservation flow is also Important, if it has been much warmer due to the water sitting in the top of a reservoir behind a dam. All this will impact the growth and survival of fisheries that may be needed for food supply.

Another source of water for cities are wells, which get their water from groundwater or underground reservoirs (see discussion for Ivory Coast over the fun controversy between French and English on the vocabulary for this water). Wells can provide a good decentralized source of water - often good quality water, which can be shared in communities, as well as a major source for a good sized city. However, wells can draw groundwater that may take centuries to recharge, so that it needs to be taken in a sustainable manner, and it may be drawn from a large area that in essence takes water from neighbors, who may need the water or may not want to share it. Two other important aspects are that the water quality must be protected from pollution (e.g., due to leakage of pesticides from agricultural, areas or industrial pollution or pollution associated with energy extraction. Second, high water use from wells can lead to subsidence of the ground in a very surprising amount - some areas, such as Mexico City, have had areas drop as much as 50 feet.

As discussed in the Juba, Southern Sudan section, the distribution of water is also an issue. Should there be a distribution system of pipes set up to bring water from a central facility (where it may have been treated) or should there be a series of distribution centers. And also, of major concern, to what should the quality of the water be (who clean, how treated for bacteria, etc.). What is the tradeoff between water quality and water quantity - building an ideal system may take too many resources or too much time. Perhaps it’s better to get a somewhat lower quality water to as many people as possible as quickly as possible. Remember there are often high densities of people in need of ANY water. Can a community or a household be trusted to boil water that may be contaminated with bacteria? Are their techniques for getting a community to work together to improve or maintain water quality, similar to the techniques used for instance in improving sanitation in Nairobi (through local entrepreneurs?) In some areas, such in Canada (research for African examples), seasonal water is captured in small lakes and these become good habitats for growing a seasonal crop of fish - perhaps that could work in some of these cities, where there is excess water during the rainy season.

As done in Senegal, groups in the cities might also be trained to work together on construction and other projects (see chapter). Building berms, water detention areas and holding ponds are relatively low effort local projects, can bring communities together and may prevent pollution or flooding. Is it always ideal when a problem or issue can be converted to a benefit - and if it would possible to capture water at an appropriate time, perhaps even polluted water (containing sanitation waste or excess nutrients) and use it to grow crops that becomes a benefit. The crops might not be deemed suitable for human consumption, at least not without further treatment, but they in turn might be used to produce energy (see chapter on biofuels and anaerobic digesters), feed fish or even small animals (rabbits, chickens, ducks, or perhaps goats). In that way we have found a win-win solution, with benefit for the environment (through control of floods and run off), engineering (by capturing water, reducing flooding) and economics (feeding people and preventing destruction of areas from floods, etc.). Removing water from some areas, and perhaps using the technique started in rice paddies in Asia, and now used in Africa, have fish in the ponds to eat insects, particularly mosquitoes, also reduces the incidence of disease.

Capturing water at the household level can also be effective, in that it provides more sustainable water supply for the family - if water can be captured in rain barrels, etc. This reduces the need to bring water in, which is also a laborious task in some communities. It can also be a source of somewhat better water quality - and it can be filtered or boiled if there are health concerns. Remember this water can be used on crops of vegetables, which can become the family source of money for health care and education for the children (as seen in Burkina Faso). Obviously there is a need to store water for somewhat longer periods due to the dry season, but it can contribute. As noted earlier, the best does not need to be the enemy of the good - and some of these techniques may only be partial solutions to the problems, but if they are moving matters in the right direction, they might be used.

There are many other benefits to having water around at the household or community levels. As learned in the early days of western cities, such as New York, the most important reason for water was to have it for fighting fires (see book Water for the cities). The building of water supply networks was in those cities considered essential to save lives. While decentralized water supply might be the answer in newer cities, this function remains important.

Water for cleaning and waste disposal and sanitation is also of major importance to a city. Again, controlling the transfer via water or water percolation through the ground of sanitary waste and other pollution can be a major part of household level and community level sanitation. For instance, one of the most unfortunate situations was in Juba, where there were no sanitation facilities and a one acre area near the center of town that was used for the purpose. During the rainy season, the area would flood and spread disease all around. Due to the usual dry climate, usually this was not a problem, but during the wet season insects would spread many diseases. A system that controlled the ponding and run off in the area would have remedied the situation. In this case a virtual decentralized facility, which had the benefit of not needing piping and other equipment, needed management to keep it from being a disease trap. Something like the Nairobi facility might have helped - or any other good idea. The key to good sanitation is also to keep water supply separated from sanitary waste. Their waste cannot be allowed to percolate into the ground and contaminate the ground water that is being used in a well. Again, if an area with a clay soil or similar impermeable material would prevent much of this problem. While not fully acceptable, in A. the sanitary waste is seen as a positive material in places like China, where the night soil" is used to fertilize plants in the garden. It would need to be determined whether this could work in Africa - again perhaps as a preliminary crop for animals and then humans.

Another approach is to adopt a hybrid approach to sanitary waste treat similar to those used in the Western cities. In those areas, sanitary waste is carried through pipes by flushed water and brought to a central facility, where it is treated through a process that is essentially anaerobic digestion - the partially treated waste is put in a large air–tight tank and the materials are digested by bacteria. This has the benefit of generating good quantities of methane gas that can be used for energy (cooking, etc.) and reduces the quantity of infectious materials. In an African city a series of anaerobic digesters could be load with waste - perhaps waste that was stored in waste containers and brought to the digester. The operator of the digester could have the financial benefit of the gas produced - which could be very lucrative. This gives an incentive to make it work and helps the communities to stay healthy. Given the density of folks living in-the city it might work.

Other LID ideas have already been mentioned such as water off roofs, controlling runoff and flooding, separating water supply from sanitary waste, etc.

CHAPTER 26: ENERGY IN THE CITIES

Energy is needed in the cities for lighting houses, cooking meals and for other tasks; such as pumping water. This section will review ways that energy is provided and new techniques that are arising that may jump start and jump over older technologies to use forms of energy that may be more appropriate in a decentralized environment.

The model for energy production in the West is power plants, which are fired by coal, oil, or natural gas or nuclear. All of these are large investments; require extensive technology, highly skilled maintenance, a large supply of power fuel. To get the power from the plants they deed an extensive distribution network and home rind offices need to be in a position to use that power - therefore there are substantial investments in electric and other equipment. This approach has worked well in Western cities, despite some lack of reliability. The question is whether there are other techniques that can be more appropriate to the African cities, ones that may involve less pollution, cast the home owners less and be a smaller investment for the community or local/national government.

CHAPTER 27: WIND ENERGY

Ranging makes it feasible to monitor wind speeds without the need for tall towers. In addition, lower cost instrumentation is becoming available for monitoring small wind turbine sites.

It is preferable to record the wind speed and direction as close as possible to the proposed site for at least a year. However this will only give information for a particular time period, and weather patterns change. In order to ascertain the longer term wind speed characteristics, it is useful to correlate the measured data with data measured at one or more nearby meteorological stations or other wind recording sites. Then by statistical analysis of the two data sets, and extrapolating over the long-term data from the meteorological station, an estimate of the longer term wind speed characteristics at the site can be made. This technique is referred to as the Measure-Correlate-Predict or MCP method.

There are a number of different ways of implementing the MCP methodology all based on different statistical analysis techniques (Rogers et al, 2005, 2006a). These methods are embedded into different software packages, but their application requires careful judgement - consistency in the use of the methods is important and more than one algorithm should be employed in order to avoid bias.

If it is not possible to carry out wind speed and direction measurements at a proposed site, or where a preliminary analysis is required prior to installing instrumentation, there are a number of techniques that can be employed to give an approximate estimate of the wind speed characteristics of a site.

Using wind speed measurements from a nearby location.

This involves making use of existing wind speed measurements from one or more locations nearby and deriving the data for the proposed site by interpolation or extrapolation, taking into account differences between the proposed site and the sites for which measurements are available.

Estimating the wind speed characteristic of a site

It is expensive to carry out detailed measurements at a site and wind speed measurements are often not carried out for small wind turbine installations. However, the use of remote sensing methods such as SODAR (Sonic Detection And Ranging) and Doppler LIDAR (Light Detection And

**Energy yield from PV systems**

The annual amount of energy that will be produced by a PV system depends on various conditions, including:

* the animal total quantity of solar radiation available at the site. This can be estimated from meteorological data giving the measured number of kWh (or GJ) per square metre per year incident on a horizontal surface at the nearest meteorological station. In typical UK conditions, this is around 1000 kWh m-2 y-1 (as described in section 2.3) but in very sunny countries the figure can rise to well over 2000 kWh
* the orientation (azimuth) an d tilt (elevation) (lithe PV arrays. For maximum energy output, the arrays should be oriented close to south and with an elevation roughly equal to the latitude of the site - although departures from these optima do not have a marked effect, and the choice of tilt angle can be varied according to the seasonal output profile desired
* the peak power rating of the arrays (or, alternatively, the area of the arrays in square metres)
* the energy conversion efficiency of the PV modules
* the variation in the efficiency of the modules with temperature
* the extent to which module efficiency is affected by the spectral distribution of the solar radiation. This varies according to the elevation of the Sun and the extent of clouds and water vapour in the atmosphere
* the power-reducing effects of array shading by trees, nearby buildings, accumulation of dirt etc. (see Figure 2.39).
* the efficiency of the inverter used to convert the DC power from the PV arrays into AC, and any losses that occur in the wiring between the PV system and the final consumer (these can amount to about 10% of the electricity generated).

The European Union's Joint Research Centre at Ispra, Italy, has produced PVGIS (PV Geographical Information System), a very useful online tool giving solar radiation data and estimated PV outputs for Europe and surrounding countries. Users can input the geographic location, type of module, its power rating, array orientation, etc., and the software will calculate the expected monthly and annual energy yield. (See EC JRC, 2011.) Key aspects of this information have been summarized in a Solar Radiation Map of Europe (Figure 3.25).

**Landfill gas**

A large proportion of municipal solid waste is material of biological origin (Figure 4.11), and its disposal in deep landfills furnishes suitable conditions for anaerobic digestion to occur naturally. It was known for decades that landfill sites produced methane, and systems were fitted to burn it off safely, but the idea of collecting and using this landfill gas (LEG) developed only in the 1970s.

The natural digestion process in a landfill (Figure 4.20(a)) takes place over years, rather than the days or weeks of in-vessel systems. In developing a landfill gas site, each area is covered with a layer of impervious material after it is filled, and the gas is collected by an array, of interconnected perforated pipes placed at depths of up to 20 metres in the refuse (Figure 4.20(b)). In a large well-established landfill there can be several kilometres of pipes, with as much as 1000 m3 per hour of gas being pumped out.

In theory, the lifetime yield per tonne of waste in a good site should tie in the range 150-300 m3 of gas, with between 50% and 60% by volume of methane. This suggests a total energy output of 5-6 GJ per tonne of refuse, but in practice, at the average UK gas extraction rate, the heat energy output per tonne of wastes (as collected) is rather less than 2 GJ.

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CHAPTER 28: RENEWABLE ENERGY

Renewable energy fits under the criteria of meeting engineering, economic and environmental standards. It is, as so many things, a work in progress, but has the potential to save resources today, preserve resources for the future and improve the quality of life for people in both urban and rural areas. At this point the only other technology that has been really successful in Africa, consistently, has been the cellular phone, which had a lower barrier to entry in terms of cost, infrastructure and acceptance.

First, I want to remind you of one of the basic principles in economics that applies to many of these environmentally related tasks. Any new technology or product starts out expensively - expensive to develop and research, and then expensive for going through pilot stages and gaining acceptance from the consumers/public. This kind of statement can apply to consumer products (like TV and phones), cars, or computers, for instance. Why would someone want to bear the extra expense and time with a new item? Because of the potential that it will make things faster, better or, most import, cheaper in the end. Thus there is a price hump (figure x), that must be overcome. There are a variety of techniques, including subsidies, loss pricing, etc. that can work on both the private and public sector levels. I recently read that the new Boeing super jumbo aircraft is a good example - the first five years and approximately 100 planes are expected to lose money, but in their accounting system they have assumed that they will sell a much larger quantity and that over the selling cycle - of say 25 years- they will make a profit. Meanwhile they have the benefit for the financial market to bear the cost of these losses, as well as a balanced product line (with other items at a different part of the cycle - some of which presumably are making profits).

So, if renewable energy falls into the category of greater expense/losses in the beginning what do we do about it and how do we proceed in this category. Will it indeed benefit Africa (in this case) -? That first analysis is now going on in the West as well as Africa and it needs to consider several categories that are quite different in the two cases. In the west, there is already a substantial investment in thermal power plants, so one of the questions is whether to replace that equipment only when it is at the end of its usable life, or replace it for efficiency, economic savings, etc. Alternatively it can be used to add needed capacity. As we will discuss there are also issues of reliability, availability of power at the right time, etc. In Africa the issue is whether to use renewable energy INSTEAD of thermal power plants, which have not yet been built. The same issues of reliability and availability of power at the proper time also apply.

So, back to the general example - if renewables are to be used, what is the proper role of foreign aid or foreign investment in the process. The answer generally has been that they support the cost of getting over the initial hump of higher costs for the technology in order to bring the technology in place and in the long run save money. So as with so many things, an n investment in the beginning can lead to a savings and lower costs later. In fact, most forms of energy are subsidized anyway. Thermal plants have subsidies for their fuel, taxes and many other aspects. Think about depreciation allowances, drilling on public lands and many other tax and business credits. So, in a way, providing foreign aid with grants or very low interest loans can have the same functions in Africa.

So a decision needs to be made on whether to help provide power to African communities and in what form- funds for hydro power (dams), thermal plants or renewables. There has already been much written on funds for dams and thermal power plants (ref), so most of the discussion will be on the full range of renewables, which do include a variety of new techniques for smaller "micro-Hydro." Also most funding groups, including USAID are now changed priorities are not funding large infrastructure like power plants and dams. So let’s switch our discussion to technology. What are renewable energy and why should they be considered for energy projects in Africa (or even in the West)? Renewable energy projects are those that do not deplete resources and include solar, geothermal, wind and hydro systems. These are opposed to thermal power projects, that require the use of oil, gas or coal, which are at least depleted, although some would argue that as the cost of these items go up, then we will always find more - so the new revolution in tracking has provided a dramatic new increase in natural gas and was unforeseen a decade ago, thus bolstering this position and discouraging the use of the new technologies of renewable energy. The cynical folks also note that there is such a very large investment already in thermal energy, and the oil and gas companies have a vast investment, and in the properties, in the trillions of dollars that they want to safe guard this investment and use it before moving on to other resources, such as renewables. While that position may be true for the West, since there is no existing investment in much of Africa (with some big exceptions such as Nigeria), renewables should be considered FIRST.

Renewables are new technologies and have only worked in limited situations in other countries. So other critics argue that Africa should not be the test situation. Why should untried technologies be used in places that need reliable and sure solutions. The general response is that undeveloped areas will benefit by leaping over problems and techniques that have not worked in the West - and that the techniques are now sufficiently developed that they will be reliable. And they have the potential of solving some of the problems in Africa - such as no power in many rural areas -and meet another of the new criteria of trying to use de-centralized organization, so as not to have to invest in large infrastructure, such as long-range power distribution systems.

Thus, from an economic and technological and environmental perspective renewables should be considered for future power needs in Africa and the west.

Let me clarify some categories of power before proceeding. In the West, the principle use of power is to generate electricity, which is then distributed in used in industry, office and residential applications. These are fixed locations and use of power. The second biggest use of power is for transportation - moving goods and people around via trains, buses, trucks and cars. Individual cars and trucks represent the highest use of power. Other forms of transportation such as rail, marine and mass transit are much more efficient per capita but are not generally not considered convenient or are not presently available in many locations. As an example, when the new airport was being built for Johannesburg, there was planning to use a new rail system to transport people to the airport (as is being planned in many other locations). Presently cars are the main transport mode. However, sociological studies found that people preferred cars and that it was considered unacceptable for them to ride the rails (socially). These ideas need to be considered when planning these systems.

In any cases, which form of power is needed has to be considered in discussion of renewables. At this point, the main renewable being considered for transportation are electric vehicles and this to my knowledge has not been proposed in any substantial way for Africa. So again, we will concentrate on fixed power modes.

Discussion of Renewable technologies

Intro

The main renewables being explored in Africa are wind, solar, micro-hydro. Each of these have the potential to provide local or location-specific power to isolated villages, farms, etc. They all require specialized equipment and training, but in many cases limited capital investment. Examples of a need are providing electric light to schools at night through simple solar cell (solar voltaic or SV) systems (see movie: from Renewable energy class xxxxxxxxxxx). Other systems can provide power to pumps for irrigation, or low power requirement industry, such as a measuring tools or small cutting motor. They can also be used to charge cell phones and other communication equipment.

While there are some technological challenges for these, the main thing needed is limited seed money for the equipment and connection to markets that make it available. Once a market has been created, then local entrepreneurship can probably lead to rapid growth in the techniques.

Solar power

Let us start with photovoltaic power systems - or put simply, solar energy. These systems work by using sunlight to activate a semi-conductor "sandwich" of flat plates ("arrays") that are combined together through wiring to produce the amount of power desired. As with many products, the better the array, the more expensive, but the more efficient it is. These arrays produce direct current (DC current) that must be converted into alternating current (AC current) to be used in most modern devices, so some "converters" or "rectifiers" are needed. The array must be pointed towards the sun for maximum efficiency (rule of thumb is xxxx) and only functions during sunlight, with somewhat lesser efficiency on cloudy days. In order to have power during dark, there need to be a storage system - almost always a battery, such as that used for automobiles. The solar system provides power to lights, etc. and charges this battery during the day. The system needs to be set up with an appropriate number of arrays to match the power requirements for the lights and for charging the battery. Once the array and batteries are set up, the system needs almost no maintenance and provides free power for many years - in many cases 10-20 years. If it is combined with high efficiency light systems it can be used for many rooms. It should be noted that the solar panels are very strong and resist impact, and that the wiring needs to be coated with a covering that is also resistant to sunlight otherwise this covering insulation will crack and the system will need maintenance.

Solar collection systems can also be sized much larger in order to do bigger tasks or act as a regional power system. One of the biggest expenses for some of the international development projects has been running power lines to new installations - for instance see discussion of electrocution needed for the new proposed irrigation schemes in Burkino Faso. The SOLAR power systems save this major expense {along with the maintenance) and can stretch a budget to cover far more individuals. (see appendix for more details on these systems). These larger solar arrays can be situated in open areas, with the ground still available for alternative use, such as growing low light crops, storage of materials, grazing for animals, etc.

Solar systems can also be used in large cities, put on roofs to provide power to houses, hotels, etc. Again these systems need to be sized appropriately, but one of the advantages is that when they are located near a location that already has power from the grid (which is powered by a power plant), during daylight any excess electricity can be sent back into the grid. In most deals the power company must then pay to have the power taken back, and in some cases pays a strong premium. While none of these systems are known to be operating in Africa at this time, they are working well in Western countries such as Germany. In that case, people with solar systems (and they can make the systems as large as they want) can sell the power into the grid for a premium of almost twice the price that they pay the power company to purchase power (as of today that is about 50 cents U.S. for each Kilowatt of powers. sold to the grid).

While this is a very high price to pay for electricity (approximately 5 times that paid in the US), it is a policy to encourage the growth of this industry. It also saves the building of new power plants and allows for local distribution of power, so that there is no need for a nation-wide power grid. It also saves the usual cost of fuel (coal, nuclear, oil or gas). So once again, it depends on the size of the geographic area or the size of the sector considered. If the renewable energy can be justified economically at the villages, city, region or country level it may be a useful technique. And as mentioned earlier, with the many subsidies in other energy sources, such as oil or gas, the costs of solar energy might be provided with a subsidiary, or other government subsidies to allow this industry to grow.

(add a cost section here to show the trade off in costs? Reference to other texts).

Wind power

Wind power is now taking advantage of more advanced blade design, more efficient motors and studies on how to have the most steady wind. The new power systems easily provide enough power for entire villages - which means that there must be at least minimal distribution systems and there must be built. These systems require a generator/motor that is mounted above the ground to catch prevailing winds - which are often found more than 30-50 feet in the air. There is a significant expense in purchasing these units, and at this time a backlog of at least 2 years in getting a unit. These are viable options compared to power plants, but must be planned well in advanced. Usually there is a need for a wind study (which can take up to a year to complete). Again power is generated as DC power, must be converted and then distributed. And as with solar, it is not always available due to the lack of wind or strong weather when it may shut down for safety. (see appendix for more on this).

Hydropower

Hydroelectric facilities take advantage of water passing over a turbine generator --the higher the distance of fall and the greater the water flow the greater the power. Thus some of the biggest power sources in the world are hydro generators attached to major river systems. For instance the Columbia River in the U.S. has been managed for power by building large dams for almost 100 years. (by contrast some river are preserved for fisheries and other uses, such as the Fraser river in Canada, just north of the Columbia system. Many countries are still building dams, with approximately 2500 in progress now. Dams occur all over the world, with the biggest one in Three Gorges on the Yangtze River of China.

Large dams have been criticized for a large variety of environmental problems, including loss of fisheries, change in water quality, loss of water behind the impoundments, flooding of areas and the need to move large populations of people (see discussion on Sri Lanka, for instance). They-are also some of the most costly structures in the world.

The alternative that is being developed are micro-hydro installations, which can work on smaller river systems. They meet the criteria of being useable in a decentralized area and are relatively low cost. Again this technology is relatively new, but has high promise in all the areas that need to pump water for irrigation and other uses.

(insert micro-wind above).

There are a wide range of rotors available for these installations. The major complaint is that none of them are manufactured in Africa and therefore depend on foreign trade or grants to put them in place.

(concepts to rover - population growth (covered in Côte d’Ivoiree section), (add references and illustrations).

(what do you believe and why and how do you believe it section). Did I already cover confidence limits, etc.

The growing interest in the storage of electrical energy in recent decades, particularly in the industrialized countries, is a consequence of increasing contributions from two very different sources: nuclear power and renewables. The output of a nuclear reactor cannot easily follow large hour-by-hour variations in demand, so if the nuclear input to a national supply rises above the base-load level, it becomes important to find a means of storing the excess output at times of low demand. (Indeed, many other types of generating plant also run most efficiently at their full rated power, and the cost of constantly varying the output can be significant.) The second reason is the increasing use of renewables for electricity, and here the problem is that the output of many renewables does vary - sometimes suddenly and often for reasons outside the operators' control. Back-up power is therefore needed which can be brought on stream very quickly.

At present the only practicable and economically viable way to store electrical energy in very large quantities is to use it to pump water up a mountain. Pumped storage has thus become increasingly important, with installed capacity worldwide having grown from 78 GW in 2005 to reach 127 GW in 2009 - nearly a seventh of world total hydro capacity (REN21, 2010).

The principle is simple. Electrical energy is converted into gravitational potential energy when the water is pumped from a lower reservoir to an upper one, and the process is reversed when it is released to run back down, driving a turbo-generator on the way (Figure 5.7). The economic viability of the method depends on two nice technological facts,

Figure 5.7 Pumped storage system (a) at time of low demand, (b) at time of high demand

A suitably designed generator can be run 'backwards' as an electric motor: the machine which converts mechanical energy into electrical energy can perform the reverse process.

A suitably designed turbine (see Section 5.8) can also run in either direction, either extracting energy from the water as a turbine or delivering energy to the water as a pump.

The complete reversal is thus turbo-generator to electric pump. The machines must of course be designed for this dual role, but the cost saving is obviously significant.

There will, as always, be losses associated with the conversion processes, but turbines and generators are very efficient, and nearly 80% of the input electrical energy can be retrieved as electrical output when needed. The value of the system is enhanced by its speed of response: any of the six 300 MW Francis turbines of the Dinorwig storage plant in Wales can be brought to full power in just 12 seconds if initially spinning in air, and even from complete standstill the process takes only a few minutes (Dinorwig, 2011). Pumped storage is thus particularly useful as back-up in case of sudden changes in demand, or failure elsewhere in a grid system.

The location must of course be suitable. A low-level reservoir of at least the capacity of the upper one must be available, or must be constructed. Sites such as Cruachan in Scotland (Figure 5.8), where the mountains rise from a large loch or lake, are obviously ideal. The high-level reservoir, behind a large dam, provides an operating head of 365 metres, Running the four 100 MW reversible machines for one hour at full capacity, as electric pumps or turbo-generators, raises or lowers the reservoir level by about a metre, storing or releasing about 400000 kilowatt-hours of energy (Cruachan. 2011).

Figure 5.8 Cruachan pumped storage plant (a) the installation, (b) the dam

History

China's Three Gorges plant on the Yangzi River was the largest of a series of hydro developments worldwide that attracted major opposition on environmental and social grounds. Originally proposed in 1919 by Sun Yat Sen, the project had a varied political history, culminating in its approval in 1992 against the unprecedented opposition of a third of the Congress delegates. Table 5.n summarizes the arguments in China at the time. (The table originally appeared in ChinaOnline, in English, and the wording here is verbatim,)

**Table 5.6** Summary of arguments for and against the dam

|  |  |  |
| --- | --- | --- |
| **Issue** | **Criticism** | **Defense** |
| Cost | The dam will far exceed the official cost estimate, and the investment will be unrecoverable as cheaper power sources become available and lure away ratepayers. | The dam is within budget, and updating the transmission grid will increase demand for its electricity and allow the dam to pay for itself. |
| Resettlement | Relocated people are worse off than before and their human rights are being violated. | 15 million people downstream will be better off due to electricity and flood control. |
| Environment | Water pollution and deforestation will increase, the coastline will be eroded and the altered ecosystem will further endanger many species. | Hydroelectric power is cleaner than coal  burning and safer than nuclear plants, and steps will be taken to protect the environment. |
| Local culture and  natural beauty | The reservoir will flood many historical sites and ruin the legendary scenery of the  gorges and the local tourism industry. | Many historical relics are being moved, and the scenery will not change that much. |

Table continues over page

SECTION VI. REFERENCES

**APPENDICES**

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**PUMPED STORAGE**

Having finished a rendition of environmental consultancies overseas what can we learn and what are the themes in this work.

1. international development is driven primarily by political concerns ...
2. There is a continual shift in priorities in the programs. The UN has recently identified a few (see newspaper article and other Internet research). Project in the 80's tended to be large infrastructure - dams, irrigation, large agricultural. More recently, not documented above -- update? does included Malawi health, where is a shift towards education, health programs. There is also a shift in scale and input from local countries as seen by millennium challenge's attempt to let the country lead the way - to avoid what had been charged that USAID is micro-managing projects, as generally is the World Bank.
3. Overall lessons on using planning, programmatic assessments, environmental assessments sector assessments, etc. can be useful in identifying win win situations or at least ways to reduce environmental impacts and improve sustainability.
4. There has been increasing use of measures of success to see how lessons learned can improve future projects.
5. Countries and between countries do not seem very good at least in Africa in coordinating activities - the overlapping use of pesticides is a dramatic example. With health, crop and special programs all doing repeated spraying of pesticides in fragile areas.
6. There appears to be a total lack of the concept of mass balance - is a program improving food security or only shifting from one form to another - e.g. from fish to rice or from millet to rice with loss of other resources.
7. Population growth is not emphasized as a priority and is somewhat controversial, but is the only solution to intensive resource use e- the Green revolution from Rockefeller has only delayed the time when food would run out from still booming population growth. Hoping for another green miracle is wrong - there will always be a road block. True, far fewer people are hungry (article) but can this be sustained.
8. There is total hubris that we can manage natural resources better than nature -opening up wild areas to resource exploitation will and can backfire. Hence there needs to be a balance in the push for anti- malaria programs. There needs to be a balance between lives saved from this terrible disease and how we will provide for all the survivors.
9. Water is a scarce resource and we need to find more ways to protect it and restore areas that have polluted and destroyed it. The answer is not just efficiency, but also changes in how things are done.
10. Energy needs to be converted to renewable sources and probably de-centralized sources in order to provide for populations that want a higher standard of living. "burning in the Sun" movie. At the least light is needed to do night education for students, since the y often work during the day. - Much more discussion here.
11. Communication has greatly improved - cell phones etc. are helping.
12. Development in cities needs to look more at LID, (for water - to reduce sewage etc. and there need to be new ways to look at sanitation, food and potable water -lots of developments in Juba, Nairobia.
13. As every war gets in the way (Sri Lanka) but surprising enough not in Southern Sudan.
14. Examine whether market changing economics are a useful concept for Africa.
15. Environmental Economics issues to be explored.

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