

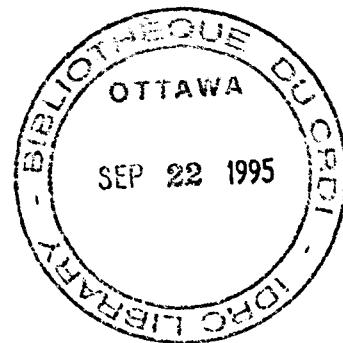
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D I V E R S I T Y

GLOBAL TRENDS AND ENVIRONMENTAL MANAGEMENT INTO THE XXI CENTURY

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CHAPTER 1

INTRODUCTION

GLOBALIZATION AND THE WAYS OF NATURE

Globalization trends are changing the world every day. The information society is allowing inexpensive generation, processing and rapid communication of facts, news, data and ideas throughout the planet, almost immediately.

The world is becoming a financial web, in which economic and financial decisions are made at a moment's notice and with almost instantaneous impact. Transportation systems have become fast, standardized and less expensive. Trade relations have become all encompassing and agile, while capital and products cross national borders with growing ease.

This increasingly integrated "new order" is having a strong impact on the distribution of economic roles worldwide. Investments and production move from place to place following cost-effectiveness and convenience. Mexico's "maquiladoras"¹ are assembling American computers, Chinese factories are manufacturing Japanese toys, and Egyptians workers are producing French garments.

All these changes are having important effects on societies and environments. One of these effects is the growing tendency towards uniformity and standardization. Diversities are being wiped out or threatened.

From the environmental point of view, human activities are becoming less and less sustainable. Monospecific agriculture based on exotic species, chemical fertilizers and pesticides, is affecting ecosystems, soils and water. Mining is causing land degradation. Widespread burning of fossil fuels is slowly modifying the Earth's atmosphere.

The whole planet is changing, all the while losing the flexibility provided by the myriad of its diversities.

Humankind is also squandering away its richness, its cultures, its proven traditional production systems, the wealth of experience accumulated through history.

In order to address these issues, we must optimize our ability to build on all relevant knowledge, being aware that the present is not only the boundary between the history and the future, but also the time to decide upon the successful strategies for survival.

¹ See Chapter 11

THE NEW GLOBALIZATION PROCESSES

Globalization processes have existed since the dawn of the "Modern" era. They took place as a result of the development of the first colonial empires such as those of England, Spain or France, through worldwide establishment of commercial networks (more or less politically or militarily controlled) through the opening of new markets in "peripheric" areas, and through the extraction of raw materials for various purposes, including industrial utilization.

Continued technological development during the XVIII and XIX centuries made still easier the growth of these "globalization" trends. The main technological breakthroughs that promoted "globalization" during the XIX century were the steam boats and trains and the telegraph.

At a later stage, the invention and spread of new telecommunication systems such as the telephone, the radio and more recently television, permitted a quantum leap toward a more global planet. However, these forays into "globalization" seem to have been only the beginning of a much larger process that is only now becoming better defined.

During the last few years, as a result of new technological advances (computer, fax, cable TV), and of the reorganization of the international framework of economies, societies and states, profound changes, with all-embracing socio-economic effects, have taken place. Macro-economic trends are affecting local and regional environments and societies, while accumulation of processes and activities on a local scale are having global environmental and social impacts. New ideas permeate through the "global" culture changing cultural patterns at all levels. Traditional cultures are being attacked by forces of uniformity, but they are also fighting back, utilizing the most modern technological means.

In the light of these developments, some new questions need to be formulated: How do we make sense of this myriad of apparently contradictory signals? What is, and will be, the effect of these changes in the environment and ways of life of people in local communities? What is the destiny of national states? Are we witnessing the birth of a new global culture, or perhaps even more, a global intelligence? What will be the destiny of the planet's diversities, both natural and social? Will the forces of uniformity recreate the nightmarish homogenous and standardized world that has been a frequent scenario in sci-fi novels?

Obviously, there are not easy answers for these questions and we are aware of that. In this document we will try to address some aspects of the issues, particularly in relation to their effect on the "environmental management" of the planet. Our basic hypothesis is that this new era will have enormous effects on the human and natural environment, and not necessarily all negative.

Contradictory forces are at work and stereotypes, as usual, are inaccurate. A preliminary task will be to unravel the critical components, filtering out the "noise". Some initial trends are real, some others are myths. In the following pages we will attempt to put together some thoughts that may shed some light on these issues.

CHAPTER 2

GLOBALIZATION TRENDS AND THEIR EFFECTS ON THE ENVIRONMENT

THE INFORMATION REVOLUTION

The end of the XX century is characterized by a profound technological revolution with strong effects on the socio-economic and environmental make up of the world. It has been defined by many as the "Information Age" , by Alvin Toffler¹ as the "Third Wave" and by Daniel Bell as the "Post-industrial Society"². Because it is in reality, the revolution of information, we will call it the "Information Revolution".

The two main phenomena which have allowed the growth of this new historical trend are the development and spread of computers, which make possible the storage and processing of large volumes of information, and the growth of new telecommunications technologies, permitting the transmission of these huge quantities (bytes) of information over long distances almost instantaneously.

These two sets of technological developments are not growing in isolation from each other. On the contrary, they are being integrated in many ways, to produce powerful tools and systems, increasing by several orders of magnitude humankind's capacity for collective memory and providing a huge world arena for social interaction.

As a result of these changes, the storage, processing and movement of information has become much faster, allowing large volumes of data to be sent very far in a very short period of time. Today, sending an encyclopedia from one terminal to another located at a distance of several thousand kilometers may take just a few minutes.

¹ Toffler, Alvin; 1980; *The Third Wave*; Bantam Book; New York.

² Bell, Daniel. "The Coming of Post-industrial Society: A venture in Social Forecasting"; New York, Basic Books, 1973.

In addition, these operations have become very inexpensive, require a minimum amount of energy and human effort, and are becoming more accessible and easier to utilize for a growing number of people throughout the world.

This information/ telecommunications revolution is generating a kind of "global intelligence", a computerized neural network with increasing numbers of information producers and users worldwide. The producers are not only the public and private institutionalized information packaging/ delivering systems, but also growing scores of smaller groups and individuals with computer terminals and the will to be connected. Consequently, billions of bytes of information are constantly being sent or exchanged among information producers, relay stations and users and receivers of various kinds.

Complementary with these advances, and in a large measure as a result of them, a number of accessory capabilities have become widely available to people. These include such facilities for production and reproduction of information/ ideas, as photocopiers, home printers, faxes.

By means of all these new techno-resources, many more social groups are now able, even at the local level, to express themselves in new and complex ways -electronic bulletin boards, community newspapers, and local cable-TV channels. At the national level, too, media are developing their own locally-customized versions.

THE EFFECTS OF THE INFORMATION REVOLUTION

The effects of the development of these global networks are many.

In first place, they provide wider public access to many more sources of information than ever before, not only from the centrally produced "info-stream", but also from a myriad of local sources. The possibilities of interactive reactions/ exchanges are multiplying accordingly. As a result, many social contacts are becoming independent of distance, giving rise to a new spectrum of relations that were not possible before³.

One overall effect appears to be a general "democratization" of information flow, both at the producer and receiver ends, with loss of power by the monopolistic information

³ One example of these processes is provided by the establishment and development of "Internet", a fast-growing electronic computer network linking tens of thousands of users worldwide.

holders (information control has always been a tool for power-holders to maintain and power-seekers to access). This is particularly important with regard to many aspects of technological and non-technological know-how as may become increasingly available to all.

We assume (and hope) that these networks will remain open and not controlled or censored by any existing or future to-be-developed "information power" as was often the case in the past⁴. To keep them open is going to be a global challenge for some time to come.

A related potential effect of the "information revolution" will probably be the increasing diversification of the points of view and approaches which can be expressed, and to which people can have easy access. This "diversification" effect is key; it may be in fact the most effective antidote against the "uniformizing" forces that are coming into play in the "globalized world".

The complex processes of globalization have promoted the development of a "main stream" standardized culture which includes not only widespread homogenization of production and consumption systems and patterns, but also a greater cultural uniformity, including expression codes, attitudes or beliefs. The new tendency toward diversification and differentiation is building on the opening of information barriers to allow a freer expression of innumerable perspectives, including those coming from numerous social minorities and disadvantaged groups who are able, in this way, to find relevant and accessible channels for the expression of their opinions and dissemination of their information.

This building of new roadways for public participation is activating, and will continue to activate, an immense potential for knowledge utilization, generation and innovation at the grassroots level.

⁴ Control of information for political purposes was common during the Cold War, and in a large measure, still is today. The major world powers strongly influenced the flow of news through press agencies, which in a more or less subtle manner, censored all "inconvenient" information. Another example of information control is provided by the "authorized" TV networks, which are regularly used as political tools both by governments and wealthy elites.

Many traditions that were eliminated, nearly-forgotten or simply discredited by mainstream culture may now have a second chance. Traditional knowledge, in many cases at the limit of extinction, could be rescued and revived, adapted, sustained.

The more marginalized aspects of complex cultures, some now being intentionally, or by omission, wiped out by the forces of standardization, may also stand a chance of survival if enough of their carriers are determined to act by means of these newly-developing mechanisms.

In all likelihood, meso- and micro- cultures (as well as sub-cultures), will survive at a different level than the mainstream "standard" culture. That said, the future coexistence of several cultures, on different planes or levels, will likely become more common and important. These smaller, probably weaker cultures should be able to transcend their limited ground spaces, however, to claim more extended "virtual" territories. Persons will be able to assert belonging to a specific culture without abandoning their rights as part of the wider set of standard cultural norms.

The potential of this development is enormous. People will have room to become more homogeneous at a certain level, but increasingly heterogeneous at a different one. The impact of these phenomena on the future of meso- and micro- cultures and nations can be very important as the disappearance of cultures, the result of their being drowned out by the mainstream, no longer happens; as the industrial national state, imposed through the asphyxiation of less powerful national/ local groups, loses its main source of power. Unavoidably, this phenomenon will lead to fragmentation of power and perhaps more instability; it should surely lead to more and different forms of democratization as well.

EFFECTS ON ENVIRONMENTAL MANAGEMENT

Environmentally degradatory processes have developed, often as a result of central decisions, based on concerns of powerful groups about how better to control or utilize existing natural (and human) resources and territory. Typically, in the centralized industrial states of the world⁵, local groups are among the least powerful, their environment and culture often undermined or destroyed without their being able to do

⁵ This is particularly true in the "developing world", but it can also happen in "First world" countries.

anything about it. The reigning ideology has tended to preach that practically any transformation of nature equals progress, that progress equals modernization, and that both of these are good. Local communities, in consequence, are often presented with the dilemma of choosing between their immediate convenience on the one hand and their long term good on the other. To make things worse, they have very little accurate information on the potential long term effects of the centrally-driven natural and socio-cultural transformations.

Even where communities may not agree with proposed measures, in many cases few effective channels of expression have been opened in the national state structures. The right of local communities to define their own destinies has not been well-acknowledged in practice, even if present in policy . In most cases, at the central level, few decision-makers, if any, cared to act to reverse this situation.

But circumstances may now be changing; in some cases, radically. First, there is coming into play a rethinking of development paradigms. Probably a combined result of negative development experiences throughout the world and of the change in mainstream culture consequent to the early effect of the "Information Revolution", new and alternative approaches are now being considered, typically conceptualized under the rubric of "Sustainable Development".

The "Information Revolution" is opening, and will certainly continue to open, many new channels for the expression of local groups in, among other things, the field of environmental management. People are becoming more involved in their communities, better informed on potential options and determined finally to have a say about the definition of their future, be it devising new development models at the local level, formulating policies with local effect, or advocating decisions at the central level on issues affecting them.

Thanks to increased access to more and more diverse information, environmental management can no longer be considered the reserve of the few. If they want, now, to carry out environmentally- unfriendly actions in communities, authorities are more often forced to first convince ombudsmen, local groups, senior citizens, schoolchildren, women and men of all professions of the positive impact of their projects. And more people are acquiring the means to propose their own solutions, based both on their own traditional and empirical knowledge, gradually becoming

properly valorized, and on the contribution of the scientific and technological knowledge of the modern sector becoming increasingly available to all.

DEVELOPMENT OF GLOBALIZED FINANCIAL MARKETS

Times have changed since wealth was expressed in terms of salt, corn or gold coins. Even paper money is losing status as the nearly 200 million Visa credit cards accepted in 6.5 million stores throughout the world serve to transact about 650 million dollars in business every day⁶. If all credit cards are considered, that figure is multiplied at least by a factor of five. In addition, huge numbers of transactions are carried out by other instruments, such as cheques, shares, money-orders and so on.

As a result of the Information Revolution, a growing volume of financial operations are thus carried out with, in effect, "electronic money". The trend is clearly toward more widespread substitution of paper-based transactions by electronic operations.

The development of this "virtual" framework has made possible the increased agility of international monetary systems: movement of currencies and financial and commercial transactions can be done at a speed that is changing the rhythm with which political and economic events take place. Financial decisions need to be made at a moment's notice, at any hour of the day or night. Global markets never close. The effects are almost as instantaneous. Once a major financial operation takes place or an economic policy declaration made, widespread repercussions can be felt throughout the world in a matter of minutes.

In further consequence of this information-based management of money, there has been profound internationalization of money markets, and a subsequent blurring of financial borders. There are increasing ties between currencies; national governments are experiencing greater difficulty in defining autonomous policies, independent of the international context.

Somewhat paradoxically, however, as monetary globalization proceeds, financial trends are developing "on their own"; it is becoming increasingly difficult to control markets as many more people, acting on their own, are making many more decisions

⁶ Data shown in p.61 of "Powershift", Alvin Toffler, 1990; Bantam Books, New York, pp. 611.

in very short periods of time. Central banks are having problems ensuring the stability of national currencies or the behavior of other financial parameters.

This trend is being accelerated by the similarly widespread automation of the markets and the development of new early forecasting programs.

According to **The Economist** there are "a dozen firms ... managing more than 100 million dollars each on the basis of advice generated by computers"⁷. Growing numbers of mathematicians and computer experts are dedicated to the task of unveiling market trends automatically through computerized non-linear forecasting and other tools which increase the speed and accuracy of financial decisions. The effects of this growing tendency are not yet wholly understood, but they are already playing a role in the globalization trend and liberating at least some aspects of the financial market from monopolistic control.

DEVELOPMENT OF MORE EFFECTIVE MERCHANDISE TRANSPORTATION NETWORKS

Although to a much lesser degree than in the case of the flow of information, the transportation of merchandise has also been deeply affected by post-industrial changes. The internationalization and generalization of air traffic allows for the rapid transportation of increased varieties of lightweight, high value and/or short life-span merchandise: electronic equipment and parts, food and flowers, newsprint. Maritime freight has also become more agile and effective, with the development of more computerized shipping and the associated improvement of commercial systems, faster ships and modular packaging. One of the major elements improving the effectiveness and safety of shipping has been the worldwide adoption of container systems reducing risks of both theft and spoiling, and significantly speeding up loading and unloading of goods.

One effect of these processes has been to promote trade growth worldwide by reducing shipping costs and making easier the redistribution of production roles at the world level. As a result, production is moving more and more toward the most

⁷ "Frontiers of finance"; in "The mathematics of markets", "A survey of the frontiers of finance"; *The Economist*; October 9 - 15, 1993; Vol 329, Number 7832; pp. 22, ref. in p.3.

"convenient" place; that is, the most economic, simplest and safest option available at any given time. This new framework is making it more difficult for governments and lobbying groups, artificially, to retain industries or other economic activities in non-economical situations.

The "lubrication" of merchandise transport systems is also playing a role in the development of the "uniformity coupled with diversity" trend. On the one hand, there will be a movement toward standardization, through the stricter and more widespread delineation of standards and special specifications and "filtering" quality controls. On the other hand, container systems are permitting the movement of very diverse products in the framework of a highly standardized transportation system. As with information, the final result will likely be a combination of both tendencies. At a certain level, there will be a flow of highly standardized merchandise. At a different level, very specific, specialized and custom-made products will also find their way more easily through the system.

MOVEMENT OF PEOPLE

A final element of this changing world is the increased speed, volume and accessibility of transport for people. The main technology driving the process is, of course, air travel. In any given moment, throughout the world, there are several thousand planes in the air, transporting tens if not hundreds of thousands of people through distances of hundreds or thousands kilometers each. Access to this type of transportation is becoming the norm throughout the world. Complementarily, ground transportation (automobiles, buses and trains) has also become much more flexible, accessible and rapid, increasing severalfold the number of kilometers that any given person travels during his or her lifetime.

The effects of this increase in travel are felt in different ways. First, there has been a phenomenal growth in the tourist industry. A number of countries receive in excess of 10 million visitors annually (mainly tourists); in some highly touristic nations, such as Spain, Italy, the United States and Mexico, the number of visitors can surpass 30 or 40 million per year.

Business travel has similarly increased. Business dealings are performed more frequently and effectively, complementing tele-communications with face to face contacts.

Thirdly, many new types of international and national social contacts, difficult before, are now becoming commonplace. Thousands of international or interstate sports competitions, congresses and other events are becoming the rule rather than the exception.

Last, but not the least, the facility of international travel has permitted a continued increase in the flow of international migrants. The main streams of emigration fueled by social, economical and political situations and events have been greatly promoted by the accessibility of transportation for millions. Such an increase in the transnational flow of people is acting as a major factor in globalization. Visitors interact in many ways with their host countries, exchanging money, purchasing products, influencing (and being influenced) culturally. Migrants interact still more. They affect local job markets, they experience and produce cultural changes, they mix socially and genetically.

The final result is an unprecedented mixture of cultures and groups, with the subsequent acquisition or loss of know-how, changes in outlook, faster evolution of phenomena and processes, behaviors and attitudes.

As with other aspects of the information revolution, increased travel has produced "uniformity" at the same time as it has fostered the spread of diversities. As described before, the two processes are taking place simultaneously, though probably at different levels of social systems and consciousness.

GLOBALIZATION AND THE UNEQUAL DISTRIBUTION OF WEALTH

One of the main effects of globalization on the world's "heterogeneities" seems to be the development of global tendencies toward less differentiated features in many of the aspects of society and life throughout the world. As described above, this "uniformity" is reaching into cultures, technologies, and economies; it is also altering environmental management methods.

As we have seen in the previous sections, there is at the same time, and at a different level, a rebirth of diversification, promoted by a certain "democratization" of information through the gradual expansion of the electronic networks and increasing number of channels of communication.

In addition, however, there remain some important elements of both national and international spheres that do not seem to be profiting from either the trend toward uniformity or the potential of diversity. These are the processes leading to the unequal distribution of resources, products and access to financial means among much of the world population.

International economic disparities do not appear to be shrinking as a result of recent developments; on the contrary, they seem to be growing.

The difference between real incomes of the poorest and richest populations of the planet is huge. The per capita income of the 16 richest countries varies between 10,420 and 21,250 dollars per year with an average of approximately 15,000 dollars per annum. At the other extreme, the per capita incomes of the 25 poorest countries⁸ vary between 80 dollars (Mozambique) and 350 dollars (India) dollars; with an average of about 220 dollars per year. Five days of per capita income in the richest countries⁹ (19 countries with a total population of 725 million¹⁰) is equal to one year of income in the poorest (total population: 1,575 million) (source: World Resources 1992-1993¹¹).

In spite of the magnitude of these disparities, the reality is still more dramatic. It must be remembered that the per capita income is calculated by dividing total national income by population. This means that in reality, the actual income of the poorest sectors of the poorest countries is considerably lower than national average figures, which contain the income of the very rich elites, who receive incomes much higher than the national average. It can be estimated that the per capita income of the poorer sectors of the poorer countries is less than 60- 80 dollars per year, and in the poorest tenth, probably does not exceed 40 dollars. To earn the equivalent of the hourly salary

⁸ Income per capita below 350 US dollars.

⁹ Income per capita above 14,000 US dollars.

¹⁰ Projections to 1995.

¹¹ World Resources 1992-1993; A Report by The World Resources Institute; New York, Oxford, Oxford University Press, 1992.

of a First World professional¹², a poor inhabitant of a poor country must work several months and even years...

DIFFERENCES IN QUALITY OF LIFE

In the face of these figures, one must ask the question whether such quantitative contrasts reflect differences of the same order of magnitude in the **quality of life** of populations? Expressed in other words, is the quality of life in the poorer countries ten, one hundred, one thousand times lower than in the richer countries?

The answers to this question vary; there are many different criteria for evaluating such an elusive concept as life quality.

From one point of view, the quality of life of an itinerant farmer in the highlands of New Guinea may actually be higher than that of a neurotic and stressed executive of Wall Street, the astronomical differences in income notwithstanding.

From a different point of view, however, a completely opposite conclusion may be drawn. The United Nation Development Programs has defined a "index of human development" based on several parameters, putting into global terms the various aspects which constitute the concept of "quality of life". From these indicative figures the UNDP has assessed the level of human development in every country of the world. Though the figures obtained from these calculations give only a general idea of life quality, and cannot be taken as an arithmetic expression, the human development index of richest and poorest countries shows an abysmal gap between them in quality of life as well as income.

In order to better understand these differences, it is worthwhile to express them as qualitative comparisons.

¹² The hourly salary of a well-paid professional in a First World country is frequently in excess of U\$ 100 which can represent two or three years' earnings for the poorest sectors of the poorest countries.

People in developed countries are better fed and live in a healthier, less contaminated¹³ environment, with fewer infectious diseases. They therefore get sick much less frequently. In spite of that, these "healthy" people have much easier access to a much more efficient health service with the best human resources, expensive medicines and sophisticated clinical analyses and equipment.

The average individual from a poorer country often works in unhealthy environments, in confined spaces, breathing toxic substances and in uncomfortable positions, with long working hours, and long commuting trips in crowded buses or trains, to support a large family on an insufficient salary. In addition, they live frequently in degraded environments, with higher risks of natural catastrophes such as landslides or floods.

On another level, the average person in a richer country has more free time and more varied options for both leisure and consumption, and he or she can practice sports, have access to a range of healthy products and obtain a maximum level of health prevention.

On the other side of this "development wall", a person from a poor country has very little free time, eats a largely unbalanced diet without any real possibility for change, and has a weakened resistance to disease. Often living in high density population areas and coupled with inappropriate hygiene habits, the poor must face a much larger occurrence of infectious diseases and do so within health systems that are overloaded, with insufficient budgets.

For these reasons, it can, in principle, be stated that the real differences in quality of life between the two "remaining" worlds (the "First" and the "Third"; the "Second" being increasingly in the process of "third-worldization") are well in line with the critical gap shown by the figures.

To be absolutely objective, we must recognize that all the previously mentioned facts and evaluations do not apply across the board to all social sectors in rich and poor countries. There are poor sectors in the richer countries and very rich sectors in the poorer ones. The standard of living of the higher classes in some poor countries may

¹³ This is not always true, however. There are forms of contamination that are not easily detectable found in many sites of the developed world and less so in Third World countries. These cases are become less common due to the globalization processes mentioned throughout the book.

seem sumptuous even when compared with that of the average person of the First World.

That said, an evaluative comparison of the two worlds shows huge contrasts which appear to be increasing daily.

The reasons for this are several. Firstly, the populations of poorer countries are growing much faster than those in the richer countries, making it yet more difficult to provide employment and services for all. Secondly, poor countries are degrading their environments much faster and as a result their productive base is reduced. Thirdly, the poorer countries are losing their best human resources through emigration to the North. Finally, goods and wealth produced in the poorer countries are being systematically transferred to the rich through export of capital, payment of royalties and profits and of loans and interest, gradual deterioration of the terms of exchange and varied processes of cultural alienation which are promoting unnecessary and frivolous types of consumption (again favoring this transfer of money and resources from poor to rich).

FACTORS FOR INTERNATIONAL MIGRATION

These differences in quality of life are occurring in an epoch of intense globalization of communications and transport (particularly, expansion of TV networks beyond national and continental borders; universalization of radio broadcasting; telephone, fax, and electronic networks; popularization of air transportation, expansion of highway networks, and so on).

As a result of these factors, and for first time in history, the majority of inhabitants in the poorer countries have become aware that other people in other places live not only differently, but much better, qualitatively.

Today's reality shows an increasing aspiration of Third World people to emigrate to the developed world. Salvadoreans, Nicaraguans, Peruvians and many other Latin American people look forward to emigrating to the U.S.A. and Canada; thousands of

North-Africans would like to move to France, Belgium and Switzerland, and many Indians and Pakistanis would like to emigrate to Britain or Saudi Arabia.

Several millions attempt it every year, and a considerable number succeed. They utilize the most varied and imaginative methods. Some attempt it by crossing a river or the desert (as do the "wetbacks" of the US-Mexican border). Others migrate using small boats (such as the Haitians who cross illegally to Florida, and are returned in large numbers). Others try their luck by legal means through selective quotas (cases of immigration to Canada and U.S.A.) or through agreements between governments.

Professional people and entrepreneurs are in the best position. When they possess special expertise or belong to the more qualified professions, they are accepted with relative ease.

In fact, perhaps some of the more active components of the world demographic dynamics are the migratory fluxes. Many people residing in developing countries (representing more than 80% of the population of the world) want to move to developed countries where there is currently less than 20% of the world population.

One result is that the richer countries are developing stricter policies and strategies to prevent these uncontrolled arrivals. Careful migratory controls, visa requirements and financial guarantees are all geared to helping close borders.

In spite of these measures, migratory pressure is such that large numbers manage to squeeze through or around the different "filters", and finally settle in the targeted countries.

The situation of these "undocumented" individuals is often regularized after several years through periodic amnesties which, in a certain way, are a recognition of the impotence of the police and immigration systems in preventing this trend of escaping the disparity of life conditions in the South.

Presently, the main recipient countries of immigration are the largest and less densely populated: the United States, Canada and Australia. These three countries absorb about 1.5 million immigrants every year, which is approximately half of the total migration to developed countries. The U.S. alone receives more than 1 million

is evidence of a switch in the types of jobs that are available in the United States. Due to the movement of the country into a "post- industrial" Third Wave¹⁹ society and a redistribution of its global productive roles, a large number of labor intensive productive activities are being transferred to less developed countries (i.e. Mexico). Many jobs which were once filled by immigrants or non-specialized American workers have disappeared, a situation that is affecting that part of the American working force dependent on these jobs for its subsistence.

One frequent argument is that it is the continuous flow of immigrants that is creating the job scarcity. While this is not necessarily true, as has been demonstrated by a Canadian report by IRPP²⁰, it can be an additional factor causing more acute levels of frustration in the society. As a result, a widespread feeling of many American citizens is that it will be necessary to stop or drastically reduce immigration to solve the unemployment problem.

Reality may show otherwise: the less that cheap labor is available in the U.S., the quicker the economic realignment is going to take place as factories and farming activities start moving South. At least in some activities, the lack of inexpensive immigrant manpower may promote the transfer to Mexico, Brazil, Guatemala or other countries of many jobs, including some now performed by American workers.

IMMIGRATION TO OTHER DEVELOPED COUNTRIES

Similar observations can be made about Canada, Australia, and to a lesser degree, about several of the European countries.

Canada and Australia possess a low population density (less than 3 inhabitants per sq.km). Immigration to Canada has varied from 100.000 to 200.000 people per year during the last few years. Australia has accepted figures slightly lower than those of Canada.

¹⁹ Here we are using the very graphic expression of Alvin Toffler, see ref. "The Third Wave".

²⁰ A report of IRPP in Canada demonstrates that immigrants create more jobs than they take (add reference...?).

Lately, Canadian immigration has been composed of a relatively high number of people from Asia (who normally settle in Vancouver, Toronto and the other larger cities), Eastern Europeans, and to a lesser degree, people from the Middle East and Latin America. As a result of the recent war in Somalia, many citizens from this country have also migrated to Canada, many of them as refugees.

In Australia, the migrating groups include a considerable number from neighboring Far Eastern countries (China, Indian, Pakistan, Vietnam, Indonesia, Philippines, Melanesia and Polynesia) as well as Eastern Europe.

In Europe, immigration patterns are closely related to the earlier affiliation of Third World former colonies and their metropolises. For this reason, France and Belgium have received many immigrants from the francophone countries of French Africa (Morocco, Algeria, Tunisia); the United Kingdom is the destination of Indians and Pakistanis; Holland of Indonesians; Portugal of Angola, Mozambique, Cape Verde Islands and Guinea and Spain, Spanish-Americans, Moroccans, and other Africans.

The Southern coast of Spain, in Andalucía, near Tarifa, is the destination of tens of thousands of illegal immigrants attempting the crossing of the Strait of Gibraltar in "pateras"²¹. Moroccans, Mauritians, Senegalese and other Africans from South of the Sahara cross the strait using the service of the "pasadores" or "lobos" (people helping migrants to cross the strait). Once they reach Spain, a certain number manage to move into other countries, such as France and Germany, but many remain on the Iberian Peninsula.

In Europe, the African and Asian workers provide inexpensive labor for jobs not attractive to nationals and it has, as a result, become increasingly difficult for some of the richer European countries to do without their work.

In addition to the large number of immigrants with low professional qualifications, Europe receives an important number of immigrants of high or medium qualification (generally through legal or semi-legal ways) arriving as students, invited professors, professionals and qualified technicians.

It is interesting to note that an important part of the earnings of the immigrants is transferred to their countries of origin. It is estimated that as a result of these

²¹ Boats utilized to cross the strait of Gibraltar.

remittances, Morocco receives an amount in excess of 1 billion dollars²². Similar figures are reported from Algeria, Tunisia and, to a lesser degree, from the Sub-Saharan countries.

Similar to North America, a non-negligible sector of the immigrant population reaches its countries of destination with a high level of schooling, strengthening the "know how" of European countries while simultaneously and consequently reducing such resources in the countries of origin, another example of "brain drain". Third World countries spend their limited financial resources in training their professionals, only to have the few well trained who complete their studies quickly absorbed by the much richer North.

THE DEVELOPMENT OF FREE MARKETS

Immediately after the Second World War, the main political powers started discussions to reduce tariffs and duties worldwide, giving birth to a new institution called the "GATT" (General Agreement on Tariffs and Trade). With the participation of 23 countries this agreement was concluded in Geneva, Switzerland in 1947, to take effect in 1948.

The objective, at that time, was to approve an interim agreement until an international agency could take over the responsibility for coordination and management of international trade relationships. Because this agency was never implemented, however, GATT became the principal tool for the stated aim of liberalizing world trade. With time, GATT expanded to include 78 countries in 1971 and more than a hundred by the early nineties.

A second, regionally restricted attempt at trade liberalization took place in Western Europe after 1958 when the European Common Market was formed with the participation of France, Germany, Italy, Holland, Belgium and Luxembourg. This market, which at a later stage was renamed "European Community" grew further to include the United Kingdom, Ireland and Denmark (1973), Greece (1981) and Spain

²² According to L'Express, reproduced in El País, Montevideo, Uruguay, 27/11/92, p.2.

and Portugal (1986). By 1993, other European countries were negotiating their incorporation and it is very likely that before the end of the century the remaining Scandinavian countries (Sweden, Norway and Finland) together with Austria, will join.

Hungary, Slovenia, the Czech Republic, Poland, Estonia, Latvia, Lithuania and Malta are also interested though their incorporation will not probably occur before 2000.

The EC countries carry out their trade mainly with their partners of the European System (Holland: 78% of its exports; Belgium/ Luxembourg: 75%; Ireland: 75%, Portugal: 74%; Spain:71%; France: 62%; Italy: 59%; United Kingdom: 55%; Germany: 53%). Most of the remaining commerce is directed to North America and the Far East. The role of Third World countries in European commerce is less important.

Starting in 1988, a second major commercial bloc was formed in North America when the U.S. and Canada agreed on a Free Trade Agreement. More recently, in 1993, an agreement was reached between these two countries and Mexico to ensure its integration in the process through the North American Free Trade Agreement (NAFTA). The formalization of this Treaty has generated strong opposition from some sectors of both the Canadian and American public who consider that the opening of borders will release a flood of companies moving South to Mexico to establish themselves in a less expensive environment, while posing the risk of increased immigration to the U.S. and Canada.

Opinions on this are not unanimous. A recent article in *The Economist*²³ expressed the view of many who think there may be exactly the opposite effect. For example, it cites the case of a General Motors plant planning to move a large portion of the production of Cavalier vehicles from Ramos Arizpe, Mexico to Lansing, Michigan. According to the same article, Mexican labor costs are only 35% lower than in the U.S. and 40% lower than in Canada, when average wages are adjusted for benefits and lower productivity. The trend produced by the treaty, thus, may be less pronounced than is feared by those who oppose it.

Following a proposal of then-President of the United States George Bush (Initiative for the Americas: 1990) other Latin American countries are also making progress towards

²³ "NAFTA, South of the Border; Across the Rio Grande", *The Economist*, October 9, 1993; Vol. 329, Number 7832; p.67.

similar agreements. The most important regional block is the MERCOSUR, composed of Brazil, Argentina, Uruguay and Paraguay, complemented by the Central American Free Market (Guatemala, Nicaragua, El Salvador, Honduras and Costa Rica) and the Andean Group (Venezuela, Colombia, Ecuador and Bolivia). Chile and Peru have not joined any of these liberalization initiatives.

It is important to note that there has been, since the sixties, a wide-ranging attempt for a Latin American free market (after the formation of the Asociación Latino-Americana de Libre Comercio, the A.L.A.L.C. which after the treaty of Montevideo became ALADI, Asociación Latino Americana de Integración). ALADI's role has been mainly to provide an institutional framework for regional agreements dealing with integration processes, including trade liberalization.

The more recent GATT negotiations, which started in Uruguay in 1986 (the **Ronda Uruguay**) have taken place in this environment of globalization. This "round" encountered many difficulties, particularly because of the insistence of some EC countries on maintaining certain farming subsidies. The final document of the Uruguay Round of the GATT was approved and signed by the 117 members countries on December 15, 1993 in Geneva, Switzerland. Although the final agreement was not as widespread as expected, tariffs will decrease by an average 40% throughout. The relatively successful conclusion of this agreement shows that the world continues to move toward globalization and that although the reality of international commerce is complex, the barriers that used to prevent the development of open trade relations are gradually being dismantled.

COMPLEXITIES OF INTERNATIONAL COMMERCE AND THEIR EFFECTS ON THE GLOBALIZATION TREND

Much evidence from recent history tends to show that globalization processes are unstoppable. The reasons are several: globalization of the movement of capital and, in general, of financial operations; internationalization of larger companies (becoming "transnational" entities); development of maquiladora-type phenomena and other processes of transfer and international complementarity of productive activities; increased agility of merchandise transportation systems (air, ground, maritime); and explosive development of telecommunications and computerization.

The framework of "unidirectional" openings (liberal approaches in developing countries, continued protectionism in developed economies) provides the basic scenario of all current globalization trends. It is an "internationalization" controlled from the financial centers of decision-making in the North.

Farming systems in the U.S. and the E.C. remain supported by direct and indirect subsidies. In the case of Europe it has been considered by some as an overt protectionism, while in the U.S. the subsidies are more indirect, such as the water subsidy for irrigated agriculture in California and other Western States.

Third World countries, on the other hand, pressured by the need to service large debt loads, and conditioned by liberalizing programs imposed by the I.M.F. and other lending agencies, have been drawn into export promotion campaigns. These have forced them to accept "leonine" terms of exchange, both at the level of import "quotas", allocated in the framework of political and financial negotiations (i.e. as instruments of political pressure) or in relation to refinancing of their foreign debt.

The "desperation" to export, coupled with the need to create new sources of employment, have pushed many developing countries to be less selective in their acceptance of new industries transferred from developed countries, including the rapidly spreading "maquiladoras", which in general represent production systems that not only are highly exploitative of the work-force, detrimental to health and environment-unfriendly, but also are "non-formative" for workers, who learn practically nothing which can be applied elsewhere.²⁴

²⁴ In Chapter 11 a more detailed description of this phenomenon is presented.

ECONOMIC GLOBALIZATION AND ENVIRONMENTAL DEGRADATION

These processes of economic globalization and liberalization of trade barriers are having strong effects on the environmental situation at the local, regional and global levels. It is a trend likely to continue.

Anytime trade barriers are lowered or eliminated, many economic activities which had been carried out under their protection tend also to disappear, often to relocate in other areas where economic survival is easier.

Generally speaking, the commanding factor of productive competitiveness is cost. Developed countries must compensate for their high labor, tax and environmental costs through more productive technologies, higher production and more efficient management strategies.

In some technological areas, there is a clear advantage to producing certain goods in developed countries in spite of the high costs, due to well organized and efficient infrastructures, high capacity of existing human resources, better quality control, proximity to consumption markets, etc. There are a number of productive activities in developed countries, however, which if left on their own would not be able to survive for long. The survival of these activities can only take place behind the shields of protectionist trade barriers and subsidies.

Because globalization processes tend to remove these barriers, many productive activities traditionally related to developed economies are gradually being transferred to developing countries.

In some cases, this happens through a partial transfer of some operational aspects of the productive chain, such as assembly or production of parts for industrial use. Such transferred operations can be carried out at a lower cost in the receiving site of transference due to lower labor and environmental costs.

Normally, this involves agreements between the countries allowing productive complementarity. In most cases, the transferring country charges duties only on the added value and the host country opens "free zones" to allow the entrance and exit of raw materials and merchandise with no or minimal import/export duties.

These are the industries called "maquiladoras", common in Mexico, Guatemala, Costa Rica, and Dominican Republic, and with slightly modified modalities, in some East Asian countries and North Africa.

More often, when the "whole" economic activity becomes anti-economic in the developed country, the whole productive process can be transferred to the "partner". Many industries in the metallurgical, textile and electronic fields, among others, have been transferred in this way.

Similar phenomena are occurring in relation to agricultural activities (some Californian crops have been gradually "transferred" to Mexico, Chile and Brazil), to forestry (Canadian forestry is having trouble competing with Chilean and Brazilian forest industries) and aquaculture (shrimp farms have been established in Ecuador and the Philippines).

This global restructuring of production is having a profound effect on the environment. Most of the industries or activities moving to developing countries have some potential for environmental degradation. A considerable number of them produce toxic wastes or emissions that can introduce negative elements into water, air or soil surfaces.

When these industries/activities were located in developed countries, mainly as a result of a long social learning process, a set of environmental laws was developed that gradually addressed, more or less efficiently, the potential deleterious effects of these hazardous activities. Developed countries constructed a preventive reactive system, including the development of technical solutions to environmental degradation, formulation of policies and rules for that purpose, definition of responsibilities and accountability and development of appropriate institutions to deal with environment problems.

In many developing countries nothing similar exists. Some laws may be in place but are poorly applied (if at all). In several countries, recently, progress has been made, but not enough to prevent serious environmental degradation from occurring.

Thus, the productive restructuring of the world economy appears to be threatening the environment at local, national, regional and global levels.

One illustrative case of this problem is acid rain. Once a typical phenomenon of the "industrialized" world (N.E. North America and Western Europe) it now has become a serious issue in several Third World countries, including China, India and Brazil.

Industrial procedures to check environmental degradation in developed countries are often by-passed; some industries relocate in Third World countries specifically because such requirements do not apply or can be circumvented.

In some cases, new irrigated farming projects located in developing countries are using water well above the renewability potential of aquifers or surface water bodies. In others, farming and neo-forestry activities are carried out following the elimination of rich and diverse native forest ecosystems.

The balance is systematically negative: less care exercised and responsibility taken, fewer resources applied to environmental protection, soil erosion, contamination of aquifers, streams, lakes and coastal waters, deforestation, introduction of exotic species without consideration for their eco-systemic effects, and degradation of the atmosphere.

Any long term approach to environmentally sustainable development will need to take into consideration these effects of globalization. They will need to be addressed and solved before they become irreversible, or too expensive to correct.

EFFECTS OF INTERNATIONAL DISPARITIES ON THE ENVIRONMENT

The huge differences separating the rich and poor populations of the world are having an unmistakable effect on the environment at local, regional and planetary levels.

We must remember that poverty is a prime cause of many of the world's serious environmental problems. In most countries, although they live in crowded environments, the urban poor must survive without appropriate sanitation and waste disposal services. As a result, poor neighborhoods are becoming major sources of water and soil degradation, both in the proximity of the areas where they are located and down-slope or downstream.

In some countries, landless rural poor are forced to move into inappropriate locations, cutting and burning trees for subsistence farming or cattle raising, or excavating the soil and sediments to extract the minerals that allow them to survive.

A large part of the environmental degradation, including desertification, erosion and contamination processes, are the direct result of the efforts of poor people to make a living; very often, simply to survive. The question, however, is not why these people are harming the environment and how they can change their behavior. The real question is why they are in a situation where this is their only recourse.

However, it must be emphasized that not all environmental problems are the results of poverty. Many (perhaps the most acute and wide-ranging problems) are, in fact, the result of economic affluence and indiscriminate consumption. In effect, it can be demonstrated that wealthy countries are responsible for the burning of most of the non-renewable fuel resources that are utilized in the world. They produce the largest volumes of solid and liquid wastes, throw into the air enormous volumes of unnatural emissions, possess the largest depredatory fishing fleets, consume much of the world's production of many consumption items produced in environmentally unfriendly ways in the poorer countries; and finally, through the promotion of export-driven economics in the developing countries, force these countries into positions in which environmental degradation becomes the unavoidable outcome.

These comments aim to emphasize the strong relationship between the basically inequitable social structure of the world at the international level, and the main processes of environmental degradation similarly taking place across the planet. A sustainable approach to environmental management must address this as a paramount issue: the need to restructure the distribution of wealth among countries and among people.

Harmonization of production-consumption and the more equitable distribution of wealth are the pre-conditions of sustainable environmental management.

CHAPTER 3

PLANETARY DEGRADATION

INTRODUCTION

People know that their actions can have and indeed do have considerable effect on "local environments". When a fire is lit, large forest areas of several hundreds of hectares may disappear under the flames. If a dam is built, extensive low-lying areas can be flooded. Cities produce effects on the local climate, increasing average temperatures and changing several other parameters of the overlying atmosphere. Large lakes can be rendered lifeless due to the contaminants that are put into them.

It is not as easy to recognize that human activities can change the environment at a regional scale. However, it is now becoming clear that whole regions downwind of large industrial areas are being deeply affected by acid rain; that some species have disappeared from fishing regions; and that overgrazing or deforestation are affecting the regional climate of the Sahel and Amazonian regions.

It is even more difficult to imagine that the **whole global environment** can effectively be modified by anthropogenic action. The Earth is such a large place... the atmosphere contains many million km³ of gases. Past experience would suggest that human activities will never reach the dimension necessary to produce changes at a planetary scale. But, as we know, times are changing in almost exponential degrees and many past truths may no longer apply.

THE EXAMPLE OF OUR SISTER PLANET

The Earth is not moving around the sun on its own. In its annual orbit, our planet has as faithful companion the Moon. Before the 1960s humans had not had influence on the lunar environment. For 4 billion years or more, our sister planet has evolved according to the general laws of celestial physics, its surface modified only by lava flows (in very ancient times), meteorite impacts, terrestrial tides and solar radiation and particles. For many years even during the lunar landings of the late sixties and early seventies, it was believed that the Moon did not have an atmosphere. Now we know that this is not true, the Moon possesses a very thin atmosphere made up

mainly of helium, argon, sodium, potassium, radon and polonium¹. The total mass of the lunar atmosphere is very small, just 30 tons or so for the whole planet.

The effect of the Apollo missions on the lunar environment was considerable. Each flight increased the mass of the lunar atmosphere by 1/3 to 40 tons. The gas escaped after a few weeks, but it was "renewed" in each mission. It is obvious that if any kind of settlement was established on the Moon the impact on the planet's environment would be enormous. The example of the moon missions shows that humans can change planets, even without meaning it.

The Earth is a much bigger planet than the Moon, its diameter 4 times bigger and the total mass some 90 times larger. However, on the earth there are everyday the equivalent of several hundred thousand "Apollo missions" carried out by a similar number of aircraft. In addition to these "flying" missions, there are at least 500 million cars and 10 million factories everyday using some atmospheric gases and releasing others in ways quite contrary to natural cycles.

The production of CO₂, for instance, has been increasing exponentially since the beginning of the industrial revolution. During the first stages of the industrial era, fossil coal was burned in large quantities. At a later stage, many coal burning factories were discontinued and widespread utilization of petroleum took place. Today, the consumption of petroleum continues and the volumes of CO₂ and other associated gases emitted into the air is gradually augmenting.

One question arises: how many emissions can the atmosphere of a planet like Earth take before changes start to show in the dynamics of the gaseous and crust spheres?

We don't know the answer for sure; the changes could already have started; started already, perhaps we are nearing the edge. In any case, we are "playing with fire" in the literal and symbolic senses of the phrase.

Some people are worried and with good reason. We should be worried mainly because we still know so very little... In the following section we will try to explore some factors which perhaps will allow us to decipher some of the indicators of global change. factors which may help to solve the planetary environmental puzzle.

THE UNUSUAL OXYGEN PLANET

¹ The identification of lunar helium and argon took place during the Apollo 17 flight in the LACE (Lunar Atmospheric Composition Experiment) in 1972. Similar results were obtained with radon and polonium. The discovery of sodium and potassium in the moon took place in 1987 in the McDonald Observatory using a large reflector telescope (ref: Stern, Alan, "Where the lunar winds blow free", *Astronomy*, November 1993, Vol.21, No 11, p.36-41).

When the other planets of the solar system are observed, the Earth appears as an oddity. Although there are other planets that are not so different in volume and mass (i.e. Venus, Mars, Mercury, Ganymedes and Titan) some features of the Earth can be considered very unusual. The Earth is the only planet (that we know of) possessing a large "oceanic" sphere. Its atmosphere is unique in that it contains very little CO₂ gas (about 1/3 of 1%) and a large amount of free oxygen (21%).

The level of oxygen appears as particularly high when we consider that oxygen is a very active gas and combines with many other elements. It is found in many other planets, but normally combined with C and H forming CO₂ or H₂O (in the gaseous or ice forms) or with silicium, aluminum and other elements to form the crystal lattices of most minerals in rocks. No free oxygen in significant quantities exists on any other planet.

The Earth has oxygen in its water, ice and rocks. In fact, oxygen is by far the most common element in the Earth's crust representing 45% of the total mass and 90% of the total volume. However, it is the huge amount of free oxygen in the atmosphere that is unique in the solar system (and perhaps elsewhere) and this oxygen has existed for many hundred million years. Every indication is that its proportion has grown during geological times, explained by geologists as the result of a long period of photosynthetic activity by organisms such as algae and green plants.

Originally the planet Earth was probably very similar to Venus and Mars² but with time, photosynthesis activity released the oxygen contained in CO₂ to form organic matter³. A large part of the carbon was buried in sediments as limestone (which are mainly carbonates), coal, petroleum and gas. A very small portion remained in the atmosphere or dissolved in ocean waters.

At the same time that CO₂ decreased and carbon (C) remained trapped in geological layers, oxygen atoms were released in the atmosphere, gradually increasing its content to more than 1/5 of the air composition. The upper limit for oxygen release relates to the growing probability of natural fires; the more free oxygen there is, the more likely that spontaneous fires will break out. And of course fires have the effect

² Venus atmosphere is mainly composed of CO₂ (95%) and N (4%); Martian atmosphere contains 94% of CO₂ and 5% N. According to various authors the contents of CO₂ in the earth 3,000 million years ago was also very high (perhaps more than 90%).

³ It is believed that noticeable volumes of free oxygen appeared for the first time in the earth about 2 billion years ago. One billion years later, its content was probably between 1% and 3% of the present atmospheric level and ozone started filtering the ultraviolet radiation. The 5% barrier was probably crossed about 750 million years and the present oxygen concentration was not reached until about 100 million years ago. (ref. "The Oxygen Cycle", Preston Cloud and Aharon Gibor; in *The Biosphere*, a Scientific American book, U.S.A.; 1970, p.57 to 68.

of oxidizing the carbon in the organic matter (i.e. of wood) forming again CO₂ (that is reducing O₂ in the air and increasing CO₂).

The decrease in CO₂ during geological times brought important climatic changes. The likely main change being a decrease in the average temperature. CO₂ has a strong greenhouse effect, and its elimination promoted a general cooling of the atmosphere.

The decrease in CO₂ was not continuous. It seems that this process occurred in leaps, and that the qualitative changes were determined by the development of new, more sophisticated biological systems to utilize it.

According to Lovelock⁴, this decrease in CO₂ was also a way for the planetary organism called Gaia to cool off the planet in the face of increasing solar heat⁵. In other words, life seems to possess a "thermostat" which has ensured a relatively constant temperature throughout geological times, a temperature allowing survival of life systems. Every time the solar heat increased reaching certain levels, new biological systems developed allowing the utilization of smaller proportions of CO₂ and therefore making possible a compensatory "cooling" of the biosphere.

Through successive adaptations of their photosynthetic processes, the bio-systems managed to reduce CO₂ contents in the air to 0.3%, the present level. If solar radiation increases, there is very little room for additional cooling (that is for continued decrease of CO₂). Therefore, in a way, the biological systems (Gaia) are living on the edge. If additional CO₂ is thrown into the air, and if the CO₂ utilizers (algae and plants) are reduced in volume and activity (i.e. because the forests are eliminated and the water bodies are contaminated with pesticides and "a molecule thick film of oil"⁶, then, there is a certain risk that the thermostat may break down. If so, at the moment when the ceiling is reached it may be too late to change course.

This is why, we must start seriously to consider a rapid and drastic reduction in systems based on the burning of fossil fuels while producing large quantities of CO₂ and other greenhouse gases. Not to do it may put at risk, not just the survival of humankind but of the "Gaia" itself.

THE PARADOX OF OZONE

⁴ James Lovelock, 1988; "The Ages of Gaia"; A Biography of Our Living Earth; W.W. Norton and Company, Inc., New York, pp. 252.

⁵ We don't know for sure if the sun radiation increased during geological times, but it is very likely that there was an augmentation of the heat received by the Earth which could explain some curious characteristics of the chemical evolution of the atmosphere.

⁶ Preston Cloud and Aharon Gibor, 1970, ref. in Scientific American described before.

Ozone is a problem gas. In the lower atmosphere because there is too much and is toxic, in the upper atmosphere because there is not enough to block undesirable solar radiation. In both cases, the problem results from anthropogenic contamination of the air.

What is ozone?

As explained before, oxygen is a basic building block of our planet. The crust, the oceans and the atmosphere all contain important proportions of oxygen; free oxygen (only present in the atmosphere) appears as a di-atomic molecule: O_2 . In some cases, as a result of various natural or artificial causes, oxygen may appear as a tri-atomic molecule: O_3 . This oxygen molecule is called "ozone".

Too little ozone

When normal di-atomic oxygen molecules reach the stratosphere, they are hit by high energy ultraviolet radiation; tri-atomic molecules (ozone) result. The presence of ozone at the stratospheric level filters out an important part of the ultraviolet solar spectrum. Without stratospheric ozone ultraviolet radiation would increase negatively affecting organisms throughout the planet, including humans. The main effects would be at the molecular level, it is considered that increased ultraviolet radiation could produce genetic malformations, cancer and other diseases.

The measured concentration of ozone in the stratosphere has been gradually decreasing (when seasonal variations are eliminated) particularly on both polar regions. In Antarctica, where the process is more notorious, an "ozone hole" has been identified since the early eighties; more recently an "arctic hole" has also been recognized. It is considered that in the remainder of the ozone stratospheric layer, too, there is a widespread thinning significant enough to start having some effect on biological activities very soon.

The identified culprits of this change are the chlorofluorocarbons (CFC-11 (CFCI₃) and CFC-12 (CF₂Cl₂)) contained in aerosol sprays, refrigerants, solvents and foams. About 1 million tons of chlorofluorocarbons are emitted into the air every year. Their average residence in the atmosphere ranges from 60 to 100 years and the present concentration is of about 3 ppb (chlorine)⁷.

According to Lovelock⁸ already in the early 1970s it was possible to measure chlorofluorocarbons in Antarctica. At that time, there were about 40 parts per trillion in the Southern Hemisphere and 50 to 70 in the North. At that time the threat to the ozone layer was still not known. In 1974, Sherry Rowland and Mario Molina⁹ developed the hypothesis that CFCs were a source of chlorine and, therefore a threat to the ozone layer. Since then, considerable scientific work has been done, and although there is not unanimity, it is generally considered that CFC's are indeed affecting the ozone layer with potential deleterious effects.

Too much ozone

At ground level, ozone is a secondary photochemical oxidant which is formed as a result of various human activities and automobile engine combustion. Although it does

⁷ "The Changing Atmosphere"; Thomas E. Graedel and Paul J. Crutzen, September 1989, in "Managing Planet Earth"; Scientific American; vol 261, Number 3, p.58 to 69.

⁸ "The ages of Gaia: a biography of our living earth"; Lovelock, James; 1988, W.W. Norton and Company, New York and London; pp.252; ref. in page 164.

⁹ Paper in Nature referred by J.Lovelock, "The ages of Gaia".

not appear in the actual emissions it is formed immediately after becoming an important component of "smog". Contamination in urban and industrial areas can be measured in terms of "ozone concentration" and so this gas is a clear indicator of air quality. The more ozone is found in the lower atmospheric layers, the more contaminated is the air. If the atmospheric situation in large metropolitan areas improves, a reduction in the concentration of ozone will take place as a "by-product". Ozone in itself in small concentrations is not a very toxic gas, but its presence reveals that pollution emissions are taking place.

OCEANS CAN BE DEGRADED TOO!

Not only the atmosphere at large is being affected by contaminants emanating from anthropogenic sources; oceans and large water bodies are also suffering continuous degradatory influences from human activities. Although oceans are very large, occupying nearly 3/4 of the total Earth's surface, the continued outflow of untreated effluents into the sea, have had persistent and growing effects, particularly along the shores. Sediment accumulation has consistently increased at the outlet of several larger rivers, industrial and urban pollution plumes are intruding in many oceanic coastal areas and overfishing has determined a profound and negative change in marine ecosystems. Today, thin films of petroleum, foam from detergents or various floating wastes can be found even far from the largest concentrations of population. The degradation of oceanic basins has become a planetary phenomenon.

The rivers are becoming muddy

Some time ago, Erhart, (author of "La genese des sols entant que phenomene geologique") travelled by ship along the rivers Congo and Amazon and was puzzled by the lack of turbidity in the water. No sediments, no clays, nothing of the brown color that one expects of mighty rivers draining such large basins. Eventually, Erhart realized that this clear water was the expression of what was happening in the basins of these rivers. The large streams flowed from rain-forest basins, and in the forest there was no erosion. They were environments where chemical processes of organic origin predominated. The water from these rivers was exporting salts, slowly but certainly, as the soils were loosing their ions, dissolved in the river water, toward the sea. But no sediments were being transported. Ions of calcium, sodium, potassium, magnesium, silicium, anions of carbonate, phosphates and chlorides were carried in the water in small proportions but, by the end of each year, in impressive enough volume, producing a gradual increase in the salinity of the sea, providing raw materials for the shells of sea organisms.

Erhart also realized that this was the origin of geological limestone, old processes of soil formation (weathering as it is called) in rain-forest environments. Today's calcareous mud at the bottom of the ocean were the present equivalent of these

ancient limestones that had formed 100 or 200 million years ago in the Mesozoic Era, at the time when the dinosaurs roamed the Earth¹⁰.

However, these old calcareous muds of the past did not continue forming forever buried by younger sediments, such as clays and sands. Erhart read the geological book and concluded that the forest had disappeared, and that subsequently the soils had been eroded⁽¹¹⁾⁽¹²⁾.

Today, the large forests are disappearing even faster due to human action. Deforestation is widespread. Forests are logged and burned; the soils are eroded; the rivers are changing their clean waters free of sediments into muddy streams. Overflying the Amazon, every year there are new surprises: the tributaries are becoming yellow and brownish; the Amazon itself is not longer dark green; in geological terms, the forest is starting to die.

In old times, some forests would die, while others were born; there were always some forests to contribute to keeping the CO₂ low. Now, all forests are disappearing at the same time. Although we do not know exactly how this is going to affect the planet's dynamics, we suspect that there is considerable risk.

OVERSHOOTING?

It is difficult to know for sure which will be the future of the planet. Exponential growth of some components (such as the world population) or some factors (temperature of the oceans, content of CO₂) can give us some idea of direction, but, by no means, they provide sufficient elements to effectively predict the future of the **Gaia** system. The Earth is a extremely complex environment, and growth curves are crude instruments for understanding it. In reality, we do not know where the "overshooting" is going to take place... At the most they provide us with flashing lights indicating the risk...

We should remember that natural processes are never indefinitely linear or exponential. Once they reach their ceiling, a change takes place, and new relationships are established. Sometimes factors that are overlooked may be growing or decreasing exponentially and suddenly its effects start to be felt on the process we are looking at. The greenhouse effect produces an increase in temperature, which in

¹⁰ This type of ecological situation was called by Erhart: "biostasie".

¹¹ These sediments is what geologists call "flysch" composed of claystones, siltstones and associated sandstones, corresponding to a drier period after the humid period that produced the limestones.

¹² This ecological situation where mechanical processes predominated was called by Erhart: "rhexistasie".

turn increases evaporation, which increases cloudiness, increasing the albedo of the planet, which in turn reduces radiation, producing a decrease in temperature. Even a relatively simple model like this, can be very difficult to calculate, mainly because the data and relationships are insufficiently known. If we introduce the role of algae and photosynthesis in the upper layer of the oceans or the effect of ice melting in the poles, it becomes still more complicated. The final model of the planet requires the understanding and measurement of thousands of variables, some of which of biological or anthropogenic nature.

Although much can be advanced toward solving the riddle of our environmental future, we must remain very cautious on guaranteed forecasts... In fact, we really don't know. Or better, we don't know yet... However, because so little is known, and the risk is there, survival strategies must maximize the interpretation of existing data playing safe at all levels. As described in "Beyond the limits" by Donella H. Meadows, Dennis L. Meadows, and Jorgen Randers (Earthscan Publications Ltd, 1992; London) we may at the end "go beyond the limits inadvertently", because of inattention, inadequate information, slow response or simply because of the momentum. However, in this "Spaceship Earth" we cannot afford to risk overshooting the limits, which ever they may be. Perhaps we will not have a second chance.

CHAPTER 4

FORESTS UNDER ATTACK

A HISTORY OF DEFORESTATION

Management of forest ecosystems has always been one of the most difficult challenges presented to human societies. At the time of the agricultural revolution, in Europe, the Middle East and in other parts of the world societies inhabiting forest areas started clearing their forests for crop production. In that way, in Roman times, hundreds of thousands of square kilometers of Mediterranean forests with deep and fertile soils were eliminated to make place for cereals such as wheat and barley. During the first centuries of the Christian Era, in Sudanese Africa, also a considerable part of the forest ecosystems gave way to locally domesticated sorghum and millet crops and itinerant cattle raising, in America, many of the forests surrounding the valley of Mexico were gradually removed to make place for corn and bean farming and in Asia, rice agriculture substituted the pre-existent extensive forests of China, Indochina and some of the largest Indonesian islands.

In spite of this widespread reduction of forest lands worldwide, at the time of the industrial revolution they still occupied nearly 30% of the continental land masses, mostly concentrated in humid and sub-humid environments. In the early 1600's, at least more than half of Europe, and more than 90% of the humid regions of North America and South America were still covered by trees.

In Africa, although long term human occupation had significantly reduced the forests (mainly through burning) through a process of "savannization", large tracts of lands in humid and sub-humid regions also remained covered by forest ecosystems.

In Europe, the industrial revolution brought upon a systematic and intense degradation of the forests. The main causes were the increase of population and the burning of firewood in industries and cities. During the XVIII and XIX centuries new villages formed in peripheral forest areas in less productive environments such as steep and stony slopes in the cooler mountain highlands of the Alps, the Central Massif of France or the Apennines in Italy were incorporated into agricultural production reducing the extension of the forests.

In many areas of Europe, the growth of population outpaced the opening of new farming lands (often because there weren't any more lands available, but also, in many cases, due to concentration of real state property in a few landowners).

At the beginning, most of the excess manpower moved to the cities to work in the new industries. However, gradually, European industries were insufficient to receive

all the new rural migrants promoting the international migration movements from Europe to America which by the end of the XIX century and first half of the XX century had become intense and widespread.

In North America, the arrival of millions of European migrants promoted the opening of new forest lands to farming. New England was completely covered by forests in 1620 and totally deforested 150 years later. Four million hectares of Arkansas marsh and swamp forests were converted to farms in the XVIII century¹.

The population of Minnesota (next to the Canadian border), increased from 10,000 to 150,000 inhabitants in only ten years (from 1848 to 1858 when it was promoted from territory to state). A similar case took place in the territory of Dakota in the 1870's².

By the late 1870's more than half of the temperate forests of North America had been eliminated. After that time, the process continued for many decades. Because in the East the land had become scarce, most new arrivals and even many old settlers or their descendants kept moving West clearing new forest land for agricultural production.

In South America, the process of deforestation in mountain lands which had developed since pre-colonial times continued reducing the forest areas which at the end remained restricted to the steeper or coolest slopes. A considerable portion of the tropical forests remained largely untouched until the beginning of the XX century. Probably this delay in deforestation of tropical lands resulted from the abundance of grasslands rather than forests in the more productive temperate areas of the continent (i.e. the Pampas). The only forest areas with temperate climates were located in the narrow plains and valleys along the Pacific coast in Central and Southern Chile and in the highlands of the Planalto of Southern Brazil where there were extensive Araucaria ecosystems (which were finally wiped out in the 1960's and the 1970's).

Most of the South American forest areas were situated between the tropics, particularly in the basin of the river Amazon and in the upper basins of the Parana and Orinoco. Early deforestation of the tropical ecosystems occurred during the colonization process, along the northeastern coast of Brazil to make place for sugar cane plantations and later, by the end of the XIX century in Sao Paulo for coffee production.

¹ Source: "The Cadillac Desert", Marc Reisner, 1986.

²The Making of America; Northern Plains; Produced by the Cartographic Division of the National Geographic Society; Gilbert M. Grosvenor, President, National Geographic Magazine, Wilbur E. Garret, Editor, John B. Garver, Jr. Chief Cartographer; John F. Shupe, Associated Chief, Washington, D.C. December 1986 (map).

DEFORESTATION IN THE XX CENTURY

During the XX century, deforestation proceeded at a much faster rate, and by 1980, the Araucaria forests of the Planalto and the forests of the western foothills of the Amazonian basin from Colombia to Bolivia had been partially or totally eliminated.

In more recent dates, new forest areas were logged or burned in eastern Paraguay, Mato Grosso and Santa Cruz in Bolivia as a result of the encroachment of soy bean and rice plantations.

According to Fearnside, Tardin and Meira Filho, 1990³ deforestation rates in the Brazilian Amazonia have been of about 21,000 km² per year for the last decade, reaching a total of more than 1/2 million km² for the last two centuries of human occupation.

In Africa, deforestation processes became widespread during the XX century, particularly along the Guinean coast, to make room for peanut, cocoa, coconut and banana plantations. Other areas affected by these processes included the Central African Highlands (from Rwanda and Burundi to Uganda) and the tropical forests of South-Central Africa from Angola to Southern Tanzania. Presently, African rainforests are greatly diminished to less than 1 million km² which is barely 4% of the total area of the continent and less than 20% of its original extension.

In the Malian region, deforestation has occurred mainly as a result of utilization of wood for various purposes (such as firewood, charcoal, construction, etc). Actual consumption of wood in these regions has been calculated at about 300 kg. per person (360 kg. and 270 kg. per person in urban and rural areas respectively) for a total consumption of 1.7 million of tons per year. Of these, more than 200,000 tons are for the Bamako metropolitan area causing a gradual retreat of the forest towards the South of the country. In the Mopti region, wood is also utilized for smoking fish promoting a still faster trend towards environmental degradation and deforestation. Although some reforestation projects have been started (often giving priority to non-proved-locally exotic species instead of more appropriate indigenous trees), the general balance has clearly been towards deforestation.

Deforestation has also been very intense in Southern and Southeastern Asia. This trend has accelerated during the last few decades, particularly in Indonesia and Malaysia where larger areas of Sumatra, Borneo and the Malaccan Peninsula, previously untouched have experienced extensive forest degradation.

³Deforestation Rate in Brazilian Amazonia; Philip M. Fearnside- INPA, Antonio Tebaldi Tardin- INPE and Luiz Gylvan Meira Filho- INPE, August 1990, PR/SCT Instituto de Pesquisas Espaciais and Instituto Nacional de Pesquisas da Amazonia; National Secretariat of Science and Technology; Sao Jose dos Campos, Sao Paulo and Manaus, Amazonas; pp.8.

The continued expansion of demand for timber during the first half of the XX century was supported on a resource base mainly composed of natural or semi-natural forests⁴. During this period, the value of a forest was related to their potential for logging.

However, in the last decades, new potential values of the forest were emphasized; i.e. the potential of forests as touristic resources, biodiversity richness. These new scopes have promoted a different approach to forest management and exploitation. Native people in Canada and the U.S.A. who were and are reluctant to accept logging in their traditional lands have found important allies within environmentalist groups. Pro-logging lobbies are losing their clout and exploitation of temperate forests in North America and Scandinavia is becoming gradually more difficult. In addition to "politically incorrect", in some cases are also becoming anti-economic (the slow growth of trees in cooler climates compared to other areas is a factor that does not help).

In many areas downwind of industrial centers some wood stands are being affected by acid rain, further complicating things for forestry companies⁵ in the Northern countries.

Another element affecting the forest business in the North is the growth of a strong paper recycling industry which competes successfully in the paper market with wood pulp.

The result of these tendencies have been to decrease demand and production of timber and paper pulp from Northern forests gradually substituted by more competitive artificial plantations in warmer latitudes (such as the Southern United States, Brazil, Chile and Argentina).

In many Third World countries, natural forests have also been attacked by continuous logging not allowing regeneration and reducing dramatically the total forest cover in those countries. For this reason the amount of production coming from tropical (or even some temperate) natural forests in these countries has also decreased. In some cases, new artificial forests were planted in place of the natural ones (cases of the Southern forests of Chile and the forests of Misiones in Argentina). In most cases the new artificial forests are mono-specific plantations of exotic trees.

In some areas, the cleared land has been dedicated to agriculture or animal production.

⁴ Interesting comments on this subject are included in the paper by Carlos Pérez Arrarte: "Desarrollo forestal? Una aproximación convencional"; 1993; p.9-54; in "Desarrollo Forestal y Medio Ambiente"; published by CIEDUR and Hemisferio Sur.

⁵ Profitability of Canadian companies dealing with the exploitation of forest products has substantially decreased during the last years (1990- 1993).

Whatever the purpose, the results are similar. Globalization processes are promoting the gradual substitution of natural forests by artificial systems.

The redistribution of economic roles is having its effects in the forestry industry at all levels. Some countries that were traditional producers are withdrawing from the scene while others that were not producers are increasing their exports. This trend is taking place when demand on timber and paper pulp is increasing worldwide. In spite of this growth of requirement, the increased production (from 2,700 million m³ to 3,431 million m³ between 1977 and 1988; 27%) was enough to meet the demand.

Particularly important was the augmentation of paper pulp production (about 30% for the same period) which appears to be related to the increasing consumption of paper promoted by the information revolution. Wood and charcoal production also increased considerably (33% between 1977- 1988)⁶.

RAIN-FOREST ENVIRONMENTS

Tropical rain-forests are located in areas in which steady high temperatures and high availability of water allows continuous vegetation growth. Tropical rainforests enjoy a permanent growing season. Daily average temperature remains practically always in the 20o's or early 30o's and humidity shortages are infrequent. In addition, solar radiation is high, further favoring photosynthetic activities and associated biological processes.

These environments are characterized by a multi-strata vegetation reaching maximum heights of 40- 60 meters above the surface. The nutrients are mainly stored in the living biomass with much less nutrient content at the soil level.

For this reason, when the vegetation is removed, the chances for return to its former state are limited. In addition, micro-climatic changes (such as decreasing air humidity, increased variations of temperature and augmentation of wind speed) can produce dramatic effects and germination or regeneration of most native plant species may become difficult or impossible.

Soil erosion, which is practically nil under forest cover, becomes very intense, due to increased effect of rain drop impacts and soil friability, further reducing the potential for recuperation of the ecosystem.

In brief, all these modifications: losses of nutrients, deterioration of air and soil microclimates and soil erosion brings about a complete change of the whole

⁶ FAO's Year Book of Forest Products ref. in Carlos Pérez Arrarte: "Desarrollo forestal?: una aproximación convencional"; p.15. In "Desarrollo Forestal y Medio Ambiente"; 1993; pub. by CIEUR and Hemisferio Sur.

ecosystem. When this change occurs in a small plot (such as 1 or 2 hectares), the system can rebound. However, when the deforested areas measure several tens or hundred of square kilometers, the process may become irreversible.

The main factor for forest destruction is human action. In some cases this takes place as a result of macro-economic trends (i.e. South American forests removed to make place for commercial cultivation of soy beans and rice), and in others due to intense population growth (some areas of Africa and Malaysia).

AFRICAN FORESTS

In Africa, the causes for utilization of forest areas are twofold: firstly, the need for new farming lands, and secondly the demand for lumber and firewood. When old growth forests are eliminated, productivity decreases because of nutrient losses. In most cases, the loss of fertility is such that application of fertilizers renders uncompetitive any agricultural activity. For poor farmers, the option of buying fertilizers is not affordable (except in those cases in which natural fertilizers or phosphate rock are easily available locally). In most cases, the only accessible alternative is clearing more forest land for further cultivation.

In earlier times, shifting cultivation in small plots gave time for recuperation of the ecosystem. However, with increased density of population and/or with encroachment of commercial plantations, this recuperation becomes impossible and the forest ecosystem disappears for good, with all its ecological consequences (losses of bio and cultural diversities, of water resources). As a result, the African forest has been retreating at a sustained rate.

During the XX century, the main culprit has been commercial agriculture of crops requiring or reaching maximum competitiveness under humid tropical conditions, such as banana, oil palms, rubber and cocoa.

In Nigeria, the oil palm plantations replaced the forest in large areas (particularly in the east of the country) which coupled with the rapid growth and high density of population has left very little forest remains. Nigeria possesses a population in excess of 100 million people in a territory of 800,000 km².

In Ivory Coast, the annual extent of deforestation has been estimated at 1/2 million hectares. From an original area of 14 million hectares in 1956, it has been reduced to one third or less than 5 million hectares, in 30 years to make place for cocoa, coffee or food products. The export of these items and the sale of lumber explain the relative success of the Ivorian economy in the short term. However, the unsustainability of the model is evident.

THE SOUTHEAST ASIAN RAIN-FORESTS

In Southeast Asia the original rain-forests have been greatly reduced. In Burma, Thailand and Indochina forests have been substituted by farms and plantations. The forests of the more densely populated Indonesian islands (Java, Bali, Timor, Flores) were also logged or burned and presently there are very few remaining relicts. More recently, the deforestation drive has affected some forest areas that had remained untouched in peninsular Malaysia, Sumatra, Mindanao (Philippines) and other less populated islands of the region.

Still today, large tracts of forest can be found in Borneo (Kalimantan), New Guinea island and Celebes (Sulawesi). The Indonesian government attempted to promote settlement in Borneo, New Guinea and Celebes as a way to solve the extremely high density of population in Java⁷. The initiative had mixed results. In some measure, it relieved part of the population pressure in Java (although only temporally). At the local level the effect was disastrous. Large areas of rain-forests were eliminated and the native people were dispossessed of their lands. Javanese are alien to New Guinea or Borneo. The traditional culture of these two large islands has been profoundly and negatively affected and the degradation processes still continues.

The island belongs to three countries: densely populated Indonesia (which is large and unevenly occupied), oil-producing Brunei (which is small, rich and densely populated) and the Malaysian States of Sarawak and Sabah.

Deforestation and annihilation of wildlife are still going on at fast rates in the Indonesian part of Borneo where settlement plans are still targets in the government strategy. The attitude of the Malaysian authorities has been until very recently not very concerned with the preservation of the natural rain-forests. An example is provided by the declarations of a Malaysian minister which in 1991 was quoted as saying: "It is not our business to supply the West with oxygen"⁸. More recently the attitude has somewhat changed. However, a large deal was announced (October 1993) by a large company (owned by the Minister for environment and tourism) which involved a logging concession on 200,000 hectares of rain-forest (plus a coal mine and other components). Sarawak forests contribute with 80% of Malaysian timber related products. Malaysian environmentalists predict that the Sarawak rain-forests will disappear in 20 years.

Other places conserving some tracts of rain-forests have at least halted exporting timber (i.e. Thailand, Philippines and Sabah⁹). In those countries deforestation continues, but at a slower rate, mainly as a result of agricultural encroachment.

Less important was the effect of deforestation and settlement in the Eastern half of New Guinea (belonging to the Republic of Papua New Guinea) and the nearby islands (i.e. Solomon islands).

⁷ Java is a relatively small island (120,000 km²) and possesses a population of 105 million. The density is one of the largest of the world (nearly 900 people per square km.). The capital of Indonesia, Djakarta (10 million), Surabaya (3 million), Bandung (3 million) and many other large cities of Indonesia, as well as most industries, government offices, and agricultural production are located or take place in Java.

⁸ Source of this information on Malaysia: "The Economist"; in an article entitled "Not yet out of the woods"; October 16- 22, 1993; Vol. 329; Number 7833; p.38.

⁹ Sabah and Sarawak are the two Malaysian states situated in Borneo.

THE AMAZONIAN RAIN FOREST

The exploitation of rubber, mainly after 1840, was one of the main elements of the occupation phase in the Amazonian forest. In 1844, 367 tons of rubber were exported, in 1851, 1391 and in 1910 rubber exports had increased to 42,000 tons. During this period about 600,000- 700,000 new settlers immigrated into the Amazonian region, with its arrival directly or indirectly related to the above mentioned plantations. The population which was of about 137,000 in 1820, increased to 323,000 in 1870 and more than 1,200,000 by 1910.

During the XX century, occupation processes of the Amazonian region accelerated mainly as a result of governmental policies promoting agriculture, cattle-raising and logging. At a later date, particularly after the discovery of the Serra Pelada mineral deposits, mining activities (i.e. "garimpo") developed resulting in a widespread degradation of the natural landscape and water resources. The gold was exploited in open air quarries, in mines and in alluvial placers throughout the region (i.e. in Mato Grosso, in the Madeira river, etc).

There were also other large scale mining activities after the installation of the Carajas iron ore and tin exploitations.

Another factor for the loss of forest habitat relates to the construction of large hydroelectrical complexes, such as the Tucuruí dam on the Tocantins river (with a flooded area of about 2,000 km²), the Samuel dam in Rondonia and others.

Interpretation of satellite data, referred by Salati showed that during the 1978-1988 period, cumulative deforestation reached 410,000 km² (which is almost 10% of the whole area of the region) reducing the total forest cover to slightly more than 4,5 M. km².

Of the approximately 425,000 km² of deforested Amazonian land that had been recorded in Brazil by the early 90's, about three quarters was eliminated in the last two decades (Preston, Julia, 1991¹⁰)

At about the same time that this was happening in Brazil, the Colombian Amazon (total area about 280,000 km²) had been reduced by 7% to 260,400 km² (Carrizosa Umaña, 1987, ref. Salati) and the Peruvian Amazon had shrunk by about 60,000 km² (Dourojeanni, 1987 (ref. from Salati, E.¹¹)).

¹⁰ Preston, Julia, The Washington Post, 17/3/1991, Sect .A p.35, Washington, U.S.A.

¹¹ Salati, Eneas, A regio amazonica e as mudancas globais; necessidade de um plano de pesquisas; report to IDRC, meeting on Environmental Policies, etc, Manaus/ Montevideo, 1991.

In Ecuador, the main problem has occurred as a result of petroleum exploitation. The frequent spills in the Ecuadorean oil fields have had an important effect on the environment. One of the largest spills occurred in "La Joya de los Sachas" and affected the river Napo basin (as described by Varea, Anamaria, *El Comercio*, 23/8/92, p.10 sec.B, Quito, Ecuador). Similar spill problems are very frequent in Colombia where the main oil pipelines have been (and still are) frequently attacked by "guerrilla" forces.

Recent news from the Amazon region have shown a slow down in the deforestation process, which has been less intense in 1990 ("only" 14,300 km², from previous figures of 19,600 km² in 1989 and about 27,000 km² in 1988 (Preston, Julia, 1991¹²) .

EFFECT OF DEFORESTATION IN THE AMAZONIAN REGION

Very important effects of the deforestation processes have been described by Salati, Eneas and Nobre, Carlos A. ¹³ as a result of an empirical model developed by Shuttleworth (1988)¹⁴.

According to these studies, over the period September 1983 to September 1985 "approximately 10% of the rainfall was intercepted by the forest canopy and this accounted for 20% to 25% of the evaporation." The remainder occurred as transpiration from the trees. "Over the same period, about half the incoming precipitation returned to the atmosphere as evaporation, a process which requires 90% of the energy input. 75% of net radiation goes into evaporating water and the remaining 25% is used to heat the air."

Again according to Salati E. and Nobre, Carlos A., (1991) it is estimated that 50-60% of rainfall in the region originates from the recirculated water vapor through evapotranspiration.

These data show clearly that decreased forest cover may negatively affect precipitations (perhaps with decreases of one half or more) throughout the Amazon region and down wind neighboring regions such as the Bolivian "Altiplano" or the Andean east-facing slopes.

¹² Preston, Julia, *The Washington Post*, 17/3/1991, Sect .A p.35, Washington, U.S.A.

¹³ Salati, E. and C.A. Nobre, *Climatic change* **19**: 177- 196, pp. 177- 196; 1991, Kluwer Academic Publishers. Printed in the Netherlands (Manuscript of 24/5/1989).

¹⁴ Shuttleworth, W.J.; 1988, "Evaporation from amazonian rain forest", *Proc. Roy. Soc. B.* 233, 321- 346.

Other studies, particularly of palaeo-geographic nature tend to show that less humid periods have been relatively common during the Quaternary history of the Amazonian region. Colinvaux, Paul A.¹⁵ thinks that these changes have been one of the causes of the high biodiversity of the macro-ecosystem and that they coincided approximately with the glacial period. According to this author, "the contemporary reality is that much of the Amazon basin will be turned into pasture as people clear the land for cattle grazing"; "history does suggest that parts of the Amazon can be exploited productively without causing mass extinction, but wise use must be the overriding theme".

In spite of the recognized modifications suffered by the Amazonian forests at the geological level, it is clear that during the last few thousand years the core of the great forest has remained largely unmodified in spite of a demonstrated human occupation of at least 3-4,000 years. It is symptomatic that the production systems developed during those years did not bring about a generalized degradation as it is happening nowadays in newly settled areas.

It is generally accepted that indigenous production systems are sustainable on the long term and although we do not know for sure how was the forest before human occupation, we know that the present forest ecosystem is the result of the type (s) of indigenous management that has reigned in the region for several millennia. This management system is based on a careful slash, burn and plant technique, where small patches of forest are cleared for selective planting, utilized for a few years (3 or 4) and then gradually abandoned. Some other areas are utilized for extractive purposes (i.e. of medicine plants, etc) or just left aside for other ends. These management strategies tend to utilize some areas without affecting their potential and protect the rest of the ecosystem, resulting in a long-term conservation of the system.

TEMPERATE FORESTS

The total area of temperate forests is of about 2,252 million hectares which is more than the remaining tropical forests (1,700 million hectares). As it can be seen in Table I more than 70% of temperate forests are found in North America and Russia.

¹⁵ Colinvaux, Paul A., Scientific American, May 1989, p.102- 108.

Table I

Region	Area (M.has)	%
Europe	181	8
Ex-USRR	930	41
North America	735	32
Australia and Islands	116	5
Temperate Asia	233	10
Temperate Africa	5	0.2
Temperate Latin America	52	2

In temperate forests, exploitation of lumber and other forest resources has led not only to decrease of forested areas but also to loss of biodiversity. Temperate forests are normally classified as old growth forests, controlled forests and tree plantations.

Management of forests often produces negative effects: substantial changes in the structure of the forest, decrease in the number of species, damage to wild fauna, etc.

In the tree plantations, the negative effects are still greater because they are normally mono-specific and frequently they utilize exotic species. Although temperate forests still cover large areas, their actual value has been reduced by diminished diversity and other ecological changes.

The utilization of temperate and cool-climate forests has diminished recently due to decreased competitiveness (as a result of slow growth) and opposition of environmentalist groups (particularly in North America). In other temperate areas, such as in Southern Chile, the old indigenous temperate forests (which were rich and diverse and traditionally locally exploited: the Mapuche indians and other local populations) were substituted by exotic mono-specific plantations (i.e. *Pinus insigne*) for export. The negative environmental effects and the loss of diversity (both biological and cultural) are widely recognized.

EXAMPLES OF ENVIRONMENTAL DEGRADATION IN SOUTH AMERICAN FORESTS

SOY BEANS AND DEFORESTATION

The health-conscious population of the developed countries has discovered a food staple that is the "remedy to all cures": soy beans. Rich in proteins, but low in cholesterol, with proven effects to avoid cancer and heart disease, soy beans have become the dietetic mode of the 1990's.

In fact, soy beans have been used for long time in many areas of the world, but never its consumption reached the present levels. The plant is native from East Asia, was domesticated by the Chinese about 4,000 years ago, and since then, it has been a familiar component of the diet of most East Asian countries.

Per capita consumption has been traditionally high in China, Japan, Korea, Thailand, Indochinese countries, Indonesia, Burma and others. This dietary habit is probably one of the causes of low heart disease and cancer in these countries.

Western countries have known and consumed the bean since Marco Polo times, but it has been only recently that this staple has become important in the diet of the population. Increase in consumption has been particularly dramatic during the last decade. In the U.S.A. it has practically doubled during the period 1980- 1990. A

similar trend is observed in Canada, France, Britain, Germany and other developed European countries.

World production has followed this tendency increasing substantially in the last few years. In the United States, production of soy beans augmented from 1,127 M to 1,905 M bushels from 1970 to 1987. Some increase in production was also observed in Europe and Asia.

However, most of the added consumption of soy bean has been satisfied by clearing forest lands for soy bean production in South America. The largest producers of soy bean in this continent are Brazil and Argentina. Bolivia and Paraguay have also recently substantially increased their production. Other South American countries also produced important volumes of the bean but in lesser volumes.

SOME FOREST SOILS ARE GOOD FOR SOY BEAN CULTIVATION (but without the forest)

For higher productivity, soy bean agriculture requires well drained, high fertility soils, high temperatures and abundant rainfall. The best soils for this type of production are sandy and silty tropical soils in humid areas not subject to regular flooding.

If soy bean is planted immediately after deforestation, the best results are obtained. For this reason, producers have identified the large forested regions of Central South America as the best places for soy bean production.

Normally, trees are logged down and sold, and the root stumps removed with heavy machinery. After clearing the vegetation, once the soil is bare, the plots are ready for soy bean cultivation. It is important to note that often soy bean is combined with other crops on a semi-annual basis. The main crop normally associated with soy is wheat.

This additional load on the soil adds up to a faster reduction of its fertility in some key nutrients (P, K), although we must remember that because soy bean is a "leguminosae" it conserves the nitrogen fertility of the soils (but not phosphorous, potassium and other nutrients).

Tropical soils, can sustain soy bean and associated crops for 3 or 4 years before fertility is affected. Once the fertility decreases, yields and productivity also decrease, and fertilizers must be applied. Application of fertilizers increases costs and reduces competitiveness and earnings for the producers.

In most cases, soy bean farming companies/ entrepreneurs prefer to obtain new forested land to clear instead of spending their resources in fertilization. The result of this system has been systematic clearing of forest lands throughout the Mato Grosso-Santa Cruz- Paraguayan region.

In map , tropical soy bean production areas are shown. They extend for more than 500,000 km² in Brazil, Paraguay and Bolivia, to which we must add the production in temperate soils, such as Argentina, Uruguay and Southern Brazil (another 500,000 km²).

EFFECT OF DEFORESTATION AND SOY BEAN CULTIVATION ON RIVERS

The radical change in vegetation cover in such a vast region is and will continue influencing the hydrological regime in the downstream rivers. The main rivers affected by these changes are the upper tributaries of the Paraguay (Corumba and Cuaibá rivers among others) and of the Parana (such as Iguazu, Paranapanema and Tiete rivers), and in a lesser extent some Amazon tributaries from the right (Southern) margin (i.e. rivers Xingu and Tapajoz).

The main effects of deforestation have been increased run-off, higher peak floods, soil erosion, augmented suspended sediments in the water, rapid silting of dams, longer droughts, and in general less regular river flows throughout the year.

However, there is a hydrological feature in the region which smooths up the above mentioned flow "irregularities": the "Pantanal" wetland. This swampy area is a 90,000 km² plain which receives the water from the west, north and east during the rainy season, allowing a very slow flow south toward the Paraguay river.

The Pantanal is a huge natural flow regulator. Some of the water is lost to evaporation and the rest moves toward the southern outlet to become a free flowing river (the river Paraguay) a couple of hundred kilometers south. The rainy season occurs in January and February (Summer rains) but the Paraguay flow spreads for more than six months due to the presence of the "Pantanal".

For this reason, the Upper Parana and the Paraguay have their flow peak periods in different periods of the year, the Upper Parana reaching its maximum level in March and the Paraguay a few months later.

If the Pantanal is eliminated, then the flood will occur at the same time producing very disastrous flooding in the Middle Parana (downstream of the confluence of the Paraguay with the Upper Parana). The rest of the year, the river levels will be much lower than they are now, not leaving too much room for navigation, and seriously affecting the movement of merchandises from and to Rosario, Santa Fe, Parana and the whole of Paraguay.

Another element adding to the effect of the anticipated peak flows is provided by the Bermejo river which is a sediment- loaded tributary of the Paraguay inflowing into its lower course. The Bermejo is the outflow of a torrential basin descending from the

highlands of Salta, Jujuy and the Bolivian Altiplano. Similarly to the Upper Parana, the Bermejo high peak occurs by late Summer, early Fall. Without the Pantanal, the Bermejo waters will find an already flooded river not leaving too much space for inflow of new volumes with potential catastrophic consequences downstream.

In brief, the result of deforestation plus drainage of the Pantanal will be significantly augmented in Summer and early Fall with much increased sediment load throughout the basin, and simultaneity of flood peaks.

The volumes that can be expected have not been calculated yet, but they will probably multiply by a factor of 2 or more the highest instantaneous water flows of the Paraguay and by a factor slightly smaller the highest flows of the Middle Parana.

Winter and Spring flow, on the other hand, will be much reduced (probably several times less throughout the basin) without potential for navigation and even leaving dry, in some cases, the water supply of certain cities (it is already happening in Cuiaba, Mato Grosso).

It is important to note that several hydro-works were built recently in the Parana basin. The most important infra-structural work was without doubt the Itaipu dam, which was built in the largest falls (largest in flow volumes) of the world: the Guaira or Sete Quedas falls. This dam, with a cost exceeding 10 billion dollars (US\$) was finalized around 1982 forming a 2,000 km² lake and producing a very important amount of power¹⁶. After Itaipu was finalized and in spite of the huge amount of unused energy, the Argentinean and the Paraguayan governments decided to move ahead in the construction of a new "mega-dam" at the island of Yacyreta (about 300 km. downstream of Itaipu). The final cost of this dam may reach more than 5 billion dollars and will add a significant amount of energy to the already enormous surpluses of the region.

More recently, plans have started to keep moving in this hydro-works spree with the proposed mega-works of the "hidrovia" or "hydro-way". What is proposed is to ensure river navigability through a complex array of hydro-works (such as dams and drainage and navigation canals). The cost of these works may also reach several billion dollars adding to the considerable foreign debt of the Parana countries. There is great concern that these works may end up in the virtual elimination of the Pantanal and that when finished, they will be useless, with canals remaining dry for most of the year and catastrophically flooded during the river peaks.

¹⁶ Note that half of the energy belongs to Brazil and half to Paraguay. The amount of energy produced is such, that Paraguay only uses 5% of its share. The remaining 95% is sometimes bought by Brazil or lately not utilized at all. The possibility of selling this energy to other countries is not allowed by the binational treaty.

The final result of these mega-plans will not be "development" or even "modernization" but rather the complete annihilation of some of the largest planetary ecosystems, together with their associated traditional cultures and significant losses of opportunities, natural and human resources and future financing possibilities for the countries and cities located in the lower reaches of the rivers.

THE GUARANI INDIANS WERE RIGHT

Before science was invented, humans knew many things. The old knowledge was not supported by a theoretical framework of the type we have know, but it was rich and diverse. Each group living in a specific environment knew many things about it. They knew the plants, the insects, the mammals and the birds. They knew the plants that could be used as medicines and the ones that could be used as venoms. Knowledge was site specific. In most cases, it was very difficult to apply it somewhere else, but locally, it allowed many groups to survive with a quality of life that should not be underestimated.

Science developed slowly, gradually, painfully. In many ways, it developed receiving its nourishment from this traditional knowledge of the local groups. Something we may call today: "empirical" knowledge.

Many generations later, scientists are still taking elements of knowledge from traditional societies. What is called the "main stream" scientific thought is after all the result of multi-generational elaboration of what was found out in many "small places".

However, many scientists who possess this multi-generational knowledge have preferred to ignore that traditional knowledge in one way or the other, provides the basic insights that allow a constant enrichment or review of the paths of science and technology. These scientists are sometimes arrogant. They take, but they don't give. They don't even give the credit when is due. And they cash the royalties.

In the meantime, a huge body of knowledge about nature and its ways is being lost everyday with the death of each shaman, of each wise man or medicine woman.

The agronomists failed. They believed they knew about production. They invented the green revolution. And in fact, production rose. But 20 years later, whole ecosystems have disappeared taking with them species that were not even recorded, hundred of crop varieties had been deleted from the face of the earth, erosion became rampant. More food was produced for a finite period. But tomorrow? Our children, and the children of our children will not be able to produce anymore in eroded soils. The mono-specific artificial ecosystems are vulnerable to plagues, it is necessary to use large quantities of pesticides, and then the water is contaminated, the fish are dead.

Dead fish, eroded soils, unique animals and plants eliminated, the technologists have failed. After all, the Guarani indians knew how to do it. How to clear a parcel, what, when, where and how to plant, how to keep untouched larger areas to find the medicines and to keep happy the spirits.

We did not keep happy the spirits of the forest. The spirits that were somehow living deep inside the millions and millions of genetic changes that allowed the ecosystem to be. The Guarani called them "spirits". The scientists call them "genetic biodiversity". Basically it is the same thing. Now we know. The guarani were right.

CHAPTER 5

EFFECTS OF GLOBALIZATION ON GRASSLANDS

THE SAVANNA GRASSLANDS

Savannas are very extensive tropical grassland areas extending for more than 10 million km² worldwide. Their largest extensions are found in Africa (nearly 4 million km²), in South America and in a lesser degree in Asia and Australia.

Savannas are normally composed of a dominant grassy vegetation with intercalated shrubs, bushes and trees. In some cases shrubs, bushes or trees dominate and savannas become "cerrado" (Brazil), "chaco" (Paraguay and Argentina) and Sudan in Africa.

The main element characterizing present-day savannas is its periodic (annual) water deficit. These ecosystems possess soil- moisture deficiencies and both vegetation and fauna have adapted to it. The main strategies that plants possess to overcome this periodic lack of water are the development of deciduous (leaves) aerial systems for multi-seasonal plants and an annual cycle of growth.

However, not all savannas are primary ecosystems, many, perhaps most savannas, are secondary ecosystems which have resulted from anthropogenic action. Frequently shrubby, bushy and/or forested areas have been or are burned for farming, cattle raising or hunting activities. In some cases, fires are fueled for other reasons (protection from enemies, easy access, transportation, religious beliefs).

It is difficult to know to what extent present savannas have been the result of transformation of other preceding ecosystems or if they have been more or less naturally formed without human intervention. In Africa, the "savannization" process started very early (after all, humankind developed from African ancestors). Forest fires are a common hunting strategy in many hunters societies and Africa was the home of hunters for several hundred thousand if not millions years.

As a result, it is very likely that the more fragile non grassy ecosystems gave rise to savanna or even steppe environments perhaps as early as the mid- Pleistocene period. Obviously, climate also changed during this geological epoch, there were more humid periods with "savannization" of the desert or encroachment of the forest into former savanna lands. However, the natural effects of geological episodes during the last few hundred thousand years were somewhat "obscured" by the continued human action on the ecosystems.

Once domestication of herbivorous animals and agriculture developed (starting about 10,000 years before present but more intensely during the last 3,000 years), the processes of environmental "savannization" progressed further.

The savannization of the Sudanese region is probably related, at the same time to domestication of sorghum and millet and to the adaptation of some domesticated animal species to local environments (mainly cattle, goats and sheep, but also at a later stage, dromedary camels in the Sahelian periphery).

In more recent times (end of XIX century and first half of the XX century), mainly after widespread European occupation took place, new commercial crops were introduced (i.e. peanuts), demographic growth accelerated and new forested areas were savannized transforming the majority of intertropical Africa into savannas. Remaining forests are retreating at a fast rate.

In South America, the process of savannization is very recent. Upon the arrival of the Europeans, in the 16th century, there were very few (if any) typical savannas. Most intertropical ecosystems are located in sub-humid climates with seasonal rains and apparently during the mid-Quaternary humid sub-epoch they were covered by trees or a bushy vegetation (it is the case of the "cerrado" and the "chaco"). In more arid areas, a less dense shrubby or bushy steppe vegetation developed (such as the *catinga* of NE Brazil). Grasslands were restricted to temperate areas (particularly in the Southern cone: the "pampas").

There are also some ecosystems that could be defined as savannas in Asia (of secondary origin: in India, in SE Asia) and in Australia.

EFFECTS OF GLOBALIZATION ON SAVANNAS

The globalization of the economy and the encroachment of land-intensive and labor-intensive agricultural activities in some savanna-lands is producing some important environmental changes.

In first place, undulating and hilly savannas are being subjected to erosive processes by water, reducing soil thickness and consequently its agricultural potential. In flatter topographic locations, soils are less affected by water erosion, but instead, they may be seriously degraded by aeolian (wind) action (deflation). Irrigation activities may also have long term consequences, such as waterlogging, salinization or alkalinization.

In all cases, repeated cultivation of the same plots brings about a gradual loss of nutrients, reducing fertility with a negative effect on the biological potential of the areas under exploitation. When fertilizers are utilized to complement the chemical impoverishment of the land, other side effects can occur. Firstly, not all nutrients are replaced by the application of fertilizers, some of them (particularly micro-nutrients) may not be contemplated and some impoverishment takes place in any case).

Secondly, some nutrients may be unnecessarily applied in excessive volumes with potential deleterious effects not only on the soil, but also on the natural hydro-systems giving rise to algae growth and in some cases to eutrophication processes in lakes and reservoirs.

Pesticides can still have more degradatory effects due to their natural toxicity (after all, the main purpose of pesticides is to kill pests...). They may find their way not only into the crops themselves (such as leaves, fruits, or vegetal tissues) but also into surface or underground waters. Some long-life pesticides may reappear some years later in the water supply of nearby towns or rural communities.

One of the land uses of savannas, particularly in Africa, is animal production. In drier savannas or in steppes, overgrazing can become a serious problem and produce extensive decertification patterns. This can be seen in many African countries (particularly in the Sahelian region) where overgrazing has reduced vegetation density and diversity promoting soil erosion and decay and loss of productivity.

One major factor that is associated to overgrazing is the indiscriminate drilling of wells in the countryside. In pastoralist societies possessing cattle is frequently an important element of prestige. In those cases, animal raising activities have important social functions, such as allowing the man to get a wife or to obtain more power.

The main limitant for increasing the herd has traditionally been the availability of water. The main water holes were heavily overgrazed but the peripheric areas were left almost intact.

When many new wells are drilled people increase their herds and start moving to the new locations. After a few years, the whole landscape is degraded beyond recognition and an irreversible decertification process develops. Examples of this are found throughout the African continent, as in Northern Senegal¹, Northern Kenya, Sudan, Mali and Niger.

In South America, a number of savanna environments are being utilized for agricultural purposes. The most typical cases are found in Brazil. The savanna ecosystems of southern and central Brazil developed as a result of the elimination of pre-existing forests. In Mato Grosso it was a tropical rain-forest (slightly less dense than the Amazonian rain-forest) which gradually has been burned (or logged) to make place for various crops, particularly dry rice and soy. In rice crops, normally fertilizers are not applied, the soil (which as is normal in most tropical soils possesses low fertility) is still further reduced in its already limited nutrients stock and quickly becomes

¹ As described in "Reforestation around wells in Northern Senegal", in "Agroforestry in Africa: a survey of project experience" by Paul Kerkhof, Ed. by Gerald Foley and Geoffrey Barnard; Published by Panos, London, UK, 1990- 1992 p.105- 112.

inappropriate for further cultivation (unless heavy doses of fertilizers are applied, and this may be anti-economical).

Normally, dry rice cultivation is not productive after 3 or 4 years and the land is dedicated to extensive cattle ranching (note that secondary savanna in Mato Grosso is a low productivity rangeland for cattle).

Soy cultivation is done in a large scale commercial way (for production of various types of human foods including oils and cattle feed) in large farms with a similar non-sustainable approach. Here, fertilizers and pesticides are applied (frequently with little concern for the environment) seriously affecting the aquatic ecosystems of nearby streams. Many South American indigenous communities depending on fish for their subsistence have seen curtailed their livelihood and incomes due to aggressive agricultural practices in these secondary savanna-lands.

In Southern Brazil, from Sao Paulo to Rio de Janeiro, the original vegetation was subtropical rain-forest and an almost mono-specific ecosystem of araucaria "Brazil pine". The "Paulista" forest was gradually eliminated by the end of the XIX century and first half of the XX century to make place for coffee plantations and in a lesser extent other crops. In many places a savanna-type vegetation came to substitute the former forest. More recently, sugar cane for alcohol fuel has been widely planted throughout the San Paulo region taking the place of coffee plantations in many locations. The "araucaria" forest suffered a similar fate. During the 1950's through the 1970's practically the whole forest was logged and secondary savannas developed for ranching or for planting of several crops (such as soy). In some cases, artificial forestation with exotic trees developed in its place.

THE TEMPERATE GRASSLANDS

Modification of natural ecosystems may have unexpected effects on neighboring production systems. One of the main problems in biological production systems is the development of plagues of multiple kinds. These plagues are in close relationship with the distribution and configuration of natural and artificial ecosystems located in the proximity of the crops.

In grasslands environments, the incorporation of artificial and exotic trees can become a disturbing factor because some species of birds can find nesting niches in the upper branches of the trees that cannot be reached by the native predators. Some birds can have flight autonomies of more than 50 km. making necessary to be very careful before implanting exotic trees that are very different from the native vegetation.

Exotic trees can also provide feeding resources that can promote excessive growth of the population of some birds or insects that can become a plague for many crops. The crops that can be affected by bird plagues are many. Mono-specific crops such as sunflower, corn, etc, are favored feeding grounds for these animals. Another

preferred feeding resources are fruit trees that can be seriously affected by feeding habits of parakeets, pigeons and other birds.

Eucalyptus artificial forests are a principal nesting place for many birds. They are tall trees (up to 30 m. or more), rather difficult to climb for grassland mammals and other vertebrates.

The selection of species to utilize in artificial forests must take into consideration their potential to enhance the development or effect of plagues that could affect agricultural production systems.

The temperate grasslands were occupied by agricultural crops (such as wheat, barley, etc) very early in history. The process was general in all primary prairies in the Eurasian continent (in the territories of present day Ukraine and Southern Russia, etc). Similar processes took place in other regions of the world in later dates (i.e. in the South American pampas, in the North American prairies, in the South African rangelands and in Southeastern Australia.

Remaining grasslands are often secondary (regrowth after agricultural withdrawal), related to intensive cattle-farming activities (such as dairy farming), or areas with soils inappropriate for farming purposes (such as stony, rocky or sandy soils, grassy wetland, etc).

In some countries, due to various reasons (frequently inadequate access to markets, but also due to cultural influence or other causes), grasslands soils with agricultural potential, remain relatively unaffected by intensive farming. This phenomenon is particularly found in South America (i.e. Uruguayan pampas) but also in a lesser degree in Australia, Texas and in the Transvaalian countryside.

A typical case of surviving original prairie ecosystems are found in the South American pampas. The "pampas" are flat or undulating landscapes extending for about 1 M. Km.2 between the latitudes of 28 and 40° S and, East of the isohyet of 500 mm.

Buenos Aires pampas are flat, and largely dedicated to farming particularly towards the more humid zones (i.e. 750 mm rainfall per year). East of the Parana River the flatland gradually become more undulating and in Uruguay and Rio Grande do Sul (Brazil) undulating and flat areas are intercalated with hilly landscapes.

In spite of the dominance of herbaceous species the pampa region does have associated indigenous natural forest environments. This is particularly so, next to streams and in protected valleys or slopes in the hilly areas. The South American pampas are grasslands, not because trees cannot grow, but because they cannot compete with grasses.

Human intervention can radically change this situation, through actual planting of trees (mainly exotic but occasionally also indigenous). However, artificial forest in the Pampas remained a restricted phenomenon for many years.

PLANTING TREES IN GRASSLAND ECOSYSTEMS

Lately, as a result of globalization and transfer of labor-intensive, land-intensive activities to LDC, large scale forestation has reached the Pampas and other grassland areas of the world. The trees utilized are mainly eucalyptus and pine-trees². Large tracts of former grasslands have been dedicated to mono-specific plantations of eucalyptus or pine trees for lumber, fuel or paper-pulp (often for export, but also for internal consumption in the Pampa countries).

The consequences of this widespread forestation with exotic trees are only now apparent. Local trees in the Southern prairies are not very tall and are sparsely distributed throughout the territory. The new, exotic trees offer an interesting nesting niche for many birds that have spread beyond their natural habitat.

The prairie predators of birds (such as southern raccoons ("mao peladas"), foxes, opossum, wild cats) have not developed the skills to climb to tall trees and as a result the new tall exotic forests have resulted in an explosive demographic growth for some species of birds nesting in the upper branches of the trees (such as parakeets and wild pigeons). These birds have become a plague for nearby agricultural crops reducing their competitiveness at its best or liquidating the farming systems at its worst.

Mono-specific plantations of eucalyptus are good nesting niches for many birds (particularly the older forests), but they don't provide a feeding ground (in eucalyptus forests there is very little or no undergrowth). For this reason, birds take advantage of the proximity to agricultural crops for their feeding forays. These crops only supply the necessary food during few months of the year, particularly from late spring to fall. During the winter, some birds can feed on pine trees seeds. For this reason the frequent association of eucalyptus- pine trees in agricultural areas can be a recipe for disaster. Eucalyptus provides the nesting place, pine trees the winter food, and crops the main staple for the rest of the year. A new artificial ecosystem was formed, but not for the best interests of the farmers or local biodiversity³.

² Several eucalyptus species are used in the Uruguayan forestry plantations, the main ones are: **Eucalyptus globulus**, **E. grandis** and **E. rostrata**. Pine trees species includes **Pinus pinaster** and **Pinus maritimus** ?

³ An excellent paper on this subject has been written by M.O.Gutierrez; R. Caffera, C. Cespedes, A. Gonzalez and D.Panario; 1993; "Hacia una evaluacion de efectos ambientales de la forestacion en Uruguay con especies introducidas"; p.157-206; in "Desarrollo Forestal y Medio Ambiente"; Compilador: Carlos Perez Arrarte; co-published by CIEDUR- Editorial Hemisferio Sur

In addition, Eucalyptus has been pinpointed as a strong "aridificator". Poore, M.E.D. y Fries C., 1987⁴ found that *Eucalyptus grandis* produced a strong hydrological effect after the third year with reduction of stream flow (measured in equivalent -rainfall) between 300 and 380 mm per year. In Nigeria, Sharda et al, 1988⁵ found a reduction of hydrological yield in an eucalyptus planted basin of about 23%. Similar studies in India showed a decrease of 28% in run-off (Poore and Fries, op.cit).

Eucalyptus has also effect on soil fertility. Decrease in some nutrients (such as P) in soils have been recorded in many cases. However, the main decrease in fertility relates to logging practices which remove large volumes of key elements reducing the potential for other uses.

Once two to four cuts of Eucalyptus are performed, which may take about 30 years, the land is rendered useless for any other productive purpose. Not only the soils become infertile and dry, but also crisscrossed by the remains of many root systems. This condition does not enable any farming activity without heavy and very expensive corrective measures (which are totally anti-economic for most existing agricultural activities). For all practical purposes, "eucalyptus soils" are not longer usable for farming.

In a number of African projects described in "Agroforestry in Africa"⁶ eucalyptus was introduced in traditional African societies without much consideration to suitability to local ecosystems or cultures. As in Uruguay, the effects have been in most cases deleterious to the local environment or quality of life.

In spite of that, strong pressure and funding is coming from many sources to expand this non-sustainable type of forestation (i.e. Uruguay received in excess of 50 m. dollars from the international banks for forestation of this type which is being applied in a very indiscriminate manner).

ENVIRONMENTAL BALANCE OF GLOBALIZATION ON GRASSLANDS ECOSYSTEMS

⁴ Poore, M.E. D. y Fries, C., 1987; "Efectos ecologicos de los eucaliptus". Roma, FAO, (Cuadernos Tecnicos, Estudio FAO; Montes, Number 59; mentioned in M.O. Gutierrez et al, 1993 (see ref.).

⁵ Sharda V.N. et al (1988); "Hydrological behavior of the Nilgiri sub-watersheds as affected by bluegums plantations; Part II. Monthly water balances at different rainfall and run-off probabilities"; Forestry Abstracts, 50(5) 298 Number 2779, Netherlands, referred by M.O.Gutierrez et al, p.189.

⁶ "Agroforestry in Africa; a survey of project experience"; 1990, reprinted 1992; by Paul Kerkhof; edited by Gerard Foley and Geoffrey Barnard; published by Panos Publications Ltd, London, UK; pp. 216).]

The balance of the effects (actual and potential of globalization in the grasslands environments is not very favorable. To start with, most savannas were (and are) the result of degradation of forests. Although climatic savanna soils are more fertile than forest soils, because many present savannas, in reality, occupy former forest areas, the fertility is more related to the previous eco-systemic situation, and therefore substantially lower than it would be in climatic savannas.

Continued farming on savannas will normally reduce whatever fertility is left, unless fertilizers are applied. In many cases, this is not economic and savanna-lands are abandoned for other uses, normally extensive and little productive cattle raising or forestation with exotic trees with all the unbalancing ecological effects that were mentioned before.

In areas with steeper slopes the soft and highly friable savanna soils can be easily eroded, further reducing production potential.

The above mentioned ecological changes, bring about important, geomorphological and hydrological changes. Gullies and ravines are formed, stream regimes become much more irregular (stronger droughts, increased frequency and intensity of floods) and hydro-works suffer many negative consequences: navigation canals are blocked with sediments, dams and reservoirs may become useless (or at least their lifetime may be strongly reduced), water intakes may become clogged, water treatment plants become more difficult (and costly) to operate, etc.

Environmental degradation in prairies is also frequently the result of excessive run-off, soil erosion, and related geo-dynamic phenomena. In addition, there is a growing risk of soil deterioration due to careless forestation.

The stereotype "tree equals good" is not necessary correct in grassland areas, where forestation may bring about an ecological imbalance that may end in a substantial reduction not only of the production potential, but also of the system bio-diversity.

CHAPTER 6

WATER ECOSYSTEMS

Aquatic ecosystems have been utilized for a long time to obtain various resources, and more particularly for the production of food. Historically, by and large, aquatic ecosystems have been exploited using extractive methods.

This has been so because these ecosystems are more difficult to manage than more closed systems, such as crop or (land) animal farming systems. In fact, it is very difficult, even to establish on them a well defined ownership that could be honored by all societal or national parties eventually interested in their exploitation. There are however, numerous cases in which traditional aquatic resource management is based on community utilization of the resource which is honored by other neighboring communities.(i.e. Japan and other West Pacific countries).

It is not always easy to fence the areas under exploitation, keeping the target species within a specific limited area as it is routinely done on land. This is particularly true in oceans, and still more in open sea environments where even accurate locations have been historically difficult to come by. There are however examples of actual fencing of fishing areas (i.e. Japan and other East Asian countries).

In larger lakes and rivers, exploitation of resources may present similar characteristics: difficulty to keep the exploited species within a limited area or to prevent their exploitation by other parties. Environments suitable for actual control of ecosystems are normally located in smaller bodies of water (lakes or streams) or in shallow coastal waters (preferably in bays, estuaries and tidal zones).

In some countries, this exploitation of controlled or artificial aquatic ecosystems has been a significant part of the production culture (aquaculture) since ancient times. Some agricultural production systems in Asia (i.e. in South China) also include intensive fish farming in carefully managed ponds frequently associated to rice production (which also requires careful management of water). Other areas of the world where traditional aquaculture was historically important include Philippines and India. However, by and large, most aquatic ecosystems have been exploited for centuries in an exclusively extractive manner.

While fishing methods did not produce a significant reduction of existing stocks, the larger aquatic ecosystems remained virtually unchanged. This situation changed dramatically around the end of the 19th century when large fleets started fishing in extensive scale throughout the more productive fisheries of the world. Productivity of ecosystems is mainly limited by the scarcity of dissolved oxygen and some key

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nutrient elements (such as P or N). Oxygen level in the water principally depend on its temperature, with the higher levels encountered in low temperature environments.

Presence of nutrients depends on supply from continent sources (such as rivers, underwater streams, etc) or from upwelling of deeper and cooler waters which have removed nutrient elements from the sea bottom during their ascent. Finally, another factor favoring production in aquatic ecosystems is solar radiation. Its effect is primarily to increase primary (photosynthetic) productivity.

As a result of the combination of these factors, the main fisheries are located in areas with cold water, abundant nutrients and sufficient solar radiation. Examples of traditional fisheries include the South American Pacific coast, the Northwestern Pacific and the North American Grand Banks in the North Atlantic.

Recent improvement of fishing methods, including the widespread use of trawlers and draggers and radars to target precise locations of large fish schools has made very difficult to ensure sustainable management of the stocks in many fisheries. Additionally, in the more accessible fishing zones there has been a convergence of fishing fleets from several countries which gradually resulted in an increasing reduction of the yearly catches.

Agreement came late, it was insufficient, and poorly respected. At the end, many of the largest stocks such as the South American Pacific and the North Atlantic fisheries were exploited beyond the limit of sustainability and rapidly decayed.

THE PERUVIAN FISHERIES

In the case of the Peruvian coastal water fisheries, the main exploited species was a pelagic species, the Peruvian anchovy or "anchoveta". The exploitation of "anchoveta" took place in a large measure as a result of extensive fishing by newly formed Peruvian fishing companies or through concessions given by the Peruvian government to foreign fishing fleets (Japanese, Russian, Polish, etc). Production rose very fast reaching a maximum of 13 million tons in 1970. In 1973 the crisis hit and the catch volumes dropped dramatically to less than 2 million tons. Since then production remained always below 5 million tons (ref).

THE NORTH ATLANTIC FISHERIES

In the North Atlantic, large scale fishing concentrated in the North Sea, along the Norwegian coast, in the coastal areas of Iceland and Greenland and in the Grand Banks not far from the North American coast.

The North Atlantic fisheries are (were) based mainly on cod, herring and some industrial species (such as Norway pout, capelin, blue whiting and sandeels). Due to

the heavy extraction cod and herring catches started decreasing in the late sixties continuing through the seventies. The large cod catches of about 3.3 million tons in 1970, plummeted to 2.2 million by 1978. Herring production dropped to 0.8 million tons in 1978 from 2.6 million in 1970.

In the early seventies the annual catch for the whole North Atlantic averaged approximately 15 million. In later years this figure was considerably reduced. The tendency has continued unabated during the eighties, ending in the present critical situation which forced to declare fishing bans in some of the main fisheries (i.e. the Grand Banks).

THE GRAND BANKS

The Grand Banks are naturally one of the main Atlantic fisheries. Located in a shallow area with rich supply of nutrients and oxygen from the cold current of Labrador they have been contained one of the largest fish stocks of the Atlantic Ocean, and fishing fleets from throughout the world have been regularly exploiting it for many centuries. The large and intensive harvesting effort became very strong in the 1960's. At that time, the main species exploited was the cod. In 1968, trawlers from West Germany, USSR, Spain and several other fishing countries as well as Canadian used to move back and forth with the purpose of catching cod and other commercial species. At that time, the total catch obtained from the Banks was of nearly 1 million tons of fish per year.

After 1977, the process somewhat slowed down with the extension of territorial waters and economic zone within a 200- mile- wide coastal zone by Canada and the USA. However, international exploitation beyond than limit continued and a relatively intense Canadian and American¹ exploitation of the territorial waters went on gradually affecting the resource.

In Canada, during the seventies and early eighties, fishing plants were installed, fishermen were encouraged to buy bigger boats and even the government established two off-shore trawling corporations. During these years, there was also the competing action of U.S. and French fishermen, and with time, the cod resource was practically depleted.

Other factors also played a role, such as the suspension of the seal hunt which has increased dramatically the numbers of these sea-mammals. In any case, there is not doubt that the equilibrium of the ecosystem was ruptured by human intervention severely curtailing production with very serious social, economic and environmental implications.

¹ In addition, French fishing fleets also regularly visited the area taking advantage of the French territorial jurisdiction in the waters surrounding the islands of Saint Pierre and Michelon, in the Gulf of Saint Lawrence.

OTHER WORLD FISHERIES

The North Pacific is a very important center of world fisheries. The continental shelves are narrower but the pelagic catches are very large. They are based on mackerel, anchovy, sardine and herring. The catches in this areas reached a maximum of 22 million tons mainly concentrated in the Northwestern sector.

The main fishing countries are Japan and China and in a lesser degree Canada, United States, Russia, South and North Korea. In Japan there are more than 1,500 fishing ports and the total catch exceeds 10 million tons of which about 20 % are coastal fisheries. It is important to remember that fish contributes with about half of the protein intake to the Japanese diet.

The Sea of Okhotsk fisheries have been exploited intensively for several decades, mainly obtaining the pollack, which is the most important commercial fish of the region². Traditionally Russian and Japanese fishermen were the main fishing countries in the Okhotsk. Presently, the pollack resources seem to be seriously threatened. The fish is today unavailable even in the countries that were traditional consumers of pollack (such as the Russian cities of the Far East). The cause for this overfishing, is again, lack of control. The catches that are declared to the Pacific Ocean Research Institute for Fisheries and Oceanography seem to be much below reality. Recently in a meeting in Vladivostok (September 1993) the requests from Russia, Japan and the US for a moratorium were rejected by the Polish and South Korean delegations. However, it is widely considered that the main cause for this continued overfishing are the "joint-ventures" established between Russian and foreign fishing enterprises. The result is an unsustainable model of production that, unless is severely reviewed and modified, will end depleting the resource.

Most data from Asian and other world fisheries show a halt in the growth of fish catches at a global level. During the period 1950- 1988 the annual growth of fish production was 4%. In the following 4 years (1988- 1992) it has fallen at a rate of 0.8 per annum³.

THE MISSING FISHERIES AND THE GROWTH OF AQUACULTURE

One part of the missing production from the large fisheries was partly compensated by the opening of new fisheries (such as the Southern Atlantic). Another reason of

² *New Scientist*, Vol 140, " 1902, 4/12/1993; "Russia's favourite fish on verge of extinction"; Chris Bird, Sakhalin, p. 10.

³ From "State of the World, 1993", Edited by Lester R. Brown, article "A new era unfolds", by the same author p.3 to 21, Worldwatch Institute, 1993, N.York, U.S.A.

stability was the growth or persistence of artisanal fisheries, which are much less predatory than high sea factory fishing fleets. This helped to stabilize production figures in spite of decreasing catches in many of the largest fisheries.

Presently, world production stands at 87 million tons per year⁴; another 13 million is produced through aquaculture, totalling about 100 million tons per annum. Of these, about 70% is used for human consumption and approximately 30% is processed for oil production or animal feed. Continuing growth of demand will promote increased fish production and natural fisheries are nearing their limits of sustainability. Gradually, production from the main fisheries will continue to shrink but it can be forecasted that even facing an immediate disaster the greed of some may end still further increasing fishing activities, until they become anti-economic or until finally global awareness of the problem forces the implementation of appropriate controls throughout the seas. Hopefully, at that moment it will not be too late.

PROBLEMS OF SEAWATER QUALITY

Over-fishing is not the only problem affecting aquatic ecosystems. Water quality of the seas has consistently been degraded by polluted outlets coming from coastal, industrial, urban and farming areas. As a result, in some coastal zones, important fish stocks have been reduced or eliminated by increased pollution and habitat degradation and some others cannot be consumed safely because of the concentration of contaminants in their tissues.

CONCLUSION: THE FUTURE OF FISH PRODUCTION

As a result of these restrictions in extractive production, it has become clear that this type of exploitation will not be able to satisfy the growing needs for seafood of the world, particularly in developing countries.

In spite of this reversal of fish production tendencies, consumption requirements worldwide have maintained and even increased their rhythm of growth. There is widespread agreement that seafood contains some necessary nutrient and oligo-elements that are not present in land animals or plants, and that their non-saturated fats possess proved healthy effects (i.e. reducing cholesterol levels in the blood, etc).

It is expected that by the year 2000, the demand for fish products will increase by another 30 million tons. It is not going to be easy to meet, particularly when production from most large scale fisheries is reaching its ceiling or decreasing. Locally, some increase may be expected from artisanal fisheries, but it cannot be expected to

⁴ "Fish for the future"; Summary Report; A study of International Fisheries Research; 1993; World Bank, UNDP, Commission of the European Communities and FAO; (A World Bank Publication)

satisfy the demand. It can be expected, that this situation will increase investments in aquaculture.

THE GROWTH OF AQUACULTURE

During the last few years and mainly as a result of the globalizing trends and demand of sea food, large investments at the international and national level have been channelled towards aquaculture, particularly in some (mostly developing) countries with good conditions for this type of activity (i.e. adequate temperature, abundance of nutrients, inexpensive labor and operation costs, etc). One important species grown through aquaculture systems is shrimp which has is or has become a regular food staple in most developed countries.

The shrimp consumption is satisfied by a few Third World suppliers. Some countries have become large producers due to their strategic environmental location (i.e. Ecuador and the Philippines). In Ecuador, shrimp production for export to the USA, Canada and other countries grew from 56.8 million US in 1980 to 491,3 million in 1991. There are today (1993) about 150,000 people dedicated to shrimp larva catching and shrimp farming, which is several times as much as the people dedicated to artisanal fisheries (50,000) or industrial fisheries (2,600).

Several fish species can also be grown through aquaculture: some of the most important species that are been farmed are carp, tilapia, salmon and trout. The "artificial" production of various types of sea species is introducing profound changes not only in the economic structure of the fishing sector but also in the aquatic ecosystems worldwide.

Aquaculture has a strong effect on the aquatic environment: water contamination of water by organic matter resulting from wastes from shrimp farms, disturbing of trophic chains, etc. In any case, increased aquaculture production may have unexpected impacts on aquatic ecosystems beyond those that have been preliminarily identified which may add to existing over-fishing and contamination problems.

A worldwide increase of 30 million fish production, based mainly on aquaculture, will require to multiply by a factor of 2 or 3 aquaculture production in a few years (i.e. from 13 million tons to 35 -40 million in 6-7 years). This may be very stressful for most ecosystems under exploitation, and not sustainable in the medium and long term.

SUSTAINABLE FISH PRODUCTION

The future of the exploitation of aquatic ecosystems will finally depend on the sustainability of the production strategies. Natural aquatic ecosystems, as any other

natural systems, can be exploited for long time only through carefully controlled extractive methods not affecting stock levels and biodiversity of the systems.

Obviously, sustainable extractive methods will not be able to satisfy the demand worldwide and a substantial amount of aquaculture will be necessary to keep up with the growth of the demand.

Aquaculture (as it happens also with agriculture) must also be practiced in a sustainable manner. If aquaculture strategies take into account the protection of the surrounding environments, the biodiversity of the aquatic systems and the conservation of stocks, then it may become another effective tool to feed the world population without diminishing the value of the aquatic ecosystems of the world.

MANAGEMENT OF ESTUARINE ENVIRONMENTS

Estuarine ecosystems are a common occurrence in high density populated areas of the world. It is estimated that about 150 million people live on or near estuarine bodies in the five continents. Estuarine regions are also of particular importance because they represent the outlet of agricultural, fishing, commercial and navigation activities involving very extensive areas much exceeding the proximity of the estuaries themselves.

Estuaries, even when they remain undisturbed by anthropogenic action, are very fragile environments due to their high dynamism, expressed in their frequent changes in salinity, sediment load, content of nutrients and other physico-chemical characteristics.

When human influences are added, the fragility of the estuarine systems increases, and degradatory effects can take place that may finally result in irreversible processes with losses of production potential and biodiversity.

It is generally accepted that, due to their complexity and continuous changes, estuarine ecosystems require a much more careful and thoughtful management approach than other larger or more stable bodies of water.

Although estuaries occupy such an important geographical "niche" in populated areas, no specific methodologies have been developed in order to address the issue of their sustainable environmental management.

The main elements that need to be considered are the following: a) pattern of normal changes that take place on a regular basis as a result of the interaction of the coastal and fluvial regimes; b) periodic catastrophic natural events, such as floods, hurricanes, unusually high tides, abrupt changes of salinity or extreme variations in sediment load, etc; c) anthropogenic influence (contamination, fishing, infrastructure works in coastal areas, changes introduced in the neighboring basins, etc).

In addition to all these physical and biological constraints, estuarine management is also limited by social, economical, political and cultural elements which also can affect the human environment in which the management decisions must be taken.

In order to properly address this issue, it is necessary both to obtain the necessary scientific and traditional/ popular knowledge base and to develop an adequate methodology for formulation and implementation of appropriate policies and strategies.

There are many estuarine ecosystems throughout the world. In North America the Saint Lawrence, in New York, the Hudson river and several others. In South America, the Rio de la Plata, the Guayas in Ecuador, the Amazon estuary in Brazil and the Orinoco, in Venezuela.

In Africa because of the scarcity of well developed coastal plains few estuaries are found (only the Senegal, the Congo and the Niger river have large estuarine ecosystems near their outlets to the Atlantic ocean).

In Asia, there are important estuaries in India (i.e. the Ganges), in Indochina (the Mekong), in China (i.e. the Yang Tse and the Yellow rivers) and several others in other countries.

THE CASE OF THE RIO DE LA PLATA

The Rio de la Plata fluvio-marine ecosystem represents one of the most typical estuarine environments of the world. It is the widest body of water with these characteristics in Latin America and sustain a wide spectrum of valuable species, some of which are unique.

The Rio de la Plata coastal zones are utilized on a regular basis by several fishermen communities which exploit the fish and invertebrate resources of the area. The main fish resources under exploitation in the Rio de la Plata ecosystem are hake ("merluza") and croaker ("corvina").

Hake, squid, tuna, "anchovy" and several others are obtained in deep water and high sea environments, where the estuarine influence is less important, by commercial fleets which are owned by many small and medium and a few larger fishing enterprises. Fishing resources of the typical estuarine zone are croaker, flounder, flat fish, "lacha", "lisa", "white pargo", "brótola", etc (add English or scientific names). In the fresh water environment the fish resources include "sábalos", "bagre", "surubí", "patí", etc.

The croaker resources, which are among the most important of the Rio de la Plata region, are mainly found in the heart of the estuarine zone near the city of Montevideo and are exploited by artisanal fishermen and the coastal commercial fleet. The total annual production of croaker is of 25,000 tons (data from Uruguay, 1992).

The main fishermen communities are located in Pajas Blancas, Puerto del Buceo and San Luis. The commercial fleets are based in the ports of Montevideo and Buenos Aires. There are presently 20,000 people related directly or indirectly to the estuarine fishing industry in both countries. Commercial fishing is channelled toward export markets while artisanal fisheries satisfy the local consumption.

Recent developments in the Rio de la Plata highlight the fragility of the estuarine ecosystem. Firstly, it is becoming more and more common the occurrence of poorly understood episodes of widespread fish mortality in which million of fish die throughout the region. Secondly, contamination from coastal sources seems to be gradually increasing. It is important to note that there are at least 15 million people and 50,000 industries (of which more than half throw polluting effluents into the environment) located along the shores and practically no treatment is implemented in any of them. This phenomenon is accentuated by the outflow of fluvial waters loaded with sediments, fertilizers and pesticides coming from the farming areas surrounding Montevideo and in a lesser degree from Buenos Aires.

The outflow of these contaminants together with over-fishing or inadequate fishing practices may jeopardize the sustainability of the estuarine eco-resources, and with them the viability of the artisanal and commercial fishing production systems. An unwanted sub-product of this contamination process may be the degradation of the quality of the fishing resources that may end affecting the general health of the fish-consuming population.

CHAPTER 7

"IN THE WEST WATER FLOWS UPHILL TOWARD MONEY"

A common saying in the Western U.S.A.

MANAGING PLANETARY THIRST

SOME GLOBAL WATER FACTS

Most of the world water is stored in the oceans (97.39%) and in a lesser degree in glaciers and in inland seas (2.01%). A large part of the remaining volumes is contained in geological formations (0.54%). Only about 0.06% is surface water, of which more than half is salty, making it unusable for most purposes. Available fresh water constitutes therefore less than 1/5,000 of the hydrosphere.

Ninety-five percent of all surface fresh water is stored in lakes. Flowing water, then, represents only about 0.001% of the water of the planet¹.

However, although flowing water is only a very small fraction of the total water of the planet, its volumes are more than enough to satisfy all present human needs and the foreseeable requirements of the near future.

In effect, every year, 496,000 km³ of water fall as precipitations. That is 496 x 10¹² m³ per year, or 1 million m³ per person².

¹ According to Baumgartner and Reidal, referred in Bethemont: "Geografía de la utilización de las aguas continentales",

² The actual stored volumes in the sea are of 1.348 M Km³ and in the continents 36 M Km³. Annual precipitations are about 0.5 M Km³/year). If spread evenly throughout the world, these precipitations would reach about 973 mm per year. Of all the water fallen as precipitation (496.000 Km³/year) about 385,000 Km³/year falls on the oceans, and only 111,000 Km³/year on the continents (25%). The continent which receives more water is Asia in spite of the low average precipitation of 696 mm per year (30,700 Km³/year in an area of 44 M.Km²). South America which is considerably smaller (18 M Km²) receives almost as much water

If we restrict our calculations to precipitations fallen on the continents (111,000 km³ per annum) and subtract average evaporation (about 60%) still more than 80,000 m³ could still be available every year for each individual. Human needs vary from place to place, but generally speaking they don't exceed 1 m³ per day. These figures show that effective water availability for human society does not relate to insufficient volumes, but is rather influenced by many other factors which we will try to identify and characterize in the following pages.

ABUNDANT WATER BUT INADEQUATELY DISTRIBUTED AND OF VARIED QUALITY

In spite of the above mentioned enormous volumes of fresh water that circulate every year through the continents, which would suffice to satisfy the needs of humankind for centuries, many people throughout the world do not have access to this vital liquid.

The reasons are many. Firstly, freshwater suitable for human consumption only exists in large volumes in some small zones of the planet: lower-reaches of rivers, larger lakes, high yield aquifers. Secondly, available freshwater is not always of the required quality, sometimes due to natural causes, but more often as a result of anthropogenic degradation. Thirdly, not all water reservoirs have the same renewal rate. Long term use of any water resource is limited by its renewability. And finally, the social need for water, as well as its potential and actual demand, are concentrated in a few highly densely populated areas, which not necessarily coincide with the sites of greater availability.

In brief, good quality fresh water in large volumes and with appropriate renewability to satisfy in a sustainable manner the needs of cities and various productive activities is not so easily found and has increasingly become a limitative factor for demographic and economic growth.

(28,000 Km³/year) due to its higher average precipitation (1564 mm). Africa receives less water (20,000 Km³) and the average precipitation is similar to Asia (696 mm). Average levels of precipitations in North America are slightly lower (645 mm) with a total volume of water received of 15,600 Km³/year. Assuming that the stored volumes of groundwater are unchanged, the total volumes of water that are evaporated from the land masses is as high as 84% of the total precipitations in Africa, 67% in Australia and 62% in North America. In Asia and South America evaporation takes 60% of the fallen water and in Europe 57%. Only in the Antarctic, these rates are considerably smaller (17%).

ABOUT HYDROGRAPHIC BASINS

Hydrographic basins are natural units composed of the different terrestrial environments through which the water moves towards a given outlet. In that sense, hydrographic basins can be defined as the upstream territories of a water body/stream.

Basins are complex features, including both surface and underground waters. These two types of waters are closely interrelated and must be considered in a combined manner. The main components of a typical basin are:

- a) Watersheds
- b) A hydrographic network
- c) Groundwater systems

These three elements are interconnected: watersheds receive precipitations, which in turn infiltrate to groundwater systems or flow towards the valleys forming the streams. Part of the groundwater can go back to the streams and water from the stream beds often recharges the underlying aquifers. Some of the water may go back to the atmosphere through evaporation and fall again in the watersheds closing the cycle. However, by and large, the water cycle is open because most basins exit towards the sea or other major water bodies. The outlet of the basin is also an outlet for sediments, dissolved salts and contaminants.

ABOUT THE GEOMORPHIC WATER CYCLE

Surface waters are composed of a complex array of surface hydrological features and systems including all types of streams, lakes, swamps and other flowing or lentic water bodies.

Surface water bodies are fed from three main sources: a) instantaneous supply from rainstorms and subsequent run-off, b) supply from springs (groundwater discharge) and c) ice and snow melting. In tropical and temperate arid climates, streams are mainly fed through run off, precipitations fall on bare soils, with little or no infiltration, and the water flows downslope toward the river valleys. Arid rivers are very irregular suffering catastrophic floods and droughts. In humid climates, the opposite happens, the soils are covered by vegetation, and rainwater is intercepted by leaves and branches. Most of the water evaporates or infiltrates and only a small fraction flows immediately as run off. The infiltrated water moves through the geological formations reappearing as springs next to streams, lakes or swamps.

For this reason, in humid climates most of the water comes from springs while in arid climates the supply of water to the surface natural systems is related to run off processes. In addition, as a result of the increased evaporation rates and the presence

of salts in the soils, water in arid climates tend to possess high contents of dissolved solids, while in humid environments the opposite happens.

THE DIFFICULTIES OF MANAGING INTERNATIONAL HYDROGRAPHIC BASINS

Hydrographic basins, both surface and underground do not "respect" national boundaries. Expressed in other terms, national borders do not always take into account water boundaries. In fact, they seldom do. Shared water resources are very common throughout the world. In some of these cases conflicting interests may develop and water issues may become important international political factors.

Some hydrographic basins, even a few larger ones, are mainly or wholly inside a single country, such as the Yang Tse river in China and the Mississippi river in the United States. However, very frequently, hydrographic basins are shared by two or several countries, making more complex to reach agreements on management strategies.

WATER USE AND OVERUSE

Water is the most varied and widely used substance on earth: it is utilized in houses for washing, cooking or drinking, it is consumed by industries for innumerable purposes (as raw material, for cooling or washing, to make possible certain processes, etc), it is used for farming, and for many other reasons. The main water users are the farmers which take more than 80% of the world consumption. Of the remaining 20 % about half is utilized domestically and the rest for industries and other activities.

However, in these figures only the water actually used is considered. The large volumes of water that are only "affected" (but not used in the strict sense of the world) by human action are not taken into account. In effect, good quality river or lake water often loses its quality due to the inflow of untreated or insufficiently treated wastewater that is returned into the environment. The volumes of water that are influenced by this degradation processes are huge and difficult to quantify. In all likelihood the "degraded" volumes are at least of the same order of magnitude of all the water used worldwide, and probably substantially more.

Another anthropogenic cause of water degradation or at least decreased availability relates to the processes of inappropriate soil management on slopes. Inadequate farming or grazing practices produce soil erosion, washing off of agricultural fertilizers and pesticides and high rates of instantaneous run-off.

As a result of soil over-use, water flow is concentrated in a short period producing flooding which is a destructive event and makes more difficult optimum utilization of the water resource. Flood water is normally loaded with suspended particles which not only lower the water quality but also affect the intake operations (due to clogging) making more costly and difficult treatment procedures.

In summary, actual availability of water is much less than it could be if water was evenly distributed (in space or time) and properly managed.

ANTHROPOGENIC IMPACT ON WATER SYSTEMS

During geological times the evolution of water systems basins occurs in a natural manner, at variable paces depending on climatic, geological and biological factors.

Since the beginning of history, societies have introduced changes in this natural evolution. Agriculture, cattle raising, logging, excavation of quarries and the construction of artificial structures have had an effect on the hydrological dynamics throughout the planet.

The growth of the world population, particularly after the industrial revolution, has gradually increased the intensity of these processes by promoting all-encompassing modifications of the land surface and increased utilization of water resources.

These effects have been particularly intense after the urban revolution of the XX century. Overpopulation in many rural areas and the development of large multi-million cities has determined a growing and concentrated demand for water.

During this century, water consumption has increased for agricultural, domestic, industrial and other purposes; dams were built, wells were drilled and water abstraction from natural water bodies has substantially augmented. Used water is returned to the environment with much lesser quality producing widespread degradation of streams, lakes and aquifers.

VULNERABILITY OF WATER RESOURCES

Vulnerability of water resources to contamination varies from place to place. Generally speaking, it depends on the flow volumes. Large rivers are less vulnerable, small rivers are very vulnerable. The same rational applies to lakes, although their vulnerability is normally higher than rivers due to their lower rate of renewability.

However, in spite of their vulnerability to pollution which makes them very hazardous in densely populated, industrial and/or mining areas, surface water sources are relatively easy to clean up once a decision in that sense is made. This is particularly true in the case of rivers and in the lakes with faster rates of renewability.

On the short term, groundwater is less vulnerable than surface water. Contaminants take long time to find their way to the deeper aquifers. In some cases, they may even be protected by impermeable layers. This may nurture a false sense of security. In fact, groundwater reservoirs can be polluted very easily through contamination of the recharge areas or inappropriate drilling operations, and when this happens it may be

very difficult and expensive to correct. In most cases, contaminated aquifers cannot be utilized for long time and in some cases they may be lost forever for any practical purpose.

WATER PROBLEMS IN DENSELY POPULATED AREAS

As a result of the industrial revolution there has been a gradual growth of urban centers which by the beginning of the XX Century had already exceeded one million inhabitants in many places (i.e. New York, London, Paris). In the following decades, this growth continued and today there are as many as 200 cities with more than 1 M people and more than 20 exceeding 10 M³.

In most cases, when these cities started to develop or were founded, water resources were abundant. Many of these cities utilized nearby rivers or lakes for water supply and did not have major problems of scarcity. In the cases in which surface freshwater resources were not available, the cities used easily accessible underlying aquifers. In fact, in practically all cases it was the presence of these types of water resources (ground- and surface water) which made possible the development of the new cities

However, both in the cases of spontaneous or of planned development, with practically no exceptions, the location of the cities was not selected for the type of growth that was going to take place at a later date in many of the largest urban areas of the world.

During their first years of existence in the XVIII and XIX centuries, the size of most of the largest cities of the world today would be considered typical of small or medium size cities. By the year 1800, not a single city in the whole American continent exceeded 100,000 people.

For these levels of population, only small volumes of water resources were necessary. This does not mean that water supply problems were solved. On the contrary, in the early XIX Century, even in cities with small population, water supply systems were still very poorly developed. For this reason, per capita consumption levels of water were much lower than they typically are today.

WATER SCARCITY IS ALSO A BY-PRODUCT OF THE DISTRIBUTION OF POPULATION

Water problems in this increasingly urbanized world are not always problems of "real" scarcity of water. Large cities consume, obviously, large volumes of water. Los Angeles, Mexico city and Tokyo three of the largest cities of the world, consume

³ See Chapter 12

between 50 and 150 m³/sec. Even with the growth expected during the next decade, the consumed volumes will not exceed 200 m³/ sec. in any of these metropolitan areas. The flow of the major world rivers is hundred or thousand times this figure. The Amazon outflow into the Atlantic Ocean is of about 150,000 m³/ sec (that is, 2000 times more than the consumption of the largest mega-city of the world) and the Congo flow volumes into the Gulf of Guinea averages 60,000 m³/ sec. Many other rivers possess flows in excess of 5,000 m³/sec at their outlets into the sea or coastal estuaries (i.e. Parana, Yang Tse Kiang, Mississippi).

However, as explained before, this apparent overabundance of water does not reflect actual reality. Rivers such as the Amazon or the Congo are not representative, because they have a significant part of their basins in "non-average" high rainfall areas. For many other rivers with large basins (i.e. the river Nile or the Niger), the flow is considerably less. When all rivers are averaged out, there is much less water available.

On the other hand, the stated flow figures reflect only the flow at the mouth of the rivers, where the maximum flow occurs. In other stretches of the river courses or in their tributaries (even in the Amazon and the Congo), the flow is much smaller (in relation with the size of the upstream basin and local rainfall).

Finally, not many larger cities or densely populated areas are located at the mouth or in the lower reach of the large rivers or their tributaries where the flow is maximum⁴. As a result, the actual surface water resources available for cities and densely populated areas in nearby streams are much smaller than what they would be if the cities were located in the lower river valleys.

In addition, many cities located next to the mouths of these rivers cannot use the stream water directly because of the entrance of brackish water from the sea during the dry season (i.e. Georgetown in Guyana, Montevideo in Uruguay).

Some cities are close to the water-divides and available water is limited (i.e. Sao Paulo in Brazil and Madrid in Spain) or next to relatively small streams (i.e. Los Angeles in the U.S.A. and Lima in Peru). For this reason, available resources are frequently below the growing needs of the metropolitan areas located in their proximity.

In spite of the potential problems of water availability, at the beginning of the XX century the main urban centers of the world had more or less managed to survive with their nearby water resources without major problems of scarcity.

⁴ Some areas with high density of population located next to river mouths include Bengal in the Lower Ganges and Brahmaputra, Shanghai and neighboring areas next to the Yang Tse and Saigon/ Ho Chi Min and other high density areas next to the mouth of the Mekong river in Indochina. Density of population in the lower reaches of the two larger rivers: the Amazon and the Congo are much smaller.

WATER PROBLEMS BECAME MORE ACUTE IN THE XX CENTURY

During the XX century, the situation changed radically. Those 50,000-100,000 cities of 150-200 years ago have grown to urban areas of 10-15 or more millions, housing as many or more millions in the surrounding areas. With the present rates of growth, and even predicting some stabilization in the near future, it is very likely that by the beginning of the next decade there will be several megalopolises of 15 M plus.

In many of these larger "megalopolises", local water resources were exhausted or degraded many decades ago and water authorities were forced to move into neighboring hydrographic basins or aquifers.

As a result, actual costs have risen considerably, although in most cases they have been somehow disguised in the national budgets. Very often, urban water supply accounting only includes operational costs, investments are financed at the national level, and in some cases, even replacement costs are not fully taken into consideration.

However, it must be noted that when cities do not pay the full price of the water, somebody else does. In fact, in many countries large cities are being subsidized by the population at large, including by the population from small towns and rural people not benefiting from the water works investments.

Continued growth of the large urban areas will make more acute the problem. New sources of water can only be found much farther or deeper, they will require costlier dams, conduction systems, storage structures, distribution networks and treatment plants.

Unfortunately, water availability is decreasing simultaneously with the increase of the demand. One strategy to solve the problem has been to find new resources and "ship" them to the cities or to build mega-projects of trans-basin water transfer. However, this strategy is not sustainable in the long term. Costs skyrocket and resources dwindle.

A successful strategy will be possible if management strategies are redefined aiming not only to increase supply, but also to reduce demand, unnecessary consumption and losses through a comprehensive approach to the water problem.

And of course, a longer term solution to the problem will require to review the "constant growth" development paradigms that are the cause of the unsustainability of the water models. A general new approach may be required in which water consumption will relate more with its distribution and availability and where rational and equitable demand policies are given priority before overexpenditures and wastage.

SOMETIMES GROUNDWATER MAY BE A SOLUTION

In many cases, groundwater resources are very abundant with volumes that may be severalfold larger than surface water resources, frequently between one and two orders of magnitude larger for usable freshwater. However, these resources should not be counted on their volumes but on their renewability. When groundwater resources are utilized beyond their capacity for renewability, water levels drop down, pumping costs increase, and sooner or later the resource is spent.

If we only consider the aquifers according to their renewability, available volumes are of the same order of surface water resources or even less. In addition, groundwater availability and urban distribution do not necessarily coincide. There are large aquifers in sparsely populated areas or where they are not needed because there is sufficient surface water, and large urban areas with very little groundwater available in their proximity.

In spite of these limitations, groundwater offers many advantages. It is less vulnerable to contamination, normally it does not require treatment, it can be exploited with a modular approach with smaller investments and local participation, there is not need for large and sophisticated distribution systems and there is not need for expensive storage structures (storage takes place under ground).

A word of caution must be introduced because, as previously explained, although aquifers are less vulnerable to degradation, when it happens it may be irreversible. Therefore, groundwater can be an option, but taking particular care to protect the resource from degradation from outside sources, and through a sustainable and integrated approach to its exploitation.

WATER AVAILABILITY AND OPTIONS

In summary, although total available water resources are more than enough to satisfy the needs of all the cities and densely populated areas of the world 100 times or more, the relative location of these resources and of the consumption areas (which do not coincide), reduce their actual availability to only a fraction of the total volume.

In some of the larger cities, the presence of mighty rivers next to the city would make surface water supply an easy proposition from the point of view of availability of resources. Some of the cities with these characteristics include: Calcutta next to the Ganga, Shanghai next to the Yang Tse, Buenos Aires on the Rio de la Plata and Cairo on the Nile. However, because of better quality, brackishness or of the size of the city, the utilized source of water supply may also be groundwater. This is particularly true for the neighborhoods that are located farther away from the rivers banks.

The Greater Buenos Aires is an example of a city, which, although is located next to one of the largest rivers of the world, obtains one third of its supply from the underlying Puelche aquifer, due to economic (distance) considerations. Shanghai, Calcutta and Bangkok also utilize groundwater in spite of their location in proximity of large rivers.

In many other cities, only relatively small rivers are found, and they possess limited availability of water for satisfactory and sustainable supply for a metropolitan area. Some of the cities located next to relatively small rivers include: Sao Paulo on the river Tiete and Caracas on the river Guaire. In most of the above mentioned cities, the rivers are heavily contaminated and their use is limited.

For these cities, the selected options were to build new systems drawing from larger and farther away streams or to drill more well batteries, also gradually moving away from the city area.

Other strategies, such as reducing demand and losses and ensuring protection of the resources under use were not considered as potential alternatives. Consequently with this approach, more investments were engaged, new loans were contracted, and the environmental effect of water abstraction was further extended beyond the outer limits of the urban areas themselves into the surrounding countryside.

THE PARTICULAR PROBLEMS OF COASTAL CITIES

In coastal cities, the problems were similar but more specific. Most coastal cities developed next to streams that together with available groundwater were enough for the needs of small towns but that soon became completely insufficient once the urban areas started to grow. A common additional limitation in coastal areas was the intrusion of brackish water into the lower reaches of the rivers which forced sometimes the cities to move their water intakes further upstream (i.e. London in the Thames, or Guayaquil in the river Guayas).

At the same time, nearby aquifers suffered over-exploitation producing saline intrusion or excessive drawdown of the piezometric levels. As a result of this, many of those coastal cities had to extend their conduction lines to get the water from farther away rivers or groundwater fields. This was the case of Recife in Brazil, Calcutta in India, Dakar in Senegal, Georgetown in Guyana and Maracaibo in Venezuela (next to the brackish Maracaibo lake).

In other cases, due to the salty nature of the river or estuary, the city moved quickly to nearby tributaries without the salinity problem. New York for instance was forced to use groundwater because the Hudson river water is brackish. Presently the supply comes from upstream reservoirs. Montevideo in Uruguay is an example of this situation; the city cannot depend on the river de la Plata which has a salinity averaging 10/00, and gets its water from intakes in the Santa Lucia river which is a

tributary of the river de la Plata located about 30 km. from the mouth of the river and between 15 and 30 from the city itself.

Finally, in some other urban areas, rivers are practically absent. This is particularly true in coastal cities located in karstic or volcanic sites. No-rivers cities include Djakarta in Indonesia, Manila in Philippines, Miami in the U.S.A., Havana in Cuba and Merida in Mexico. In these cities, water supply had to be developed mainly through the utilization of existing groundwater resources.

All these elements demonstrate that available water resources in the proximity of larger coastal cities are in a large measure limited due to their location.

OTHER LIMITATIONS

One problem that is gradually becoming a central issue is the growing degradation of the surface water resources due to lack of treatment of wastewater. In a few cases, surface water bodies that have received wastewaters from cities, industries or farms, cannot be used for any practical purposes due to quality problems. In many densely populated areas, all kinds of wastewater find their way into the natural water systems (i.e. rivers Tiete⁵ and Pinheiros in Sao Paulo). In several other cases, water quality has been seriously damaged and it is very likely that streams will be unusable very soon. In many other examples, water quality has only been partially affected, but there is a firm trend towards degradation that will probably produce analogous effects in the future.

In summary, there are two basic problems affecting the water supply of cities and densely populated areas of the world. One is the inadequate location of the cities in relation to the location of existing natural water resources, and the other is the growing degradation of those resources.

THE OTHER SIDE OF THE WATER PROBLEM

However, the water problem has two sides: the water resources/ supply side and the water demand/consumption aspects. When the water demand and consumption aspects are taken into account, it can be concluded that many actual water supply problems wouldn't exist, or would be much lesser acute if more sustainable policies and strategies were formulated and implemented.

⁵ There is a 10 billion dollar plan to recuperate river Tiete, but it is not likely that this recuperation will take place before the year 2000.

Actual consumption is in reality much larger than it would be required to simply provide water for activities and dwellings. This wastage of water takes place practically at all levels of the water systems: leakage from the pipelines, wasteful attitudes encouraged by lack of metering or inadequate pricing policies, inappropriate water-appliances technology, etc.

In order to improve the situation, therefore, it is necessary to attack the two sides of the problem: 1) increase supply and 2) reduce demand. And of course, in both cases there is a need for improved management strategies.

SUSTAINABILITY AND EQUITY IN URBAN AREAS

To solve the urban water problem management strategies must take into account the required investments against returns in a framework of sustainability and equity.

For each one of the densely populated areas of the world there are several possible sustainable and equitable water supply options. Normally, once sustainability and equity are assured, the main criteria to choose among the various alternatives, would be to assess the actual financial costs of the proposed systems. And in fact, this would be the most straightforward notion that we can define as a general rule for urban water systems.

However, there are many other factors that enter into the equation that must be considered as well. Some of them relate to the previously mentioned concept of sustainability. Firstly, water systems should not affect the sustainability of the water resources themselves (i.e. as it is the cases in which there is over-abstraction from a stream or reservoir, over-pumping, from an aquifer, degradation of water quality, etc). Secondly, the sustainability concept includes also the protection of other natural resources of the region under consideration (i.e. fluvial or lacustrine ecosystems should be protected, etc).

In addition to the "ecological" sustainability, water systems must be socially sustainable. The implementation of any water system produces various socio-economic implications, not only from the perspective of satisfying the needs of all the population in an equitable way but also from other points of view. Among other things. Water services create employment, they can promote some types of industries, and even, they can be an effective element to support many urban strategies (the availability of water will stimulate the development of some neighborhoods instead of others).

WATER AND MODELS OF DEVELOPMENT IN URBAN AREAS

When all the potential solutions to the water problems are examined we must realize that everything that was mentioned before relates to only one aspect of the problem.

Because the main reason for the lack of sustainability of the water systems is the type of **development** models that have flourished throughout the continent. When the size of the cities and type of growth are considered, it is very clear that mega-cities are not sustainable propositions. One wonders, what is going to happen to Mexico City with 20 million people and increasing their numbers. Water is becoming insufficient, huge sums of money and energy are being spent in producing larger and larger volumes of water, pumping up millions of m³ per day, but the city and surrounding urban centers (i.e. Toluca, Puebla, Cuernavaca, Cuautla) are still growing. The development model of Mexico City must be substantially reviewed, the growth should be curtailed, the country economy and management system must be decentralized. If that is done in an intelligent manner, there is a real possibility that the water problem will disappear on its own (or at least be significantly reduced).

The development model of Philippines or of Thailand with a growing centralization in two large megalopolis are not sustainable. Neither the site of Manila, nor the site of Bangkok can house an urban population exceeding 10 million people without irreversible deterioration of the environment, including the water supplies.

The model of Brazil is also clearly unsustainable. Sao Paulo was (hydrologically) in the wrong place to start with, and obviously with time and further growth of the city the hydrological suitability of the site will not improve. A new model promoting the relocation of Sao Paulo activities somewhere else may be the only real long term solution to many serious problems of the city, including the water problems.

The same argument could be applied to many other cities of the world such as Teheran, Bombay, Dakar, Kinshasa, Lagos and Lima which, in various degrees, present similar problems.

In summary, the water problems of most Third World mega-cities is less a problem of the water systems (although there are plenty of problems to solve at that level) than an indirect consequence of a history of uncontrolled urban growth due to the unsustainable models that have been and are being applied throughout the world. The solution to the urban water problem will finally be closely related to the solution of the basic structural issues of the societies where these megalopolises are inserted. Until then, the best that can be done in the water field is to devise and implement strategies tending to reduce the damage on the natural and human resources and to improve the services in order to provide, at least temporarily, a better quality of life for the population.

IRRIGATED AGRICULTURE: ONE OF THE LARGEST WATER USERS

In most countries, it is not urban use which takes the largest volume of water, but irrigation. Irrigated farming is a very high water consuming activity, particularly because places where watering is necessary to grow crops are normally located in

high evaporation areas, which is further exacerbated by the type of crops, some of which can be very evaporative.

Irrigated rice may evaporate as much as 2,000 mm per year which in one hectare represents about 20,000 m³. Even in less demanding crops, for most irrigated farms the yearly needs of 1 ha of an average irrigated crop are approximately equivalent to the needs of 40 urban homes. For this reason, irrigated agriculture can be competitive only with high market value crops or where the price of water is very low.

Frequently, the low price of water for irrigation does not reflect actual costs. In some irrigated zones, water is obtained from very expensive dams or other hydro-works whose cost has not been incorporated to the price. In those cases, the low price of water allows the development or persistence of irrigated farming in areas where normally the cost of irrigation could reduce competitiveness and make impossible economically sustainable agricultural activities. In those cases, farming survives because it is being subsidized by the institution or agency that built or financed the hydro-works and is not charging the cost to the water users.

In many examples, the institution that provided the investment is a national government who contracted a loan from a lending agency/bank and which is being paid by the society at large. This is the case of California, where the large hydro-works on the Colorado river and others, were financed by the U.S.A. Federal Government. A similar approach has been utilized in Mexico where the investment needs of most irrigation districts were supported by the Federal Government.

URBAN NEEDS AND IRRIGATED AGRICULTURE

Finally, one of the main pressing problems when water strategies for the future are designed, relates to the conflicts and related policies of water allocation for irrigated farming and urban use.

As described above, farmers use much more water than urban dwellers (even when large water consuming industries are considered). The competitiveness of agricultural activities is closely related to the cost of water. Expensive water excludes the irrigation farmer from the market. Inexpensive water has the opposite effect.

Urban dwellers can pay much more for each unit of volume of water. This is so mainly because the cost of bringing the water is shared by many more individuals and enterprises, and also because they use much less water on a per capita basis.

In the competition between farmers and cities, the cities tend to have the upper hand. In some cases, this may mean the destruction of traditional farming activities by many small farmers which depend on irrigation (i.e. in Egypt). In other cases, the development of irrigated farming activities are the result of speculative water politics taking away water from some small farmers or indian communities to give it to larger

companies for commercial production (i.e. as it was the case in the water transfer from Owens valley to the lower valleys in California).

DEFINING WATER STRATEGIES

For this reason, it is necessary to define water strategies taking into account **all** the elements of the equation. How much water is available; who needs it the most; what share should correspond to each user; who has the first right; what makes more economic sense. And finally, to answer all these concerns within the **framework** of sound development models in which quality of life and sustainable use of resources are the main priorities.

Water resources use will be optimized and the water situation will be satisfactorily addressed, only when these sustainable social and environmental models are properly defined and adopted.

SOME REPRESENTATIVE EXAMPLES OF WATER ISSUES THROUGHOUT THE WORLD

Water has always been a central element in human history and its utilization has frequently had profound social, economical and political implications. Policies and decision-making in the water field can have strong effects on the future of countries and societies. There are many examples in which water conflicts have been the determining factor of the evolution of countries and societies. A brief description of some representative cases will be presented in the following pages.

THE CASE OF THE AMAZON BASIN

The Amazon basin, which is one of the largest of the world (6,157 km²) is shared by 7 countries⁶ (Brazil, Venezuela, Colombia, Guyana, Peru, Ecuador and Bolivia).

The region is characterized by a high annual rainfall in excess of 2,000 mm. per year distributed in four pluviographic period (two rainy and two drier seasons). The vegetation is mainly a dense rain forest including very extensive wetlands, (almost

⁶ Almost two thirds of the basin are in Brazil (about 4 million km²), nearly 1 million km² in Peru, 825,000 km² in Bolivia, and the rest in Venezuela, Ecuador, Colombia and Guyana.

600,000 km²). The Amazon region is also home of some of the largest and biodiverse ecosystems of the planet.

Because the basin is sparsely populated (25 million people, mainly living in the highlands and slopes of the Andes, with a density of only 4/ km²) and there is plenty of water available throughout, there aren't yet many contentious issues related to the management of its resources⁷.

The actual population density of the rain-forest is very small, with settlements mainly along the rivers. The major cities of the basin are Manaus and Belem with about 1.5 and 2 million people respectively. Other cities include Iquitos in Peru and Santarem in Brazil. The key "roles" of the rivers water are transportation and fishing. Travel between communities of the basin has been traditionally through the river, although lately air travel has become also very important. Land routes are few and in the heart of the forest they are almost nonexistent. Fishing activities have been traditionally one of the main means of subsistence for the Amazonian people. The risk of degradation of the aquatic bio-resources may represent therefore not only a health hazard but also the elimination of a source of food and income.

In addition to the urban centers, the region is populated by a numerous group of indigenous micro-nations well adapted to the exploitation of the forest ecosystems⁸. These groups exploit the water ecosystems in a traditional way and although their destiny is closely linked with the water systems, the decisions on basin management are made without any consideration for their point of view or interest.

The Amazon basin is presently under a process of disorderly occupation. Land allocation policies in Brazil have traditionally preferred the "posseiro" (occupant) who proves its possession by burning or logging the forest to the native groups who have been in the land for many generations.

On the other hand, an important drive toward the occupation of the region has been promoted by the building of dams particularly by Brazil, which is the largest Amazonian country and has defined hydroelectric dam construction as a national strategy. There are plans to build dams with that purpose at 43 sites on 13 rivers with a generating capacity in excess of 70,000 MW⁹. This "hydro-development" drive would be

⁷ It is expected however, that with the growing drive toward dam construction and the encroachment of mining operations conflict situations will gradually arise.

⁸ See Chapter 4

⁹ Mbugot, Luc J.A. (1988); *Hydroelectric development and involuntary resettlement in Brazilian Amazonia: planning and evaluation*; Edinburgh: Cobham Resource Consultants, 106 p.

concentrated in three river systems only: the Xingu (32%), the Tocantins (20%) and the Madeira (15%). A number of these hydro-works have already been built¹⁰ and in some cases disastrous environmental and social effects have been observed (i.e. in the Tucuruí impoundment in the Lower Tocantins).

As a result of deforestation, hydrological regimes are already changing throughout the basin. Droughts and floods formerly unknown, are taking place along the courses of many tributaries and water quality is being deteriorated by increasing effluents of wastewater from cities and mining operations.

Contamination from mining is related to the exploitation of gold placers and mines by the "garimpeiros". Gold is extracted from the ore by using mercury or by means of cyanide solutions. Both procedures are strongly damaging for the environment. Cyanide is highly poisonous and quicksilver concentrates through the trophic chains and may end reaching toxic levels in some aquatic organisms that are consumed by the riverine populations¹¹. Mercury pollution is particularly serious in the upper basins of the Madeira, Tapajos and Xingu rivers and there are indications that widespread poisoning may be taking place in some of the most polluted areas. In the fishing community of Rainha, upstream of Itaituba on the Tapajos, some tests on the population showed mercury content much in excess of the 6 ppm maximum accepted by the WHO. Similar data have been observed in several other locations. In the Madeira river basin, hazardous levels were found in fish-eating Kayapo Indians communities. Continued mining operations will undoubtedly increase the environmental and human health effects of mercury contamination.

With deforestation and indiscriminate occupation, the apparently invulnerable Amazonian ecosystem can be deeply deteriorated affecting not only its inhabitants but also the planetary population at large. It will not be easy to address the many issues that are producing these changes in the Amazon basin, but a central element of any strategy to be implemented, will be to take into account the views of the Amazonian traditional people who have managed their land in a sustainable way for innumerable generations.

THE RHINE BASIN

The Rhine basin is, in many ways, the opposite of the Amazon basin. Firstly, it has a density of population more than 120 times larger. In a relatively small area it houses a population of more than 50 million people and drains a basin located in seven

¹⁰Both in the Amazon and in other neighboring basins (i.e. in the Parana basin) with similar characteristics.

¹¹Mercury poisoning or Minamata disease affected the villagers of the Minamata bay in the fifties and ended killing 1,382 people (source: Time, January 10, 1994. p.28.).

countries: France, Switzerland, Austria, Germany, Belgium, Luxembourg and Netherlands. Secondly, the river is much smaller. It is only 1,320 km long and its basin area is barely 185,000 km². The river flows down from the Alps to the North Sea crossing four countries (Switzerland, France, Germany and Netherlands)¹².

In this medium size basin, there are scores of large cities and some of the more densely populated countries of the world (i.e. Netherlands, Belgium).

Not only this river basin has a high density of population, but it is located in one of the most heavily industrialized regions of the world. The majority of the production of Germany, the Netherlands and Switzerland and an important part of the production of France (Alsace and Lorraine) is produced or finds its way out in the Rhine basin or through this river tributaries.

The intensive utilization of the basin waters has had heavy contamination effects in the river, particularly at its lower reaches, in Germany or in the Netherlands¹³. The situation worsened until 1980, but in later times the situation has improved. Presently the four Rhine countries are cooperating under the Rhine Action Plan with the purpose of addressing the problems of water quality in this river. One of the main strategies to be implemented includes improvement of industrial processes for reducing the load of contaminants thrown into the environment.

In more recent times, there has been a trend towards relocation of some highly polluting industries to Third World countries with less stringent environmental controls and cheaper labor (see Chapter 2).

THE NILE BASIN

The Nile basin, on the other hand, presents potential management problems that could become litigious issues between the basin countries.

The sources of the White Nile and its tributaries are in the African Great Lakes region, mainly in Uganda, but also in Kenya, Rwanda and Tanzania). The Blue Nile and the

¹² Source: J.W.Maurits la Riviere; "Threats to the Worlds Water; p.80- 94; ("The Rhine" in p.88); in Scientific American, Special Issue, "Managing Planet Earth"; September 1989; Volume 261; Number 3.

¹³ The pollutants in the Rhine in the Netherlands-German border in 1985 were as follows: chloride: 1,100,000 tons per year; phosphate: 3,500 tons per year; copper: 450 tons per year; cadmium: 10 tons per year and benzpyrene: 1,600 kg. per year.

Atbara, which are the main Eastern tributaries flow down from the Ethiopian highlands providing not only a substantial portion of the flow volumes but also most of the sediment load. The middle course of the Nile below the confluence of the White and the Blue tributaries, is located in Sudan and its lower course in Egypt.

Because the river flows from humid lands (in the South) to increasingly dry areas (in the North), the arid lands societies of the North (Northern Sudan, Egypt) have grown very dependent on its water since old historical times. In the case of Egypt, where rainfall do not exceed 100 mm. practically in any place, the Nile water is the only source of water that can satisfy the water needs of the country. Egypt possesses a population of almost 60 million people concentrated chiefly along the Nile banks (most of the Egyptian towns and farms are densely packed in the 40,000 km² of the Nile flood plains).

Any modification to the Nile regime, can become a matter of life and death for the Egyptians. Presently, there is a international basin treaty that ensures a minimum flow for Egypt at its Southern border with Sudan. Presently, Sudan does not use all its water share and therefore problems have not (yet) arisen.

One of the potential problems that exists relates to the use of groundwater in the Sudanese sedimentary areas located in proximity of the river. In Northern Sudan and Southern Egypt the river crosses the Tertiary sedimentary basin of the "Nubian Sandstone" which contains a large and poorly known aquifer. An important part of the recharge to the aquifer comes from infiltration in the bed of the river Nile. Any large scale utilization of the Nubian aquifer may translate into losses in the river flow downstream of the pumping sites. It will be very difficult to enforce irrigation control in Sudan taking into account that the relationship between groundwater and surface water use has not been firmly established (and may be, there will not be much interest to establish it).

Fortunately for the Egyptians, the Sudanese are too busy trying to keep their multi-ethnic country together and water utilization for irrigation purposes (both from the river itself, or from the neighboring aquifers) did not increase much.

Another potential problem for the Nile communities is the proposed draining of the Sudd wetlands by means of a 360 km- canal (the Jonglei canal) and other related water works. The Sudd region of Southern Sudan is a high biodiversity area which not only regulates the flow of the White Nile reducing the risks of catastrophic floods and droughts but also provides abundant resources to the Nuer, Dinka and other nations inhabiting the zone for many generations. The continued situation of war in Southern Sudan has forced to abandon the project and it is not very likely that it will be completed in the near future.

Similar problems may arise from Ethiopia which is the source of 85% of Egypt's water. The main Ethiopian tributaries of the Nile are the Blue Nile and the Atbara rivers. Egyptian concerns are related to the possible future construction of dams for

power production or irrigation in the upper basins. As in Sudan, political instability in Ethiopia has made impossible any large scale hydro- development but this situation may change in the future. There has been talks of the construction of a dam on Lake Tana which is the source of the Blue Nile¹⁴ and this may alter the present Egyptian control of the Nile waters.

A more actual and pressing problem in the Ethiopian highlands has been the widespread degradation of the forest or shrubby ecosystems in the upper basins. As a result of this widespread degradation of natural ecosystems, river regimes have become much more contrasted due to increased run off and extended droughts. Intense soil erosion in the basin soils has produced a considerable increase in the solid contents in the water increasing silting effects downstream¹⁵.

The Aswan dam in Upper Egypt was finalized in 1970 and its inauguration allowed the opening for agriculture of extensive formerly arid lands. However, in addition to its initial positive effect on agricultural production, the dam has had a number of negative impacts on the medium term. One of these relates with the conditions for flood plain agriculture downstream of the dam. Because the natural supply of silt has dwindled, artificial fertilizers are required increasing costs and affecting the water quality of the river water. On the other hand, the newly- irrigated soils have also had problems (waterlogging and salinization of soils and groundwater have become a common problem). Human health was also affected (i.e. increase of schistosomiasis). Construction industries were also affected because the brick industry is very dependent on alluvial silt. Brick makers often compete successfully with farmers for the same land reducing its availability for farming. As a result, traditional farming areas have been reduced and agricultural production too.

As it can be seen, the basin of the river Nile is a very fragile hydrographic system, requiring careful management. It will be necessary much coordination to ensure that its utilization is appropriate and sustainable. However, basin management of such a complex and multi-national basin is not a mere scientific endeavor. In addition to its ecological, hydrological and engineering technical aspects it encompasses political, social, economical and historical issues. Only a holistic approach will allow a non-conflictive resolution of its long term problems allowing an optimum utilization for the improvement of the quality of life of its population.

¹⁴ Source: "Africa at a watershed"; Fred Pearce; *New Scientist*; 23 March 1991, p.36.

¹⁵ The Aswan dam has been particularly affected by this increased silting reducing its life expectancy to merely a few decades.

THE JORDAN RIVER BASIN¹⁶

Although the Jordan is a small river (basin: 20,000 km²?), it is located in an area where water resources are extremely scarce due to low precipitations (ranging from less than 100 mm in the South to about 500 mm. in the farther Northern highlands) and a background of acute political conflicts between the countries sharing its basin.

There are five countries¹⁷ in the Jordan basin. The upper basin is mainly located in Lebanon and Syria (the Hasbani and the Banias rivers) which together with other neighboring springs in Israel form the Lake Kinneret (Sea of Galilee) with a 4,000 Mcm storage capacity. The main outlet of this Lake is the Jordan river, whose waters are shared by Israel, Jordan and the West Bank. The total annual flow of this river reaches a maximum of 611 Mcm at its entrance into the high salinity¹⁸ Dead Sea.

To further complicate things, a considerable part of the water flows underground (some toward the river valley and lakes, and some toward the Mediterranean) increasing chances for conflicting situations.

In an international basin as such, environmental management must, by necessity, be based on water management policies and strategies. From this point of view, every human activity depends in one way or the other from the types of decisions that are made in the water field. Solving the water problem, in this case, will probably be the first step towards a lasting conflict resolution approach.

THE ARAL BASIN

The Aral Sea, located in Central Asia, was for long time one of the largest freshwater bodies of the planet (the 4th largest lake) with a unique ecosystem which has remained in isolation and evolved for many million years housing a very diverse flora and fauna in its 50,000 km².

¹⁶ Source: Stephen C.Lonergan and David B.Brooks; 1993; "The economic, ecological and geo-political dimensions of water in Israel"; Centre for Sustainable Regional Development, University of Victoria, Victoria, B.C.; pp. 133.

¹⁷ Lebanon, Syria, Jordan, Israel, and after the recent Middle East agreements: Palestine.

¹⁸ Dead Sea salinity is 250,000 ppm, or 7 times sea water salinity.

During the early sixties, the Soviet government implemented a mammoth project for irrigation to grow cotton using water from the rivers Syr-Darya and Amudar'ya¹⁹. Unfortunately for the communities depending on the lake, the volume of the lake depended almost exclusively on the water brought by these two rivers. The flow of these rivers has been substantially reduced due to water diversion to cotton irrigation sectors. The water returning to the rivers and to the lake is only a fraction of the diverted volumes, and still, heavily loaded with agro-chemicals seriously affecting the lake both in water quality and quantity. After three decades the lake Aral is dying... The ports are now more than 80 km. from the lakeshore, the marshes, oasis and forests have died and the aquatic ecosystems have shrunk and lost much of their biodiversity²⁰. The Aral sea has lost 60% of its water in only 33 years, its volume decreases 27 km³ per year, the surrounding aquifers are also drying up, and it is expected that in about 20 years this water body will completely disappear²¹.

The unsustainability of the model is clear. The cotton fields are suffering from waterlogging and soil salinization, there are practically no more fish in the lake, in some communities (i.e. in the city of Nukus) the water is not suitable for drinking anymore, and, in spite of a general agreement of the various interested states to improve the situation no targets or timetables for reducing consumption or introducing desalination plants have been set. Unfortunately, in the present economic situation of the basin countries it appears doubtful that these corrective measures will be implemented in the near future.

THE CHAD BASIN

The Chad basin is an endorreic hydrographic system extending for about 2,67 M Km² located in the western part of Central Africa.

The northern portion of the basin is situated in the semi-arid and arid Sahelian and Saharan regions. The South and the Eastern section of the basin mainly belong to the Sudanese, Cameroones and Central African savannas, although forested lands are found in the South.

¹⁹ The project affected directly or indirectly the Republics of Kazakhstan, Kirghizia, Turkmenistan and Tajikistan.

²⁰ "Neighbours sign deal to save Aral Sea"; Fred Pearce; *New Scientist*, 22/1/94; p.10.

²¹ "How disappearing lakes are swelling the oceans"; *New Scientist*; 22/1/94; Fred Pearce; p.17.

The main rivers of the basin are the Chari and Logone rivers flowing from the highlands of Cameroon and the Central African Republic.

The Chari-Logone systems are by far the main contribution to the lake Chad of which 28 billion m³/year come from the Chari and 12 billion from the Logone.

These rivers produce yearly floods in their alluvial plains (Yaeres) and in the lake margins, which are mainly used for farming rice and millet and for livestock breeding. The actual flooded area has been calculated at about 59 M has. The Yaeres are the bread-basket of the Chadian region.

Rice is cultivated using the flood water and millet in the less humid areas or after recession of the yearly flood. Animal production is carried out in association with farming activities using itinerant strategies. It is estimated that over 100,000 animals are annually brought into the Yaeres for grazing.

Chad also produces an annual average of 80,000 tons of fish which complement the productive spectrum of the hydro-system.

The variations of the hydrological regime of the Logone river are very important, such as is observed at Baibo-Koum, from a maximum of 4,438 m³/s; a minimum of 13 m³/s.

The basin is shared by countries, of which the largest is Chad which depends on the basin for most of its agricultural, and fisheries production.

In the 1960's a large development project was proposed out with international funding for widespread irrigation in the Chad lowlands: the South Chad Irrigation Project fostered by the Nigerian project for the development of the Northern provinces of the country. The purpose of the endeavor was to use the water of the lake for irrigation "turning green the surrounding deserts". The planning of the project started in 1962, at the end of a period of unusually high rainfall. According to Terry Evans of the Firm Mott MacDonald in Cambridge who helped to design it, the project was a disaster²². The hydrology was done in a very short period ("three weeks"), the idea of securing a different source of water "was dismissed out of hand" and it was assumed that the project was designed to operate at all stages of lake level. In 1992, the intakes are dry, and many ships are rotting littering the landscape "at times more than 60 km. from the lakeshore".

THE RIVER COLORADO BASIN

²² Source: "Africa at a watershed"; Fred Pearce; *New Scientist*, 23 March 1991; p.34 through 40.

The Colorado river rises in the Rockies flowing down the West face of Longs Peak, almost at 4,000 m. of altitude, starting its 2,400 km. long way toward the ocean. It receives the run off of the western areas of the State of Colorado forming the Grand Valley where the first large irrigation developments are located. When it inflows into the valley the river salinity is only 200 ppm. The salinity of the return flow from the irrigated crops of the Valley averages as much as 6,500 ppm.

Further downstream, the river receives the Gunnison and the Green tributaries before forming the Powell reservoir behind the Glen Canyon dam. Several new tributaries are collected below this dam (Little Colorado, Virgin) increasing the flow, which is again dammed further downstream forming several artificial lakes: lakes Mead, Mojave and Havaser.

After these lakes, the river receives the brackish water of the Gila river which increases slightly its salinity until it reaches the intakes of one of the largest interbasin water transfer operation in the world: the aqueduct to California where 1/3 of its flow is pumped Westward.

The pumped water is channeled to the Imperial Valley, Los Angeles and San Diego to satisfy the need of thousand of Californian farmers and millions of urban dwellers.

Much of the fresh winter vegetables of the U.S.A. are produced with Colorado waters and at least half of the water of Greater Los Angeles, San Diego and Phoenix comes from the Colorado.

Very little water and of poor quality is left of the river when finally it crosses the Mexican border. To solve this critical binational problems, a treaty was signed with Mexico in the seventies aiming to ensure a better quality water flow through the borderline. Recently, the Congress approved investments for salt removal in the Yuma plant that will cost U\$ 300 dollars per acre/ foot. Upstream, the irrigators buy it at U\$ 3.50.

THE CASE OF THE AQUIFERS OF WESTERN UNITED STATES

At the beginning of the century almost all the water in California came from groundwater sources (now is forty percent). The farmers of the Central Valley (valleys of Sacramento and San Joaquin) over-pumped the aquifers and by the 1930's, farming was approaching collapse.

The farmers convinced the legislature to authorize a huge water project (the Central Valley project), by far the largest of the world, partially paid by the Roosevelt government. Another project, the California Water project of similar size was build in the sixties. Both projects together captured enough water to supply 8 times the city of New York.

However, in spite of the added water, over-pumping continued because, instead of merely substituting the older over-exploited sources with the new water, the farmers opened more lands for cultivation. Estimates of over-pumping above the renewal capacity of the aquifers, only in California, are as high as 3,000 M. m³ per year producing a growing water crisis throughout the state.

The lack of regulation on groundwater pumping, a traditional "absent" feature in California legal system was probably one of the main facilitating factors which ended in the present critical situation. However, the cases of over-exploitation of groundwater resources are not restricted to California or the U.S.A.

THE OGALLALA AQUIFER

The Ogallala aquifer is one of the largest groundwater reservoirs on Earth and also one of the most heavily used. Most of the irrigated farming in Texas, Kansas, Colorado, Oklahoma, New Mexico and Nebraska is contained in this huge underground basin. Gradually, the continued over-extraction has reduced pressure, flowing wells lost their artesianism, water levels have dropped, pumping costs increased. Lately, faced with the awareness of a vanishing resource questions arise on the need to respect the limits of renewability as a way to protect the water resource.

Traditionally, sustainability of groundwater exploitation was not a major concern in the Middle West of the U.S.A. A good example of the type of philosophy inspiring groundwater policy and decision-making in the field of resource exploitation in the U.S.A. during the 50's and 60's (and still today in some cases) was given by Felix Sparks, former head of the Colorado Water Conservation Board. When asked about the future of groundwater in the State, he responded with a rhetorical question: "What are you going to do with all that water; leave it in the ground?". The State Engineer in charge of water in New Mexico (Mr. Stephen Reynolds) made a similar remark which further illustrates this line of thought: "We made a conscious decision to mine out our share of the Ogallala in a period of twenty-five to forty years."

According to this approach, the solution to water scarcity was: **more water projects...** including some very expensive with little return (some as little as 5% of economic benefits). The traditional philosophy accepted that water could be taken (with minor or no compensation) from the legitimate owners, Indians and small traditional farmers and supplied at extremely low (heavily subsidized) prices to larger farmers and speculators.

"In Reno, gambling and prostitution are legal, but water-metering for long time was against the law."

CHAPTER 8

PROTECTING AIR QUALITY

An average person breathes about 12,000 (12 m³) of air every day and dies if it does not breathe for 5 minutes. The importance of this fluid for human life is obvious, and its monitoring and protection should be first priority in any environmental program. Human activities can have strong influence in the air quality at the local level, changing its composition, type and concentration of suspended particulates, temperature and other physical properties.

COMPOSITION OF THE AIR AND PRINCIPAL TYPES OF CONTAMINANTS

Normally the air at the sea level contains about 78% of nitrogen, 21 % of oxygen and almost 1% of argon. Carbonic dioxide (CO₂) is present in smaller quantities (0.03%)¹.

The main biological active components of the atmosphere are CO₂ (which is the "raw material" for the photosynthetic processes producing organic matter) and O₂ which allows "burning" this matter into CO₂ to close the circuit.

In addition, to the natural components of the air, there are some more appearing in variable concentrations, which are related to the previously mentioned human activities. Some of these substances are considered as "contaminants" because they may appear in concentrations that could be harmful for human health. The main gaseous "contaminants" of the air are sulphur dioxide (of which 160 a 180 million are thrown into the year every year throughout the world), nitrogen oxides and dioxides, carbon monoxide (CO: produced as a result of incomplete combustion), chlorofluorocarbons and ozone (O₃: which is a secondary photochemical oxidant composed of a tri-atomic oxygen molecule) (see chapter 3).

¹ The average atmospheric composition at the sea level is as follows:
Nitrogen: 78.09; Oxygen: 20.95; Argon: 0.93%; carbon dioxide: 0.3%; Water vapor: variable; other noble gases: 0.01%.

CHARACTERISTICS OF AIR CONTAMINANTS

The main atmospheric pollutants are the following²:

Sulphur oxide (SO₂) is produced naturally by indirect emission as derivative of biological H₂S and artificially by direct industrial emission (146 tons per year). It is highly soluble in water (10%), with which it combines to form SO₃ and H₂SO₄, and with nitrogen to form ammonium sulphate (NH₄)₂ SO₄, which eventually falls in precipitations. Rain falling downwind of sulphur dioxide emissions can be very acid, affecting natural acid ecosystems, such as lakes, or some forest soils (acid rain).

Nitrogen oxides (N₂O and NO): N₂O is produced in smaller quantities by bacterial activity (about 600 M.ton per year) and lightning. Artificial sources are important but because it is not toxic, there is not need for correction. Although NO is also produced naturally by bacterial activity (about 430 M. ton/year), artificial sources are more important, particularly in combustion processes at temperatures above 1,300o. It is removed naturally by conversion in HNO₃, nitrate salts and precipitations. It is very toxic.

Nitrogen dioxide (NO₂) is practically absent in nature. Its presence is mainly due to artificial processes, such as combustion at high temperatures (more than 1,500o. It is very toxic and it is removed as NO.

Hydrocarbons (i.e. methane, ethane, ethylene, toluene, benzene, terpene, etc): they come from various natural sources (bacterial activities, natural leaks from gas fields, etc). The main artificial hydrocarbon is terpene (hydrocarbon of high molecular weight) which leaks from petroleum fields and from refineries. It is estimated that about 20% of the total is artificial of which 3/4 relates to vehicles and 1/4 to industrial activities.

Carbon monoxide: it is mainly produced from CH₄ (methane) through chemical reaction with O and OH (normally in swamps and other areas of methane generation). Artificial sources relate to incomplete combustion processes (both in vehicle engines and industries). Carbon monoxide is very toxic for humans.

Carbon dioxide: it comes from several natural sources such as cellular respiration, organic degradation, volcanoes, natural fires, natural

² Sources: La pollution atmospherique; Paul Chovin et Andre Roussel, Presses Universitaires de France, 1968,

dissolution of carbonates, etc. There are also many artificial sources like artificial fires, industrial combustion, vehicle engines combustion, etc. It is removed by photosynthesis, chemical and organic precipitation of carbonates and burying of organic matter.

In strict terms, CO₂ cannot be considered a "contaminant" but its excessive production from the above mentioned artificial sources without sufficient removal can increase its concentration beyond natural limits, producing a "greenhouse effect" worldwide.

Chlorofluorocarbons are only artificially produced and are thought to affect the stratospheric ozone molecules reducing their density and increasing effect of ultraviolet radiation (ozone hole). At the ground level their effect is weak or absent.

Ozone is a natural component of the atmosphere at the stratospheric level (due to natural ionization produced by solar radiation), but at the ground level its generation is related to various human activities, particularly traffic of automobiles.

In addition to gaseous contaminants there are many solid and liquid contaminants (aerosols), that are often also the product of human activities such as industrial and engine emissions, traffic or over-cultivation in dry soils.

PROCESSES OF CONTAMINATION IN INDUSTRIAL AND URBAN AREAS

The development of the industrial revolution produced acute episodes of contamination in many industrial areas. Air pollution problems in industrial Europe during the last decades of the XIX century and first decades of the XX century are well known (i.e. in London, England, in the Ruhr basin in Germany and in the Moselle basin in France). Similar phenomena developed in the Northeastern states of the U.S.A. (i.e. in Detroit, Pittsburgh, New York), in Los Angeles and in the largest industrial areas of Japan.

Gradually, control measures (such as improved combustion technologies, utilization of filters, etc) were implemented and the emitted contaminant load was significantly reduced. In spite of that, the problem still remains and most industrial zones in developed countries are also zones of poor air quality.

In Third World industrial and urban areas, air contamination problems developed at later dates, but in many cases they have become real "nightmares" for their populations. Such is the case of some highly contaminated cities of Latin America (i.e.

Sao Paulo, Mexico City and Santiago de Chile) or in East and South East Asia (Shanghai, Bangkok, Bombay and Manila).

Some Asian countries owe this situation to their over-dependence on coal (i.e. China and India). In other cases, air degradation processes are the combined result of geographic over-concentration of high- emission industries and inadequate controls.

THE CASE OF SAO PAULO

The Sao Paulo region is located in the water divide of the Serra do Mar not far from the Atlantic ocean (about 60 km.) and at an elevation ranging from 650 to 1,200 m. Dominant wind direction is from the southeast with some influence of sea breezes, due to its proximity to the ocean. Dispersion of contaminants is very slow during the winter as a result of frequent atmospheric inversions.

The worst case of contamination of the Sao Paulo region is found in Cubatao which is a valley located 45 km. from Sao Paulo itself on the Serra do Mar scarpment. The peaks of the Serra do Mar (1,000 m. maximum elevation) and the neighboring Morrao and Quilombo hills enclose the basin, reducing air circulation. This area was selected as a site for installation of many industries (such as chemical, metallurgic, etc) which were the cause of a critical situation in the air quality of the site. At some point, Cubatao became one of the most contaminated cities of the world. More recently, a decontamination campaign was initiated and the air pollution levels were considerably lowered.

Due to increased control of industrial sources and the consequent reduction of their contaminant emissions, a higher portion of pollution generation can be assigned to vehicles. According to data from CETESB of 1990, the vehicle fleet of Sao Paulo was composed of about 3.5 million vehicles, of which 1.5 million were burning gasoline, 1.5 million alcohol and 250,000 diesel. Vehicles produced also most of the CO and hydrocarbons, nitrogen oxides and sulphur oxides (diesel). Industries produced most of the aerosols and sulphur oxides. According to the available data, diesel vehicles are the most polluting, followed by gasoline powered vehicles. Alcohol engines appear as relatively "environment friendly". Industries remain an important source of pollution but less than vehicles. Due to over-concentration of population and increased traffic (and decreased speed of the traffic due to traffic jams) it is very likely that this trend will continue.

In table 8.1 estimated levels of contaminant emissions in 1990 from vehicles and industries for the Metropolitan Region of Sao Paulo are presented³.

³ Taken from "El aire que respiramos"; CETESB (Compañia de Tecnología de Saneamiento Ambiental), Secretaria del Medio Ambiente, Gobierno del Estado de Sao Paulo; pp.24; 1992.

Table 8.1

AIR CONTAMINANTS IN SAO PAULO

Type of vehicle	Type of contaminant				
Type of vehicle	CO	HC	NOx	SOx	MP
Gasoline powered	835	77.7	28.9	4.5	4.3
Alcohol powered	172	14.3	10		
Diesel	218	35.6	159.0	73.0	9.9
Taxi	52	4.6	2.2	0.13	0.16
Motorcycles	32	6.1	0.2	0.26	0.11
Industrial sources	38.6	12.0	14.0	44.0	44.0

CO = Carbon monoxide; HC = hydrocarbons; Nx = Nitrogen oxides;
SOx = Sulphur Oxides; particulates

THE CASE OF LOS ANGELES

The metropolitan area of Los Angeles, the second largest in the United States and one of the largest of the world has experienced for some time one of the most heavily contaminated atmospheric situations in the world, violating the federal health standards for ozone, carbon monoxide, nitrogen dioxide and fine particulates . The air degradation occurred mainly as a result of the sustained increase of population, automobiles and industrial activities.

The number of inhabitants in Metro L.A. tripled from 4.8 million in the 50's to the present 14 million, while at the same time the vehicles fleet augmented by a factor of 4 from 2.3 million to today's 10.6 million.

Some of the main identified sources of air pollution include motor vehicles, trash incinerators, barbecues, paints, dry cleaners, industrial coatings and commercial ovens⁴.

⁴ Data for this section obtained from "Clearing the air in Los Angeles", by James M. Lents and William J. Kelly; Scientific American; October 1993; Vol. 269; Number 4; p. 32 to 39.

FIGHTING AIR POLLUTION

In 1947, the sources of air pollution that were identified included heavy industries, foundries, motor vehicles and backyard incinerators. These causes produced the most acute effects during meteorological "inversion" periods which are rather common in the Southern California Pacific Coast. By 1953, L.A.'s smog rivalled London's.

In order to solve the problem, a Commission⁵ was formed which proposed five measures to decrease air contamination: 1) reducing hydrocarbon emissions; 2) setting standards for automobile exhausts; 3) promoting usage of trucks and buses using liquified petroleum gas instead of diesel fuels; 4) asking the worst polluting industries to slow their growth; and 5) banning open burning of trash. Gradually, the recommendations of this commission grew into a general air-quality management plan for the region.

An important step was implemented when the regional governments joined efforts in the South Coast Air Quality Management District (AQMD) with jurisdiction in Los Angeles, Orange, Riverside and part of San Bernardino.

As a result of the Federal Clean Air Act, it was required that all American cities would have to meet standards by 1987 (although nobody hoped that this could be possible for L.A.).

Some of the measures that were implemented to curb air pollution included banning of trash incinerators (1958), use of vapor recovery equipment to transfer petroleum products, use of non reactive solvents in industries using ozone-producing solvents (i.e. construction, auto-manufacturing, dry cleaning, etc)⁶, improving the quality of gasoline (low content of olefine, at some point by adding methanol, eliminating lead gasolines), installation in automobiles of devises to prevent the emission of hydrocarbon fumes (the "crankcase device") and the use of catalytic converters. As a result of these measures, any new car sold in California emits just 10 % of the pollutants it used to emit in 1970.

In more recent times (1987) incentives were offered (through companies with more than 100 employees) to encourage carpooling increasing the number of people per car from 1.13 to 1.24.

In spite of all these advances, the situation is still very difficult. Figures given by Lents and Kelly (1993) (ref.mentioned above) show that daily emissions are as follows:

⁵ This commission was chaired by Arnold O. Beckman of Beckman Instruments and came to be known as the "Beckman Commission".

⁶ Ironically, at a later time, it was known that the non-reactive solvents destroy the ozone layer in the atmosphere.

Table 8.2

Hydrocarbons: 1,375 tons
Nitrogen oxides: 1,208 tons
Carbon monoxide: 4,987 tons
Sulfur oxides: 134 tons
Particulates: 1,075 tons

The main contribution is from vehicles (47% hydrocarbons, 70% nitrogen oxides, 90% carbon monoxide, 60% sulfur oxides) followed by industries: 26% hydrocarbons, 18% nitrogen oxides and 30% of sulfur oxides.

EFFECT ON HEALTH

According to the AQMD mentioned by Lents and Kelly (refer. already mentioned) the poor quality of the air is affecting the health of the population, increasing costs on health systems of about 9.4 billion dollars per year. 15 million person days are lost due to respiratory disease and there is an increased risk of dying prematurely due to exposure to particulates. According to this report, if L.A. was able to meet the ozone standards the annual benefits on human health and economy would be as follows:

- a) Elimination of 18 million person-days of restricted activity
- b) " of 65 million person-days of chest discomfort
- c) " of 120 million person-days of coughing
- d) " of 180 million person-days of sore throats
- e) " of 190 million person-days of eye irritation

THE CASE OF MEXICO CITY

The city of Mexico is one of the most problematic from the point of view of atmospheric contamination. The valley of Mexico is located at an altitude of about 2,300 m. above sea level, and consequently available oxygen is 23% less than at sea level. The population of the valley is in excess of 16 million people with approximately 2,500,000 vehicles and 30,000 hydrocarbon-burning industries. The valley burns 43 million liters per day of hydrocarbons of which 54% are utilized by vehicles, 28% by industries, 11 % for domestic use and 7% for thermoelectric plants.

As a result of the high density of population and economic activities the air of the valley of Mexico has experienced a gradual deterioration in their contents of some atmospheric contaminants such as CO, CO₂, Pb, sulphur, ozone, nitrogen oxide, etc.

A large air decontamination plan (4,700 million dollars from official sources, 6,500 million if private investments are included) has been launched and presently the trends of increasing pollution have been stopped and even reversed. The program has included improving quality of fuels (reducing lead, etc), introducing catalytic converters in car engines, etc, with favorable effects. According to recent data, most atmospheric contaminants are below admissible maximum levels for most of the time (with the exception of ozone levels which still remain rather high)⁷.

PRESENT AND FUTURE TRENDS

The seriousness of the contamination problems and their effects on the health of the populations prompted policy and decision-makers in many urban and industrial areas to define and implement campaigns to reduce the levels of contaminants produced by industries and vehicles. Although the effect has been clearly insufficient, some success was obtained and concentrations of several contaminants were significantly reduced. During the last decades there was a reduction in the burning of coal, incorporation of filters in chimneys, improvement in combustion and other industrial processes, reduction on the use of solvents, reducing burning of trash, improvements in gasoline quality, car engine combustion and exhaust systems, and many other measures tending to reduce harmful emissions. The problem, however, remains serious in many cities, and more particularly in neighborhoods and fragile ecosystems located downwind of industrial areas. Some of the remaining problems include the persistence of the phenomenon of acid rain in the traditional industrial countries and in some Third World areas still depending on coal, such as China, India and Brazil.

In most larger cities, the main remaining (or growing) problems are the excessive "dirty" emissions from cars. The situation can become more critical in cities that are

⁷ The air of the city of Mexico is monitored through a network of 32 automatic stations and 19 manual stations.

situated in enclosed locations or at high altitude (such as Santiago de Chile, Mexico City and Cubatao near Sao Paulo, Brazil).

Recently, there have been some attempts to improve processes of coal burning, and if this technological breakthrough takes place, it is very likely that coal utilization will be less harmful than it is now, benefitting the larger coal consuming countries. Because coal is in plentiful supply it is also possible that many countries that have abandoned coal may come back to utilize it⁸.

⁸ Source: "In search of a better burn"; Charles, Dan; in "The future for coal"; *New Scientist*, No 1857; 23 January 1993; p.20 to 41.

CHAPTER 9

AFRICA IN THE XXI CENTURY: sunset or sunrise?

AFRICA TODAY¹

At the end of the XX century, sub-Saharan Africa is entering a new phase which is normally presented in a negative light from the perspective of the "central"² countries. The forty-something national states, formally independent and recognized by the international political "establishment" show widespread symptoms of disarticulation and impoverishment. With the exception of South Africa, almost all countries (including as such all political units generally accepted as independent) possess per capita incomes of less than 1,000 U\$ per year, and the 450 U\$ average income of all countries of the intertropical region is in the lower quarter of the world. Some people have called this group of countries the "Fourth World".

On the other hand, during the last few decades, sub-Saharan African participation in international trade has consistently fallen from 4% of world trade in the 1960's to 1.5 % in the early 1990's, affecting their economical as well as geo-political role, particularly after the end of the Cold War.

Today, many African national states are experiencing growing hardships to merely function. There is little money to pay public employees, and national debts³ are nearly impossible to serve, consuming a large proportion of export revenues. Some countries are paying more than a third of their export income in debt service (i.e. Uganda: 81%; Ghana: 49%; Ivory Coast: 41%; Guinea-Bissau: 45%; Kenya: 33%). In most countries, legal exports do not cover the minimum import needs, and military expenses still absorb a large part of the financial capacity of the states.

As a result of these financial problems, many governments have searched for, and to some extent, obtained assistance from richer countries, under the form of "soft" loans, subsidies, technical support, and to a much lesser degree, preferential commercial treatment. This has encouraged some African governments to become

¹ Sources of statistical data: World Resources 1992-1993; The World Resources Institute (with UNEP and UNDP), New York, Oxford University Press, 1992.

² We prefer to use the world "central" over "developed", because this latter word implies accepting a linear view of "development" with which we do not fully agree.

³ African debt in 1993 stood at 140 billion dollar, requiring payments which consumed 33.4% of the revenues from exports of goods and services.

dependent upon international aid, to the extent that, if this assistance dwindled, their political equilibrium would be disrupted threatening the institutional structures. In some cases, the Official Development Assistance (ODA) represents a large part of the Gross National Product (GNP). Examples of this are Mozambique where ODA is 74.2% of the GNP, Guinea-Bissau (64.4%), The Gambia (50.7%), Somalia (47.6%), Cape Verde (32.2%), Tanzania (31.8%) and Equatorial Guinea (30.4%).

Table 9.1

INCOME PER CAPITA IN SUB-SAHARAN AFRICA⁴

COUNTRIES	US DOLLARS/CAPITA/YEAR
Angola	620
Benin	380
Botswana	940
Burkina Faso	310
Burundi	220
Cameroon	1010
Cape Verde	760
Central African R.	390
Chad	190
Comoros	460
Congo	930
Djibouti	1070
Equatorial Guinea	430
Ethiopia	120
Gabon	2770
Gambia	230
Ghana	380
Guinea	430
Guinea-Bissau	180
Ivory Coast	790
Kenya	380
Lesotho	470
Liberia	450
Madagascar	230
Malawi	180
Mali	260
Mauritania	490
Mozambique	80
Namibia	1245
Niger	290

⁴ Sources of statistical data: World Resources 1992-1993; The World Resources Institute (with UNEP and UNDP), New York, Oxford University Press, 1992.

Nigeria	250	
Rwanda	310	
Senegal	650	
Sierra Leone	200	
Somalia	170	
Sudan		540
Swaziland	900	
Tanzania	120	
Togo	390	
Uganda	250	
Zaire	260	
Zambia	390	
Zimbabwe	640	

THE ROOT CAUSES OF POVERTY

There is a widespread stereotype that some of the more critical problems experienced by Africa are related to frequent and catastrophic natural or bellic events, such as droughts and wars. In some situations, there is some degree of truth to this interpretation, but in many others the issues are much more complex, and the causes must be found elsewhere.

Drought resulting from lack of rain has been frequently identified as the number one reason for the famines and widespread poverty in many areas of the continent. However, where the specific cases are analyzed carefully it is not clear that the problem can be reduced to a mere "lack of rain" syndrome.

It is important to note that the notions of drought and aridity are only partially related to meteorological statistics. In the "arid" countries, such as in the Sahara or the Namib/ Kalahari regions, drought is an elusive concept. Arid climates are dry by definition, and in most cases rain irregularity is the rule. Therefore, it cannot be said that those years of little rain are "drought" years; there are in fact drier years which are part of predictable climatic patterns to which pastoral and oasis societies have adapted for long time. If no external factors are introduced, traditional production and social systems tend to survive these "drier" periods without major problems.

In semi-arid countries where pastoral activities are combined with rain-fed farming, the occurrence of arid spells has been traditionally mitigated by trade with more humid areas in the proximity. Obviously, when the dry periods extended beyond a certain period, conflicts arose. But this was more the exception than the rule. In brief,

"drought" is not a main root cause of African poverty and problems, it only exacerbates them.

The case of "war" is different. In fact, wars have become all too frequent in the African continent. In most cases, they are a main cause of some of the more desperate situations. They can bring to a halt economic activities: production systems is reduced, distribution of goods is disrupted and social systems can be seriously damaged or even destroyed. Nevertheless, wars are a consequence of the African situation, and not its basic cause.

From a "standard" economic point of view the main apparent reason that can be offered for African "underdevelopment" is its decreased production levels, when measured both in terms of GDP and exports. In fact, with a few exceptions that confirm the rule, exports and GDP's of African countries have been decreasing consistently for the last few decades. This has been coupled with sustained and widespread demographic growth.

Obviously, when GDP decreases and population increases, income per capita (IPC) shrinks reducing the availability of financial resources both for the state and for the population at large. A list of the IPC's of Sub-Saharan African countries is shown in Table...

A second element adding to this "image of poverty" relates to the gradual fall of international trade figures for the continent. The decrease of African exports appears to be produced by a complex array of factors. In large measure it is the result of the degradation of the terms of exchange for traditional African products (such as cocoa, copra, cotton and palm kernels⁵) and of the disappearance of markets for their products (frequently due to changes in market/ consumption trends). On the other hand, it is also a by-product of a widespread loss of competitiveness, which develops mainly due to the dislocation of national production/ commercialization systems, and of the degradation or inadequate exploitation of natural resources.

DEMOGRAPHIC GROWTH

Another factor, already mentioned, that increases the effect of this tendency is the rapid demographic growth persisting in most countries⁶. This has been mainly

⁵ In the period between 1977 and 1989, cocoa prices fell from 5.41 US\$ /kg in 1977 to 0.94 US\$ / kg in 1989; copra from 574.7 US\$/t to 264.7 US\$/t, cotton from 2.22 US\$/kg to 1.27 US\$ /kg and palm kernels from 466 /t to 190.9 /t.

⁶ In most countries population growth exceeds 2% per year, and in some it reaches 3.5% or more (i.e. Ivory Coast: 3.78; Uganda, 3.67%; Zambia 3.75%; Kenya: 3.58%). The average for the whole of Africa is 2.98%, which is higher than in any other continent.

produced as a consequence of continuing high birth rates and the lowering of death rates⁷.

Population pressure was one of the main driving forces promoting the various environmental degradation processes. Overgrazing, over-cultivation, excessive or inappropriate utilization of water resources, deforestation and elimination of natural ecosystems are, among other reasons, a direct result of excessive population load for the type of existing production and land occupation systems. The environmental effects of this situation have been negative almost everywhere. Soils have suffered (and are suffering) intense erosive processes, both eolian and aquatic, genetic diversity is under constant attack, streams are experiencing catastrophic floods, and droughts are more common and acute. All this is affecting the core of the productive natural base which is the support of the countries' economies in the present, and may mortgage the future for many generations to come.

POLITICAL UPHEAVAL IS THE RULE

From a political point of view, the sub-Saharan African sub-continent seems to be submerged in a continual series of conflicts between national and tribal groups which does not seem to diminish. It is clear that this political instability weakens the economies, affects actual planning of production and is perceived as an important factor preventing an overcome of the present difficult situation.

By the mid- 90's, open conflicts are continuing, or just have started or recently finished, in Liberia, Sierra Leone, Angola, Mozambique, Somalia, Sudan, Chad, Ruanda and Ethiopia. These continuous states of war have made more acute the economic crisis, producing disarticulation of the production, commercial and distribution systems, all of which lead to famines, high mortality and other social hardships.

THE CAUSES CAN BE FOUND IN HISTORY

The causes of this critical situation must be found in the history of the continent as well as in its particular relationship with the rest of the world.

First of all, let's remember that the African continent is the place of origin and center of dispersion of the human species. For this reason, its ethnic diversity is the most contrasted and rich of the planet; from the peoples of Hamitic roots of the Sahara and Sahel to the Bantu groups of the more humid regions of the forest periphery, from the pygmies of the tropical rain-forest to the bushmen of the southern deserts and

⁷ Recently, (and in all likelihood more acutely in the near future), death rates have started to increase again, mainly because of wars and the AIDS aids epidemics. Increased deterioration of health systems is also having an analogous effect.

steppes, the continent possesses the largest variety of clearly differentiated human groups.

Historically, African agricultural cultures started to develop with the domestication of several cereal crops (i.e. sorghum and millet) and grazing animals (bovines, sheep, goats and finally camels) which allowed a more sedentary occupation of savannas and associated forests. These processes began probably in the Nile, Sudanese and Sahelian savannas, and continued to the South and East to Eastern and Southern Africa.

It appears that at least part of the African savannas are of secondary origin, and developed after the anthropogenic degradation of intertropical forests (mainly through burning) when they were opened up for crop and animal production activities a few thousand years ago.

The oldest focus of agricultural development was localized in the fluvial valleys of the Nile river and tributaries. The main areas in which these events occurred were the Nile delta, the lower part of the Egyptian fluvial plains, the Middle and Upper Nile, the northern zone of present Sudan (Nubia), the southern plains of the White Nile (which flows northwards from the Ugandan highlands) and the sedimentary plains of the Blue Nile and Atbara rivers both descending from the Ethiopian plateau.

This Nilotic culture was based on the domestication of some cereals (wheat, etc), on the control of periodic flooding of the Nile alluvial plain, and on the domestication of some ruminants (*Bovis primigenius*, etc). The agrarian culture of the river Nile extended to the South along the main rivers reaching Nubia, present day Sudan and finally to Ethiopia where it remained isolated and relatively unchanged for a long time.

Agricultural development and organizational needs for water management promoted the development of state-type political structures in Nilotic Egypt based on a theocratic and absolutist regime and ideology: the "pharaonic" culture. The political and ideological influence of this culture extended southward together with its agrarian aspects. The example of these agricultural states progressed first towards Ethiopia and Nilotic Sudan and at a later stage, westward along the Sudanese belt to reach the Atlantic coastline.

The political empires of Ghana and Mali, the Hausa and Songhai kingdoms, among others, were based in large measure on the influence of this type of agrarian economy as well as on the political elements which were received with them.

Probably, the Sudanese peoples were the first to utilize cattle in sub-Saharan Africa (apparently in provenance from the Mediterranean region through Egypt and the Nile valley) and perhaps the Nilotic and/or Bantu people of the Sudanese periphery were the first to domesticate some varieties of sorghum and millet. In any case, with time, some groups (mainly Bantu) moved southeast settling in the East African savannas (present territories of Kenya, Tanzania, Mozambique and Zimbabwe) where agrarian

states developed (i.e. the "Zimbabwe" civilization located near Harare). When European settlers arrived to South Africa, a process of gradual encroachment of migrating agro- pastoral Bantu-speaking groups (i.e. Tswana, Sotho, Basuto, Zulu, Swazi) was taking place producing a simultaneous displacement or assimilation of the Khoisan autochthonous groups (Hottentots, Bushmen).

Another important element of the sub-Saharan evolution was the development of the trans-Saharan trade, both along the coastal Atlantic routes or through the center-Sahara (i.e. the Haggar massif). In large measure, the prosperity of Carthage in Roman times was due to its control of the trans-Saharan trade routes (ivory, gold, slaves).

At a later stage, after the Mohammedian expansion of the VIII century to the Maghreb, the Moorish/ Moroccan empires also based their power on their control of these trade routes to the heartland of Africa. The development of the Sudanese and Sahelian kingdoms was greatly facilitated by the resources concentration which resulted from this trade. Some of the Sahelian cities (such as Timbuctu) developed and thrived as a result of this commercial activity; there were important episodes of southward political expansion (particularly Moroccan) which left, as a lasting effect, a deep process of islamization in all the Sudan and the Sahel.

A parallel process of islamization was taking place on the eastern coast, particularly due to the Arab- Omani and Malay⁸ influence and the growth of the sea trade in the Indian Ocean. As a result, several Afro-Arabian cities developed (Zanzibar, Dar-es-Salaam, Pemba, Mombasa, etc).

The rain-forest ecosystems remained unsettled for some time to come, until forest-adapted domesticated plant species appeared on the African scene. The white yam (*Dioscorea rotundata*) and the yellow yam (*Dioscorea cayenensis*) were domesticated in West Africa. Some other crops were introduced from Asia -old Cocoyam (*Colocasia* spp.) and the water yam (*Dioscorea alata*)- and from America (new cocoyam (*Xanthosoma* spp. and cassavas))⁹.

The raising of domesticated animals in the forest environment was always limited due to the effect of the tse tse fly and other lethal diseases on cattle and other large mammals (including humans). At a later stage, and gradually, first through deforestation and later through depestization, a more extensive occupation of the forest was possible.

⁸ Malays were also expert seafarers who reached Africa at an even earlier stage (about 1800 years ago). At that time, they settled in Madagascar and some coastal zones of eastern Africa. It is likely that some Asian crops may have come to Africa with the Malays adapting well to the African environment becoming important tools for progressive settlement of the forests.

⁹ "Root crops in Eastern Africa; Proceedings of a workshop held in Kigali, Rwanda, 23-27 November 1980; "Foreword" by S.K. Hahn and Andrew D.R. Ker; p.5.

Some of the more ancient groups (i.e. the Pygmies) were the first to move into the forest. They developed an extractive and itinerant farming culture that gradually adapted to the complex jungle environment. These groups developed well-adjusted, sustainable production systems which allowed their survival in the hostile jungle environment with only minor changes for many thousands of years.

For the Bantu-speaking farming peoples the process of occupation took place in a different manner. In effect, these groups were savanna peoples. Their approach was to encroach into the forest, not from the inside as it had happened with the Pygmies, **but from the periphery**. The farming areas were cleared and utilized only for a few years due to the limited fertility of forest soils; subsequently they moved to a different site to continue the cycle. Their main approach to the occupation of the forest was based on itinerant agricultural production systems.

With time these two types of production systems spread throughout the rain forest region. On the one hand, the itinerant farmers in the periphery and clearings of the forest, and on the other hand, the "jungle people" more symbiotically adapted to these natural ecosystems. For many centuries this "dual" and combined approach to occupation and exploitation of the forest environments developed and stabilized.

In these forested regions, communications by land were very difficult due to the dense forest cover, and therefore agricultural expansion mainly progressed through fluvial pathways, settling in small islands of human occupation. The agro-forest societies formed through this process were discontinuous and isolated, with small political units and large cultural diversity.

HOW WAS AFRICA IN THE XV CENTURY

When the Portuguese arrived at the western coast of Africa (and later to the east) by the mid-XV century, they found a savanna region composed of many small kingdoms based on combined agro-pastoral production systems and a commercial framework structured along the trans-Saharan routes in the west, through the Nile valley in the northeast and along the Indian Ocean routes in the east.

These kingdoms were usually small, not much more than a few tens of thousands people, and even less. They had developed as a result of local history, and to a much lesser degree, external influences (which, in any case, always existed because of the constant aggression of slave traders which forced these kingdoms either to defend themselves or to participate in the traffic).

The African kingdoms frequently remained restricted within ethnically defined borders which separated people with different cultures, ways of life, language, dialects or religions.

A common factor to all these political entities was the instability of the actual political configuration and a relative stability in the type of political organization.

In the forest region, the kingdoms were still smaller, not exceeding a few hundred or thousand inhabitants, and a few hundred square kilometers. In any case, the African political units were based on a specific geographic localization, a common agro-pastoral economic base, a particular situation in relation to the commercial fluxes and overall, common traditions, language, religion and culture.

Local history determined that, in some cases, some groups dominated other groups and in others, groups might end up merging or dividing. However, in general they tended to stabilize along the line of national or ethnic identities.

In these political units, government structures were relatively small; a ruling group or family with a small number of governmental officers. The ruling group or "class" depended, in large measure, on the production surpluses of the particular society.

A number of cities developed in the points of convergence of the trade routes, (i.e. Dongola in the Upper Nile, Timbuctu in the middle Niger, Mombasa and Dar-es-Salaam in the Indian Ocean) which gave rise to more powerful political entities, with a larger concentration of population and resources, and well defined state bureaucracies. In most cases, these cities controlled small territories and exercised the role of commercial exchange centers.

AND FINALLY THE EUROPEANS ARRIVED...

The arrival of the European explorers, traders and military forces mainly occurred by sea, although at a later stage, penetration to the interior was almost exclusively by foot or animal-back (in a smaller measure this penetration took place also by boat through the few navigable rivers).

In the first phase this process mainly had the effect of promoting the development of several coastal ports. New commercial centers, particularly slave trade harbors, grew in the Guineans coast (displacing the Sahelian trade "oasis") and in the ports of Eastern Africa. In the latter, European forces gradually overpowered the Swahili and Arab elites, taking control of the whole coastal zone.

The expansion of trade, together with colonization and deforestation of coastal areas or the secondary savannas of the "hinterland", promoted the strengthening of several African states (Ashanti and Yoruba kingdoms in the present territories of Ghana and Nigeria respectively).

Later, in the XIX century, when the European powers consolidated their control, they expanded their domains towards the interior until a new political distribution took place. This process of European colonization, which in principle was based on slave

trade, became reoriented towards the exploitation of natural resources for export to the European central metropolis using slave or semi-slave labor.

In this way, copper mines were opened for exploitation in British Northern Rhodesia (presently Zambia), gold mines and placers in Southern Rhodesia (presently Zimbabwe) and bananas, cocoa, copra and many other autochthonous and introduced products were exploited throughout other suitable areas. Gradually, the slave ports became agro-exporting centers.

The colonial territorial boundaries were decided in political agreements in Europe and did not take into account the pre-existing ethnic, linguistic, cultural and religious boundaries. Almost all European colonies in Africa included people from various African nations and many nations were divided by artificial borders.

Often, the new administrative systems ignored traditional indigenous organizations, imposing "unnatural" units on the local peoples in an authoritarian and arbitrary manner; in other cases they used the traditional structures, readapting them for colonial administration purposes (as was the case, to a large extent, in the British colonial administration).

INHERITING IRRATIONAL BORDERS AND COLONIAL GOVERNMENTAL STRUCTURES

When African independence movements succeeded, the newly-formed African states had to deal with these unnaturally carved, artificial boundaries including several nations in one territory, and arbitrarily separating national groups in two or more states.

In some cases, the new states were very large (i.e. the Belgian Congo (present Zaire) and Tanganyika (presently the continental part of Tanzania)) and in others they were very small or had odd configurations (i.e. Gambia, Equatorial Guinea).

The national states resulting from "decolonization" processes are gradually paying the price of these artificial arrangements which ignored traditional organizations and knowledge. In many countries, the commercially conceived agro-exporting systems have deteriorated, and financial resources are insufficient to pay the state bureaucracies, paralysing the functions of the administration. To worsen the situation, the commercially oriented rural productive system is increasingly unable to provide the jobs and production required promoting massive rural migration to the cities.

The problem is not helped by the gradual decrease of farming surpluses which are used to feed the cities. In some countries, even the farmers are experiencing difficulties feeding themselves. One additional and very important source of stress promoting over-concentration of population in cities are migrations and resettlement of refugees due to wars (i.e. cases of Somalia, Angola and Mozambique).

Unfortunately, there are neither jobs nor services for the millions migrating to urban areas, and conflicts between the different nations or tribes become more frequent, pushing many African societies to a chronic crisis situation.

THE CASE OF ANGOLA

Angola is a large country with a very rich natural base. It possesses important mineral resources (such as petroleum and diamonds), large biodiversity in forests and savanna ecosystems, extensive agricultural soils and rangelands and important fisheries. Because it is not very densely populated (about 10 million in a territory of 1 million km²) the resource base could be more than enough to provide a high quality of life for all the population.

In spite of this, today a large part of the productive base of the Angolan territory has been degraded or eliminated. Forests have been burned or logged, many wildlife species have disappeared, infrastructures have been destroyed, roads, railroads, airports and buildings have been rendered inutile and people have emigrated, making Angola a country of refugees. And all this is the result of war.

WARS ARE ENVIRONMENT-UNFRIENDLY

The Angolan war started as a typical Cold War conflict. The Movimento para a Liberacao do Angola (MPLA) a leftist nationalist movement, was founded by an Angolese intellectual and poet (Agostinho Neto) in 1956 to fight for the independence of Angola from Portugal. Some years later, the Frente Nacional para a Liberacao do Angola (FNLA) was created¹⁰, an offshoot of which was a largely Ovimbundu-based movement called UNITAS which was founded in 1966¹¹.

In 1975, after the long anticolonial war with the Portuguese was over and the country became independent, there were disagreements between the Soviet-supported MNLA and the other two movements (FNLA and UNITAS) which were supported by the United States and South Africa and the war erupted. In the framework of the Cold War, several countries from both blocks were involved directly or indirectly (Cuba, the USSR, South Africa, the USA, etc) and many years later, although the Cold War has ended, the conflict persists. Presently UNITAS is advancing from the East and Central highlands, has taken the provincial capital of Huambo and is threatening other provincial capitals.

¹⁰ Founded by Holden Roberto, an Angolese independence militant.

¹¹ Founded by Jonas Savimbi.

On 8/9/93, Reuter reported of the final assault of UNITAS (Angolan rebel movement) to the city of Cuito (pop: 250,000) which has been under siege for eight months. This central highlands city is ruins ¹². Other provinces of the country are threatened. The whole country is in disarray.

THE TRUE ROOT OF THE CONFLICT

Probably the reason for the persistence of the war relates to deeply ingrained ethnic feelings poorly managed during Portuguese colonial times. There is a dichotomy within the Angolan society, as in other African countries: a Europeanized elite group (in this case, left or left of center) confronted by a traditionally- based movement, UNITAS (in this case, rightist). One reason for the apparent success of UNITAS is probably related to the support of the numerous Ovimbundu, while the Luanda government support is mainly based on the mixed-culture urbanized part of the population.

Here again, the European models and ideologies fail to address the local problems, and as a result a traditionally-based movement can grow using whatever support is available (even a racist regime, as was the case of South Africa in the late seventies and early eighties). After 30 years of fighting, the Angolan war is still going on, producing widespread social and material degradation.

As outlined before, one of the victims of the conflict is the environment, which has been deteriorating for several decades; forests have been burned, animals hunted in an indiscriminate way, and mines and other explosive devices have been buried in many fighting areas. The Angolan productive base is rapidly shrinking. The formal Angolan state, as in several others African states, is gradually falling apart. However, even if this is a very unfortunate situation, what is going on is probably more than an ethnic war. In our interpretation, in this struggle, as in many others, we are witnessing the end of a model alien to the real Africa. It is very likely that soon, in its place, gradually and with pain, a new society, more informal, based on traditional costumes and production systems will probably arise from the ruins of colonial and neo-colonial Angola.

THE CASE OF NIGERIA

Nigeria is another country where the European political system and boundaries have had particular trouble adapting to reality, and as a result both society and environment are suffering the consequences. Firstly, the Nigerian British colony was established including under the same political unit several ethnic groups with a history of conflicts and rivalries (i.e. the "Yorubas", the "Ibos" and the "Hausas").

¹² "El Universal", p.5A, Mexico, cable from Sto Tome, 8/9/93

As soon as the independence was agreed upon in 1960, a bloody war erupted between the "Yoruba" and "Hausa" dominated government and the "Ibo" population of the southeast (the Biafra war). The war finalized by 1962 with the defeat of the Ibos, and for some time it seemed that Nigeria was going to become a viable political entity. It was the most populated (at that time 75, now 100 million) African Nation, one of the world's largest producers of petroleum and one of the richest countries of the continent.

Time has shown otherwise. During its three and a half decades of independence, several military governments, with no accountability, controlled power while misappropriation and bribery were the rule. Today, Nigeria possesses a population in excess of one hundred million, unemployment is widespread, crime is rampant, public services (electricity, water) seldom work, consumption goods and even fuel are hard to find. In brief, the whole governmental structure is barely functioning and the formal economy is disintegrating.

The political system is not working either. After eight years of authoritarian regimes, by mid- 1993, president Babamgida refused to transfer power in spite of recent elections (in June 1993) in which one of his handpicked candidates (Moshood Abiola) was elected. Even if this political crisis is solved, it is very likely that soon another one will emerge. The problem does not seem to be this or that ruler, but rather it appears to be related to the whole (apparently inadequate) political system (including the inappropriate territorial boundaries).

The Nigerian environment has also suffered the consequences of the economic crisis. The fast growth of population, particularly near the larger cities (Lagos, Ibadan) has produced profound degradation of natural ecosystems. Formerly a forest country, Nigeria has lost almost all its forests' ecosystems. Wildlife was wiped out in most of the territory, rivers and coastal waters are increasingly contaminated, soil erosion (which was practically unknown before) has become one of the main problems affecting agricultural productivity, and industrial development has been paralyzed due to problems for supply of basic elements (such as fuel, water, electricity). In brief, the Nigerian model of development is not working.

However, as in Angola, there will be a future for Nigeria, with the gradual growth of a new, more African approach for social and environmental management¹³. The former foreign minister Joseph Garba said: "Nigeria will go back to the Stone Age...". Maybe it will not be a "Stone Age", but rather a more traditional age, still modern, but based on the African roots; in brief, a better age...

EVOLUTION OF ENVIRONMENTAL MANAGEMENT IN AFRICA

¹³ Source: Time, Sept 6, 1993, #36, p.35 and 36.

The particular history of Africa has produced effects on the environment that cannot be found in other areas of the world.

Firstly, due to the long human history, the ecosystems evolved adapting to this presence and evolving technologies. This is probably one of the reasons why such a wide array of mega-mammals is found in Africa, compared to other continents, which were occupied at a later stage.

Pre-agricultural human occupation did have effects on the environment. Hunter-gatherers and fishing cultures over-hunted some species (but not many in Africa due to simultaneous animal evolution), over-collected or spread the seeds of plants, burned forest, bush and herbaceous ecosystems for hunting or other purposes, modifying willingly or unwillingly the environments in which they lived.

Farming and animal domestication introduced additional changes to the environment. Some species (cattle, goats, sheep, camels, etc) were tamed to use the meat, milk, leather and other by-products, some others were tamed for working chores or for companionship (cats, dogs).

Agriculture required various "devegetation" practices such as burning or logging, and when sorghum and millet were domesticated, many forests had to be cleared for cultivation. After several crops, when the soils were exhausted, the parcels were abandoned and new ones had to be opened. After many cycles of "slash and burn" the original forest ecosystem evolved into secondary savannas (made up of a herbaceous cover and few bushes and trees).

The more humid forest areas remained untouched, mainly due to the the lack of crops adapted to this type of environment and the presence of several deadly diseases (such as sleeping sickness and others). However, some groups managed to colonize the forest developing a sustainable extractive management approach (i.e. the Pygmies).

Gradually, savanna ecosystems and associated cultures evolved to reach a kind of equilibrium, more or less unstable, in which some grassy areas with less appropriate soils (i.e. due to low fertility) were utilized for grazing and the best soils were used for farming. In these savanna environments two different cultures developed in close association, almost of a symbiotic nature: the nomadic shepherds (such as the present Fulani and Peul in the Sudan and Sahel and the Masai in Eastern Africa) and sedentary farmers (i.e. present Bambara in Mali).

When appropriate domesticated plants were grown, rain forest ecosystems were also occupied by some groups. The first forest dwellers based their survival on hunting, fishing and gathering with only minor farming (such as the Pygmy culture in the Congo region). They were (and still are) nomadic and became very well adapted to the forest environment.

At a later stage, more sedentary cultures encroached into the forest, principally based on crops and only secondarily on forest resources. The approach to environmental management of these two types of cultures tended to preserve most of the original components of the forest ecosystem. Although some effect did happen (mainly through selective gathering or over-gathering, or artificial spreading of some species and varieties) the forest did not change its main physiognomy (several tree strata, dense undergrowth, rich genetic diversity, strong effect on hydro- dynamics).

The arrival of the Europeans promoted or imposed the development of plantations, which gradually encroached on many forested areas. As a result, forests shrunk to a fraction of their former extension. This progression was checked when the "diseases" hazard was reduced due to pest control, antibiotics or vaccines. Presently, forested areas in Africa extend to less than 20% of their former size.

A different type of problem occurred in semi-arid and arid lands where rain-fed agriculture was (is) impossible. In those steppe or desert regions, farming was made possible by the utilization of irrigation techniques.

However, by and large, the steppe and desert cultures were herders of sheep, goats and camels. The potential for environmental degradation of these peri-desertic groups was limited to the proximity of the water holes, which were few and often far apart.

It is important to remember that cattle, goats and sheep require almost daily drinking and camels once a week, and therefore the radius of influence of the herds could not go much beyond one to four days' travel of the water holes or the places where water containers could be placed. As a result, most of the steppe and the savanna ecosystems remained very lightly touched by animal raising activities.

Water holes were normally hand-excavated wells located in wadi¹⁴ plains or related to natural springs. Natural springs are very rare in semiarid and arid areas and therefore, most water holes had been excavated in the alluvial or related eolian sediments.

Wherever the depth to water was less than 30-40 m. and the water quality was good, there was potential for well excavation. In fact, in most areas with these characteristics water holes were dug.

Several technological developments came to change this situation. Firstly, new hydrogeological techniques, such as drilling and geophysical logging allowed the identification and exploitation of much deeper and sometimes better quality, higher yield aquifers.

¹⁴ Wadi: (from arabic) arid "river" valley.

Secondly, the development of new types of mechanical pumps allowed the utilization of much larger volumes of groundwater in shorter periods of time. Finally, the spread of motor vehicles made possible the transportation of the water from the wells to drier zones.

As a result, and promoted by a culture basing prestige on possession of the largest number of animals, herds and herders rapidly increased their numbers.

These were the main causes of increased desertification in the Sahelian and peri-Saharan region. Widespread overgrazing took place and in a few decades, the southern boundary of the Sahara advanced southward several tens or even hundreds of kilometers.

A good example of this situation can be observed in Northern Senegal between the Senegal and the Ferlo rivers¹⁵. This area is a typical Sahelian steppe made up of shrubs, grasses and some trees and inhabited by Fulani (Peul) herders. Traditionally, there was no reliable source of water supply in the territory between these two rivers. During the dry season the herders retreated to the Senegal or the remaining pools in the Ferlo valley. During colonial times, the government drilled a number of wells (some of them very deep, 750 m.) to provide water supplies during the dry season. The wells were about 25 km. apart and changed completely the living strategy of the Fulani. Instead of migrating to the rivers during the dry season they remained near the wells where they settled down. During the rainy season they would still go to look for better pastures¹⁶.

As a result of these new water resources, people and livestock density increased considerably (to 5-15 people per km.2). Even during good rainy years the vegetation of the immediacies of each well were heavily damaged. When the drought of 1973-1975 struck, the cattle ate everything, grasses, shrubs, trees were stripped of their branches, and thousands of animals died. Because of the drought the plants did not regenerate and a very acute famine followed. In fact, a well-meant "development assistance" program had not considered all aspects of the problem, introducing a technical element which inappropriately changed traditional cultural and production patterns well adapted to the local environment.

The development of large cities throughout the steppe, savanna and forested regions, and the rising price of fuel has also determined an increase in the extraction of wood

¹⁵ The Senegal is a large river with permanent (although variable) flow, the river Ferlo behaves more like a semi-arid wadi, without water during the dry season.

¹⁶ A detailed description of the Ferlo-Senegal problem is described in "Reforestation around wells in Northern Senegal; in "Agroforestry in Africa; a survey of project experience"; Paul Kerkhof; 1220- 1992; Published by PANOS, London. It was used as a source of information in this section.

to be utilized as fuel for cooking, industrial ovens and other purposes. The wood products are sometimes burned as such or after their transformation into charcoal. The final result of this degradation activity has been the retreat of forests further and further away from the edge of the urbanized areas. This process can be observed practically throughout the whole continent (i.e. Mali, Burkina Faso) and even in strong oil-producing countries, wood is widely utilized as coal for domestic use or other purposes.

Another cause of environmental degradation in Africa relates to the construction of poorly designed (and/or evaluated) hydro-works. The main environmental and social impact was produced by irrigation and/or storage water systems and hydroelectric dams.

One of the main examples of failures was the Lake Chad irrigation system built in the seventies. This project was planned without taking into account the climatological regime, which is characterized by regular cycles of drought and floods. As a result, today, the many million dollars spent on the project resulted in the building of kilometers of channels which, for most of the time, have remained dry and useless¹⁷.

Both in the Ferlo and Lake Chad projects, the balance between the pluses and the minuses leaned towards the negative side, mainly as a result of poor evaluation of the needs and of the actual impacts that could have been predicted had an in-depth and independent study been conducted before the decision of construction was taken.

There are several other projects in the planning which may entail similar risks or even larger (i.e. the Jonglei canal in the Sudd wetlands in Southern Sudan, the trans-basin transfer of water from the river Congo to the Chad through the river Chari and several others).

Lack of funds, continued political instability and a growing sense of the risks of these mega-hydraulic works have slowed down the actual execution of these projects. New endeavors will probably need in depth impact assessments reducing the risks of repeated failures in the future.

THE OLD AND THE NEW DEVELOPMENT MODELS

The complex situation of present day Africa is the result of a long history of outside interference and profound ongoing internal processes.

¹⁷ See Chapter 7.

The main problem, with negative implications for the future, is the deterioration of the resource base, which in part may be irreversible: deforestation, eco-systemic destruction, depletion and contamination of water resources, loss of fertility and erosion of soils and widespread habitat destruction. One of the main consequences of these processes is a decrease in production in many rural areas, as well as in export competitiveness. These are reducing the actual volume of exports, and consequently the volume of foreign currency. Coupled with the need to service the continent's 140 billion dollar debt, these factors are increasing the difficulty of acquiring many basic imports.

As a consequence of the changing role of many farming areas (from subsistence to commercial production) and decreased production, rural migration rates are high, producing a continuous, unsustainable demographic growth of cities throughout the continent.

In some countries there is a trend towards consolidation of the strongest national groups, providing a minimum of political stability that is a basic element in defining new, sustainable developmental alternatives.

In other countries, with two or more national groups competing for power, political instability may become still more acute. In some cases the tendencies for political fragmentation may succeed. It is possible that there will be also a tendency to realignments beyond the inherited "colonial" borders.

Generally speaking, the trend seems to be one of progressive substitution of the "colonial-type" state, with formal institutions and an economy poorly adapted to African conditions, by another state more based on traditional institutions and the informal sector.

In the more densely populated areas, an acceleration of the urbanization processes appears to be taking place, with development of a new type of syncretic "afro-urban" culture that may gradually allow the sowing of the seeds of a new institutionalization.

The tendency seems to be also toward a re-nationalization of the states with redefinition of borders and institutions. This process of re-nationalization is taking place mainly as a result of a succession of conflicts and these may persist for several decades with continuous effects of disarticulation of the production systems, affecting the quality of life of the population for some time to come in many countries.

Consequently, if this trend continues, famines may develop and mortality rates may start increasing again (although perhaps in a localized manner in relation to armed conflicts or development of epidemics such as AIDS). It is very likely that this may occur simultaneously with a continued decrease in birth rates, which, coupled to migrations, may tend to stabilize the population levels in the medium or longer term.

It can also be expected that, in the same way that is happening in Latin America or some Asian countries, the growth of African cities may start slowing down because they will become less attractive places to live due to the social and environmental degradation processes.

The failure of the "colonial", "socialist" and "capitalist productivist" models will promote the search for new models based on African indigenous resources and culture. Gradually, we expect (and hope) that a revalorization of the role of the agricultural village and the grazing communal system will take place, together with tendencies towards political decentralization as a result of this predictable "shrinking" of the central power. The new indigenous-based models may allow syncretic management approaches combining traditional systems with scientific know-how.

Generally speaking, the re-nationalization process may start with a larger dependency on foreign aid (which in time, will probably decrease due to the "drying up" of funds and "aid fatigue" in developed countries). Still, at a later stage, due to the deterioration of the state economies resulting from the degradation of the resources base and the disarticulation of the formal production systems, self-management and self-development forces may gradually start taking over in a framework of growing decentralization, including even the development of re-ruralization processes.

CHAPTER 10

LATIN AMERICA AND THE CARIBBEAN: A HISTORY OF ENVIRONMENTAL DEGRADATION

The environmental changes in the Latin American and Caribbean region during the last few centuries are probably unparalleled in other parts of the world.

During this period the continent has experienced a widespread and increasingly dense, human occupation of formerly sparsely- populated areas, and a generalized process of urbanization which catapulted "provincial" size cities to huge megalopolises of many millions.

As a consequence of these changes, most indigenous ecosystems were profoundly transformed; forests became savannas and farming lands, grasslands became crops or forests, deserts were irrigated, aquifers were depleted, rivers, lakes and coastal waters were contaminated, biodiversity has been under constant attack, and quality of life has deteriorated or is under threat.

Thus, one of the continents of the world richest in natural and cultural diversities, with the strongest resources base, has been losing them at an alarming rate. The most serious concern is that the process is not slowing down; on the contrary, it seems to be accelerating every day.

Some questions arise: what were the historical conditions causing this situation? where are the problems more acute? what could be the effects of globalization processes? what can be done to prevent further degradation?

The answers to these questions are not always simple or straightforward; they are the result of a peculiar historical evolution and of a unique natural geography.

A HISTORY OF CONQUEST AND DEGRADATION

Human occupation of the American continent took place at a relatively late stage in the evolution of humankind. Although humans and hominids appeared on the Earth several hundred thousand or million years ago, their arrival to the American continent occurred at a much later date (perhaps as late as 30,000 years b.p.¹). Animal species in the African and Eurasian ecosystems, where humans had been evolving for long time, gradually adapted to this effective mammal (the future Homo sapiens), and in

¹ b.p.= before present

most cases managed to survive. In the American continent, humans found a different fauna, composed of animals not adapted to human presence, which frequently represented an easy target to the arriving hunters and gatherers. Some of these animals were large mammals (i.e. several species of Glyptodon, Toxodon, Mylodon, Mastodon), which were hunted down to extinction in a few millenia. Therefore, from the very beginning human presence provoked a profound upheaval of the composition of the American ecosystems.

After this first encounter and subsequent changes, these "paleo-indian" groups were forced to adapt to the changes that they themselves had produced. After many generations through migrations and technological and social developments, gradually the new societies managed to develop sustainable social and environmental models, which in general, allowed the conservation of the main ecosystems without major changes for several millenia. A whole spectrum of cultures evolved in the various environments of the continent, and by the time the European conquerors arrived, they had become well established throughout the continent.

In the high valleys of the Central Andes and Meso-America, there were numerous farming societies organized into relatively large kingdoms or "empires", as was the case with the kingdom of the Aztecs in Mexico and the Tahuantisuyu in Peru². The Mexican states were based on the cultivation of corn, chili pepper and tomatoes, and the raising of turkeys and dogs. Their capital, at the time of the arrival of the Spaniards, was the large island-city of Tenochtitlan. The Peruvian states of Western South America based their economy mainly on potato, corn and quinoa farming and llama raising, and were based in the large Andean city of Cuzco.

In the Northern Andes, the high valleys were also occupied by agricultural societies (the "Chibchas") who had also developed impressive gold- metallurgic technologies. The Chibcha groups were organized into small states ruled by a Zipa (chieftain). The most powerful Zipa, at the time of the arrival of the Spaniards, was the Zipa of Bacata, located in present-day Bogota.

In present Yucatan and Guatemala, there was a culture of relatively prosperous farming towns (the "Mayas") who were in the process of economic and political decline when the Europeans arrived. Several main larger towns were abandoned and apparently their inhabitants (at least part of them) settled in the mountains not far from present day Guatemala city.

² Historically, political control varied with time. Before the Aztecs, control was exerted by the city of Tula and before that by the city known now as Teotihuacan. In the Peruvian Andes, before the Cuzco-based Tahuantisuyu developed, an older kingdom had existed in Tiwanako (in the Altiplano of present Bolivia).

The Caribbean islands had been occupied by many farming and fishing communities (originally the "Arawaks", which in some islands had been displaced by the "Caribs").

The huge South American forests became the developing ground of the Tupi-Guarani cultures, which also gradually adapted very well to the richness and difficulties of these ecosystems. The Tupi-Guaranis extended from Venezuela to the Rio de la Plata and from the Andes foothills to the Atlantic ocean, and based their subsistence on itinerant farming of corn and cassava and various extractive activities (hunting, fishing, gathering of plants and small animals).

The grasslands of South America were inhabited by non-farming groups of hunters-gatherers-fishermen making their living on the hunt of the "venado" (South American small deer), ñandú (ostrich), armadillos. These societies were organized politically in small groups and confederations. Similar groups, but larger and better organized politically, existed in the prairies of North America, dedicated to buffalo hunting and other extractive-type activities.

Finally, the cooler and colder lands of the extremes of the continent were inhabited by various types of hunters and fishermen, such as the Tehuelches, the Onas and the Fueguinos in Patagonia and Tierra del Fuego (Southern tip of South America) and in the Northern regions of North America by various groups of hunters, fishermen and gatherers (i.e. Inuit, Denes, Algonquins).

Generally speaking, all the indigenous societies were well adapted to the specific conditions of the local ecosystems (the ones that did not adapt, disappeared).

In the rain forest ecosystems, complex land utilization systems developed. They included "slash and burn" farming in small plots, preservation of specific areas for medicinal plants or animals, zones for social activities and various types of behavior, frequently of a religious or magic character, that on the whole allowed a sustainable approach to forest management.

In the grasslands, hunting practices included natural totems and taboos, ensuring that no indiscriminate killing would occur that could endanger the survival of the resource species. Both in the Southern and in the Northern grasslands, hunting groups followed the herds ("venados" in the South, "buffalos" in the North) which were very numerous³ and whose number were more or less stabilized due to this type of "cultural" management practices.

³ There are many references to the huge quantities of buffalos roaming the North American central plains. Similar references exist on the abundance of "venado" in the Uruguayan grasslands which "covered the land to the horizon" according to the Portuguese explorer M. De Souza in 1532.

Farming activities in the mountain societies were also carried out in a sustainable manner. The farming systems in the Altiplano were (and still are) very complex, including cultivation of several different types of crops at the same time and a "rotation" system ensuring maximum production without irreversible losses of fertility or plagues.

THE NEW ARRIVAL: THE EUROPEANS

After 1492, when the first Spanish expedition arrived, a dramatic change occurred. Before the end of the XV century, the first Spanish explorers became conquerors, settling in several islands of the Caribbean (i.e. Santo Domingo or Haiti, Hispaniola or Cuba, Puerto Rico, etc) and shortly after, the Portuguese founded their first colonies in Brazil. In their first colony, Santo Domingo, the Spaniards treated the indigenous population as slaves, raped Indian women, and did not hesitate to kill whole communities when they offered some resistance. After 50 years of Spanish occupation, only a few hundred Indians had survived these genocidal practices and the deadly European diseases. Finally, widespread suicides of the survivors resulted in the early disappearance of these ethnic groups. Similar developments occurred in the other Caribbean islands controlled by the Spaniards (i.e. Cuba, Puerto Rico, etc).

In Brazil, the behavior of the Portuguese was not very different. Thousands of Indians were put to work as slaves, and expeditions set out from the settled areas on the coast in the countryside to obtain more manpower. At the beginning, the expeditions were based in the Northeastern towns; at a later stage, they were organized from Sao Paulo do Piratininga (Sao Paulo) near the port of Sao Vicente, formed by groups of mercenaries called "bandeirantes".

The main purpose of the conquest in the XVI century was to obtain precious metals and gemstones (such as gold, silver and emeralds). For this reason, the Spaniards dedicated much effort to exploit existing mines or open new ones. They developed silver and gold mines in Potosi, in Upper Peru (present day Bolivia) in Taxco in Mexico, and in many other places. The financial resources created by these mining activities allowed funding and implementation of a massive colonization effort.

In a large measure, Spaniards and Portuguese reproduced the European feudal social structures in America. The new Spanish settlers were awarded "encomiendas" which were the American equivalent of the European feudal fiefdoms.

The new production systems brought by the Europeans were extractive and degradatory. Widespread mineral exploitation and indiscriminate deforestation, over-cultivation and overgrazing without concern for sustainability were the rule. The results were very negative in many areas, and some ecosystems were destroyed beyond repair.

However, due to the limited number of settlers, the bulk of the American natural environment managed to survive several centuries with only minor degradation.

In Andean farming areas, the "encomenderos" controlled large number of Indian peasants who continued more or less farming as before, except that now they had to "contribute" with their time and work for long periods (sometimes many years) working in the mines.

In the grasslands, the land was awarded to "estancieros" who received got large "estancias" to grow cattle (introduced to Southern South America in the XVI century). Cattle substituted the "venado" and other prairie herbivorous animals, some of which became more and more scarce and in a few cases very close to extinction.

INDISCRIMINATE EXPLOITATION OF NATURAL RESOURCES CONTINUED AFTER INDEPENDENCE

In the beginning of the XIX century (in the 1810's) most Spanish colonies declared independence from Spain, taking advantage of the invasion of Napoleon to the Iberian Peninsula. As a result, about 20 new countries formed in Hispanic- America. Practically at the same time, in 1822, the Portuguese Brazilian colonies became also an independent monarchy. The only exception to this "independence" drive in the Spanish-Portuguese colonies were Cuba and Puerto Rico which remained under Spanish rule until the end of the XIX century.

In spite of this new independence the old feudal type of colonial exploitation persisted in the recently formed countries. The new criollo elites were in many cases composed of the largest landowners and the social structures remained practically untouched. Large **fincas**, **estancias**, and **fazendas** were the successors of the old encomiendas and continued producing in much the same way as the old Spanish and Portuguese plantations did.

During the XIX century, the Latin American and Caribbean countries dedicated themselves to the production of various raw materials and food products for export mainly to Europe, and to a lesser degree, the United States (especially during the last decades of the century).

Exploitation of natural resources continued ruthlessly with little concern for environmental effects. In high population density areas (such as in some mountain valleys or coastal zones), deforestation processes intensified, mining and quarrying proceeded at an ever faster pace, hunting pushed many wild animals to the brink of extinction, and soil erosion became commonplace in farming areas.

In the XX century, these tendencies increased continent-wide. Occupation of lands belonging to indigenous people continued without much recognition of their traditional rights and the various processes of environmental degradation further intensified.

The Latin American and Caribbean economies, which were export-oriented since colonial times, became even more so due to the establishment of railroad systems, and the growth of major ports. The basis for the economic growth of the countries varied in each; in Argentina and Uruguay, it was the production and export of beef, leather, wool and wheat. The main export center at which the whole railroad system converged was the city of Buenos Aires. This city had grown very fast both in population and commercial activities by the end of the XIX century and continued growing in a very rapid manner during the first half of the XX century. Buenos Aires surpassed 100,000 inhabitants in 1870 and grew to 8,000,000 in the 1950's. In Uruguay, the railroad system radiated from Montevideo (which was the only exporting center) and the city also experienced a very rapid growth from 50,000 inhabitants in 1860 to 300,000 in 1900, and reaching one million by 1960. The demographic growth of these countries was the result of a continuous arrival of immigrants, mainly from Europe, which in large measure determined the ethnic make-up of these cities.

In Brazil, the export drive was mainly centered in Sao Paulo and its port, Santos, and in Rio de Janeiro (which until the 1960's before the construction of Brasilia was the capital of the country). The main export products in the Sao Paulo area were coffee, sugar cane and timber (Brazil pine). In Bahia and the Northeast the main products were cocoa, copra, sugar cane and bananas, and the main exporting ports were Salvador and Recife. The Amazonian region specialized in the production of rubber (particularly in the proximity of the city-port of Manaus), which was an important source of revenue for several decades, until the rubber tree was introduced in Malaysia and the Brazilian production declined.

The Coastal Pacific countries of South America and Bolivia, (which in colonial times were exporters of precious metals, mainly silver) continued to be mineral producers (i.e. production of copper and nitrates in Chile and of tin in Bolivia). In this region, there was a less marked centralization due to its particular geographic configuration with a long mountain range and very narrow coastal plains (sometimes including also a parallel coastal range leaving narrow valleys in between). The main ports were the two oldest colonial ports of Valparaiso in Chile, and Lima in Peru.

In Central America, the Caribbean islands and the northern coast of Colombia the main products were bananas, coffee and copra. Often, these export activities were carried out by American-owned companies which controlled production and access to foreign markets throughout the region. One well-known example of that was the United Fruit Company⁴, which controlled production and export of the main fruit exports to the United States.

⁴ The United Fruit Company was all-powerful in Cuba (where it was called "mamita yunai"), in Guatemala, in Nicaragua, El Salvador, Costa Rica, etc. This company used its influence to change governments or induce American military interventions. The Central American republics under "United Fruit" control were called, ironically, "Banana Republics".

In Mexico, this process was somewhat slowed during the revolution of the 1910's, when the dictator Porfirio Diaz was overthrown by a peasant revolution headed by the leader Emiliano Zapata in the South, and by Pancho Villa in the North, which changed radically the land ownership structure of the country. By the end of the 1930's with the nationalization of the petroleum industry by Lazaro Cardenas, Mexico's main export products became nationally owned.

At the same time, gradually, the main cities of the continent started developing an important industrial base. In some cases, such as in Argentina, Uruguay and Southern Brazil, agro-exporting industries (i.e. textiles, slaughterhouses and tanneries) developed. In other cases, the industries were geared to the national markets, usually sheltered from foreign competition by protectionist policies. The main industrial cities that developed in the continent were Buenos Aires, Sao Paulo and Mexico City, but various industrial activities also developed throughout (i.e. in Havana, Santiago de Chile, Montevideo, Bogota, Lima, etc).

This widespread economic drive towards exports and increasing industrial activities had a very strong effect on the already- damaged Latin American and Caribbean environment. The elimination of the forests and spread of mono-specific plantations increased the vulnerability of soils to water or wind erosion, and hydrological regimes changed everywhere, increasing the frequency of floods and droughts. The growth of urban and industrial activities produced a cumulative deterioration of natural water systems. Small rivers near the cities became open sewers, larger rivers and lakes started to receive considerable volumes of contaminants, and aquifers became saline or polluted.

EFFECTS OF GLOBALIZATION ON THE LATIN AMERICAN AND CARIBBEAN ENVIRONMENT

Recent globalization processes had the effect of increasing this widespread degradation trend. The largest cities have become 10- 20 million people megalopolises, industrial activities, before mainly restricted to the agro-exporting sector, have already expanded or are now expanding to other sectors such as automobile and chemical production. A large scale "invasion" of maquiladora-type industries is taking place Mexico, Costa Rica, Guatemala, Dominican Republic producing environmental deleterious effects due to the lack of environmental standards in those countries or their inadequate enforcement.

Macro-economic trends are promoting deforestation in Mato Grosso, Santa Cruz (Bolivia) and Paraguay for soy bean plantation. Chilean native forests from Concepcion to Punta Arenas are being eliminated to plant exotic trees for production of timber or paper pulp. These new mono-specific plantations are the cause of a large number of side effects on the native ecosystems and hydrological regimes, with loss of diversity and significant negative social upheavals.

Grasslands ecosystems and associated farming lands are being invaded by huge forestry investments in exotic tree species, which are inducing the spread of new plagues, reducing agricultural competitiveness and damaging the future potential of prairie soils.

Rivers are becoming loaded with sediments throughout the continent due to the destruction of the controlling ecosystems in their headwaters.

All these environmental problems, are taking their toll on the quality of life of the populations. Old water-borne diseases that had disappeared or were largely unknown, such as cholera, have made a startling comeback almost everywhere. The low air quality of the main metropolitan areas is producing an increase of respiratory diseases. Geological hazards, such as landslides and floods are gradually increasing due to the encroachment of settlements on hazardous areas (i.e. favelas on the slopes in Rio de Janeiro or in the "barrios" of Medellin).

The models of development of the LAC continent have proved to be unsustainable. New alternatives must be imagined. The new models should aim to ensure that economic activities and population distribution are decentralized, that only sustainable production systems are adopted and that these systems are based as much as possible on indigenous plants and animals.

The exploitation of natural resources should no longer be done in an indiscriminate manner; the biological diversity of native ecosystems must be protected. Adequate policies defining strict environmental standards on solid waste and effluent disposal and gaseous emissions must be formulated and enforced. And, overall, it will be necessary to develop a public awareness at all levels that other development alternatives, more sustainable, more diverse and more autochthonous can be successfully defined and implemented.

CHAPTER 11

MAQUILADORA COUNTRY

THE MAQUILADORA PHENOMENON

"Maquiladoras" are industries that carry out part, or all of the phases of the industrial process outside the borders of the country where they originated. Subsequently, the custom duties charged by the country of origin of the industry are usually calculated **only** on the added costs incurred on the portion of the process that takes place outside its borders. The **host country** provides **free port** status for the industries willing to invest in designated places. In most cases, this status means that the host country does not apply duties (or only marginal ones) to the raw materials, partially industrialized products or merchandise crossing the border, in one or the other direction, in relation to the specific industrial process.

For entrepreneurs, the advantage of the system is that, by carrying out some or most industrial operations in the host country under the maquiladora umbrella, the costs of production can be reduced. In appropriate cases and situations, many costs such as labor, energy, water, raw materials, environmental expenditures and taxation can be reduced by installing maquiladora factories.

This system is being applied, in various forms, in several countries throughout the world, but the main example of a growing maquiladora region is probably the U.S.A.-Mexico border area.

THE U.S.A.- MEXICO BORDER

The border between Mexico and the United States extends for more than 1,500 km. and encompasses a territory of steppes and deserts where, traditionally, the density of population was very low. This zone has had limited settlement due to climatic unsuitability for rain-fed agriculture, and scarce surface water resources for irrigated farming.

Before 1900, with a couple of exceptions (Ciudad Juarez and Monterrey) there were only a few small towns, scattered near the border area, dedicated to low productivity agriculture, marginal animal production activities and trans-boundary commerce (both legal and illegal).

During the XX century, the economic and demographic growth of the border area was mainly related to increased traffic and commerce between the two countries, and to

the development of irrigated farming projects on both sides of the boundary. On the Mexican side, there was federal support for drilling and pumping for irrigation purposes. On the American side, new water sources from neighboring rivers and aqueduct systems were developed, which, coupled with the availability of inexpensive migrant manpower and cheap land, allowed the development of a powerful farming industry.

THE GROWTH OF BORDER CITIES

Industrial development started around the nineteen-fifties in Monterrey¹ as a result of protectionist government policies and, later in the seventies and eighties, in the remaining border areas as a consequence of the maquiladora phenomenon.

From the outset, these factories had strong effects on the economy and demography of the border region. The main existing cities increased their population very quickly to become large metropolitan areas. Sleepy towns grew rapidly, becoming large cities in a matter of a few years. The whole border "country" was profoundly modified in a very short period, and as a result, strong social and environmental impacts occurred and continue today.

The metropolitan area of Tijuana, which had a population of 461,257 in 1980, increased to 747,686 in 1990 (p.301, same source). Nearby Mexicali grew from 510,664 to 601,938 in the same period, Reynosa augmented its population from 294,934 to 376,676, Matamoros from 238,840 to 303,293 and Ciudad Juárez from 567,365 to 798,499. The whole urban border area grew from 2,842,642 to 3,815,814 people in the same 10 year period².

In table 11.1³ the evolution of the maquiladora phenomenon is shown for the whole of the Mexican economy. In 1975 there were 475 industries with 67,214 workers which grew to 1,631 with 427,244 workers in 1989. In 1994 there are now more than 2,500 factories providing jobs for 1 million people, or about 15 % of the industrial employment of the country. In 1975, the total annual added value of the

¹ Monterrey has been for many years the main industrial center of Northern Mexico. There are several other industrial cities in the rest of the country, such as Mexico City, Guadalajara, Toluca and Puebla.

² Source: "Informe de la Situación General en Materia de Equilibrio Ecológico y Protección al Medio Ambiente; Secretaría de Desarrollo Social, Instituto Nacional de Ecología, 1993, México, México (refs. in page 197 and 198).

³ Source: "El Acuerdo Libre Comercio México-Estados Unidos; Alternativas para el futuro; ; Camino para fortalecer la Soberanía; Centro de Investigación para el Desarrollo, A.C. (CIDAC); Editorial Diana S.A. de C.V., México, D.F., México, 1a ed. April 1991; 2a impr., October 1991; 291 pp. (ref.table I in page 119)

industries was 332.4 million dollars, but this had increased to more than 2.5 billion dollars by early 1989. It is expected that during 1994 the total added value will exceed 5 billion dollars.

Table 11.1

Year	Factories industrial employment	Workers	% of total
1975	454	67,214	4.2
1976	448	74,496	4.5
1977	443	78,433	4.8
1978	457	90,704	5.0
1979	540	111,365	5.6
1980	620	119,546	5.4
1981	605	130,923	5.3
1982	585	127,048	5.4
1983	600	150,867	7.6
1984	672	199,864	9.7
1985	760	211,969	-
1986	891	249,833	-
1987	1,125	305,253	-
1988	1,396	369,489	-
1989	1,631	427,244	-

(note: data from May 1993, show a total employment of 545,900 workers)

The city with the largest number of maquiladora plants is undoubtedly Tijuana, which possessed 530 industries of this type by 1992. Other cities next to the Californian border also housed a large number of "maquiladoras": Mexicali (154), Tecate (86), Ensenada (33) and San Luis Colorado (12).

Along the Arizona-Sonora boundary, the main center is Nogales, with 73 plants, and on the Texan- Mexican border the main maquiladoras centers are Matamoros (94), Nuevo Laredo (83), Reynosa (71) and Monterrey (70).

THE CASE OF CIUDAD JUAREZ

In the central border region, the city with the largest concentration of maquiladoras is Ciudad Juárez. By late 1992, this border city was the home of 330 maquiladoras, the second largest concentration of the country (after Tijuana). As a result of the installation of these industries, the city grew from a relatively medium-size town of 400,000 people in the seventies to twice that figure in the early nineties. Many new

"colonias" (suburban neighborhoods) have developed throughout its peripheral areas, making it very difficult for the municipal and state authorities to provide the required services. The city is located on the Mexican side of the Río Grande across from El Paso, Texas, which is also a fast growing city (presently with a population of more than 400,000).

Before the big maquiladora revolution, Ciudad Juárez was known for fast divorces and inexpensive dental work. Today, many of the main U.S.- based, Japanese and other transnational companies have located their factories there: General Electric, Northern Telecom, Phillips, Toshiba, TDK, Honeywell, RCA.

According to Twin Plants News, mentioned by Bettson, 1993, the metropolitan area of El Paso is the seventh most polluted metropolitan area in the United States. Atmospheric data on the air of El Paso show high levels of ozone, sulfur dioxide, carbon monoxide, nitrous oxide and lead (same source).

The people who are more affected by environmental problems in the Juarez-El Paso region are those living in the "colonias" alongside the maquilas. Recent data showed that tuberculosis, hepatitis, skin diseases, gastro-intestinal problems, miscarriages and cancer are all unusually high compared with the rest of Mexico.

According to Bettson, 1993, cases of anencephaly (babies born without a brain) normally a rare condition, have become very frequent (163 cases in a period of 4 years, 1988- 1992 and this is attributed to toxic substances utilized by maquila workers.

ENVIRONMENTAL PROBLEMS

Maquiladora plants are the source of at least 1,929 waste water effluents; however, only 10.7 % of the plants possess treatment systems. On the other hand, 1094 plants are the source of emissions of pollutants into the atmosphere and of these, 65% do not have any system for reducing the contaminant contents of their emissions. In addition about 54.6% of the industrial plants (821) produce hazardous solid waste⁴.

As can be observed, the maquiladora phenomenon includes a strong environmental degradation component. Obviously, many of these industries are taking advantage not only of the inexpensive labor, but also of the reduced environmental costs related to their installation in Mexico.

⁴ Mexico; Informe de la situación general en materia de equilibrio ecológico y protección al ambiente; 1991- 1992; Secretaría de Desarrollo Social; Instituto Nacional de Ecología; p.197

Additional data show that there are 821 maquiladoras operating near the US- Mexico border (same source) which generate hazardous wastes. Of these, only 71% had declared these wastes by mid-1992. There are, therefore, still more than 200 plants producing hazardous waste that have not even declared this fact.

Maquiladoras are a source of environmental problems for several reasons: firstly, environmental laws and controls in Mexico are much less strict than in the rest of the North American continent, promoting the relocation of many industries in search of lower costs (not only labor, but also environmental costs); secondly, a similar situation applies to industries having problems of occupational health and safety, which can see their costs greatly reduced by moving South of the border; and finally, the fact that the excessive concentration and fast growth of the maquiladora cities makes it very difficult for the Mexican authorities to build or provide the required infrastructures and/or services.

LABOR COSTS

Labor costs on the Mexican side of the border are much lower; 1992-figures showed a cost of 1.22 U\$ per hour (estimates of South Korea and Taiwan are respectively 3.67 U\$ and 4.63 U\$). At the same time, average hourly costs in U.S.A. and Canada exceeded 17 U\$⁵.

Obviously, these type of wage differentials promote the "migration" of labor-intensive industrial factories to the "inexpensive" side of the border, and in fact, in most cases, the industries that have moved to Mexico include a large component of manual, repetitive, labor- intensive occupations.

LESS CONFLICTIVE LABOR, DECREASED RESPONSIBILITY

An additional factor which is often mentioned as a cause of the installation of factories on the Mexican side is the absence of a powerful trade union movement. In effect, the main workers' union in, the Confederacion de Trabajadores de Mexico, is largely under the control of the government party (Partido Revolucionario Institucional), and it is not easy for industrial workers to initiate or organize strikes or to press for better working conditions or pay, therefore significantly reducing labor costs through lower salaries and less strikes. In addition, there is a tendency to hire more women than men. In Mexico, women, who are in a situation of social disadvantage, see the prospect of working in maquiladoras as a sort of "liberation" from the male chauvinist society. Entrepreneurs take advantage of this handicap and utilize many more women than men. However, after some years of working in

⁵ Bettson, Bob; "Surviving the new economy"; The United Church Observer, New Series, Vol. 56, No 9, March, 1993; p.16- 23.

maquiladora plants, women become very tired of the types of repetitive, non-formative jobs they must do many hours per day, every day, for many years. Trade union movements have formed several times struggling for higher wages, better working conditions and shorter working hours. In some cases, companies have simply vacated their premises during a week-end, leaving the country on a moment's notice. This "reduced responsibility" status is an added "advantage" that some industries are using to their benefit on the Mexican side of the border.

THE REDISTRIBUTION OF ECONOMIC ROLES

The *maquiladora* phenomenon is only one aspect of the effect on Mexico of the world redistribution of economic roles. Other effects can be seen in the rest of the economy. Some Mexican industrial exports to the U.S., experienced a significant growth between 1986 and 1989. The main ones are in the automobile industry (343% in 1986, 151% in 1987, 7.4% in 1988 and 16.1% in 1989 (up to October)⁶, in the production of machinery (growth was 52% in 1986, 40.7% in 1987 and 14.8 % in 1988), in the steel industry (growth: 85.3% in 1986, 42.1% in 1987 and 20.5% in 1988) and in the textile industry (growth: 71% in 1986, 70.1% in 1987 and 10.6% in 1988)⁷.

Most of the investments causing industrial expansion phenomenon in Mexico which in a large degree is complementary to that of the *maquiladoras*, originates in the United States, with a participation in more than 60% of the total foreign investment (63% in 1989). Other countries with important investments in Mexico, include the United Kingdom (6.7% in 1989), Germany (6.3%), Japan (5.3%) and Switzerland (4.4%)⁸.

PRESENT SITUATION

According to the newspaper *El Universal* of Mexico City (9/9/1993⁹), the under-secretary of SECOFI, Fernandez Sanchez Ugarte, indicated that by mid- 1993, the *maquiladora* sector had overtaken the petroleum sector as the main generator of foreign currency. The growth of the *maquiladora* added value, in US dollars, had been 13% for the last 5 months (April to August 1993). The increase for the same period in the employment rate was 9%. By May 1993, the sector provided employment to

⁶ Source: CIDAC, 1992; p.146.

⁷ Source: CIDAC, 1992

⁸ Source: CIDAC, 1992, p.165.

⁹ "El Universal"; Dora Elena Cortes; September 9, 1993, Mexico, p.3.

545,900 workers. In Baja California alone, the market of inputs to the maquiladora and exporting industries reached 2.7 billion dollars in 1992. It must be noted that there were, at that moment, 809 maquiladora plants in this state. For the whole country, the value of inputs for the maquiladora industry was of 14 billion dollars, and according to Sanchez Ugarte, if the country absorbed about 10 % of this sum, it would mean nearly 1.5 billion dollars for Mexican economy.

AGRICULTURAL EXPANSION IN NORTHERN MEXICO

The redistribution of economic roles also had an important impact on farming in Northern Mexico. California has traditionally been a very important farming state. However, very recently, as a result of decreased availability and increased cost of water and labor and environmental restrictions, the state has increased its imports of farming products from Mexico and other Latin American countries (i.e. Chile).

During the nineteen- eighties, the main Mexican farming exports to the U.S. were fruits¹⁰ (growth: 20.1% in 1986, 30.5% in 1987 and 0.2% in 1988) and vegetables (growth: 22.4% in 1986, 20.2% in 1987 and 12.5% in 1988)¹¹.

COMPARATIVE ADVANTAGES OF FARMING ON BOTH SIDES OF THE BORDER

The main reason for this trend has been and is the inexpensive labor, in spite of the much higher agricultural yields of the U.S. For instance, in 1986-1988, the yield of potatoes was 33,613 tons/ha in the United States and only 13,000 tons/ha in Mexico. Tomato (industrial) yields were 56,234 tons/ha in the U.S. and 25,182 in Mexico and lettuce production was 33,396 tons/ha in the U.S. and 30,360 in Mexico¹².

In terms of working days required to grow one ton of produce, productivity is also, in general terms, much lower in Mexico. The difference is particularly evident in the case of some basic grains. To produce 1 ton of corn, Mexican farmers require 17.84 days while American farmers need only 0.14 days (slightly more than one hour of

¹⁰ We must remember that California was and is basically a fruit-producing and exporting state. The fact that it is now becoming an "importer" of some fruit products from Mexico is particularly striking.

¹¹ Source: CIDAC, 1992.

¹² "La agricultura mexicana frente al tratado trilateral de libre comercio"; CIESTAAM (Centro de Investigaciones Económicas, Sociales y Tecnológicas de la Agroindustria y de la Agricultura; Universidad Autónoma de Chapingo; Published by Juan Pablos Editor, S.A., Mexico, DF; 1992; pp.257; ref. on "La producción de hortalizas en México frente al Tratado de Libre Comercio con EE.UU. y Canadá", by Manuel Angel Gómez Cruz, Rita Schwentesius Rindermann and Alejandro Merino Sepúlveda, p.33 to 62; data from page 52.

work!). Therefore labour input for corn production is 120 times lower in the U.S. than in Mexico. Similarly, for the production of 1 ton of beans it is necessary to apply 50.60 working days in Mexico, and only 0.60 in the U.S.. Rice labor requirements are also much higher in Mexico (33.14 days per ton) than in the States (0.23 days per ton). In wheat production, the labor input is still higher, but less than in the previously mentioned produce (3.17 days per ton in Mexico, 0.33 days per ton in the U.S., and still much lower in Canada: 0.13 days per ton)¹³.

Because, as explained above, labor costs in the agricultural sector are much lower in Mexico, these large differences in productivity are somewhat reduced when the actual cost of grain production is calculated. However, they still remain substantially higher in Mexico. Production costs of one ton of corn are 258.62 U\$ in Mexico and only 92.74 U\$ in the U.S.; 1 ton of bean is produced at a cost of 641.17 U\$ in Mexico and of 219.53 U\$ in the U.S. Rice production costs are not very different (224.20 U\$ in Mexico and 189.89 U\$ in the U.S.). Wheat production costs are substantially lower in Canada (93.11 U\$ per ton) than in the USA (143.71 U\$ per ton) and in Mexico (152.51 U\$ per ton)¹⁴.

Costs of most oil and animal food production are also higher in Mexico. For instance, 1 ton of sorghum is produced at a cost of 152.79 U\$S in Mexico and 89.25 U\$ in U.S., 1 ton of barley has a cost of 222.09 U\$ in Mexico, 153.50 U\$ in U.S. and only 69.95 U\$ in Canada, 1 ton of soy costs 324.64 U\$ in Mexico and 184.26 U\$ in U.S.¹⁵.

Some of the above mentioned figures show that, at least for some crops, American farmers are in a better competitive position than their Mexican counterparts. However,

¹³ "La agricultura mexicana frente al tratado trilateral de libre comercio"; CIESTAAM (Centro de Investigaciones Económicas, Sociales y Tecnológicas de la Agroindustria y de la Agricultura; Universidad Autónoma de Chapingo; Published by Juan Pablos Editor, S.A., Mexico, DF; 1992; pp.257; ref. in "Efectos de un Tratado de Libre Comercio en el sector agropecuario mexicano", by José Luis Calva Téllez, p.13 to 32; data from page 15.

¹⁴ "La agricultura mexicana frente al tratado trilateral de libre comercio"; CIESTAAM (Centro de Investigaciones Económicas, Sociales y Tecnológicas de la Agroindustria y de la Agricultura; Universidad Autónoma de Chapingo; Published by Juan Pablos Editor, S.A., Mexico, DF; 1992; pp.257; ref. in "Efectos de un Tratado de Libre Comercio en el sector agropecuario mexicano", by José Luis Calva Téllez, p.13 to 32; data from page 26.

¹⁵ "La agricultura mexicana frente al tratado trilateral de libre comercio"; CIESTAAM (Centro de Investigaciones Económicas, Sociales y Tecnológicas de la Agroindustria y de la Agricultura; Universidad Autónoma de Chapingo; Published by Juan Pablos Editor, S.A., Mexico, DF; 1992; pp.257; ref. in "Efectos de un Tratado de Libre Comercio en el sector agropecuario mexicano", by José Luis Calva Téllez, p.13 to 32; data from page 27.

this situation does not apply evenly to all crops. In many labor- and water- intensive crops depending on the year rainfall and demand, among other things Mexican production can reach the market with better pricing conditions than the American farming products. This is the case of some irrigated crops such as broccoli, asparagus, and others which are normally produced south of the border and sold in the U.S..

Another factor favoring Mexican encroachment into the U.S. market is the insufficient production of the California farming areas due to insufficient water resources. Further Mexican productivity is assisted by the particularly favorable conditions for pumping groundwater due to the special treatment that farmers receive for their power expenditures (in certain circumstances), when the energy is utilized for pumping purposes).

Deep pumping is especially promoted through rates that are far below actual costs¹⁶. Pumping costs increase when water table levels drop, and therefore the deeper the water levels descend, the higher the actual subsidies received by the farmers. These policies tend to promote over-pumping of the aquifers beyond their renewability limits. The risk in Northern Mexico is that gradually, some aquifers will be depleted and some others may suffer quality deterioration through intrusion of saline or other low quality waters. Inexpensive electricity and federal support for hydro-works constitute the basic subsidies framework on which the agricultural expansion of Northern Mexico is based.

In brief, on both sides of the border, farming is heavily subsidized by the federal governments. In the U.S., the price of water does not include the cost of the hydro-systems that were built to reach the otherwise dry, semi-desertic lands. In Mexico, not only are the infrastructures financed by the government, but also there is an additional subsidy through artificially-low rates for electricity utilized for pumping.

¹⁶ This special rate (Tarifa 9) was introduced by the former president of Mexico, Lazaro Cardenas in 1936. The rate was eliminated in 1992 by C. Salinas and reintroduced later due to the serious financial problems that its removal produced among the northern farmers.

CHAPTER 12

THE URBAN CHALLENGE

INDUSTRIAL CITIES ARE BORN

Modern cities are the result of the industrial age. Before the industrial revolution the largest cities of the world were relatively small by today's standards. In Europe's XIV century, only Venice and Paris reached 100,000 and London had a mere 50,000 inhabitants. Shanghai, the largest city in China had about 100,000 people and Fez, the capital of the Moorish empire did not even exceed that figure. Timbuctu in the Sahel housed less than 80,000 people and the populations of the largest Indo-American cities: Tenochtitlan and Cuzco probably did not surpass by much 100,000 people.

The 16th century "Renaissance" was to a large extent the result of the incorporation of large "non-ecumenic" areas of the world into the European "civilized fold" as a result of discoveries and political and military imperialism of the European powers. This trend towards globalization of trade and political might, allowed the consolidation of the main European states, as well as the accumulation of enormous financial resources, which allowed the necessary investments to begin the industrial revolution.

European cities, which originally had developed as commercial centers (burgs) became the places where the first industrial trials took place. Industrial processes required many workers to manipulate the new machines and gradually thousands of laborers from the impoverished European countryside started moving to the growing urban areas. By the end of the XVIII century English cities had grown considerably, London increased from 50,000 in the XIII century to about 225,000 in the 1600's, Hamburg grew from 70,000 in 1700 to about 130,000 in 1800, New York in the United States from 33,000 in 1790 to 60,000 in 1800.

The rapid growth of these urban centers did not allow for much urban planning. These cities did not possess adequate services and the quality of life of the working class was very inadequate and unhealthy.

The larger industrial megalopolises developed in the XVIII and XIX century. London was one of the first cities in history to surpass 1 million people. At the beginning of the XIX century it had 1,120,000 growing to 6,590,000 in 1901. Paris in France boomed from 550,000 in 1801 to 2,450,000 in 1891 and the largest largest industrial city in North America, New York, which had reached 1 million by 1870, kept growing to reach 5,6 million people in the 1920's. Berlin, which was a 100,000 people city in the late XVIII century had grown to 830,000 in 1871 and to 2,000,000 in 1912. Hamburg grew from 130,000 in the early 1800's to 700,000 by 1900 and

Cologne increased from 42,000 in 1801 to 370,000 in 1900. In Japan, Tokyo (at that time called Edo) had reached 1,200,000 in the 1850's. By the early XX century there were at least 10 cities throughout the world of 1,000,000 inhabitants or more.

During the last decades of the XIX century, some of the most pressing urban environmental problems were partially addressed (i.e. water supply and sanitation), but many other new aspects continued to develop (i.e. contamination of streams and air pollution). The late XIX century was the time in which smog threatened the health of the urban dwellers in the industrial world and the filthy waters of the river Thames or the Hudson invaded all with their stench.

The larger industrial cities continued growing for many years. London housed more than 7 million people in 1930, by 1940 the population of New York was of about 9 million and Tokyo had reached 5,000,000 in the 1930's. Paris, Moscow and Berlin among others had all exceeded 3 million by 1935.

The reasons for this unprecedented urban growth relate with the essence of the industrial model. It was based on the competitive edge resulting from industrial production systems. These were systems based on the use of engines of various types running on fossil fuels (coal, petroleum, etc) and later on hydro-electricity and on a complex production system in which each worker specialized in a specific task allowing a maximum output effectiveness with a centralized management which oversaw all the steps of the process and ensured their coordination and agility.

The new sources of energy and the effectiveness of the system of production allowed a multiplication of output, which in turn allowed increasing numbers of rural dwellers to migrate to the city either as laborers in the spreading factories or as workers in the myriad of service activities that were developing as a result of the economic growth.

This model did not apply only to plant production. It was utilized in all aspects of life. Large cities, very tall buildings, giant engineering works, huge hospitals, very wide highways, large schools and Universities were the rule of the times. In other words: huge was beautiful...

The development of a city was measured in the height of the taller skyscraper, in the length and width of its largest highway, on the size of the biggest factory and in the number of its inhabitants. Quality of life was totally secondary.

The old problems of environmental sustainability that had been experienced by London or New York at the end of the XIX century had been more or less solved, but new ones kept appearing. Water supply for so many millions became a difficult enterprise. In New York the aquifers of Long Island were depleted, saline intrusion ensued. In London, the Thames became an open sewer. Similar views could be found in Frankfurt on the polluted river Mainz, Cologne on the Rhine or Moscow on the Moscova and even beautiful Venice started sinking in its own ugly waters.

Suddenly, solutions had to be found. Urban planners became important people, large investments were made, a decentralization drive developed (partly as a result of planning, partly on its own) and the growth of the larger industrial cities started to dwindle. Today, the largest European metropolises have largely stabilized their populations. In the 1990's London has less population than in the fifties¹. Paris population peaked at 10 million in the early seventies and did not increase further during the last two decades. Hamburg population has decreased from 1,850,000 inhabitants in 1965 to 1,700,000 by the end of the 1980's. The growth of the core of the largest Northeastern American cities (New York, Pittsburgh, Philadelphia, Chicago, etc) has stopped for some time and a new less concentrated urban model more focused on rural development starts gradually to take form.

THIRD WORLD COUNTRIES WANT LARGE CITIES TOO

However, while this is happening in the developed countries, with a weakening of the old style processes of industrialization in Europe and North America, the Third World countries are suffering an "encore" of the old industrial experience. Humans have a tendency to stumble twice in the same rock (and what a rock!).

The largest Third World cities have welcomed many of the polluting industries that were moving out of the developed countries. The large metallurgic factories, automobile making complexes, chemical industries of various kinds, large tanneries, and many other pillars of the industrial age started sprouting all over the world: in Sao Paulo, Seoul, Mexico City, Cairo, Bombay, Manila, Djakarta and many other metropolises in the eager "developing" countries.

Gradually, the ranking of hugeness was profoundly modified. While London and New York, the largest megalopolises of the past, remained behind, several Third World cities appeared in the upper echelons: Mexico City with 20 million people, Sao Paulo with 18 million, Shanghai, Cairo, Bombay, and Calcutta with 15 million each, Seoul and Buenos Aires with 12 million, Manila, Bangkok, Djakarta and Rio de Janeiro with 10 million and so on. The list is not complete. In the meantime London, Paris and Frankfurt have not changed much. According to the old industrial standards they have remained behind. Or haven't they?

In reality, we don't need to use the old standards, and perhaps the population ranking of cities only measures the degree of unsustainability of urban places. Perhaps, the higher ranking cities are the ones with less time to change direction. Now we know that huge is not necessarily beautiful. Perhaps everybody is happily going the wrong way...

¹ London population in 1951 was estimated at 8,350,000, decreasing in the following years to 8,170,000 in 1961, to 7,380,000 in 1981 and less than 7 million in the nineties.

THE MEGALOPOLISES OF TODAY

As it was mentioned in the last section, there are many large urban metropolises today with ten or more million people concentrated in a relatively small area, trying to survive the best they can in the crowd. Some, as Tokyo or Los Angeles are still located in the "old" industrial countries. However, the majority, today, are found in the Third World. In the following section we will try to describe briefly some of these megalopolises which we believe are representative of the challenges affecting the urban areas today. We will try to synthesize some elements of their history, their environmental characteristics and evolution including some thoughts about their sustainability in the future. The cities we will deal with are: Mexico City, Los Angeles, Sao Paulo, Cairo and Calcutta.

MEXICO: A THIRSTY CITY²

Environment and history

There are probably very few cases in the world in which a physical environment has been so completely transfigured by urban development as it is the case in Mexico City. The valley of Mexico is a 9,600 km² closed basin raised to an altitude higher than 2,200 m. above sea level, located in the heart of the Mexican Neo-volcanic Belt.

Before the arrival of the Europeans, in 1521, the valley was a depression in whose bottom several lakes had developed due to volcanic obstruction of the drainage about 700,000 years ago. These lakes occupied a total area of about 2,000 km² and were partially connected, particularly during periods of highwaters. Three of the lakes contained freshwater (Lakes Mexico, Chalco and Xochimilco) and the other three, brackish water (Lakes Texcoco -the largest with 800 km²-, Zumpango and Ecatepec) (see Fig.5).

The area was (and is -to a certain extent-) sub-humid, rainfall was probably slightly more than present figures (which range from 600 mm. per year in the bottom of the valley to 1,200 mm. in the nearby mountains), with relatively cool average temperatures (for the sub-tropical latitude in which the city is located) ranging from 8 to 15 degrees C depending on the altitude, and highly fertile and easily workable deep soils.

The land was completely covered by thick forests, particularly on the slopes of the mountains and highland areas. The valley plains (which were originally also covered

² Castillo Berthier, H.F., 1983; Cortes A., Jaimes, L.R., and Farvolden R.N., 1989; Gonzalez-Moran, I. and Rodriguez-Castillo, 1989; Granado Velazco, A., 1988; Herrera I., Yates, R. and Hennart J.P., 1982; Herrera I., 1989; Ortega, A., 1988; Ryan, M.C., 1989; The Globe and Mail, 03/02/1990; and Yates, R., 1989.

by forests), were very soon dedicated to the agriculture and therefore parts of the forest were eliminated to give way to farming activities.

In addition to the freshwater lakes, there were a large number of springs providing considerable volumes of good quality water, located both around the lakeshores, and on the foothills of the nearby mountains.

Due to these environmental resources, the valley was occupied from very early by a number of indigenous populations, which based their economy on a number of locally domesticated crops and farming animals (corn, tomatoes, chillies, cacao, turkeys, "escuinle" dogs, honey bees, etc.) and fishing. Because the local civilizations did not have any domesticated working animal and did not use the wheel, most of the commerce had to be carried out by using boats (or on human backs).

Several nations successively inhabited and controlled politically the lacustrine area during the last few centuries before European conquest started. The last nation to control the region were the Aztecs. This group had arrived from the legendary land of Aztlan (probably located to the North in more arid territories) during the 14 century A.C. and due to the general occupation of the lacustrine shores by other groups, they were forced to settle in some swampy lands inside the lake.

At that time, the Aztecs probably obtained their livelihood from fishing and commerce with neighboring groups.

Gradually, they managed to build an island in the Southern sector of the lakes (in the center of the Lake of Mexico), in which a town developed: Tenochtitlan, which later was to become the main city of the valley.

Through alliances and wars, the Aztecs built an empire, and Tenochtitlan grew to become a thriving city of several hundred thousands people. A bridge was built to communicate the island with the mainland, and large boats were used to transport people and merchandises in all directions.

The Aztecs built important pieces of engineering (earth dikes) to control flooding and to separate brackish water lakes from those of fresher water. In addition, aqueducts were built to bring fresh water from the springs to the city (through the lake and along the dikes).

From Tenochtitlan to Mexico City

It is difficult to believe the extent of the changes that took place in the few centuries after the Spanish conquest.

Today, the proud Tenochtitlan has disappeared and only scattered archaeological remnants can be found during excavations. In its place stands the highly urbanized downtown area of Mexico City (see Fig. 6).

The Lake of Mexico is gone. Instead, there are several hundred km² of urban neighborhoods built on what used to be the lake bottom. The lakes of Chalco and Xochimilco are also gone. Only a few canals and little lakes are left. The rest has also been covered by streets, buildings and other urban structures.

The three Northern lakes have also disappeared. As it also happened with the Southern lakes, they were gradually drained (since 1786) and the former Texcoco lake bottom has become a flat vast plain³, in which vegetation does not grow (or grow with difficulty) due to the high levels of alkalinity (pH in excess of 10). Today, an intricate maze of wells and pipes pump the brines contained in the lacustrine sediments out of the ground for exploitation of the various chemicals contained in the groundwater (sodium carbonates and sodium chloride).

The old springs that provided water for the riverine populations are also gone, now more than 5,000 wells extract in excess of 50 m³/sec. of water from a depth averaging more than 100 m., gradually pushing down the aquifer levels by as much as 1 m./year.

As a result of this overpumping and due to compactation of the upper layers of sediments, widespread subsidence phenomena have developed. Sinking has reached more than 6 m. in several places and due to differential rates, many structures have been weakened and in some cases dangerous deviations from the vertical can be observed (as it happens in the Cathedral, in the older Basilica de Guadalupe church and the Palacio de Bellas Artes).

This type of phenomena has been exacerbated by the frequent seismic activity, of which the most recent destructive example was felt in the earthquake of September 1985.

The forests that used to cover all the adjacent hilly slopes have practically disappeared and widespread soil erosion processes have developed. On the other hand, most former agricultural lands have been covered by pavements, houses and other urban constructions.

Quarries have also been excavated throughout the whole region to obtain construction materials. Some became garbage dumps in which part of the annual 10 million tones of garbage are disposed.

³ Lake Texcoco was practically totally drained in the early 900's. However, still today, there are permanently flooded areas which are used for evaporation of the water to obtain highly concentrated brines.

A not negligible portion of the garbage is disposed in the "shores" of the (former) lake Texcoco particularly on its Southern part. Ciudad Netzahuatcoyotl, which is located in that zone of the city, is a 3 million people neighborhood built on the bottom of the lake. This recently created urban area has become a highly degraded environment in which developed areas alternate with garbage dumps and slums.

The valley drainage, which used to go to the lake, now is channelled out of the basin, together with the urban wastewater, through a system of canals and tunnels into the Gulf of Mexico hydrographic system.

A number of pumping wells utilized for urban water supply are located next to the canal evacuating both the wastewater and the excess stormwater (the Chalco Canal). Risks of contamination are obvious and, in fact, some wells had to be closed due to presence of nitrates in the water.

The atmosphere of the valley has also changed its composition due to city growth; emissions from 4 million vehicles and 25,000 industrial establishments in a poorly oxygenated environment (due to the altitude) have transformed the air of Mexico City into one of the most unhealthy urban environments for human life, particularly near the downtown core.

Twenty-one million people live today in Mexico City, making it the largest urban center of the world. Seven hundred and fifty thousand persons are added every year to its population, both by biological increase and immigration from the rest of the country. It is estimated that by the year 2000 the city will have 29 million people (surpassing the whole of Canada!) and by the year 2010, 38,000,000 inhabitants (see Table 1).

If corrective measures are not taken, all the previously mentioned problems, are going to be still further exacerbated, and the ancient paradisiac valley may become (and is in fact becoming already) one of the worst environmental nightmares of the XXI century.

The aquifer and the urban water supply

The aquifer of the Valley of Mexico is one of the key natural elements of the Mexico environmental puzzle. It provides the bulk of the water that makes possible the survival of the City as such.

Some water is brought from outside the basin (from the Lerma-Cutzamala basin), but the volumes are less than 1/5 of the total requirements.

On the other hand, any other option to bring outside water to the valley is becoming unpractical or too expensive. The Lerma-Cutzamala water resources are almost

exhausted and the utilization of other basins (as the Balsas basin or the Amacuzac sub-basin) may imply pumping the water up 1,200 to 1,500 m., plus the construction of long pipelines, storage reservoirs and other related expensive engineering works.

It must also be considered that the use of additional out-of-the-basin water will hurt a number of communities that are dependant on that water for irrigation and supply.

In the meantime, the aquifer remains the main option for the survival of the Mexico urban region.

Geology and hydrogeology of the Valley

The Mexico aquifer is contained in a number of Tertiary and Quaternary units with a thickness ranging from a few hundred meters to nearly 2,000 m. (see Fig. 7). These units are formed by a wide range of sedimentary materials, including various pyroclastic and alluvially reworked pyroclastic sediments, breccias, conglomerates and agglomerates, several types of volcanic sandy formations, volcanic ashes, lacustrine lenses and intercalated lava flows (see Fig. 7).

All of these deposits are closely related to the active vulcanism that took place during the construction of the Trans-Mexican Neo-volcanic Belt and synchronic epeirogenesis.

The base of the sequence is overlying the Cretaceous limestones of the Morelos formation, a 1,000 m.-thick heavily karstified unit, which in the Mexico area constitutes in some way the "floor" of the volcanic sequence.

The above mentioned "base" is composed of the conglomerates and sandstones of the Balsas group of Eocene-Oligocene age. This group is a molasse, which filled the grabens developed during the post-Laramidic orogenetic period. It includes up to 500 m. of conglomerates covered by poorly sorted finer deposits (sandy, but also silty and clayey) up to 2,000 m. thick.

Overlying the Balsas Group there is a complex volcanic sequence of Early Miocene age, composed of various types of pyroclasts (tuffs, breccias, and agglomerates) and alluvial clastic sediments and lava flows intercalated. Thicknesses encountered in recent boreholes varied from 390 to 1,750 m..

Overlying the Early Miocene volcanics, there is a 300-800 m. thick volcanic sequence which includes andesitic lavas, volcanic breccias and tuffs, which in turn is overlain by andesitic-dacitic volcanic of Early Pliocene age, including lava and several associated unconsolidated pyroclastics (300-600 m. thick).

On top of these extrusive rocks, the pyroclastic flows of the Otomi formation are found, with ash-flow tuffs, ash-fall tuffs, breccias, and associated andesitic lavas.

The Otomi formation is covered by a complex sequence of volcanic units including the formations Las Cruces, Zempoala, Navaja and undifferentiated Pliocene pyroclastics of Pliocene age and the formations Llano Grande, El Pino, Tlaloc, Popocatepetl, Chichihuanitsin and Iztaccihuatl of Quaternary age.

Finally, the plateau depressions are filled with a sequence of alluvial and pyroclastic accumulations with thicknesses of about 500 m. (Formation Tarango in the valley of Mexico) over which a few tens of m. thick lacustrine deposits are found (locally up to 400 m.).

The valley of Mexico, therefore, has been formed as a result of continued volcanic build up, in which the molassic detritic formations of the Early Tertiary were covered by a long and complex succession of volcanic extrusions, which included huge volumes of pyroclastic materials (more or less reworked by fluvial action) and intercalated lava flows. In moments of volcanic paroxysms, tuffs breccias, ashes and lava were formed, while in moments of less activity, alluvial and lacustrine action was more important.

From a hydrogeological point of view, the main water-bearing formations are the Tarango Formation and associated alluvia, and the Cenozoic sequence of fractured pyroclastic and lava flows. These formations are overlain by younger lacustrine sediments, giving a confined character to the main aquifer.

This whole sequence can be up to 2,000 m. thick, but the lower 1,500 m. are more consolidated with smaller effective porosity (associated with fracturation) and -hence- much less production potential. The upper tens of m. of the aquifer are too close to the upper lacustrine clays and continued pumping may produce dewatering and consolidation of these clays, unleashing subsidence processes.

Therefore, the usable portion of the aquifer is normally situated between 100 and 500 m. below ground surface.

Recharge to the aquifer mainly takes place in the mountains area (Chichinautzin in the South, Sierra Las Cruces in the West and Sierra Nevada to the East). The total recharge has been estimated at about 25 to 50% of the precipitations (25% in Sierra Las Cruces, 35% in Sierra Nevada and 50% in Sierra Chichinautzin). Of these volumes, about half flows towards the valley of Mexico and the rest outwards to other basins.

Accurate figures for inflow to the valley aquifer itself are difficult to come by. However, they are certainly below 50 m³/sec. (which is the total abstraction) due to the general lowering of the water levels. Figures of 30-40 m³/sec. are probably not far from reality.

Additional lowering of water levels will produce a consequent increase of inflow from the "Sierras" (due to increase in gradients). However, this is not enough to compensate the deficit, particularly if pumping is increased (see Fig. 7).

Precise forecasting of aquifer reaction to very prolonged pumping requires accurate modelling for which only recently adequate information on the geometry and hydraulic properties of the reservoir have been available. Modelling of the aquifer has been mainly developed at the Instituto de Geofísica of UNAM by I. Herrera and other Mexican scientists and it is expected that factual adjustments to the existing models and new models to be developed in the future will allow to predict the actual potential of the groundwater resources of the Valley.

LOS ANGELES

Los Angeles, which was founded by the Spaniards in the XVIII century had only 1,600 people in 1848, the population was half Spanish and half Indian and it was twice the size of San Francisco, which at the time with only 800 people, could be easily considered a "village".

However, when a few years later (in the 1850's) San Francisco became one of the largest cities of the United States with more than 50,000 people and one of the busiest ports in the world, Los Angeles still remained a small torpid little town. Too far from the gold fields, sitting on an arid plain, and lacking a port and a railroad it did not possess the best conditions for rapid growth. At the time an "Angeleno" said of his home town: it is a "vile little dump... debauched... degenerate... vicious".

A few years later, in the sixties, the Mormons stepped in, starting farming of fruits (i.e. oranges) and other vegetables. Agriculture was later firmly established by Quakers and German farmers even after the Mormons left. The cause that allowed this development was easily accessible and abundant groundwater, still with artisan pressure throwing the jet 2- 3 m. into the air. In 1867, when a railroad line was established, the city took off.

Getting the water from Owens Valley

The Sierra Nevada of California blocks humidity coming from the ocean and precipitation may vary from 2,400 mm in the Western slope to 300 mm or less in the East. The rivers flowing West are substantial, the rivers from the East are small, except the Owens river. It is born Southeast of Yosemite, heads westward and south into the Owens valley and then into the highly saline Owens lake. The zone contained a rich ecosystem, shrimp and flies provided food for millions of waterfowl. The main attraction was the water of the river that started to be used for irrigation. In the 1860's the Paiute Indians were practicing irrigation learned from the Spaniards. When the first settlers arrived the Indians did not last long. They were murdered or drowned in a few years, and by the 1870's the settlers took all their land and their irrigation system. By the end of the century there were 15,000 to 20,000 hectares under cultivation.

The Los Angeles river produced large floods (but people at that time did not know that those floods in reality meant "aridity"). The flow of Los Angeles river was not much, and it was gradually decreasing due to infiltration (suddenly the water levels had dropped enough to induce infiltration).

When water became insufficient, one of the first solutions to be considered was the Owens river. It was far away (almost 400 km.) but it could provide water for 1 million people... (at least this is what Fred Eaton and Bill Mulholland the two founders and executive officers of the Los Angeles City Water Company thought at the time).

However, it was 1880 and still too early to undertake an expensive engineering work of this type. At that moment, the initiative did not go much farther.

In 1900, L.A. reached 100,000 people and the artisan pressure of the aquifer continued dropping. By 1904 the government took over the company and the L.A. Department of Water and Power was created. One of the first tasks of the L.A.D.W.P. was to try to secure the water rights in the Owens valley and the construction of an aqueduct to the city.

The city insiders wanted to be able to use the excess water in the San Fernando valley (in other words instead of irrigating the lands of the Owens valley, they were aiming to irrigate the lands of the far away San Fernando valley). The words of Theodore Roosevelt give an idea of the ideology of the times. Mr. Roosevelt wrote: "It is a hundred, or a thousandfold more important to state that this water is more valuable to the people of Los Angeles than to the Owens valley".

The aqueduct took six years to build, 2,000 to 6,000 workers were involved in the enterprise, the length of the water canal was 360 km., of which 80 km. in tunnels. More than 190 km. of railroad track and 800 km. of roads and trails had to be constructed. Up to 380 km. of telephone lines and 270 km. of power transmission lines were tended. It was a huge undertaking for the times.

However, during the next twenty years no water from Owens valley went to L.A. It all remained in the San Fernando valley and was utilized for irrigation. San Fernando irrigated areas grew from less than 1,400 has in 1913 to 35,000 has in 1918. In the twenties, drought ensued and several complementary small reservoirs had to be built.

By that date, lobbying for the Colorado aqueduct had already started but it was unsuccessful. Instead, the city utilized the Owens sources, gradually drying up the river. L.A. bought most of the remaining water rights, reducing the availability for the farmers of Owens (however, increasing it for San Fernando). The tensions mounted and one day the water conflict exploded, the remaining Owens farmers flooded uselessly their land just to stop water from entering the aqueduct.

At that time the climatic situation had become serious, in 1923 rainfall was 250 mm., in 1924, 150 mm. and in 1925, 175 mm. To make things worse, in the last decade the city of L.A. had grown beyond all expectations to 1.2 million people.

The increased need for water forced the L.A. authorities to continue buying water rights pushing the farmers against the wall. And the war became nasty and violent. In 1924, in full drought, a caravan of cars drove to the gates and opened the weirs. For the first time in many years the Owens river flowed again to the Owens lake.

The L.A. authorities wanted to redress the situation, but the crowd at the canal gates was increasing (even Tom Mix visited the place). The Los Angeles times was siding with the "law-breakers". There was an agreement, and as soon the farmers left, the

L.A. bankers forgot their pledge (what pledge are you talking about?) and the situation worsened. By 1927 terrorist actions started, large pipes and sections of the aqueduct were dynamited. Roadblocks, car searches and floodlights transformed the valley in a "giant penitentiary".

When the crisis continued, William Mulholland decided to enlarge the existing dam in the nearby Saint Francisquito Canyon. It was even worse. The Saint Francis dam storage capacity was increased to 4 million cubic meters in March 1928. As soon as it was finished it started leaking and collapsed. The flood was 60 to 70 meters high. It hit 160 men sleeping downstream in a construction camp. Seventy-five families died in San Francisquito Canyon. Where the canyon opens onto the plain, the wave still was 25 meters high and engulfed the village of Castaic Junction. Total deaths were about 450.

Finally a new dam, up the river Owens (in the Long Valley) was built, and in the 30's for all practical purposes the farming and ranching community of Owens valley had ceased to exist (except in the maps). The last of the ranchers quitted in the fifties.

At a later date, several more mega-projects were built, the Colorado was "tamed" and two giant aqueducts were built transferring water from the Colorado Valley to the Californian valleys and Los Angeles.

In the fifties and sixties, new large hydro-projects continued to be constructed. The largest one, in the Central Valley, was proposed with the justification that L.A. needed the water. In reality, the purpose was to increase the value of desert lands and increase the wealth of a few speculators. The Central Valley project (which is graphically described in the film "Chinatown") was precisely that. A (successful) attempt to convince the L.A. people and authorities and the Federal government that the city needed more water. In reality, the purpose of the project was to increase the availability of irrigation water to the farming areas of the Central Valley which were overpumping their aquifer. As soon as the project was approved, the value of the land increased severalfold. Not a single drop of the water from the Central Valley aqueduct reached Los Angeles. It was used only to allow more unexpensive irrigation for the farmers. However, in spite of all the dams and aqueducts, pumping in the valley did not decrease. Groundwater levels continued dropping and very soon new ideas about new mega-projects started to develop.

A similar situation had been taking place for some time in the coastal plains next to the metropolitan area of Los Angeles. In this area, gradually, new more imaginative approaches were being considered to increase water availability. Instead of investing huge sums of money in far away projects (which in any case always ended producing benefits to land speculators the counties of Los Angeles and Orange preferred toward better management of nearby water resources, particularly through increase of recharge into the aquifer by means of extensive recharge artificial works. Today, in Orange County, groundwater recharge through artificial works in the bed of the river Santa Ana satisfies 70% of the needs of its 3 million inhabitants. In Los Angeles a

similar solution has been implemented with the river Los Angeles. Other neighboring cities of Southern California don't have the same groundwater availability problem and depend almost exclusively on imported water (i.e. San Diego).

CALCUTTA

The site of Calcutta, in one of the arms of the river Ganga delta, the Hooghly river, is located strategically 130 km from the mouth of this river in the Bengala Bay in an area of commercial transshipment from sea to river and land.

Although a village named Calcutta was known to exist in the area in the XVI century, it wasn't until the end of the seventeenth century that the English East India Company established the trading post that was going to become the present megalopolis. This post was in direct competition with the upstream river port of Hooghly controlled by the Mughals. The location of Calcutta was also selected because it was located downstream of the Dutch and French settlements and protected between the river Hooghly to the West and three brackish lakes to the East.

In spite of its strategic position, the site was far from ideal from a merely physical point of view. It is located on a low, hot and humid flood plain with an elevation not exceeding 10 m. above sea level.

The trading post grew relatively fast, first with the incorporation of merchants that had emigrated from nearby Satgaon and secondly with the freedom of trade decree of the Mughal emperor in 1717 which encouraged many tradesmen to move to the city. By 1706, the population was already in excess of 10,000, reaching more than 115,000 in 1752. In 1822 it had grown to 300,000, becoming one of the largest cities of India. In later times the city grew still further, reaching the 1 million mark around the beginning of the XX century, and ten million in 1975. In 1991, its population is estimated at 15,000,000 and it is forecasted that it will surpass 20 million before the end of this decade.

During the XIX and XX century the city has continued its expansion mainly along the margins of the river plain. The metropolitan area is now principally confined to two strips of about 5-8 km. wide on both sides of the river. The Salt Lake project which allowed the reclamation of the lowlands to the northeastern fringe of the city, was followed by other projects locally allowing the lateral expansion of the urban conglomerate.

Calcutta is located in a subtropical area with warm temperatures of about 22o C average and a rainfall in excess of 1,500 mm per year which falls concentrated in a relatively short period of 4 months (June to September).

During most of its history the city obtained its water from wells and from the river Hooghly (which by the time of the independence of the country (1947) provided 75%

of the required water). This stream provided (and provides in a much lesser degree) fresh water during the rainy season and brackish water during the dry period. However, the problems of contamination of the river from urban sources has become so acute, that presently the river water has become unusable for almost any practical purpose. In spite of that there are still many riverine neighborhood using directly the river water.

Since the construction of the Farakka barrage in the Ganges, a substantial volume of water is obtained from this surface source. The rest comes from about two hundred large wells, of which some were drilled during colonial times and some after independence.

Although the needs of the city are estimated at about 3 million cubic meters per day (considering a low per capita daily consumption of 200 liters), the actual supply is about one half of those needs.

This deficit has pushed many citizens to drill or excavate their own wells which add to the strain on the groundwater resources.

Unfortunately, no attempts were made to develop a comprehensive plan to properly manage the groundwater resources of the city. In fact, even the detailed underground structure of the aquifers is insufficiently known. The Calcutta region is a graben between two Precambrian horsts: the Shillong plateau in the East and the Chotangpur plateau in the west. Towards the North the graben is bounded by the Himalayas and slopes gently southward as a "piano keyboard" towards the Bay of Bengal.

This graben has been filled by sediments during at least three sedimentary cycles:

- 1) the Gondwana (Carboniferous-Jurassic) cycle (clastic sediments covered by lavas);
- 2) the Cretaceous-Miocene cycle (clastic and carbonate sediments) and
- 3) the Plio-Quaternary cycle characterized by clastic deltaic sediments. These last sedimentary formations contain the aquifers under exploitation.

The major water-bearing horizons are sandy (coarse and medium) with occasional gravel. In the North of the city these layers are found between 46 and 137 m., dipping towards the South where they are encountered between 187 and 274 m. In the Calcutta region, these coarse layers are covered by a confining clay layer, which disappears about 50 km. North of the city.

The quality of groundwater is medium to low, with a relatively high lime content and TDS values between 500 and 2,000 ppm (hard water). The salinity increases towards the South and East (as it can be expected due to the proximity of the Bay of Bengal

and for that reason it may become too hard for drinking. In the North and West the problem is less noticeable.

Other quality problems is the relatively high content in iron, which together with the high lime content creates corrosion problems in well tubings and screens and among the industrial users.

Recharge to the aquifer does not seem to occur under the urban area (luckily) because of the presence of the confining clay layer. It is believe, that it takes place by infiltration in the sandy deposits located near the surface towards the North and West of the city. It is essential to identify and protect these areas to avoid contamination that could harm irreversibly the underground reservoir.

The city has approximately 700 km. of sewers and about the same length of surface drains. Domestic and human wastes are improperly disposed in all unsewered areas adding contamination sources to the river water. As expressed earlier, contamination of the groundwater is less likely. However, there are indication that the Farakka barrage is receiving an excessive amount of wastes (urban and agricultural, and in spite of the huge flow of the river Ganga) that will affect the quality of the water to be treated and increase the treatment costs.

It must be remembered that the Ganga basin receives the practically untreated wastes of a population of 300 million people and nearly 1 million sq. of active agricultural land.

The continued growth of Calcutta, as well as the continued growth of the population and related agricultural and industrial activities in the Ganga basin, is going to continue affecting the quality of the water resources both at the Farakka site, and in the river Hooghly itself.

For some time already, Calcutta has been one of the less healthy cities of the world due to the disproportion between population growth and *infra-structural* investment. Calcutta is probably one the first "urban nightmare of the Third World", one of the largest megalopolis without the required resources to face the influx of population. Although, the degradation of the Calcutta environment has been somehow slowed down in recent times, the environmental situation remains very inadequate. Considerable investment and intelligent and imaginative planning is going to be necessary to transform the city of Calcutta in a livable place for the majority of its population.

THE DESERT MEGALOPOLIS: CAIRO

The city of Cairo has developed in a very fragile environment. With an average rainfall of barely 20 mm. per year, it depends almost exclusively from the water provided by the river Nile which crosses the city in an approximate North-South direction.

The Nile valley is relatively narrow during most of its course, seldom more than 20 km. wide, and frequently less than 5 km. The valley has developed as the flood plain of the river and historically, these riverain flatland has been the site of development of a very old agricultural civilization which has occupied the region in an uninterrupted manner from Pharaonic times (5000 years B.C.) to the present modern Egypt.

The base for the region economy has been (and still is, to a large extent) the utilization of the river waters and sediments for irrigation and fertilization. Lately, after the construction of the Aswan High Dam in 1960, the river water levels have stabilized and flooding does not occur any more. Although there is still water from the Nile, the supply of nutrients and sediments has been significantly reduced increasing the dependency of the Egyptian agriculture on (imported) fertilizers.

The North-flowing Nile widens significantly its course at about 100 km. from the shores of the Mediterranean sea. In this area, the river course separates into two main canals (the Rosetta and Damietta canals) and many more smaller ones forming a "delta" shaped alluvial region, which has been and still is called the "Delta" of the river Nile. By the way, all similar coastal alluvial formations in other parts of the world are also called "deltas".

The city of Cairo developed a few km. upstream of this widening of the valley.

The site of Cairo was repeatedly selected for urban center since Pharaonic times when the Giza pyramids were built (2500-2700 B.C.) to the West of the river and a few years later when the city of On (in Greek: Heliopolis) was founded as a commercial and religious center for the worship of the Sun God "Re" to the East of the Nile. This area correspond to the present Masr Gadid or New Cairo.

Although there was a Persian and a Roman fort (Babylon) in the site of Old Cairo, the city did not reappear as an important urban center until the arrival of the Arabs in the seventh century when the town of Fustat was founded which gradually extended to Askar and Katai. Almost three centuries later (IXth Century), in Fatimids times, the town of al Qahira ("The victorious") was founded in neighboring site and under Saladin, the four locales were united into a larger city.

The city has extended considerable since then, there are presently (1991) nearly 14 million people living permanently in the metropolitan area which extends for 80 km on a North-South direction from al-Matariyah to al-Ma'adi, and more than 15 km. on each bank of the river, particularly towards the North-Eastern sector.

The city has been mainly built on a plain underlain by alluvial silty-clayey deposits with a thickness of about 10 m. overlying a 60 m.-thick water-bearing sandy formation, which in turn is underlain by Mesozoic limestones outcropping towards the South of the urban region.

The city has traditionally used the river water for the neighborhoods near the river (which is very abundant, and without shortage particularly after the construction of the Aswan dam), and water wells for far away or more isolated communities. Presently, the water is obtained mainly from the river and treated in three treatment plants which cover only partially the needs of the large metropolitan population (about 3 million m³ per day). It is estimated that more than 3 M. inhabitants of Cairo are not hooked to the urban water supply system, and must buy their water from the water carriers (or obtain it from the river or shallow wells).

The number of unserved people is likely to increase in the future due to the population increase of the city. It is expected that by the end of the century as many as 5 million people will be outside of the city water distribution system.

Before 1980 the wastewater and sewage used to flow regularly the low-lying streets of the city. In the early eighties, the system was gradually reconstructed, but in spite of that by the end of the decade more than 1 million m³ of raw sewage was disposed untreated into the river (treated wastewater was slightly less than half of the total 2 M.m³ per day).

The disposal of untreated sewage into the natural systems is creating serious problems with water-borne diseases, mainly related to use of the untreated river water, particularly diarrhoea, and risks of cholera and typhoid. At the same time, the treatment plants are insufficient to process the increasingly polluted Nile waters. The result is a constantly deteriorating situation.

The gravity of the issue has pushed national authorities and international agencies towards solving some of the most pressing problems affecting the city. After 1980, an overhauling of the old system was started (James Bedding, 1989⁴). The sewers were clogged with dust, dirt and garbage that went into the sewerage system during the infrequent rainstorms. As much of 43,000 tons of muck, grits, untreated industrial waste, and other substances and residues were removed from 57 km. of sewers during a six year period.

A new system is presently under construction and is not likely to be finished until well into the next decade (perhaps in 2005 or even beyond that date). This system includes a large 5 m.-diameter tunnel to collect all the sewage for later treatment, a pumping station, effluent canals and a treatment plant.

⁴ "Mbney down the drains"; James Bedding, *New Scientist*, April 15, 1989, p.34-38.

Tunnelling under this old city is an unending archeological endeavor. Nobody knows for sure what is buried under the streets and buildings of the city. Old pipes, graves, ancient structures, buried tunnels, walls, etc require a very careful digging operation, which has to be carried out laterally at a depth exceeding 25 m. below ground surface. That has been partially done, and it is expected that when the system is finished 25 m³. sec. will be moved towards a treatment plant which will be built 15 km. away from the city. It is not sure if the plant is going to be built soon. For the time being, the untreated sewage will discharge into agricultural drains, with all the risks to the public health that it represents.

Another problem affecting the city, is the rise in water levels of the Cairo aquifer, which has created problems not only for all tunnelling operations (including not only the sewer tunnel, but also the metro tunnels) but also for some city basements, and is threatening to produce flooding in the lower lying areas of the urban region.

It is believed that the recharge of the aquifer comes only in a small proportion from surface rainfall. Because the groundwater levels are higher than the river Nile, it is known that the river does not constitute a source for this excess water. The most likely sources of recharge seem to be the following:

- 1) leakage from the water distribution system;
- 2) leakage from the sewerage system;
- 3) uncontrolled disposal of wastewater; and
- 4) irrigation return.

The solution (partial) to that problem has been to pump water out of the aquifer and to discharge it into the river. The levels of pumping were in 1979 were of nearly 300,000 m³ per day, but that was insufficient at that time. Additional pumping may be necessary to bring down groundwater to manageable levels.

In summary, the city of Cairo is drowning in its own population and wastes. The fragile environment, the lack of precipitations, the dependency on only one water source (which is also the disposal site) and the constant growth of the city will force to invest large sums in order to keep the situation -at least partially- under control. Probably, the only final solution will be to face the need to stop the growth of population as soon as possible.

SAO PAULO: THE LARGEST INDUSTRIAL CENTER IN THE THIRD WORLD ⁵

Introduction

In spite of its relatively reduced size for Brazilian standards (247,898 km²), just over 3% of the national territory, the State of Sao Paulo with its 33 million inhabitants possesses about 23% of the total population of the country with a density among the highest in the Latin American region (almost 140 inhabitants per km²).

The State also concentrates in excess of 65% of the industrial output on the country, and is the largest agricultural producer (its plantations of sugarcane, coffee and citric fruit trees are the largest in Brazil and among the largest of the world). It also possesses a very numerous cattle stock of nearly 12 million and is the first producer of milk and dairy products.

The State population is mainly urban, (more than 80%) with about 29 cities exceeding 100,000 people. The largest of those, and capital of the state, is the City of Sao Paulo, with a population estimated at 17,500,000 inhabitants in early 1990. The 37 municipalities forming the Greater Sao Paulo metropolitan area, are home for 55% of population of the state and 15% of the total population of Brazil. The Sao Paulo urban area alone produces more industrial goods than the rest of the country. By far, more jobs, are created in Sao Paulo than in any other major city of Brazil.

It does not come as a surprise, then, that the city of Sao Paulo has seen its population increase through constant immigration from other areas of the Brazilian territory. If present trends continued unchecked, the Greater Sao Paulo will possess about 26-27 million people by the year 2000 and 35-37 million by the year 2010.

Historical background

Portuguese settlement in the Sao Paulo region started in 1532, when Martin Alfonso de Souza founded the city of Sao Vicente in the Atlantic coast about 400 km. to the south of the Bay of Rio de Janeiro. In that part of the country, the coastal area is a narrow plain at the foot of the scarpment of the Serra do Mar, with little room for agricultural expansion. The next step was to found a city in the interior, beyond the coastal range. This was done by the jesuits, who had already missions in the Upper Tiete basin.

The city of Sao Paulo de Piratininga or Sao Paulo dos Campos (which was to become simply "Sao Paulo" in the future) was finally founded in 1554, on a hill between the rivers Anhangabau and Tamanduatei, tributaries of the Tiete river.

⁵ Asesor ia Recursos Hidricos- DAEE, 1988; Gardner J.A., 1977; Hermann, R.M., 1979; Mariani Neto F. et al, 1988.

During the XVIIth and XVIIIth centuries, the growth of Sao Paulo was tied to its role as traffic center of indian workers for the sugar cane plantations of the Northeast, and for the mineral exploration in the hinterland (particularly in what was going to become the State of Minas Gerais). At a later stage, in the XIXth century, the city became the center for the production of coffee, which was going to be -with time- the main export item of the region and the country for many decades.

During the XXth century, particularly during the last tens of years, the city became a very strong industrial production center, both for national consumption of industrial products and for export. Some of the most important industrial activities include metallurgy, automobile manufacturing, chemical, mechanical, textile and food industries, etc.

Geology and hydrogeology

The city is located in the heart of the "Planalto Paulistano" which is a 5,000 km² area of undulating relief, with elevations ranging from 715 and 900 m. above sea level (see Fig. 8). The region is underlain by crystalline shield rocks including phyllites, micaschists, gneisses, various types of migmatites and isolated granitic intrusions.

In the Sao Paulo site itself, there is a sedimentary basin of tectonic origin, developed during the Pliocene and Pleistocene Epochs of the Cenozoic Era (see Fig. 9). The sediments of this basin extend for about 1,000 km², with a maximum thickness of 300 m. and are composed of clays, silts, clayey sandstones, and some sandy and gravelly lenses. The crystalline areas of the Planalto Paulistano are deeply weathered, with weathering mantles locally exceeding a thickness of 70-80 m..

The main aquifers of the Sao Paulo region are the coarser sandy lenses of the Sao Paulo formation and the thick mantle of weathering in the crystalline areas. The wells in the Sao Paulo aquifer are normally screened at depths from 100 m. to 200 m. and deliver yields of 50 to 1,700 liters per minute.

The environment

The area possesses a sub-tropical humid climate, with average annual temperatures of 20 degrees C, varying from a low average of 14 degree C in the winter (July) and a high of 26 degrees C in the summer (January).

The Sao Paulo site is among the most humid areas of Brazil. Average annual rainfall ranges from 1,500 to 2,000 mm. in the Sao Paulo stations, and can reach in excess of 3,000 mm. per year in some neighboring hilly areas.

Hydrographically, the city is located very close to the waterdivides between the large Parana basin to the West and the small steep coastal basins of the Serra do Mar scarpment to the East. The city itself, has grown to occupy the valley of the river Tiete and its largest local tributary: the river Pinheiros.

The river Tiete is the hydrographic backbone of the state of Sao Paulo draining an area of 150,000 km² and flowing Westwards from its sources in the Serra do Mar highlands, to the Upper Parana, about 150 km. North of the river Parapanema confluence.

Problems of water management and supply

At the beginning, the city was supplied from several surface sources and springs by means of water carts with doubtful sanitary conditions⁶. In 1877, when the city counted about 50,000 people, the private "Companhia Cantareira de Esgotos" was created with the purpose of taking care of the water supply and sanitation of the city. A few years later (1881), the small reservoir "da Consolacao" was built and put in operation for water supply of the city. Ten years later, and due to the popular dissatisfaction with this company, the government took over the company forming the Reparticao de Agua e Esgotos (RAE). In 1897, water from the Tiete river was used at "Belenzinho". However, there were already problems of contamination in this river since those early times. In 1914, a strong epidemy of typhoid fever developed in the poor neighborhoods of the city.

Originally, all the Sao Paulo water drained towards the Parana basin. However, in 1920 a reservoir was built in the Upper Pinheiro basin (the "Billings" reservoir) with the purpose of taking advantage of the Serra do Mar fall towards the Atlantic, for hydro-electrical production purposes. The project included a reservoir near the headwaters of the river Pinheiros, a pumping system to rise the downstream Pinheiro waters to the reservoir and the actual power producing fall.

At that time, the river Pinheiros was not contaminated, because the city growth had not reached it yet. Presently, the river Pinheiros has become an "open sewer", its water is a combination of highly contaminated urban wastewaters and stormwaters and this is what is presently being pumped up into the Billings reservoir.

Instead of writing-off the reservoir for water supply purposes, the Billings reservoir has been divided in two parts: one portion which is the one who receives the water from the Pinheiros, and another smaller section which is utilized for water supply purposes by the large suburb of San Andre (with in excess 1 million inhabitants) and other urban and suburban neighborhoods. Both parts of the reservoir were divided by a relatively permeable earth dam which allows flow in both directions; however, the "water supply" water is kept at a higher level than the contaminated water in order to restrict the flow in only one direction. The Billings reservoir, however, receives probably also polluted water from urban encroachment in its basin. Close monitoring of the situation is required in order to prevent the obvious hazards represented by utilizing a water body with those risky characteristics.

The upper course of the river Tiete near and downstream of Sao Paulo, has also become a highly contaminated river (another virtual "open sewer"). Its waters are partially utilized for irrigation of vegetable farms (for consumption in the city of Sao Paulo) and then continue flowing downstream through the "Paulista" hinterland,

⁶ A very interesting research on the history of water supply in Sao Paulo was published in the DAE magazine, Vol. 50, No158, Jan/Jun 1990 ("Curso d'Agua" by Luis Avelima).

where they are utilized for water supply purposes by several communities of the Sao Paulo interior.

Several attempts to correct this situation failed⁷ and probably now it would require huge investments that are not readily available.

In 1954, the RAE, was substituted by the DAE (Departamento de Aguas e Esgotos) and at a later date (1973) the SABESP⁸ was created. As a result of the operation of the water and sanitation services by SABESP, the situation has improved from an organizational point of view. However, the growth of the metropolitan area was faster than the growth of the water and sanitation services, and as a result, there are still many urban and suburban areas with insufficient water services. In a number of communities and in many industrial plants, groundwater is utilized (it is estimated that as many as 30 % of the Greater Sao Paulo homes obtain their water from wells).

The water supply for the city of Sao Paulo and neighboring municipalities is obtained mainly from a complex network of reservoirs utilizing many small tributaries of the Tiete in the upper basin of this river (which includes the previously mentioned Billings reservoir in the upper Pinheiro basin)⁹.

Total municipal water consumption of the Greater Sao Paulo in 1990 is calculated at about 50-55 m³/sec. It is expected that by the year 2000 it will reach 65-70 m³/sec. and 80-85 m³/ in the year 2010 (exceeding the ultimate capacity of the city systems. These water volumes do not include private wells and are obtained from surface water sources.

Some groundwater is obtained for municipal purposes utilizing both the aquifer contained in the Sao Paulo formation and in the weathered mantle of the crystalline

⁷ In 1940, when Sao Paulo possessed 1,379,000 inhabitants, a "Commission of Investigation of Water Pollution in the State of Sao Paulo" was created. Unfortunately, very little was done with regard to the Tiete river and very soon it became a practically "dead" stream.

⁸ SABESP (Companhia de Saneamento Basico do Estado de Sao Paulo) was created in 1973 by merging COMASP (Companhia Metropolitana de Agua de Sao Paulo) and SANESP (Companhia Metropolitana de Saneamento de Sao Paulo) which had been created in 1968 and 1970 respectively instead of DAE.

⁹ The main water supply systems of Sao Paulo and their capacity are the following: 1) Cantareira (27 m³/sec); 2) Guararapinga (11 m³/sec); 3) Rio Grande (3.6 m³/sec); 4) Rio Claro (3.7 m³/sec); and others (1.55 m³/sec) for a total of 46.85 m³/sec. These figures are valid for 1986, the ultimate capacity of the systems will be 75.1 m³/sec. (source: "More and Better Water for Thirsty Sao Paulo, Brazil"; Kawamura, S. et al, Journal American Water Works Association, Oct. 1989).

complex. By far, the main use of groundwater is by the industrial establishments with consumption volumes of 20-25 m³/sec. (slightly more than 1/3 of the total).

In brief

Although the city of Sao Paulo is located in a high rainfall site, available water volumes are limited due to the proximity of the Serra do Mar waterdivide. All rivers are small, with small catchment basins and many dams had to be built in order to store the water required by this huge megalopolis. In addition, a complicated system of pipelines, tunnels, storage tanks, and various other conduction and storing structures have been constructed (and more are required) to bring water for Sao Paulo from the surrounding small basins and reservoirs.

Unfortunately, groundwater resources are not very abundant either. Sao Paulo is located on the crystalline Brazilian shield with few hydrogeologically productive areas. The presence of the tectonic basin of Sao Paulo allows some storage underneath the city and some water is available from the weathering mantle of crystalline rocks. However, the volumes available from this source are also limited.

In addition, the city has not controlled properly its wastes during too many years. The rivers are heavily contaminated, some catchment basins are threatened by urban expansion and therefore contamination, and groundwater reservoirs are not protected.

Sao Paulo will be facing a difficult environmental future if a much more careful management of its water resources is not implemented. Only then, it will be possible for the city and its population, to survive in this hydrological environment, which was suitable to satisfy the needs of a small or medium size city, but that is, by no means, adequate to solve the water problems of a megalopolis of nearly 20 million people.

CHAPTER 13

DIVERSITY AS A RESOURCE

During the previous chapters we have been touring the widespread processes of environmental degradation throughout the world and trying to fathom their causes, past and present, as well as the effects that new trends are producing or will produce on the environment in the years to come.

The effects of human action have been profound and cumulative. The composition of the earth atmosphere is being gradually modified introducing uncertainties about the potential consequences that could even threaten life on earth as we know it.

Planetary waters are being contaminated on the continents and in coastal areas, and even in open ocean signs of degradation are becoming all but rare.

Processes of elimination of the vegetation cover are promoting widespread erosion, changes in hydrological regimes, and frequently, floods and droughts in areas in which they were previously unknown.

Complementarily, and with similar negative effects, a large number of "scars" often irreversible are being produced by mining operations, as well as by quarrying for building construction or engineering works such as highways or dams.

The combined effects of these degradation processes are taking its toll on the survival of many species of plants and animals, which are finding increasingly difficult to survive in a changing environment for which they do not possess the necessary genetic adaptations. As a result of all these changes, the equilibrium of ecosystems is being altered and widespread modifications of their specific compositions and inter-specific relationships is taking place.

A main consequence of this deterioration of the physical and biological support of the ecosystems is the general loss of biodiversity both in number of species and varieties.

Simultaneously with this biological impoverishment, widespread trends towards social and economic uniformization are taking place, rapidly deleting the richness of hundreds of cultures including a huge volume of knowledge about nature that has accumulated during many generations. Macro-economic trends are forcing local communities into high-productivity mono-specific crops or animal production systems for commercial purposes, substituting the enormous diversity of traditional crop or animal varieties by a few ones meeting the conditions for short-term competitiveness imposed by the globalized international markets.

In much the same way in which species and varieties are becoming extinct, languages, beliefs, traditions, empirical knowledge and whole environmental management systems are being wiped out from the face of the earth by a short-sighted "main stream" culture which does not offer appropriate substitutes for the sustainable long term strategies that are in most cases contained in the older and more experienced cultures of the globe.

These human and biological diversities under attack, represent the bulk of the planetary natural and human resource base and their elimination will result in a gradual loss of the options for the future, not only for the generations alive, but also for the many to come.

INVENTORYING DIVERSITIES

In most cases, it is difficult to acquire sufficiently precise knowledge of these diversities. Although it is possible to survey plants or animals living in small restricted areas (i.e. of a few m²). It is not possible to survey all plants and animals living in larger ecosystems and even less to decipher the complex web of their relationships. The taxonomic and genetic complexity of most bio-systems is such, that even if a strong and continuous effort is made, it will be impossible for some time to come to properly characterize all existing species and varieties of plants and animals and their specific relationships. What is normally done, is to characterize the **main** (larger, more frequent) species and a few varieties. Entomologists believe that there are several millions of insect species, perhaps as many as 500,000 species of choleoptera. Varieties of all these species can run in the hundred million or more. Some high diversity ecosystems as the rain forests and coral reefs are poorly known. There are more than to 100 species of trees in just one hectare of rain- forest such as the Amazon or New Guinea and perhaps as many as 200 species of mollusca in one km.² of coral reef in the Australian Great Barrier. The task of the taxonomist is a slow and difficult one and obviously it will take centuries before a significant portion of the planetary biota can be identified and described. But by then, it may be too late.

Another reason adding to the difficulty for defining bio- species, in addition to their sheer numbers, is that species are not "frozen" components of the biosphere but rather a continuous evolving complex very difficult to keep "updated" in any given moment. In reality, species are only a brief step in the evolutionary ladder and an adequate definition would imply not only to have a proper description of the organism but also of the previous evolutionary path and the tendencies for the future. And obviously, there are no basic knowledge and the necessary resources allowing to do so in sufficient detail.

When we deal with cultural diversity the problems are similar. It is possible to inventory languages. If they are not written, scripts can be invented, dictionaries can be put together and pronunciations and accents can be recorded. However, once the language speakers are gone, they take with them not only the deep semantic code

(which no "recording" can preserve), but also the basic elements that make a language, its dynamism, its changes, its role as a potential tool for social learning and innovation. Because languages are also windows to a whole imaginary universe, language "extinctions" represent irreversible ideological losses.

Many other elements of knowledge are being lost in this flood of standardization and homogenization: local knowledge about plants, about animals, about appropriate technologies, about environmental and social strategies, about how to organize societies and their survival in the diverse planetary environments, about espiritual approaches to nature.

FUTURE RESOURCES ARE UNKNOWN

As expressed above, most diversities, both biological and cultural are poorly known or unknown. At the same time, we do know that some of these diversities will become resources in the future. Perhaps the flower of that plant has a substance that will allow to produce an important medicine to treat a particular strain of a disease that does not even exist yet. May be the shamans of this Amazonian micro-nation know about one plant producing a glue 100 times stronger than anything known. May be this traditional group has a logical approach to environmental management of its particular ecosystem that can be used and/or replicated somewhere else. The possibilities are infinite.

All diversities have the potential to become resources, and all present resources were only diversities in the past. For this reason, we can say that diversity is the "mother of all resources". Future resources are today's diversities. Yesterday's diversities are today's resources.

However, we don't know and we can't know for sure which diversities are going to become resources. The bottom line is that societies have a fan of potential resources today loosely defined as "diversities" and are experiencing a number of processes (some of them of "productive" nature) which are having the effect of destroying them.

How do we ensure that we protect our present diversities, that is, our future resources? There is only one way: by protecting present diversities.

In all situations, some basic premises must be remembered, high diversity environments are **full** of potential resources and must be protected, and although low diversity environments have probably less potential resources they must **also** be protected because we don't know the nature and importance of their potential. In other words, **all diversities must be protected.**

The over-riding aim should be to ensure that not only the well-being of today's societies is addressed, but also that the wealth of the future is not dilapidated.

BIODIVERSITY AND CULTURE

As defined in the previous section, the concept of **biodiversity**, includes both the diversity of living beings as well as their relationships between themselves and with the physical environment. This **biodiversity** occurs dynamically, experiencing continuous changes some of which are cyclical and others evolutionary.

Human societies are not isolated from this natural system, they are closely intertwined with it and it is from this ecological complex that they extract their means of subsistence. When these eco-resources are diminished, the social developmental potential is also reduced.

Every social group utilizes in one way or the other some elements of the surrounding diversity. In many cases this utilization has given rise to complex management systems which frequently have been developed through long processes of trial and error. These "management systems", based on indigenous knowledge are often well adapted to the dynamics of natural ecosystems.

On the other hand, ecosystems are complex realities, involving innumerable relationships between physical, chemical, biological and anthropogenic factors. Traditional and popular knowledge provide some empirical indications on how the system must be treated in order to ensure its future health but is often insufficient to provide the elements that are required when unexpected unusual phenomena or unpredictable changes occur.

In order to ensure the sustainability of the systems, it is also required the development of a relevant body of scientific knowledge. However, this scientific knowledge (which as all knowledge is relative) is more effective when conceived drawing upon the richness of the already existing traditional and popular know-how. Understanding, protecting and utilizing in a sustainable way the bio-systems requires a syncretic approach using both types of knowledge. By using this approach, social groups are able to increase their pool of resources and indirectly their quality of life. It is through this type of "empowerment through knowledge" that the issue of biodiversity can be addressed to produce the most profound and positive impact on human societies.

DIVERSITIES AND THE WEALTH OF SOCIETY

Although society strength lies in a large measure on the historical backbone of its heritage, its diversities (old and new) provide the flexibility to adapt to change, and therefore to project itself towards the future. From this point of view, then, the long term wealth of a society can be measured through the combined dimensions of its diversities.

As stated above, there are many kinds of diversities (i.e. geo-diversities, bio- and eco-diversities and social and cultural diversities). However, these various types of

diversities cannot be isolated into their "thematic components" for they occur in an inseparable symbiotic relationship.

Before industrial times, social insertion in natural complexes had tended to utilize the natural diversities with only secondary negative effects. In most cases, social action adapted well to natural environments keeping depredation to a minimum and when it didn't, the societies "at fault" suffered themselves the effect of their depredatory action. After the industrial revolution took place, social action has mainly tended to utilize the natural resources and the environment without much regard to sustain the productive and natural base on which societies were supported.

In addition to this process of inappropriate and excessive utilization, as mentioned before, a widespread uniformization trend developed throughout the world. As a result of the more recent globalization processes, these degradation and uniformization trends have accelerated. At the same time, as a result of these tendencies a counterbalancing tendency has developed among important sectors of the countries affected by these degradation/ uniformization processes.

It is a social trend that tends to emphasize the value of existing differences, instead of promoting uniformization. This trend is in some way contradictory with the main stream standardization drive. However, it is becoming stronger throughout the world. The more people are homogenized, the more they react by asserting their own identities and differences. This contradiction seems to be gradually growing and it is probably going to represent one of the main driving forces in future history for some time.

BIODIVERSITY AND RESEARCH

In spite of its relevant and intrinsic value, indigenous knowledge may have important limitations particularly when dealing with trans-cultural or trans-ecosystemic issues or rapidly and unexpectedly changing situations. In many cases, mainly due to degradation processes (cultural attack) it may be fragmentary and its effectiveness significantly reduced. For these reasons, it is necessary to rescue and systematize the many elements of this knowledge, for easy retrieval and appropriate utilization.

On the other hand, it is necessary to ensure that all the effort put in developing this IK not only is saved for the future, but also that the returns from its applicability and profitability go to the communities or social groups who have developed them.

In first place, the knowledge of the components and potential of existing biodiversity must be developed through promotion of an inter and multi-disciplinary approach.

In second place, the **identification and utilization of relevant traditional and popular knowledge** relating to biodiversity issues must also be encouraged and supported. The focus must be on rescuing, systematizing and applying the elements of

indigenous knowledge which could serve as a basis for socially and environmentally sustainable approaches to development.

Some of the issues requiring special attention include the following:

Research on ecosystems, their dynamics and components through the development of **interdisciplinary teams** integrating the various mainstream scientific disciplines with the relevant elements of traditional/popular knowledge.

Here the emphasis should be put on a holistic analysis of natural and anthropogenic systems and their specific components using an inter-disciplinary and a cross-cultural approach. Development of new methods to appropriately "map" the existing resources and for participative design of new, imaginative models for sustainable development represents one of the key issues that need to be addressed.

a) aquatic biodiversity

Complementarily, special attention should be put in the "aquatic biodiversity field" today strongly under attack by some environmental-unfriendly hydro-works, quality deterioration processes or eco-systemic irrational interferences.

These issues should be addressed through a combined approach based on the points of view and knowledge of local groups and communities and the scientific and academic elements and resources at the national and international level within the framework of an equitable and sustainable approach to development.

b) research on technologies aiming to valorize natural products from indigenous/local ecosystems

For appropriate valorization of natural resources it is necessary to develop methods to assist in the identification, assessment and utilization of natural resources from indigenous/ local ecosystems. Emphasis must be put on those resources that could be utilized in the framework of a sustainable approach to development and improvement of quality of life of the populations. Among the local resources it will be important to pay special attention to natural products such as plant, animal or mineral substances that could be identified as resources, and developed either for local use or for marketing outside the production area.

c) preserving the cultural and genetic basis for agricultural biodiversity

In many areas biodiversity relates to cultural transformation of many species or varieties of plants and animals. In these situations, the conservation of the basic framework of local cultures is essential to preserve the existing genetic pool.

In order to assist in the defense of these bio-cultural resources, it is necessary to find ways to ensure the preservation of the germplasm of cultivated crops, as well as developing methods and strategies for rescuing and systematizing relevant indigenous agricultural knowledge.

- d) research on methods and strategies to ensure that indigenous and local groups obtain and/or benefit from the property and intellectual rights for locally devised/ developed resources, products, technologies and ideas

This theme relates with the development of new approaches to ensure property and intellectual rights on resources, products, technologies and ideas, developed as a result of the utilization of indigenous know-how, particularly when these elements are used outside the local realm at the national, regional or international level.

A N N E X

SOME RESEARCH SUBJECTS THAT COULD BE OF INTEREST IN THE BIODIVERSITY FIELD

- I) **Research on ecosystems, their dynamics and components**
 - a) Development of interdisciplinary and trans-cultural teams
 - b) Methods for ecosystemic evaluation.
 - c) Methods for inventorying, analysis, modelling, resource evaluation, and conservation aspects of indigenous/ local ecosystems.
 - d) Methods and strategies for ecosystemic management.
 - e) Rescue, systematization and improvement of traditional and innovative indigenous management methods and strategies.
 - f) Development and/or adaptation of other (non-indigenous) ecosystemic management methods and strategies (and integration with indigenous methods and strategies when relevant).
 - g) Development of methods, strategies and actions for protection of unique ecosystems, species, varieties, etc.

- II) **Management of aquatic ecosystems**
 - a) Management of fluvial ecosystems
 - b) Impact of hydro-works on aquatic systems
 - c) Management of estuarine and coastal ecosystems

- III) **Technologies aiming to valorize natural products**
 - a) Methods for identification, inventorying, protection and management of potential or actual (natural) sources of natural products
 - b) Technological development
 - c) Methods for marketing of natural products

- IV) Preserving the cultural and genetic basis for agricultural biodiversity
 - a) Preservation of the germplasm of cultivated crops,
 - b) Developing methods and strategies for rescuing and systematizing relevant indigenous agricultural knowledge.

- V) Protecting intellectual and property rights for indigenous knowledge.
 - a) Protection of indigenous property and intellectual rights on new resources, products, technologies and ideas.
 - b) Recuperation of indigenous property and intellectual rights when these rights have not been recognized

CHAPTER 14

CONCLUSION: STRATEGIES FOR THE FUTURE

IN THE NAME OF PROGRESS

The industrial society was based on a migratory rural model. During the "industrial centuries" the relative weight of rural population decreased systematically throughout the world. Well into the XX century the number of people living in rural areas decreased below 20% in all industrial countries, without exception. The reasons were many. Rural production was technified, and therefore not so many hands were needed. Jobs were concentrated in towns and better paid, career paths required moving to cities, and after all, farm work required sacrifices; i.e. milking cows on a daily basis, long hours taking care of the crops and other farm chores, often without sufficient economic compensation. In addition, in rural areas social services such as health and education were more difficult to access and leisure and entertainment options were fewer and less attractive.

In Third World countries where the drive toward industrialization developed with delay, the situation in rural areas was (and is) even worse. Widespread unemployment, property of land concentrated in few owners, inadequate housing without water or power, and very poor health services. As a result of these poor conditions in the countryside and the offer of employment in the cities, massive migration to the urban centers took place. City suburbs mushroomed. Slums developed in public lands or in unsafe areas, such as flood plains or unstable slopes.

By the end of the XX century, there is now no country in the world not touched by the rural emigration pattern. As Toffler would put it: the "Second Wave" is reaching the last corners of the Earth.

CENTRALIZED DECISION-MAKING

In the "developed world", in spite of all the official discourses condemning "big government", the industrial system has, indeed, promoted big governments and centralized decision-making processes, both at the public and private level. In the industrial society, centralized, bureaucratic and technocratic administrations control the power. Decisions about everything are made by an "elite" of central decision makers. They make decisions about where and how to build the big hospitals, the large high schools and colleges, hydro-electric dams and nuclear power plants, water distribution networks, eight-lane highways and large football stadiums.

Together with the industrial "elites", they decide upon installation of new, mammoth factories, large shopping centers, supermarkets and giant office buildings. From the beginning, policies and decisions do not take much into account the need to protect the environment. Industrial processes were not conceived to minimize environmental degradation. Effluents go untreated into rivers and lakes or find their way to groundwater reservoirs. Gas emissions go unfiltered into the air. These processes have been going on for decades. A nightmarish scenario ensued. Many lakes died, such as huge Lake Erie on the American-Canadian border; rivers became heavily polluted, threatening drinking water supplies. Smog crisis over the "developed" industrial cities are more the rule than the exception.

In short, the industrial revolution meant a general "de-humanization" of technology and culture which coupled with the notion that the role of humans is to "control" nature as if societies were independent from their home environment. In this unwise "war with nature", even if it wins it, humankind may find itself on the losing side¹.

¹ Shumaker E.F.; *Small is beautiful*; Harper and Row, Publishers, New York; pp.324.

FOLLOWING THE LEADER

Third Countries arrived late to the industrial era, but they came enthusiastically. In some of the largest Third World countries, the industrial revolution arrived in strength and its effects on the environment are surpassing anything that had been seen in the older industrial societies. Urban rivers became urban sewers, lakes in the proximity of cities were completely contaminated, air in industrial zones has become unbreathable, health systems do not work, schools are crowded, crime is rampant. In brief, quality of life has deteriorated. Life is not very pleasant for workers in most Third World industrial urban societies.

The problems of industrialization are still more acute because of the ideology that comes with them. Large factories, large buildings and large hospitals mean "progress". Growth equals development. Environment takes second place behind this notion of "development". These developmental paradigms did not help. Life became miserable but decision- makers were proud. It was just the price of progress...

PEOPLE DON'T WANT ENVIRONMENTAL DEGRADATION

With time, in the older industrialized countries, environmental problems became so acute that civil reaction ensued. Unfortunately it did not happen until considerable damage was done. Pristine ecosystems had been wiped out, aquifers had been spoiled beyond repair, and a whole industrial and urban effluent system had been built with little concern for the environment.

However, public awareness and pressure grew to a point at which decision- makers had to make decisions. Large sums of money were pumped in to solve the problems. In the United States the environmental Superfund injected tens of billions of dollars into environmental correction. Environmental protection came to be considered a rule rather than the exception. Somehow the degradation trend seems to be under control.

Today, in the developed countries, the "industrial" ideology is dying. It is becoming more and more difficult to compel people under the banners of indiscriminate growth, modernity and progress. Local communities and neighborhoods have become very suspicious of new projects and they are examined through the magnifying glass. Increasingly, people are evaluating economic strategies as part of their quality of life scenarios. And politicians take it into account (after all, they want to be elected).

This idea of sustainable growth and environmental protection has not fully reached yet, most developing regions. In most Third World countries environmental degradation continues unabated, forests are logged and burned to make room for commercial crops or cattle raising, indigenous groups are dispossessed of their lands under the name of national sovereignty, good traditional knowledge is disappearing fast and all this is causing problems at the global level.

THE EFFECT OF NON PARTICIPATIVE ENVIRONMENTAL POLICIES

There is mounting evidence that environmental policies, decisions and actions driven by increasingly globalized financial interests, with limited attention to social implications, are responsible in large measure for the destruction of the world's ability to sustain positive development processes.

In the last decade of the XX century there are still continual losses at the eco-systemic and cultural level. While the scope of eco-systemic degradation is clearly critical, more significant in the long run, from the human development perspective is the loss of traditional and popular knowledge and practices in the effective management of social, environmental, agricultural and economic systems in communities throughout the world.

Increasingly, decisions of short or long term impact on the local, regional and global environments are being made by relatively fewer political and professional experts at senior national and international levels. Ironically, while such decisions are daily more sophisticated technologically, they reflect an increasingly narrower range of options and less divergent perspectives.

Past approaches to development imagined a totally passive receiver of grants and gifts, or at best, a more active recipient of good recipes on how to do his or her job in order to improve the quality of life.

Environmental management requires the participation of all the parties concerned and the incorporation of the best existing knowledge. The information technological revolution will have a positive effect on the future of humankind if it succeeds in releasing all the knowledge, experiences and potential that is contained in the myriad of local communities and cultures.

PROBLEMS AND RESPONSIBILITIES ARE GLOBAL

However, the problems are not just the result of inadequate policies in the "developing" countries. "First World" nations have solved or are beginning to address a number of problems at the local and national levels. But they are the ones who still contribute the most to negatively influence the evolution of the planet. They are the ones who produce most of the carbon dioxide endangering (perhaps irreversibly) human survival; they are the ones who emit most of the sulphur oxides acidifying the rain; they are the ones who produce most of the chlorofluorocarbons affecting the ozone layer and finally they are the ones who control the environmental degradation processes in the developing countries. They own the factories and the technology, they consume the industrial and farming products, the wood and paper pulp, the leather and the minerals. And last, but not least, they control the banks.

However, in this business of understanding the trends and defining the strategies for the future, it is probably immaterial to spend too much time searching who is responsible for what. It will take much positive thinking, large dosis of imagination and a comprehensive global effort to find our ways out of the mess in which we are presently submerged...

Fortunately, as Shumacher used to say: "We are not blind...we don't have to be driven hither and thither by the blind workings of the Market, or of History, or of Progress".

Humankind has indeed the option of defining its own way beyond abstract notions of unavoidable trends that cannot be demonstrated or denied or arguable responsibility. Much is to be done. Sustainable environmental management start with the conviction that something can be done and the social and political will to do it. This will be the main task in the years to come.

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