

Working Group on:

CHEMICAL HAZARDS IN DEVELOPING COUNTRIES

21-23 October 1993

Organized in collaboration with
THE ROYAL SWEDISH ACADEMY OF SCIENCES

FINAL REMARKS



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THE ROYAL
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FOREWORD

Industrialized countries have undertaken scientific, legal and administrative measures to control pollution and other side effects from the steadily increasing production and use of chemicals.

Comparable controlling measures are widely lacking or not implemented in developing countries, due to a lack of expertise, proper equipment and administrative infrastructure. Chemical hazards are therefore often a more serious problem in developing countries. It appears as a moral duty of industrialized countries, that have provided most of the chemicals and chemical products used in developing countries, to support the efforts of these countries to solve their chemical pollution problems.

Against this background the Pontifical Academy of Sciences in collaboration with the Royal Swedish Academy of Sciences and with support of the Swedish Wenner-Gren Foundation, considered it timely and appropriate to organize a Working Group on "Chemical Hazards in Developing Countries". The meeting is scheduled to take place in the Vatican City (21-23 October 1993).

The aim of the meeting is to obtain an overview of the situation concerning chemical pollution and concomitant health hazards in developing countries in different parts of the world and to discuss possible measures to protect in an adequate way the environment, food chain and human health and welfare. Other important aspects in that context are the transfer of hazardous industrial plants and technologies as well as chemical waste to developing countries. The meeting should also aim at proposing tentative guide-lines and recommendations.

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President of the Pontifical Academy of Sciences

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SOLEMN PAPAL AUDIENCE

On the morning of 22 October 1993, His Holiness John Paul II granted a Solemn Audience in the Apostolic Palace of the Vatican to the participants in the Working Group "Chemical Hazards in Developing Countries".

The group, introduced by the President of the Pontifical Academy of Sciences, His Excellency Professor Nicola Cabibbo, was paternally received by the Holy Father, who at the end of the Audience wished to greet personally all the participants.

The Holy Father pronounced the following discourse:

*Distinguished men and women of Science,
Ladies and Gentlemen,*

1. *It gives me great pleasure to meet you, participants in the Workshop on "Chemical Hazards in Developing Countries" organized by the Pontifical Academy of Sciences in conjunction with the Royal Swedish Academy of Sciences, and with the support of the Swedish Wenner-Gren Foundation. The very enunciation of the theme of your meeting highlights the importance and timeliness of your reflections. Who cannot but be deeply concerned by the prospect of the already existing and ever expanding danger from pollution and other side effects of the production and use of chemicals? Indeed, your discussions, reflecting the highest levels of scientific competence, will be of great relevance to the growing public concern about the environment. I am confident that the publication of your studies and proposals will be of interest to the appropriate agencies and to governments, both in industrialized and in developing countries.*

2. In most industrialized countries, attention is paid to the risks to human beings and to the environment from man-made chemicals. In some countries regulations are in place. But in developing countries, where most chemical hazards have their origin in the import of chemical substances and technologies, a lack of expertise and of necessary infrastructures often renders efficient control difficult or impossible. Very few countries in fact have a specific legislation regulating the handling and use of toxic chemicals. Other problems in developing countries concern the introduction of highly polluting industries, not subject to the more rigorous control that is applied in developed countries. It is a serious abuse and an offense against human solidarity when industrial enterprises in the richer countries profit from the economic and legislative weaknesses of poorer countries to locate production plants or accumulate waste which will have a degrading effect on the environment and on people's health.

The answer, certainly, is not to deny developing countries the imports and technologies they need, especially when these have to do with food production and the setting up of basic industries: "Peoples or nations too have a right to their full development" (*Sollicitudo rei socialis*, n. 32). In fact, development, which ensures the conditions required for the exercise of fundamental rights, belongs to the domain of universal human rights. It is a direct consequence of the universal destination of the goods of creation.

3. Although primarily scientific and technical, your Workshop is not without great interest also for the Church: not in the sense that the Church has any particular scientific competence in the field, but in the sense that what is in question cannot be divorced from the ethical and moral character of the development which has given rise to this problem.

A fundamental principle of the Church's approach to development is expressed succinctly in words of my predecessor Pope Paul VI: "Development cannot be limited to mere

economic growth. In order to be authentic, it must be complete: integral, that is, it has to promote the good of every person and of the whole person (Populorum progressio, n. 14). This does not mean that the Christian holds a negative view of the greater availability of material goods and the spreading of those industries which produce them. It means — as I have written elsewhere — that “development cannot consist only in the use, dominion over and indiscriminate possession of created things and the products of human industry, but rather in subordinating the possession, dominion and the use to man’s divine likeness and to his vocation to immortality” (Sollicitudo rei socialis, n. 29).

Man’s spiritual nature and his transcendent vocation imply a fundamental solidarity between people, whereby we are all responsible for each other. Respect for the natural environment and the correct and moderated use of the resources of creation are a part of each individual’s moral obligations towards others. This truth applies also to relations between peoples and nations. In this context the technical dimension of the theme of your discussions is inseparable from its moral aspects. It would be difficult to overstate the weight of the moral duty incumbent on developed countries to assist the developing countries in their efforts to solve their chemical pollution and health hazard problems.

4. The international community, for its part, should continue to promote global agreements regarding the production, trade and handling of hazardous substances. In the 1990 World Day of Peace Message I wrote that, “the concepts of an ordered universe and a common heritage both point to the necessity of a more internationally coordinated approach to the management of the earth’s goods” (n. 9). Specifically in relation to the environment, I noted that “the right to a safe environment is ever more insistently presented today as a right that must be included in an updated Charter of Human Rights” (1990 World

Day of Peace Message, n. 9). *The 1992 United Nations Environmental Conference in Rio de Janeiro took steps in this regard, and in Chapter 19 of Agenda 21 several actions, which are especially relevant to developing regions, are recommended. The Holy See gladly agrees with the proposal in Agenda 21 that recommends the setting up of an International Forum on Chemical Safety, with the purpose of giving developing countries assistance to increase their competence and capacity in this field.*

5. *The human family is at a crossroads in its relationship to the natural environment. Not only is it necessary to increase efforts to educate in a keen awareness of solidarity and interdependence among the world's peoples. It is also necessary to insist on the interdependence of the various ecosystems and on the importance of the balance of these systems for human survival and well-being. Mere utilitarian considerations or an aesthetical approach to nature cannot be a sufficient basis for a genuine education in ecology. We must all learn to approach the environmental question with solid ethical convictions involving responsibility, selfcontrol, justice and fraternal love.*

For believers, this outlook springs directly from their relationship to God the Creator of all that exists. For Christians, respect for God's handiwork is reinforced by their certain hope of the restoration of all things in Jesus Christ, in whom "all the fullness of God was pleased to dwell, and through him to reconcile to himself all things, whether on earth or in heaven, making peace by the blood of his cross" (Col 1:19-20).

6. *Ladies and Gentlemen, I wish to encourage you in your commitment. I pray that your Workshop will be successful in suggesting guidelines for controlling the problem of chemical pollution and consequent health hazards in developing countries, and that it will offer valid recommendations for the protection of the environment, food chain and human health in different parts of the world.*

Upon all of you I invoke abundant divine blessings.

PRESIDENT'S ADDRESS TO THE HOLY FATHER

At the Solemn Audience granted to the Working Group participants on 22 October 1994, the President of the Academy, Prof. Nicola Cabibbo, delivered the following address:

Holy Father,

The honour You confer to our Academy of Sciences by following our work and addressing us words of encouragement fills us all, Academicians and Participants of our Working Group on chemical hazards in the 3rd world, with profound gratitude and deep encouragement which strengthen our dedication for our work.

We come once more to report to You the results of our scientific reflections and to hear Your words of great wisdom and admirable depth. We know Your profound interest in the improvement of the existential quality of man's condition.

The Pontifical Academy of Sciences, in collaboration with the Royal Swedish Academy of Sciences, has considered the exigence to organize a Workshop on "Chemical Hazards in Developing Countries". The meeting aims at an overview of the situation concerning chemical Pollution and concomitant health Hazards in developing countries in different parts of the world, and to discuss possible measures to protect in an adequate way the environment, food chain and human health and welfare.

Industrialized countries have undertaken scientific, legal and administrative measures to control pollution and other side effects from the steadily increasing production and use of chemicals.

Comparable measures are lacking or not widely implemented in developing countries, due to a lack of expertise, proper equipment and administrative infrastructure. Chemical hazards are therefore a more serious problem in poor countries. It appears as a moral duty of industrialized countries, that have provided most of the chemical products used in developing countries, to support the efforts of these to solve their chemical pollution

problems. Other important aspects in this context are the transfer of hazardous industrial plants and technologies and of chemical waste to developing countries.

The Meeting aims at proposing tentative guide-lines and recommendations for the solution of these grave problems.

We ask Your Holiness to bless the work of the scientists who take part in the Meeting so that, from the study of the difficult situation which emerge from this work, You may draw inspiration for enlightening the behaviour of the developed Countries towards the developing ones. The developing countries must receive an authentic help so that they may reach, not in a long time, a human condition of dignity, for life.

CHEMICAL HAZARDS IN DEVELOPING COUNTRIES

INTRODUCTION TO THE SYMPOSIUM

CLAES RAMEL

The international science community has a responsibility to engage in the many serious environmental problems of the developing countries. This has been the incitement for a collaboration between the Pontifical Academy of Sciences and the Royal Swedish Academy of Sciences, which was initiated 1990 by a conference on the preservation of tropical forests after a suggestion by the former President of the Pontifical Academy of Sciences, Professor Chagas. In his speech at that conference the Pope stated the responsibility and stewardness of Man not only towards our own species but also towards other living organisms in the world and therefore the destruction of the rich ecosystems of tropical forests must be counteracted. The conference constituted a valuable contribution to the topic of preservation of biological diversity. This field obtained an international recognition through the Biodiversity Convention, which was signed at the UN Environmental conference in Rio last year.

A continuation of the collaboration between our two Academies of Sciences was encouraged, and together with the President of the Pontifical Academy, Professor Marini-Bettòlo, we decided to take up another essential and somewhat related problem for discussion at a conference in the Vatican, *Chemical Hazards in Developing Countries*. We regret that Professor Marini-Bettòlo cannot be with us today but we are very glad that his intention with such a conference now has become reality and we wish all the participants welcome. From the Swedish side the conference has been possible, thanks to economic support from the Wenner-Gren Foundation.

Since World War II the extensive use of synthetic chemicals has become an inevitable part of modern life in developed countries. We all

know, however that that development has had serious consequences on our environment. This was first given a comprehensive consideration by Rachel Carson in her book *Silent Spring*, which became the trigger for an opposition against the unrestricted use of pesticides and other chemicals harmful to the environment. Carson focused her attention on persistent chemicals such as DDT, which had had disastrous effects on the wild life, with obvious risks for negative health effects also in human populations.

In Sweden, already in the middle of the 1950ies we had in fact an experience from the destructive effects of another persistent pesticide, alkyl mercury, on bird populations. Because of the use of organomercurials as fungicides for seed dressing, some populations of seed eating birds were nearly eradicated. Worse, however, was the observation that some predatory birds were found to suffer from extremely high content of mercury by secondary poisoning through the consumption of seed-eating preys. This pointed to a risk situation also for humans by the consumption of animals, which had been exposed to mercury from treated grains. Later a more serious concern was attached to fishes contaminated by industrial release of mercury. This concern was amply verified by the intoxication catastrophes in Japan and Iraque.

In several developing countries there is today another hazardous source of mercury contamination through the use of mercury in gold panning, which we will hear more about by Dr. Moreira from Brazil.

In the western industrialized countries the risks from chemicals in the environment have become an issue of great concern. When considering health hazards to man, long term effects from the exposure to chemicals have been in focus of attention. In particular it was realized that we are exposed to many carcinogenic compounds, which we release in our domestic, occupational and outer environment. This has lead to radical regulation of the manufacturing and use of chemicals and a number of persistent and biologically reactive chemicals are now completely forbidden for use in these countries. The contamination of our food by pesticide residues is usually efficiently controlled in most developed countries. The contribution from an exposure to synthetic chemicals to the cancer panorama in developed countries probably is quite low. Dr. Bruce Ames, who introduced the well known bacterial test for mutagenicity 1973 and who emphasized the carcinogenic risk from synthetic chemicals in the 1970ies has in later years concluded that much of the concern about these chemicals as to their carcinogenicity is less justified today. Ames therefore has advocated a shift in attention to natural carcinogenic compounds, which he believes are responsible for a far higher frequency of

cancer than synthetic chemicals. Ames conclusion in this matter is supported by epidemiological and experimental evidence in developed countries. However, such conclusions derived from developed countries, clearly do not apply to developing countries in general, where the contamination of chemicals often is drastically different as compared to developed industrial countries. It should be pointed out that there is also a dramatic difference between western Europe and the former Soviet Union, where the chemical contamination of the human environment by man made chemicals constitutes a very serious environmental and health problem, also with respect to long term effects such as cancer.

In contrast to the situation in developed countries, pesticides constitute a major environmental problem in developing countries and there are imminent risks for acute and chronic health effects by pesticides — both occupational and general epidemiological. There are many reasons for this difference between developed and developing countries in this respect. The rapidly growing populations in many developing countries has compelled an increase in food production to an extreme, combined with a constant fight against pests, which take a higher toll of the production in tropical regions than elsewhere. On top of that land degradation through deforestation, desertification, soil erosion and lack of secured water supply makes the situation in many developing countries critical. For instance the deficit in Africa of grain is estimated to become 44 million tons by the year 2000.

The use of pesticides in developing countries has resulted in extensive resistance of pests to many pesticides. It has been estimated that over 500 pests have become resistant to ordinary pesticides. This has given rise to a vicious circle with increased use of pesticides. As an example in India the Cotton Boll Worm, *Heliothis*, has gradually acquired resistance to many pesticides. The farmers use up to 30 insecticide sprays to fight this devastating pest on cotton plants, including chlorinated hydrocarbons, organophosphates, carbamates and pyrethroids.

The extensive and to a great extent uncontrolled use and handling of pesticides in developing countries implies health hazards to people. Millions of people get poisoned each year and it has been estimated that 20000 deaths occur from pesticide exposure — mostly in developing countries.

The unintentional contamination by pesticides of natural populations of animals and plants can cause disturbance of the natural ecological balance, wiping off of predators of various parasites, often resulting in an increase of secondary pests. The biomagnification of persistent pesticides often cause severe effects in higher trophical levels. Other side effects are pollution of ground and surface water.

The pesticide use in developing countries is a necessity for their survival, but there is an obvious need of regulatory actions based on risk benefit evaluations. There are however many obstacles for such a development. Thus there is a lack of research facilities for control and monitoring, inadequate legislation and guide lines for registration of pesticides, lack of toxicological data on pesticides primarily used in developing countries etc. The time lapse between the introduction of hazardous pesticides and its banning or restrictive use has in many cases been unreasonably long in developing countries. Examples of this time lapse, according to Dr. Sebae in Egypt, are over 25 years for organochlorines, 35 years for toxaphene, 20 years for chlorimeform, 30 years for ethylene dibromide and dibromochloropropene, 30 years for tributyl tin, organo-mercurials, organoarsenicals and bisdithiocarbamates.

Scientific experience from developed countries to improve the situation in developing countries is important, but it must be realized that extrapolation of data from temperate to tropical zones must be done with caution. Degradation and biomagnification of chemicals can be widely different. Much laboratory work has to be done within developing countries themselves.

The developed countries are ultimately responsible for much of the chemical problems in developing countries and it ought to be their responsibility also to assist the developing countries in solving their problems in this respect. In chapter 19 of agenda 21 from the UN conference in Rio 1992, dealing with chemicals, the necessity of assisting developing countries is firmly established and several actions of particular importance to developing countries are recommended. Thus in order to better control the trade with hazardous chemicals it is recommended that all countries by the year 2000 should adopt the concept of "Prior Informed Consent", PIC, which was introduced 1989 by UNEP, FAO and ILO. Another important suggestion in agenda 21 concerns the formation of a special UN body "International Forum on Chemical Safety". In April 1994 the "International Conference on Chemical Safety" will be held in Stockholm in accordance with recommendation in agenda 21 in order to discuss the implementation of the intentions of agenda 21 on chemical safety. An important task of this conference will be the formation of the "Forum for Chemical Safety", which will constitute a particularly important aid for developing countries. Director General Kerstin Nibleus, who is our chair person today, is responsible for that meeting in Stockholm and she will give further information on that issue.

The solution of chemical hazard problems in developing countries will require the engagement of the scientific community and it is therefore

essential that scientists from developed and developing countries get together and exchange experiences in order to turn the development in a right direction. I am sure we will get much valuable information on many aspects of chemical hazards in developing countries during this conference and hopefully also suggestions of solutions of some of the many problems.

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CHEMICAL HAZARDS IN DEVELOPING COUNTRIES

FINAL REMARKS

STATE OF CHEMICAL POLLUTION IN DEVELOPING COUNTRIES

Latin America

Before World War II Latin American Countries mainly produced and exported primary products from agriculture and mining. In order to develop and broaden their economy a wave of industrialization took place with a large increase in the production and processing of metal, petroleum and chemical products. Most industries were located in or close to large urban areas on coastlines, within the water catchment areas of major rivers or important underground water resources. Minimal or no attention was paid to environmental consequences. Few attempts have been made in recent years to rectify the situation in this respect, largely dependent on economic restraints and a stagnation or a decline in the industrial production in 1980-1990's. The background of this development has been growing external debts in most Latin American countries, decline in international price, unfavourable trends in international commerce and failures of economic policies in many countries. As an example of the difficulties encountered, the export from Brasil generated a positive balance of trade 1988 with 19 billion USD, of which 17 billion were used to pay off part of the debts.

The environmental problems from the industrialization are particularly connected with small scale industries, where occupational exposure to hazardous chemicals is not given appropriate consideration. Also these small industrial plants often discharge hazardous wastes to surface and ground water, to air, soil and sometimes contaminating the food chain.

The environmental impacts of chemicals and chemical pollution are furthermore magnified by the population increase. Since 1930 the population of Latin America has quadrupled. This population increase has

been accompanied by an extensive urbanization and this development can be expected to continue. In Latin America 2/3 of the population now live in urban areas and this number can be compared to 34% in developing countries in general. This urbanization has resulted in a sharp increase in cars and in air pollution. On a yearly basis it has been estimated that the number of excess respiratory illness among children in Latin America by air pollution amounts to 2.3 million cases.

The extensive petrochemical industries in Latin America are responsible for serious environmental problems, both directly and indirectly. There is an oil spill in all oil-producing countries and off shore drilling has caused severe damage to Caribbean mangrove swamps, seagrass meadows and coral reefs. In some of the oil producing countries the pipe lines are old and corroded and they leak constantly. To that picture one has to add terrorist attacks on pipe lines causing extensive leakage of oil.

Large chemical enterprises, based on petroleum products, have been developed in Latin American countries. This production includes olefins (ethylene, propylene and butadiene) and aromatics (benzene, xylene and styrene) comprising about five per cent of world production in both cases.

There are severe environmental problems from domestic waste water — less than 2% of urban sewage is subjected to any treatment. Decades of negligence in this respect has resulted in cholera epidemics in most of the Latin American countries. Industrial effluents often carry heavy metals and synthetic organic chemicals. Much of the water pollution is linked to deforestation, which causes soil erosion, and to the abuse of agrochemicals in rural areas.

As in practically all developing countries, pesticides are responsible for particularly severe chemical contamination of the environment in Latin American countries. The money spent by some countries on pesticides has doubled or tripled from 1980 to 1990. The use of highly persistent organochlorine pesticides has caused much concern and attempts are made to move away from such chemicals to less persistent carbamates and organophosphates. Previously pesticides were imported from Europe and North America, but now a considerable amount is manufactured in Latin American countries. Thus in Brasil and Mexico 50 pesticides are currently manufactured.

The extensive use of pesticides and the lack of appropriate regulations and/or implementation of existing rules for their handling, has made these chemicals of particular environmental and health concern in developing countries in general — Latin America not being any exception. However, actual data on health effects is limited for several reasons. There is for instance an obvious underregistration of pesticide poisoning.

For example in Costa Rica 423 cases of pesticide poisoning were registered at the National Poison Center 1978-1980, but in one single hospital in an area with banana plantation there were 374 cases of such poisoning just in 1980. The number of pesticide intoxication has increased every year since 1980. 70% of these cases involve agricultural workers. Of manifested effects can be mentioned an increase of abortions in women exposed to mixtures of pesticides during pregnancy in Columbia and reproductive effects in male workers in Costa Rica, exposed to the nematocide dibromochloropropane. There is also a significant exposure of the general population to pesticides. High levels of organochlorine pesticides have been measured in mothers milk, particularly DDT and DDE. Sometime the values have exceeded the values accepted for cow's milk.

Industrial countries have introduced firm regulations concerning contamination of food stuff by pesticides. Therefore contaminated food from developing countries, when rejected for import by developed countries for that reason, is instead marketed and consumed locally.

It can be concluded that the situation concerning environmental hazards from pesticides in Latin America causes great concern because of the increasing quantities used and the low priority given by the Governments to regulate pesticide usage and labour related conditions.

Toxic wastes disposal constitutes another serious threat to the health and environment in Latin America. As an example Mexico produces 450,000 tons of industrial waste daily, of which 14,500 tons are considered hazardous. Of these hazardous chemicals 5,784 tons are generated by 39,000 manufacturing plants in Mexico City. Only a fraction of this waste is properly handled.

When it comes to chemical hazards in general, the Pan American Health Organization has stated that the improper handling of chemical substances constitutes a major threat to human well being in the Latin American region. While industrialized countries have established extensive legal protection of the people from chemical hazards, such regulations are largely lacking in developing countries. Apart from direct effects on the population, this state of affairs have indirect undesirable consequences. Products which are banned in developed countries, such as certain pesticides, wastes and drugs, are sometimes exported by these countries to Latin American and other Third World countries.

The future possibilities to come to grips with environmental and health hazards by chemicals must, to a great extent, rely on international actions and cooperations. This is true for all countries in the world, but evidently of particularly imminent importance concerning developing countries. These aspect will be dealt with in a later section of this document.

Africa

The population growth in Africa implies similar, serious problem to the environment as in other developing regions. The fast growing populations, particularly in the Sub-Saharan regions, have created a demand for an increased and sustained food production. The population growth has however outstripped food production, leading to serious food shortage. In the year 2000 it is estimated that Africa can only produce 60% of the food needed for consumption. In contrast to Latin America, the African population is mainly rural, to 80% made up by small-scale farmers. The dominating importance of agriculture in Africa has made their economy highly vulnerable to failures of the crops by climatic and biological conditions, and in particular pests. Among small-scale farmers there is a constant loss of crops around 50%, due to pests. As in other parts of the Third World, the battle against pests is fought by means of wide applications of pesticides. The unrestricted use of pesticides has lead to an extensive, genetically determined resistance to pesticides, which forces a vicious circle with the application of larger quantities and a successively wider diversity of pesticides. Accurate statistics on pesticide trade and usage is scanty, reflecting the lack of control of pesticide handling. Largest use of pesticides is found in large scale cash crop production, such as cotton in Sub-Sahara. The rapid increase of cash crop economy has resulted in an inceasing demand for pesticides and other agrochemicals.

The bulk of the pesticides used in Sub-Saharan Africa are imported from Europe, America and Japan. Some donor nations provide outdated or banned pesticides, which in many instances result in excessive supplies of pesticides, which eventually remain unused and pose disposal problems and contamination of the environment.

The chemical hazard situation in Africa differs from the one in Latin America by the fact that industrial contamination is a less dominant problem in Africa than the use and contamination by pesticides and other agrochemicals. Lack of regulations and lack of knowledge how to handle pesticides is probably even more pronounced in Africa than in Latin America.

As in developing countries in general the main issues concerning the impact of pesticides on human health, are misuse and occupational exposure. Serious problems are caused by lack of protective closing, contamination of water and food, and use of empty pesticide containers — problems to a great extent emanating from a lack of instruction and knowledge. A big threat to the environment is leakage and pollution due

to inadequate storage. Old stocks are leaking to a great extent. Moreover, some African countries receive pesticides and other hazardous chemicals from abroad to be dumped at a fee.

The solution of the severe pesticide problems in Africa is the same as for other regions that is, information, education, regulation and governmental control.

Asia

The situation concerning chemical hazards in Asia was not dealt with at the conference in any detail. It is however evident that the infrastructure and other conditions exhibit a greater variation between countries than is the case in Latin America and Africa. Therefore it is hardly possible to discern any trends of general applicability for Asian countries. However, for the developing countries in Asia many of the problems encountered in Latin America and Africa nevertheless are of the same significance. The increasing population and the formation of megacities have created similar problems as in Latin America with chemical pollution from industrial activities, which are particularly difficult to control and deal with among the small and widely scattered industries. To a large extent depending on inefficient infrastructure, corruption and lack of implementation of legal control of trade, inappropriate handling and disposal of chemicals, the pollution problems are very severe in many parts of Asia. This is especially true for the many extremely poor regions in Asia, where the survival of the population evidently is of primary concern rather than a control of chemicals from different sources.

People's Republic of China with its rapid economic development and huge population deserves a particular attention. It is obvious that environmental concern has come in very late and in many respects the situation in China mimics the conditions in the former Soviet Union, where the critical state of the environment in many regions has been revealed in recent years. Although it is difficult to get a comprehensive outline of the Chinese administration, one problem is the fact that industry and environmental issues are dealt with by different administrative bodies. Among actual environmental pollution problems dust and sulfure released from coal plants and pollution with heavy metals and organic compounds of several rivers should be emphasized.

The publication of Rachel Carson's "Silent Spring" opened the eyes of the public to the hazards of the pollution of our environment for biological life in general. At least in the industrial countries ecotoxicology has been an area of high importance and relevance since then. The attention has been focused on persistent chemicals, in particular chlorinated organic compounds and heavy metals, which tend to exhibit bioaccumulation in higher trophic levels. It was thus demonstrated at an early stage how DDT accumulated from the lowest levels in water and plankton along the food chain to predatory fish and carnivorous birds by a factor of 1000 or more. Data from tropical countries shows that the bioaccumulation occurs in similar ways also in tropical ecosystems. This could for example be demonstrated for DDT, HCH, HCB and dieldrin in Lake Kariba in Zimbabwe. Similar effects on the organisms as observed in temperate areas could also be detected — egg shell thinning, decline in bird populations, and effects on insects and their larvae. Contamination of the environment with persistent chemicals has become an escalated problem in developing countries. Such persistent chemicals are counted in hundreds today and they emanate from industrial release, i.e. of PAH from petroleum industries, from the use of PCB, chlorinated phenols, organic solvents, household chemicals and — not the least — the large spectrum of agrochemicals. The ecotoxicological concerns focus on food chain transport which is coupled to lipophilicity of the compounds, retention in soil and sediments and mobility between environmental compartments, for instance connected with volatilization, which can be expected to be of greater significance in tropical areas. It should be stressed in this connection that the persistency of chemicals cannot automatically be extrapolated from temperate zones to the tropics. During the conference it was reported that DDE, which is the most stable metabolite of DDT, in ampoules outdoor in Nigeria disappeared completely overnight. While DDT was decomposed, lindane and toxaphene remained totally stable.

The number of chemicals and the total amounts produced is increasing continuously and there are reasons to believe that this increase will predominantly occur in developing countries. A major reason for the requirement of more pesticides is the development of resistant strains of pests. In a report by UNEP (United Nations Environmental Program) pesticide resistance was ranked as one of the top four environmental problems of the world. It is estimated that 504 insect and mite species, 150 plant pathogen species and 273 weed species are resistant to pesticides.

In some parts of the world this resistance to pesticide treatment has had disastrous consequences. In Mexico and Texas an extremely high pesticide resistance had been developed in the tobacco bud worm, which is a major pest in cotton. Because of the inefficiency of pesticide application 285,000 ha of cotton has had to be abandoned. A disastrous resistance problem has been the malaria parasite, which has caused very severe problems in tropical countries. In India the malaria cases were down to 41,000 in 1961, but reaches now 59,000,000 incidences per year.

Of great concern in the present context is the fact that persistent chemicals, which are banned in industrialized countries are continuously being used in developing countries, often in an indiscriminate way. The errors of the developed world are now flourishing in the economically pressed developing world with 20-30 years delay.

Monitoring of the release of persistent chemicals into the environment from industries and other human activities is most efficiently performed by means of the bioaccumulation in suitable organisms. Mussels function as filters through which large quantities of water pass, retaining plankton and thereby accumulating chemicals, which occur in the water and have been taken up by these organisms. This bioaccumulation property of mussels obviously constitutes a valuable system for biomonitoring of chemicals in the environment. For that reason mussels have been used for a global assessment of environmental levels of chemical contaminants, The International Mussel Watch. This project has been supported by UNESCO, UNEP and governmental grants from USA. The goal of this project has been to quantify sources and rates of waste released in aquatic and especially marine environment. Regional programs are running in Europe, Canada, USA and Taiwan, but the initial implementation of the project has been along the coasts of Latin America. An important part of the project has been a quality control and quality assurance check of the analyses, prior to entering the phase of extensive field analyses. The analyses and the interpretation of the data has encountered some difficulties because of the fact that somewhat different species have been used with different physiological state of the animals. Nevertheless usually there has been a good agreement between laboratories and the results of the quality control of the analyses have been encouraging. Although it is too early to make any overall evaluation of the results, many of the analyses have been below detection limits, but local hot spots have been identified, and these are being followed up to determine the source of the contamination.

Heavy metals constitute a group of chemicals of particular importance from the point of view of ecotoxicology as well as human health

hazard. In many parts of the world, and not the least in several developing countries, alarmingly high concentrations of heavy metals are found in the aquatic environment, for example in some Chinese rivers and outside Sao Paulo in Brasil, where high levels of arsenic, lead, mercury, and zinc — beside various persistent pesticides — have been recorded.

The environmental hazards from mercury contamination have been strikingly demonstrated through the Minamata catastrophe in Japan in the 1950's and the even worse mercury catastrophe in Iraq 20 years later. Today mercury still constitutes a major ecotoxicological threat with serious consequences also for humans. The perhaps most important source of present mercury contamination emanates from the use of mercury in gold mining and panning. The technique of amalgamating gold in connection with gold panning is old, but it has received a remarkably wide application, mostly in developing countries, in recent years. The situation is particularly serious in the Amazonas in Brasil. Inofficial estimation of the number of people involved in gold panning in Brasil amounts to 650,000. 200 tons of mercury is legally imported in Brasil, of which about half is used for gold mining. In the gold panning 15-50% of the mercury is released directly into the rivers, 65-83% as vapour. The contribution of mercury contamination from this source both locally and globally evidently is very high. From an ecotoxicological point of view, mercury constitutes an extremely hazardous pollutant. It is well established from research in temperate regions that metallic and inorganic mercury become methylated by microorganisms in the aquatic environment. Methyl mercury, which was the form responsible for the catastrophes in Japan and Iraq, accumulates in the food chain, sometimes reaching very high values in predatory fishes, birds and mammals, affecting humans as well, when exposed, in particular children from early developmental stages, since methyl mercury trespasses the placental barrier. Although less data is available from tropical areas, similar methylation seems to occur also there.

The consequences of the contamination of the environment with toxic chemicals and particularly persistent chemicals such as chlorinated organic compounds and mercury, have been documented on biological life in many parts of the world. As a matter of fact the background of Rachel Carson's book "Silent Spring" was indeed observations on wildlife by persistent pesticides such as DDT. The highly unrestricted use of persistent chemicals in the Third World inevitably must have negative effects on the ecosystems and biological diversity. These effects occur as the result of direct exposure to organisms, indirect effects via contaminated preys and alterations of the habitat by elimination of food and refuges.

Several pesticides cause reproductive failures, i.e. egg shell thinning among birds. Contamination of lakes and rivers by pesticides will affect fish populations and therefore will have consequences also for human nutrition and welfare. Insecticides have often had destructive effects on insects, vital for pollination, such as bees. In some cotton growing areas in Kenya and Tanzania bee-keeping is virtually impossible because of the extensive use of insecticides. Contamination of the soil may imply toxicity to earthworms and alteration of the conditions for microorganisms, which are of fundamental importance for ecosystems.

The use of pesticides does not only hit the target pests, but also beneficial parasites and predators. The destruction of natural enemies for instance in cotton crops by pesticides has been shown to result in the outbreak of numerous pests in USA. The elimination of the natural enemies to various pests by pesticides often require more intense and expensive pesticide treatment. A similar situation was observed for rice in Indonesia where the destruction of beneficial natural enemies resulted in such a severe outbreak of pests that the rice yield dropped so much that rice had to be imported from abroad.

The maintenance of the biodiversity implies a balance between economic and environmental considerations and unfortunately this balance most likely will be in favour of economic considerations in developing countries. Putting a "value" on the environment remains however a world wide problem. The attempt for a solution in developed countries concerning the preservation of biological diversity, has been pressure from the general public and this may be the route taken in developing countries. This is likely to be aided by scientific information, but the situation in developing countries suffers from a lack of sufficiently detailed scientific information to make appropriate decisions for instance concerning the choice of the least damaging pesticides.

HEALTH HAZARDS FROM PESTICIDE USE

The extensive use of pesticides in developing countries in combination with a lack of regulatory actions to control the handling of pesticides has resulted in a situation, where acute poisoning of people has become a priority health problem. The poisoning is caused by organochlorines, organophosphates, carbamates and nitro- and chlorophenols. The aim of diminishing the use of persistent pesticides has made organophosphates increasingly dominant. The far less toxic pyrethroids are unfortunately too expensive to be used by developing countries to any major extent.

The extent of poisoning by pesticides can only be estimated on the basis of scattered regional and local data. In Sri Lanka with a population of 12 million people, about 10,000 hospitalized pesticide poisoning and 1,000 deaths occurred in one year. This data includes suicide cases, which constitutes 2/3 of hospitalizations. The number of deaths due to pesticide poisoning in Sri Lanka that year was almost twice the number of deaths from malaria, poliomyelitis, whooping cough, diphtheria and tetanus. In Sri Lanka 5% of agricultural workers become poisoned by pesticides. The corresponding data from agricultural workers in Malasia is 13%. In the developing countries as a whole it is estimated that 3% of the agricultural workers experience some degree of pesticide poisoning per year. With an estimated number of agricultural workers of 830 million, this would mean 25 million cases per year.

In Indonesia, on the basis of local studies, the number of pesticide poisoning can be estimated to 30,000 cases annually. In Thailand 4046 cases were reported 1985, of which 289 died.

In Africa it has been estimated that 11 million cases of pesticide intoxications occur annually, including minor cases without hospitalization.

In a report by WHO 1990 it is estimated that 3 million cases of severe intoxications, including suicides, may be matched by a greater number of unreported milder intoxications.

It should be emphasized that the developing countries carry a disproportional burden of pesticide poisoning — over 99% of the deaths occur in developing countries. It is obvious that acute poisoning is, to a great extent controllable, but little has been done in the developing countries to rectify the situation. There was for instance no signs of an improvement of the pesticide intoxication situation in Sri Lanka during the years 1984-1988.

Several factors contribute to the present situation in developing countries. Thus there is a lack of knowledge of the hazards involved in handling pesticides. It is generally not realized that the important route of intoxication is not through inhalation, but through skin exposure. There is a lack of protective clothing, suitable for tropical climates. Occupational exposure occurs when spraying, mixing and diluting pesticides. Concentrations in excess of requirements and poor maintenance of the spray equipment are other factors of importance.

The data on hazards to human health by chemical contamination in developing countries almost exclusively concern acute effects. Next to nothing is known about long term effects, for instance the induction of cancer. It may be mentioned however that, according to the Internatio-

nal Agency on Research on Cancer, there is sufficient evidence for carcinogenicity of 18 pesticides and limited evidence for 16 pesticides.

The actions taken in order to control the use of pesticides and other chemicals must to a great extent rest on risk assessments, which provide the bridge between research data on the chemicals on the one hand and the practical management of the risk on the other. The traditional approach in risk assessment is the determination of no adverse effect level (NOAEL) from studies in humans or animals, to which value a safety factor is applied. This approach assumes a threshold for the effect. For genetic effects, including genotoxic carcinogens, such a threshold cannot be assumed and a linearized extrapolation has to be used. An essential part of risk management is a proper knowledge of the target dose. In recent years new and improved methods to determine the dose at the level of DNA or proteins have been developed. Risk assessment of chemicals to which humans are exposed and subsequent administrative risk management has been done in developed countries, but it is far from sure that these data are directly relevant to developing countries. The rapidly growing populations and shortage of food under tropical climatic conditions make the requirements for agrochemicals more critical in developing countries and many times it is not possible to apply the same strict regulations as in some developed countries.

Much of the blame for the present predicament goes to national governments rather than agrochemical industries. It is not only the question of new legislation but also an enforcement of existing legal regulations. There is furthermore a need for a closer cooperation with agrochemical industries in control programs.

IMPACT OF CHEMICAL AND BIOLOGICAL TECHNOLOGY

Plant breeding technology has brought forward the "Green Revolution", which has led to a dramatic change in the agricultural practice in many developing countries. This implied the introduction of high yielding varieties particularly of wheat, and therefore it was of great importance for the global food supply. However negative side effects also appeared both at a social and agricultural level. In the present context it is of relevance that the new crops have been bred also for high tolerance to certain herbicides and fertilizers, which has caused a drastic increase in the use of such chemicals. The hazards of an increased use of pesticides is obvious, but also the increased application of fertilizers has negative side effects. Of particular importance is high amounts of nitrogen

used in some regions, such as China and also Europe. Of the nitrogen in the fertilizers, 25-50% stays in the crop. Of the remaining nitrogen 20-50% is lost by erosion, 10-50% by leaching and 10-50% by volatilization. This nitrogen eventually may contribute to eutrophication and fish killing by the depletion of oxygen. The uptake of nitrogen in leafy vegetables, such as spinach, may imply a health hazard by causing methemoglobinemia and the formation of carcinogenic nitrosamines.

Conventional breeding towards resistance to pesticides, high yields etc. begins to be supplemented by modern biotechnology, in particular at the DNA level, and this trend no doubt will be further emphasized in the future. So far this advanced technology has not reached developing countries to any appreciable extent, but it certainly is only a question of time, when it will be transferred to developing countries. Material for this biotechnology is furnished by tissue and cell cultures, regenerating tissues, somatic clonal variation, anther cultures, cell fusion, genetic transformation and gene transfer through suitable vectors. It will be possible to more efficiently acquire resistance to pests and diseases, to herbicides and to abiotic stress factors like drought and salinity. During the last few years a large increase in the release of manipulated crops has occurred in developed countries. It is however obvious that this development, beside its great potential for economy, agricultural practices and food production, also comprises drawbacks and hazards, which have been thoroughly discussed and dealt with in most developed countries. Of major concern can be mentioned the risk for transfer of introduced genes in crops to wild weeds through cross-fertilization, the risk for the spread of manipulated crops beyond the cultivated fields and possible effects on the local flora and fauna. Most of these problems can be analyzed and checked at laboratory and controlled field experiments — but not all. A major problem for developing countries, is their lack of scientific expertise and infrastructure, necessary for a safe management and control of this kind of biotechnology. Assistance from developed countries is here of fundamental importance at least at an initial stage.

The need among the developing countries for scientific education and assistance is imminent in many fields, beside biotechnology. Some measures taken in developing countries concerning the choice and management of pesticides have been influenced by the situation in developed countries in temperate regions, without sufficient knowledge of the local conditions and requirements. In temperate regions the banning of DDT was justified, but it can be questioned, whether the replacement of DDT in some developing countries by toxaphen, which is persistent, extremely toxic to fishes and a carcinogen, was a sound step to take. There is an

obvious need of education in the developing countries in basic knowledge of the toxicity and biochemical properties of chemical contaminants. The management of chemical pollution and hazards is furthermore dependent on monitoring of the environment, which requires reliable chemical analysis data. This implies access to relevant laboratory facilities and sufficiently trained personnel. Training courses set up by experts from developed countries must be adapted to the conditions in the region dealt with. That means that situations of unusual occurrence in developed countries have to be dealt with, such as occasional cut of water and electric supplies, risk for corrosion of the instruments because of high humidity, insufficient service organizations etc. It is essential that training courses for chemical analyses and other scientific activities involves the personnel, which will actually handle the laboratory work.

INTERNATIONAL GUIDANCE AND REGULATIONS

It was repeatedly emphasized during the conference that an important contributing cause of the problems of chemical pollution and hazards in developing countries, has been a lack of basic knowledge and information of existing knowledge, as well as a lack of application and implementation of guidance and rules, mainly worked out in industrial countries. This neglect has been prevalent not only within developing countries, but also among developed countries in their relationship towards developing countries.

The problems and hazards from pesticides were recognized in the 1950's by FAO, and 1962 the "FAO Committee on Experts on Pesticides in Agriculture" was established to advice on matters relating to pest control. These activities led to the establishment 1985 of the "International Code of Conduct on Distribution and Use of Pesticides" with particular aim of assisting developing countries. It is voluntary in nature, but defines the responsibility for safe handling and effective use of pesticides.

In order to introduce a better control of the trade with pesticides, based on available scientific knowledge, the UN introduced the "Prior Informed Consent (PIC)", were it is established that international shipment of a pesticide that is banned or severely restricted for use, should not take place without the consent of the importing country. The practical implementation of PIC has been laid down in the "PIC procedure". The PIC regulation and procedure has been extended to cover also other hazardous chemicals than pesticides, and the operational responsibility has been shared between FAO and UNEP in such a way that FAO is

responsible for pesticides, while UNEP is taking care of industrial and consumer chemicals. Within this joint FAO/UNEP programme a database on chemicals included in the PIC procedure is established, and guidance documents are worked out and distributed. To implement PIC, the 118 member countries have nominated Designated National Authorities. Furthermore Guidance for Governments has been published as well as Decision Guidance Documents, giving summaries of ecological and environmental characteristics of the PIC chemicals. FAO's Technical Cooperation Programme (TCP) provides assistance to developing countries for the legal, practical and scientific management of pesticides. Also mainly for the benefit of developing countries a number of Technical Guidelines and workshop and training reports have been prepared.

The strategy of plant protection by FAO, in accordance with the UNCED conference in Rio 1992, is the Integrated Pest Management (IPM), the purpose of which is to optimize various actions for pest control and minimize the hazards. Assistance to developing countries to implement the IPM strategy has resulted in a diminished use of pesticides, for instance in Indonesia.

During the UNCED conference in Rio 1992, the responsibility of the developed countries to assist developing countries in solving their problems concerning chemical hazards, was emphasized and inscribed in chapter 19 of agenda 21, dealing with chemicals in the environment. Apart from discussions of available international regulations to improve the situation concerning chemical hazards, an important suggestion deals with the creation of a special UN body: "Forum for Chemical Safety", which is meant to be of particular help to the developing countries. In accordance with the recommendations in agenda 21 an International Conference on Chemical Safety will be held in Stockholm in April 1994 and one important task of this conference will be the establishment of this "Forum for Chemical Safety". Hopefully the formation of this international forum, as well as other actions recommended in chapter 19 of agenda 21, will pave the way for a closer cooperation between developed and developing countries in handling the critical chemical hazard problems at a global level.

RECOMMENDATIONS

International actions and assistance

1. Implementation of the recommended actions in Chapter 19 of Agenda 21, presented at the Rio conference 1992 on:
 - * Risk reduction;
 - * Harmonization of classification and labelling system;
 - * National capacity building;
 - * Prevention of illegal traffic.
2. Exchange of information between developing and developed countries concerning risk, hazard and effective use and disposal of chemicals.
3. Assistance to developing countries in providing information and advice for the judicious use of chemicals and their disposal.
4. Technical and scientific support for developing countries to minimize human/environmental contamination, improve legislation, develop competence and infra-structure.
5. IPCS should play a major coordination role by facilitating a better articulated work of the international and intergovernmental agencies active in the various fields associated with chemical safety.
6. Information by ILO on occupational health should reach trade unions and the workers, not only governmental institutions.
7. The results of the assessments of health and environmental risks from toxic chemicals by IPCS should be made more easily available to developing countries.
8. International regulations should be brought up to date and respected by all authorities both in developing and developed countries.
9. A consistent implementation of PIC-programme and binding of national aid programmes to exclude economic support for production and marketing of hazardous chemicals.
10. Emphasizing the moral obligation for developed countries to reduce the dumping of chemical wastes in developing countries.
11. International agencies should establish PIC and values for cultivation and use (VCU) for the transfer of varieties and genetic material, produced by genetic engineering, to developing countries.
12. Existing guide lines by OECD for safe development of plant biotechnology products should form the regulatory basis for developing countries with appropriate adaptation to their needs and the environment.
13. Ways for developing countries to avoid that biotechnology products reduce the diversity in their agro-ecosystem should be examined.

14. Support from developed countries should be provided to developing countries in the risk management of chemicals. Risk assessment methods should be improved for the special conditions in developing countries, also allowing comparisons between chemicals under these conditions.

Actions at national levels

15. Increase in public awareness and a proactive community participation by:
 - * Concentrating on a few relevant problems, instead of an across the board type of strategy;
 - * Improving risk communication;
 - * Promoting the "right to know" and "responsible care" strategies.
16. Reinforce considerations pertaining to the influence of social and economic problems on environmental/human health.
17. Strengthen collaboration between agencies and ministries within developing countries.
18. Strengthen comprehensive regulatory control of pesticides and industrial chemicals.
19. The "phasing out" of the recognized particularly hazardous chemicals should be carried through.
20. Promote substitution of chemical technologies with other technologies, when feasible.
21. Strengthen the manpower to operate regulatory services through capacity training and provision of adequate resources for their operation.
22. Improving reference national laboratories, as the support unit to an extended network of laboratories.
23. Improving preventive strategies to reduce chemical accidents, including the formulation of contingency plans.
24. Implementing risk reduction as well as clean up actions of contaminated sites, with special consideration on those ecosystems where human health and well-being might be compromised.
25. Internalizing into the local economies the costs of chemical safety and prevention programmes.
26. Training specialists to promote effective use of chemicals in industry, agriculture and forestry.
27. Education and training in safe use of chemicals should be given highest priority within programmes for technical assistance to developing countries.
28. Support monitoring of exposures locally and regionally as a basis for risk assessment and management.
29. Epidemiological studies should be encouraged as a major support for risk assessment and management activities.