United Nations Environment Programme

Distr.
GENERAL

UNEP/GC.7/4
30 January 1979

Original: ENGLISH

GOVERNING COUNCIL
Seventh session
Nairobi, 18 April - 4 May 1979
Item 5(c) of the provisional agenda

THE STATE OF THE ENVIRONMENT: SELECTED TOPICS - 1979

Report of the Executive Director

The present report focuses on four contemporary issues receiving widespread attention both on the regional and international scale: schistosomiasis, resistance to pesticides, noise pollution and environmental impacts of tourism.

Na.79-0060

I. INTRODUCTION

1. The environment - defined as that outer physical and biological system in which man and other organisms live - is a whole, albeit a complicated one with many interacting components. The wise management of that environment depends upon an understanding of those components: of its rocks, minerals, soils and waters, of its lands and their present and potential vegetation, of its animal life and potential for livestock husbandry, and of its climate. It demands positive and realistic planning that balances human needs against the potential the environment has for meeting them.

2. By resolution 2997 (XXVII) of 15 December 1972, the General Assembly of the United Nations decided that the Governing Council of the United Nations Environment Programme should "keep under review the world environmental situation in order to ensure that emerging environmental problems of wide international significance receive appropriate and adequate consideration by Governments".

3. To assist the Governing Council in this task, the Executive Director prepares each year a report on the state of the environment. The first reports (1, 2, 3) discussed a broad spectrum of environmental issues, such as climatic change, the condition of the biosphere, the effects of toxic substances, food, energy and raw materials, population growth, stress and social tension and pollution. At its fourth session, the Governing Council decided 1/ that the annual state of the environment report should be selective in its treatment and that an analytical, comprehensive state of the environment should be prepared every fifth year. Accordingly, subsequent annual state of the environment reports (4, 5) dealt with some selected topics: the ozone layer, environmental cancers, land loss and soil degradation, firewood, chemicals and the environment, malaria, the use of agricultural and agro-industrial residues and energy conservation. The criteria for the selection of these topics are given in the state of the environment report for 1977 (4). This year, the state of the environment report focuses on four topics of broad international significance: schistosomiasis, resistance to pesticides, noise pollution and tourism. These and other issues dealt with in the annual state of the environment reports will be treated in greater depth in the first comprehensive analysis of the state of the environment to be carried out for the decade after the conduct at Stockholm, of the United Nations Conference on the Human Environment, which will be published on the tenth anniversary of the Stockholm Conference in 1982.

4. The rising concern with environmental issues since the Stockholm Conference has been mainly attributed to an increasing realization of the limited carrying capacity of the environment and to the fact that man, in his activities to satisfy his needs and in his aspirations for further

---

1/ Governing Council decision 47 (IV), sect. I, para. 10.

development and achieving better living conditions, has created an increasing number of environmental problems. Such problems could have been largely avoided through appropriate development planning and environmental management. This is, however, easy to say but rather complex to implement.

5. In his efforts to increase the agricultural base for food production, man has embarked since prehistoric times on countless irrigation and water development projects. Such projects have led to the development of many regions, but as a result schistosomiasis has now attained an unprecedented prevalence. The disease occurs mainly in the tropical and subtropical regions, where it ranks high among the major public health problems. It has been estimated that at least 200 million people in 72 countries and islands suffer from this chronic disease, which saps their energy and reduces their resistance to other infections (6). Productivity is inevitably affected through increased absenteeism and decreased work capacity. In view of its harmful effects, schistosomiasis has been considered a real social and economic scourge. It has also been regarded as a disease of the poor rural population, and as a consequence of improperly planned development.

6. In combating disease, and in order to grow more food, man has used a variety of chemical pesticides. Over the years, pesticides have prevented untold misery in many tropical and semi-tropical countries through control of parasitic diseases, and their contribution to increased agricultural production cannot be denied. But pesticides have also caused ecological damage. In addition, the continuous application of pesticides to a pest population has resulted in the selection of individuals which can tolerate higher doses of the pesticide than normal. This resistance to pesticides has become a major limiting factor in the successful application of pesticides in agriculture and in the public health sectors.

7. Industrialization, modernization and urbanization have their own effects on the environment. Besides air and water pollution problems, effects on land use and other environmental aspects, man has become increasingly concerned about noise pollution. Although it does not constitute a major public health problem, noise of unacceptable levels can cause annoyance and other psychological disorders, especially to a wide variety of susceptible groups. In certain occupations, noise can cause gradual impairment of hearing and, in the long run, may cause deafness in highly sensitive subjects.

8. The pressures of modern society have encouraged man to seek relaxation in a variety of leisure activities beyond his normal habitat. This has led to a marked increase in national and international tourism. The latter has become possible for the "average" public through the development of "group" tourism and other measures, and is no longer restricted to the rich elite. International tourism has grown considerably in scale: 55 million individual journeys in 1958, 243 million in 1977. Like other major sectors of human activity and development, tourism has both positive and negative effects upon the physical and socio-economic environment.

9. The four topics dealt with in this report are important contemporary issues, although not the only urgent ones confronting mankind. It is not the intention to give here a detailed description of these issues but to present a balanced brief account highlighting the problems encountered and the attempts to solve them. The report does not pretend to give any final solutions or recommend plans of action. It is rather designed to stimulate discussions from which solutions may emerge. Furthermore, it illustrates that through appropriate development planning and environmental management, man can avoid undesirable environmental problems and satisfy his needs and aspirations on a sustainable basis.

II. ENVIRONMENTAL DISEASE: SCHISTOSOMIASIS

10. Schistosomiasis - known also as bilharziasis or bilharzia - is caused by a water-borne parasite that is snail-transmitted and that infects humans on contact. The disease is estimated to affect at least 200 million people and endanger another 600 million in 72 sub-tropical or tropical countries in Asia, Africa, the Caribbean and Latin America, creating public health problems of varying magnitudes (6, 7). Although recent figures on the number of infections are difficult to obtain because of the lack of reliable statistical data, it has been estimated that present infections are also in the range of 200 million, with half of this figure occurring in Africa (8). There is unequivocal evidence that schistosomiasis is spreading and its severity increasing in many regions.

11. Human schistosomiasis is caused by four species of flatworms, or blood flukes (schistosomes). The first species, Schistosoma haematobium, is found in the Eastern Mediterranean area and over much of Africa. The second, S. mansoni, is found in the Eastern Mediterranean region, Africa and part of Central and South America, while the third, S. japonicum, is found only in East Asia. These three species of Schistosoma have similar life cycles, involving sexual stages in man and asexual stages in various species of snails which are the intermediate hosts. The fourth species, Schistosoma intercalatum, may infect man, particularly in Equatorial Africa, but is of lesser significance. Species of Schistosoma of veterinary importance include S. bovis, S. mattheei and S. spindale and have been reported in many African and Asian countries. S. japonicum has high prevalence in many types of wild and domestic animals (9, 10, 11).

12. Methods used to control schistosomiasis depend upon interrupting the life cycle of the parasite in such a way as to break its continuity. This can be achieved by reducing the contamination of natural waters by human excreta, controlling the snail intermediate hosts, reducing human contact with infected water by provision of clean water supplies, and treating infected people.

13. The efficient disposal of human excreta should, in theory, be an adequate method of controlling transmission of schistosomiasis, but the socio-economic conditions prevailing in many endemic areas make the provision of adequate latrine facilities difficult. Better health education is required

so that sanitation will be accepted and recognized as desirable. Washing and laundry facilities require a safe water supply, as bathing in water containing cercariae is a common mode of infection. If adequate water is provided to meet the needs of the population, contact with natural waters will be reduced and fouling of the river or pond environment will consequently be reduced. The provision of water should be linked with ensuring adequate drainage. Unless this is done, snails may become established closer to habitations than previously, and the problem of schistosomiasis and other infections may even be aggravated.

14. Control of the molluscan intermediate host is generally considered one of the most effective means now available for reducing transmission of schistosomiasis, and its efficacy is likely to be enhanced if it is combined with other methods of control. The life-cycle of snail intermediate hosts, their infection and subsequent production of cercariae, and the transmission of infection, are all affected by seasonal changes. Cognizance of these relationships, together with the identification of all transmission sites, must form the basis of the timing and application of measures directed against snails in an attempt to control transmission. Failure to achieve a successful degree of control is usually attributable to a lack of basic information on the above-mentioned relationships. It should also be remembered that the factors responsible for transmission may vary considerably, and direct extrapolation of data on snail populations and cercariae or on the behaviour of the definitive host, from one area to another may not always be valid, even in closely adjacent areas. Reduction in the prevalence of schistosomiasis has been achieved in the Philippines (12) through the application of methods directed against the molluscan intermediate host and based upon well-founded data and sound logistics.

15. During the past 20 years about 10,000 chemical compounds have been screened for molluscicidal activity, and the most promising ones were further evaluated in field trials (13). An ideal molluscicide should combine the following characteristics:

(a) It should be lethal to snails and their eggs, but harmless to other forms of animal life, especially fish and livestock, and should also be harmless to crop plants;

(b) It should be economical in price and light in bulk to reduce purchase and transport costs;

(c) It should be simple to apply to water and harmless to the operator;

(d) Its solubility should be such that it reaches the snail tissues, but not so great that it is quickly lost;

(e) It should remain unaffected by the organic content of the water long enough to have effect.

The range of currently available molluscicides does not, however, meet all these requirements (14, 6). Many available compounds affect plants and other non-target organisms in the snail habitat, and this biocidal activity is unfortunately possessed by the few molluscicides of accepted effectiveness (15). The most commonly used molluscicides are niclosamide, N-trityImorpholine and copper sulphate. Although these compounds have been effective in controlling the molluscan intermediate host, they have a toxic effect on non-target organisms, especially fish (16, 17, 18, 19). In addition, the long-term effects of small accumulated concentrations of these compounds (especially those adsorbed on silt and clay) have not been thoroughly evaluated.

16. There are numerous records of the harmful effects of different parasites, predators and competitors on snails intermediate hosts, and various species of bacteria, fungi, protozoa, arthropods, molluscs, amphibia, fish, birds and animals affect snails directly or indirectly (14, 20). The introduction of a harmless species which might compete for the food and living-space of an intermediate host species, or prey upon its eggs and young snails, is in principle an attractive proposition. The ampullariid snail Marisa cornuarietis is currently employed in schistosomiasis control programmes in Puerto Rico (21). Other experiments on competitor snails include those using Helisome duryi (22). Various reports of experiments with mollusc-eating fish suggest that drastic reductions in snail population density can be obtained in certain habitats. Such a series of observations was conducted in Kenya, where dams were stocked with Astatoreochromis alluaudi and observed over a prolonged period, impressive reductions in population density of Biomphalaria being obtained (23). Reports indicate that Gambusia species may also effect similar reductions in intermediate host populations in certain habitats, as does the "shell-cracker" fish, Lepomis microlophus, in Puerto Rico. Successful biological control methods would undoubtedly be of economic advantage, but much more research is required into the feasibility and practicability of the application of organisms of potential value before they can be considered for use in the field (24, 25).

17. The most satisfactory method of eliminating the snail intermediate hosts is the destruction of their habitats, either by removal of water or by rendering the water source unsuitable for them. Minor sites of infection can be removed by drainage or filling, but environmental control is not easy in irrigation schemes. Any large-scale irrigation project undertaken in an endemic area may create a schistosomiasis problem. It is a disconcerting aspect of schistosomiasis that the disease may be spread to new areas, hitherto uninfected or of low endemicity, by dams and irrigation projects intended to increase prosperity; the incidence of schistosomiasis increases with the population density. Practices involving an occupational exposure risk such as rice growing or fish farming also tends to increase the incidence of schistosomiasis.

18. The principal environmental methods used to eliminate or significantly reduce the breeding habitats of snails, with or without the additional use of molluscicides, are:

(a) Complete removal of all water inhabited by snails;

(b) Rendering water sources unsuitable for snail breeding;

(c) Enclosure of water to prevent contamination with excreta;

(d) Periodic drying out of irrigation channels;

(e) Weed clearance.

The removal of water involves the drainage of swamps, fens, seepages and small lakes or ponds, and, when complete, should eliminate the snail's habitat. Obviously, this perfect method of eradication can only be applied if a safe alternative water source is available, so that the water eliminated is not required for human needs. In the case of large bodies of water the cost may be prohibitive. Small accumulations of water such as borrow pits, flooded quarries or mine workings, obstructed irrigation channels or small ponds may be drained or filled in with any suitable material available. An environment which is uncongenial for snails can be produced in a watercourse by a strong flowing current, by perpendicular or sharply sloping banks, by removal of the weeds which provide food, oxygen and a substrate for egg masses, by periodic flushing controlled by sluices, by the use of holding canals lined with cement and by various other techniques. Better still is a pumped water supply driven through closed pipes or conduits. The continued use of primitive irrigation methods such as the sakia (water-wheel), the shadoof (counter-balanced bucket swinging on a beam) or the Archimedes screw, which expose the operator directly to cercariae in the water, is partly responsible for the phenomenal incidence of schistosomiasis in the Nile Valley. There are examples where control of irrigation water, improved agricultural methods, and adequate drainage have proved successful in controlling schistosomiasis (26, 27, 28, 29).

19. Mass chemotherapy is currently thought to be an indispensable method for schistosomiasis control. Several effective drugs are now available, but none is perfect or effective for all species of the parasite, and all may pose hazard for a few patients. Hycanthone and niridazole, two newer and generally effective drugs with fewer serious side-effects than older drugs, have shown signs of possible carcinogenic or mutagenic characteristics in some animal tests. Weighing the known benefits against the risks involved, it is still advisable, according to the recommendations of the International Conference on Schistosomiasis held in 1975, to use these drugs until better ones are available (30).

20. Immunological approaches to schistosomiasis are currently attracting considerable attention. Laboratory experiments on animals showed that the presence of adult schistosomes reduces either the extent of, or the damage done by, later infection. On the basis of these facts, several trials are under way to produce a vaccine that confers immunity to infection (30, 31), but many complicated problems of sophisticated technology will have to be overcome, and an effective vaccine cannot be expected before the year 2000.

21. The control of schistosomiasis is an urgent requirement not only for improving health in endemic areas, but also for enhancing socio-economic progress in these areas. While the existence of economic losses due to sickness and treatment costs is generally recognized, the lack of consistent methods of estimation and of reliable data bases have led to widely different financial estimates and, hence, to some controversy over the total costs of the infection. In addition to absence from work, reduced productivity, and cost of medical care, all of which can be expressed in monetary terms, other losses are more difficult to quantify, for example, the discomfort of illness, and the increase in the dependency ratio due to morbidity. Thus it appears that the economic significance of schistosomiasis is much more than has, hitherto, been estimated. Another important aspect of the economic significance of schistosomiasis is that it constitutes a classical example of an "economic development-related disease". The increase in the number of water development projects in the last few decades has greatly increased the number of habitats available to the snail hosts, hence the rise in prevalence of schistosomiasis. In some projects, the emergence of this problem has impeded the realization of sound economic returns.

22. Schistosomiasis control programmes have sometimes been avoided in some countries because they have been considered too costly. However, the costs and availability of labour and the epidemiological circumstances that may occur in endemic foci vary so much that it is not usually possible to state accurately the probable costs of a control programme. In general, control programmes have been estimated to have annual recurrent costs with a range of $0.40-12.00 per capita (6). In St. Lucia (West Indies) a two year control programme showed that chemotherapy reduced incidence of S. mansoni from 18.8 to 4 per cent; snail control, from 22 to 9.8 per cent; and the establishment of adequate water supplies, from 22.7 to 11.3 per cent (32). The annual costs per capita in the first two years were $1.10 (chemotherapy), $3.7 (snail control), and $4.0 (water supplies). Chemotherapy was the cheapest and most rapidly effective method of achieving disease control. Chemotherapy requires population co-operation and a stable community. Co-operation is also required for water supplies to be effective.

23. No single method for the control of schistosomiasis can be recommended; only an integrated approach which takes local factors into account can achieve successful results. Health education, medication and surveillance of population movements are the principal tasks to be undertaken in relation to human population. Environmentally sound water development projects, sanitation, and adequate water supply are environmental prerequisites for the control of the disease. Finally, chemical, biological and environmental methods should be applied in an integrated manner for snail control. It must be emphasized that the success of any control operation depends upon public awareness and participation. It was mainly due to public participation that it was possible to control

schistosomiasis in China. During the first half of this century schistosomiasis, in the most severe form of the disease, afflicted more than 10 million Chinese, and probably resulted in a greater number of deaths than in any other country before or since. The blood flukes caused constant misery and even depopulation in many villages and provoked liver, spleen and intestinal diseases and early death. Since 1950 China has enjoyed a dramatic success against the disease. A national campaign against the disease utilized the abundant manpower to destroy the snail host. Mass drug therapy, together with proper treatment of human wastes, contributed to the successful control of the disease. Canals in the infected areas were drained, the snail-infested mud was dug out and buried in dry land, and snails were killed by sticks (33, 34, 35, 36). Elsewhere, endemic areas of schistosomiasis cut across political boundaries, and the political co-operation necessary to ensure control of the disease is not always available. Migration and nomadism, still very common in Africa, increase the prevalence of the disease, since the snail hosts are generally more widespread than the infection. Persistence of effort is crucial to bringing about human behavioural changes favourable to the prevention of schistosome transmission. Although health education has seldom seriously been applied, it must rank as one of the most important basic tools for control in endemic areas.

III. RESISTANCE TO PESTICIDES

24. The control of plant pests and vectors of human and livestock diseases has been based, during the laster quarter of a century, on the extensive use of chemical pesticides. The figures available for the average annual world production and consumption of pesticides in general vary from one year to another, but the order of magnitude of world expenditure for pesticides is several billion dollars per year; in 1975 it was estimated at $5 billion (37).

25. Extensive use of chemicals for pest and vector control has dramatically reduced a morbidity and mortality due to vector-borne diseases, and has been a principal factor in boosting agricultural productivity in many parts of the world. This achievement enabled global food and fibre production not to lag too far behind human population growth.

26. However, pesticides have also caused some ecological damage. When carelessly applied, chemical pesticides can result in acute and long-term side effects including sickness and death of people, useful animals, fish and birds, and destruction of crops. Even when properly used, chemical pesticides have a number of unavoidable side-effects. Their persistence and ubiquitous nature, coupled with a tendency for some compounds to concentrate in organisms as they move up the food chain, may increase their toxicity to fish, birds and other forms of life, including man, and cause other harmful effects on man's health and well-being.

27. The repeated application of pesticides to a pest population can result in the selection of individuals which can tolerate doses of the pesticide higher than that required to kill the majority. The individual members of "resistant strains" can breed and thus produce resistant populations. Although these resistant strains can be killed by increasing the dosage of the pesticide, the intensity of resistance can vary over a very wide range, so that while some resistant strains can be killed by a small increase in dosage, some remain practically unaffected. Although resistance to pesticides has been known since 1911, it has occurred at a greatly accelerated pace since 1947 as a result of the large-scale introduction and application of synthetic pesticides (38). Resistance to pesticides has been reported for such diverse groups as insects, mites, tickes, fungi, and rodents. The danger of the situation is that there is reason to suppose that all pests are likely to be able to develop resistance to all types of chemical pesticide in time, given appropriate selection pressure. This could seriously and adversely affect the efficiency and economy of pest control operations on a global scale, with corresponding grave effects on both world health and world food production.

28. The appearance of resistant strains of a pest species is due to the selective survival, after a period of application of pesticide to the pest population, of certain individuals which possess genes conferring resistance to the particular pesticide. The genetic basis of this process is now clear, and a number of the actual mechanisms in the pest which confer this resistance have been discovered. These include the development of enzymes which detoxify the pesticide or alter its sites of action inside the pest, or some property of the pest which slows down the penetration of the pesticide to the site of critical action in the organism. In some cases, double, triple and quadruple resistant strains have been found, in which the organism develops resistance against a very wide range of compounds. The existence of this multiple resistance magnifies the speed of development and seriousness of the resistance phenomenon.

29. The outstanding example of this on a global scale is the effect of large-scale use of wide-spectrum agricultural pesticides on control of disease vectors. Although these compounds were directed at crop pest targets, disease vectors sharing the same ecosystem were also subjected to the selection pressures. In some cases where a given insecticide was used both against crop pests and vectors, the selective pressures from the two were additive. These problems are compounded by the processes of cross-resistance, whereby the continued use of a pesticide in agriculture or in vector control can lead to the development of resistance to another pesticide used in either of these fields.

30. Several factors influence the development of resistance in a population, but the main ones are: the presence and frequency of resistant genes in the original pest population; the selection pressure, involving the proportion of the population exposed to selection and the proportion killed; the number of generations per year of the pest;

the isolation of the population affected. Of the second is by far the most important, as is borne out by the fact that resistance has appeared mainly in pests of major economic importance which have been subjected to pesticide application of long duration over wide areas. Thus large-scale campaigns may be expected to cause development of resistance; a good example of this is the correlation between the reported increase in resistance to dieldrin over the period 1955-1960, which coincided with the global WHO malaria eradication programme (39).

31. The FAO Panel of Experts on Resistance to Pesticides has carried out a series of world surveys of arthropod pests (insects and mites); the first survey (40) in 1965 listed 182 resistant strains, the second (41), in 1968, 228 species, and the latest, in 1977, 364 species (42). As regards insect pests, the last survey shows, over the period 1965-1975, a large increase in resistant pest species of cotton and rice, which is related to the fact that these crops receive repeated applications of pesticides. The survey also shows intensification of resistance problems both geographically and in the number of pesticides to which resistance has been reported. Arthropod pests of agriculture are by far the largest group that has developed resistance to pesticides. The FAO survey (42) lists 223 agricultural pests which have become resistant to nine of the major groups of pesticides. Many of these are major pests of major crops, such as cotton bollworm, the boll weevil and the leafworm of cotton, the rice stem borer and the brown plant hopper, the Colorado beetle of potatoes, spider mites of fruit and glasshouse crops, and cutworms and weevils of cereals.

32. WHO reported in 1976 (43) an increase in resistance of arthropod pests to pesticides, with 121 resistant strains reported compared to 102 in 1968. In anopheline mosquitoes, the vectors of malaria, there was an increase of resistant species. By 1969, 15 species of mosquito had developed DDT resistance. The build-up of resistance to dieldrin was even faster: 37 species in the same year. By 1976, a total of 43 species was known to be resistant to dieldrin. Twenty-four species were also resistant to DDT, five to organophosphates and two to carbamates. In culicine mosquitoes, which include the vectors of yellow fever, filariasis and dengue, incidence of resistance has increased from 19 species in 1968 to 41 species in 1975, again with several cases of multiple resistance. In addition to these major vector groups, 38 other species, including such important general disease vectors as house flies, black flies and fleas, were reported as showing resistance. The house fly seems to be the insect showing the greatest ability to develop resistance to insecticides over the widest geographical area. A total of 121 resistant strains was reported in 1975.

33. Herbicides now account for some 50 per cent of all pesticides applied; this increase has occurred comparatively recently. But although annual or more frequent use of the same type of herbicides may quickly alter the weed spectrum in a given location, no evidence has yet come to light that indicates the development of genetical resistance in susceptible biotypes similar to that occurring amongst insects (44). For long-lived perennial

and vegetatively reproducing weeds such as Cynodon dactylon, furthermore, the potential for development of genetical resistance seems low bearing in mind that experience with insects and other classes has demonstrated that in the field many generations must pass before such resistance reaches noticeable levels.

34. The background to the appearance of plant pathogens resistant to the newer fungicides illustrates another aspect of the resistance problem. Up to 1965-1970, very few reports of resistant pathogens were received by FAO; after this date, however, and concurrent with the introduction of new systemic fungicides, the problem increased, and now more than 35 species of plant pathogens have been reported as resistant.

35. Rodents have in the last decade become a major pest problem on a global scale, both in agriculture and in public health. Various species of rodents cause extensive damage to growing crops: Rattus argentiventer and Bandicota bengalensis are major pests of rice in South East Asia, while in Africa Mastomys natalensis and Arvicanthus niloticus damage cereals and cotton. Rodents attack food in store, and also reservoirs and vectors of a number of diseases such as plague, murine typhus and leptospirosis. The latest figures (42) show that seven species of rodent, including two important and widespread species, Rattus rattus and Rattus norvegicus, have become resistant to rodenticides.

36. The discovery of pesticides with novel or unconventional modes of action, such as chemosterilants, hormones and growth inhibitors, was hailed as important, because it was thought to be less likely that pests could develop resistance to them. This was particularly the case with the hormone pesticides, but resistance to these has already appeared. Chemosterilants are so toxic that they cannot be used except in the laboratory; but even here, artificial selection has shown that it is possible to induce resistance. New compounds such as growth regulators and microbial pesticides have not been in use long enough or on a wide enough scale to show perceptible resistance, but here again as with chemosterilants, it has been possible in the laboratory to develop resistance by artificial selection. In addition, and more worrying, is the fact that it has been found that certain insects like the flour beetle, Tribolium, which has developed multiple resistance to conventional pesticides have acquired significant cross-resistance to the growth inhibitor methoprene. As regards microbial pesticides, it has already been shown that house flies can become resistant both to the spores of Bacillus thuringiensis and to its toxin. The general picture at present, therefore, is that it seem probably that most types of pesticides are capable of exerting selection pressure on target pest populations leading to resistance.

37. This situation therefore requires the development of alternative strategies, and fortunately several components of such an approach are now available. The classical alternative approach is to change the pesticide (45). In the short term and in the case of pest control programmes already in progress, this is probably the practical solution. However, the

situation is complicated by the existence of multiple resistance, which often limits the number of substitute pesticides which can be used; in some cases cross-resistance has even been found to compounds which have never been used on a large scale against the particular pest in question. Another limiting factor is price; the use of an alternative compound satisfactory from the point of view of resistance may not be practicable because of the increased cost. Substitution may also be limited by environmental considerations; compounds acceptable from the resistance and financial points of view may have unacceptable environmental effects.

38. The best alternative approach, especially in the long term, would be one that altogether obviates, or reduces the need for, the use of pesticides. There are five alternative approaches to chemical pest control: (i) environmental control; (ii) genetic and sterile male technique; (iii) biological control; (iv) behavioural control; (v) resistance breeding.

39. Environmental control measures comprise all man-made alterations to the micro- or macro-environment of the pest/host contact. Techniques can vary from simple cultural practices like digging up egg pods of pests, or planting trap crops, through provision of services like piped water supplies and sewage disposal facilities, to major environmental modifications like altering river or lake levels. All these methods hold considerable promise for the future, but they need to be developed in relation to the particular ecosystem in which they are to be applied, and they may develop secondary environmental problems. Thus, their costs and benefits must be assessed carefully.

40. Field experience with genetic and sterile male control techniques suggest that the practical problems are great. Here again, there is evidence that pest populations can evolve biological strategies which nullify, in part or in whole, the effects of control.

41. Biological control is an important technique which can be used to great advantage, but again it needs to be developed in relation to the requirements of the pest/host ecosystem, which takes time. Also, care has to be taken not to produce unwanted environmental effects by import of esoteric predators/parasites. Again, there is the likelihood that pest populations could in the long run evolve behavioural strategies which could limit the effectiveness of biological control.

42. Behavioural control of pests by use of sex pheromones and related compounds, and by attractant and repellent chemicals, is also in its infancy. Although some field experiments have been successful, many practical problems have yet to be overcome, and the cost and cost/benefit economics need to be clarified. As with biological control, there is no inherent reason, given sufficient selection pressure, why pest populations could not evolve mechanisms to minimize the effect of behavioural chemicals.

43. Resistance breeding, the development of varieties of plant and animal with build-in genetic characteristics which confer resistance in the

genotype to a particular pest or pest complex, is a most elegant method of pest control. In crop-breeding, this technique has been practised for centuries with great success; it is less developed as regards animal production. However, it is already known that pest populations can and do develop strains which overcome the plant resistance; this is because the nature of the relationship between pest and host is one of biological co-evolution. This being so, any change in the host will eventually evoke, if selection pressure is sufficient, a change in the pest.

44. Faced with these difficulties, increased attention focuses on the concept of "integrated pest management", which seeks to develop an approach to pest control based on the integration of all control techniques, environmental, biological, behavioural and chemical, relevant to the specific pest/host complex under consideration. While this system has been considerably developed, both in theory and in practice, as regards agricultural pest control, there are difficulties in its application to public health vector control. The difficulties of developing successful pest management systems for major vectors of public health, such as malaria mosquitoes and tsetse flies, can only be overcome by extensive research programmes.

45. In respect of agricultural pest control therefore, the most important requirement is to devote resources to the development and practical implementation of the integrated pest management approach. This is already accepted policy as far as FAO is concerned, and the FAO/UNEP Panel of Experts on Integrated Pest Control has, over the last few years, developed a Global Programme for Integrated Pest Control in relation to various priority crops, cotton, rice, sorghum, maize, millet, roots and tubers and grain legumes, and is seeking to extend this to vegetable crops (38).

46. As regards public health campaigns, the twenty-second report of the WHO Expert Committee on Insecticides (43), which was concerned exclusively with the resistance problem and its effect on vector campaigns, expressed alarm at the problems which resistance had caused to major campaigns, and the latest WHO figures for malaria, showing a rapid rate of resurgence of the disease, support this concern. The Committee also recognized the problems facing other major vector control programmes, particularly that against onchocerciasis in West Africa, which at present relies entirely upon one larvicide to control the larvae of the vector, the black fly Simulium damnosum. If resistance should develop in this species, then the problems of finding a replacement insecticide would become acute because of the very severe environmental requirements demanded of the compound by the control techniques, which require direct application of the insecticide into the major river systems of the area.

47. Although various ecologically sound alternatives hold great potential for future pest control strategies, no method used singly will be effective for the total control of pests. Pesticides should always be used in combination with other feasible control measures (46). Improved housing,

sewage systems and better general drainage and refuse disposal can largely banish some insect disease vectors from human dwellings. Control of these diseases can be supplemented by prophylactic drugs or immunization. Various agricultural practices, such as crop rotation, changes of sowing, harvest or irrigation times and the use of immune varieties, are employed for pests affecting crops and domestic animals. Better control and supervision of the distribution and application of pesticides where their use cannot be avoided is also required. However, there is no single solution to the problem of resistance; each case must be considered from many angles. An important prerequisite for the success of pest management is the dissemination of adequate information, public awareness and the training of non-professionals.

IV. NOISE POLLUTION

48. No one can escape the unwanted sound that is called noise - a disturbance to our environment escalating so rapidly as to become one of the major threats to the quality of human life. The sound of cities is the jarring staccato of the jackhammer and the angry roar of the automobile, the bus and the aeroplane. In homes, especially in developed countries, but also in big cities of developing countries more and more power gadgets constitute additional sources of noise. The effect of these multiple causes of noise can, unfortunately, be cumulative. Noise exposure at work is added to exposure while commuting, to exposure at home, and to exposure during leisure activities. Slowly, insensibly, man seems to accept noise - and the physiological and psychological deterioration that accompanies it - as an inevitable part of his life. The problem knows no political or social frontiers. It affects the rich who sleep in a quiet suburb, but travel by plane and cruise by motorboat, just as much as the poor who must live next to a highway or railway or near an airport runway. Because noise does not pose as obvious and immediate a danger to health as polluted water or polluted air, public awareness of noise and public commitment to noise reduction have been modest.

49. In their book, published recently, Bugliarello et al (47) indicate that major differences exist between noise and other forms of pollution. They list these differences as follows. First, noise is everywhere: it is not as easy to control as the sources of water and air pollution. Second, although certain effects of noise, like those of many other pollutants, accumulate in the organism, if noise pollution were to cease there would be no noise residual in the environment, as there would be in the case of water and air pollutants. Third, unlike air and water pollution, the effects of noise are felt only close to the source. Fourth, an essential awareness of noise and motivation to reduce the problem are not present: people are more likely to complain and demand political action about air or water pollution than about noise. Fifth, noise is not likely to have genetic effects, while some forms of air and water pollution, such as radioactive pollution, can. However, the annoyance, frustration, impedance of learning and general stress caused by noise pollution may all have effects on future generations.

50. Almost everyone has had the experience of being temporarily "deafened" by a loud noise. This "deafness" is not total, and normal hearing comes back within a few hours at most. However, continued daily exposure to noise over a period of years can cause hearing loss which may vary from partial to "complete". It has been estimated that there are about 500 professions and occupations which under the present conditions of industrial production involve the danger of impairment of hearing due to noise (48). Great efforts have been devoted to evaluate the relationship between noise exposure and hearing loss, particularly in the context of establishing reliable damage/risk criteria for noise exposure. Such criteria may take the form of standards, for example, those of the International Organization for Standardization (ISO). In 1977, the International Labour Conference adopted a convention and a recommendation concerning the protection of workers against occupational hazards in the working environment due to air pollution, noise and vibration, and the ILO published a code of practice on the protection of workers against noise and vibration (49). Provisions for the prevention of and compensation for occupational deafness have been made in many countries. They vary from country to country, and are shaped by prevailing legal doctrines and Government practices. In general, legislation follows two complementary approaches. On the one hand, it prescribes safety and health practices involving technology and solutions which, if enforced, reduce the risk of exposure to noise. On the other hand, compensation if prescribed for those who have suffered impairment of their hearing through noise exposure at work. Thus, occupational safety and health acts and workmen's compensation acts are complementary; clearly, however, the more effective the former, the less need is there for compensation provisions.

51. Some countries (for example, the United States of America) have set the permissible noise exposure for workers at 90 dB(A) 2/ for a duration of 8 hours a day. Under such standards, it has been found that one-fifth of the exposed work force will suffer a disabling loss of hearing (47), and several countries have therefore lowered the limit to 80 dB (A) (for example, the Netherlands). Present knowledge indicates that an upper limit of 75 dB(A) would considerably reduce the risk for noise-induced hearing loss, as well as for other adverse effects of noise (50, 51). Although this might be difficult to achieve in practice, several measures are being taken to lower the decibel level to a feasible figure. Efforts in this respect have been intensified as a result of the remarkable increase in the number of industrial workers with hearing impairment. In Sweden, for example, 16,000 cases of hearing loss due to exposure to industrial noise were reported to the National Insurance Board for Monetary Compensation in 1977, compared to 5,000 in 1973 (50).

2/ dB = decibel, a unit to measure sound pressure level, dB(A) for weighted sound level (47).

52. Noise-reduction can be achieved technologically at different points: at the source, by technically modifying the machine or by introducing "damping" devices; between the source and receiver, by introduction of sound-absorption or sound-isolation devices, and at the receiver, by the use of ear plugs or ear muffs. The noise reduction at the source or between the source and the receiver is in many cases restricted by economic consideration, and in several occupations it has been found that the use of ear muffs provides the best practical solution. Although ear muffs may reduce noise by as much as 40 dB if properly worn (52), they are often annoying and uncomfortable to wear.

53. External noise from industrial plants is generally small, and few residents near the plants are affected. However, an occupational activity that has a major impact on the general population is construction. Large numbers of passers-by, as well as the people in dwellings and offices located near construction sites of buildings, subways, etc., complain about the noise generated by this activity. In the United States of America, some 15 per cent of the population live and work in the vicinity of construction sites. Passers-by are estimated at some 24 billion encounters per year. It has been estimated that as a result of construction activities, speech communication is severely degraded for about 300 million man/hours per week and the risk of moderate hearing damage is present in about 10 million man/hours per week, primarily in passers-by. Speech interference (due to exposure to more than 60 dB) occurs additionally for as many as 10 million man/hours per week (53).

54. Background noise (or ambient noise) is determined by the environment of the dwelling. Street and aircraft noises are the most common determinants of background noise, but construction and human noise, for example a school yard or a market, can also be important. The type of community generally determines its environmental noise. For example, rural areas tend to be quieter than urban areas; wealthy communities are quieter than poor ones. Background noise levels vary with the time of the day, and in certain cases can also be seasonal, thus defying simple categorization. For instance, background sounds due to traffic tend to mask interior sounds, but when they subside - when traffic noise is reduced at night - obnoxious interior sounds become noticeable.

55. Although the home is generally a sanctuary from damaging noise, it contains, nevertheless, noise sources with decibel levels high enough to damage hearing with sufficient exposure, that is, for many hours a day seven days a week, as well as many other sources that can produce severe annoyance. Household gadgets (air-conditioners, blenders, washing machines, coolers, high-fidelity equipment, televisions ... etc.) have dramatically increased in numbers in developed countries, and are now on the rise in several developing countries. Recreational vehicles and craft - motorcycles, snowmobiles, all-terrain vehicles, and pleasure boats - which have greatly increased in popularity in recent years, produce noise levels at the user's ear that are so high as to lead to impairment as a result of prolonged exposure.

56. Although hearing damage risk from ambient noise is much smaller than from occupational exposure, high noise levels have a number of extra-auditive effects. Irregular noise is particularly disturbing to sleep. Aged people, sick people and people afflicted with psychic disturbances, as well as children between 4 and 6 years old, are very sensitive to noise, and could be easily disturbed during their sleep by excessive noises.

57. Sudden and unexpected noise has been observed to produce marked changes in the body, such as increased blood pressure, increased heart rate, and muscular contractions. Moreover, digestion, stomach contractions and the flow of saliva and gastric juices all stop. These changes fortunately wear off as a person becomes accustomed to the noise. However, even when a person is accustomed to an environment where the noise level is high, physiological changes occur. Cardiovascular as well as ear-nose-throat disorders have been reported among subjects exposed to high levels of noise (53). Significant changes in the secretion of hormones, and in gastric, physical, and brain functions, have been detected in some subjects (47).

58. That noise has psychological effects is undoubted. The question is how these effects can be assessed - and whether they lead to damage. No clear case has been made thus for psychological damage caused by moderately high levels of noise - the levels that would cause hearing damage to only small fraction of the people exposed. Irritability, tenseness, moodiness, insomnia, fear, etc. are some of the psychological effects of exposure to high levels of noise. Why people are annoyed and to what degree depends on many factors: (i) the characteristics of the noise - intensity, time duration, etc; (ii) in what the noise interrupts - trying to concentrate, watching television, etc; (iii) personal sensitivity to noise - people are more sensitive to noise not of their own making; (iv) personal attitude toward the noise source.

59. Of all present-day sources of noise, the noise from surface transportation - above all that from road vehicles - is the most diffused. In Europe and Japan, it is the source that creates the greatest problems. Everywhere it is growing in intensity, spreading to areas until now unaffected, reaching ever further into the night hours and creating as much concern as any other type of pollution. Surveys carried out in the United Kingdom of Great Britain and Northern Ireland, France, Norway, Japan and Sweden (54, 55, 56, 57) show not only that the traffic is considered to generate the most annoying kind of noise, but that it is often one of the most serious problems that town-dwellers must face. The world motor vehicle population (private cars and commercial vehicles) rose from 100 million units in 1960 to 200 million in 1970 and is expected to exceed 300 million units by 1980 (58). To predict what the levels of noise from motor vehicles will be over the next few years is, like all forecasts, a hazardous enterprise, which requires consideration of a number of factors: (i) technical evolution of motor vehicles and progress in reducing their noise; (ii) population and urbanization trends; (iii) economic trends and trends in motor vehicle ownership; (iv) changes in public attitudes toward the noise problem. In France, for example it has been estimated that noise will increase by 2-3 dB(A) between 1970 and 1985 (58). It can be concluded that as a result of the increase in road traffic, noise levels will increase unless preventive or corrective measures are taken.

60. Many countries have adopted regulations to control maximum permissible noise levels for the different categories of motor vehicles (see, for example, (59),(60)). However, the problem still remains, and more efforts are required to reduce the exposure to noise from traffic. This can be only achieved by an integrated approach, using besides legislations: (i) adequate urban planning and road design, including use of sound screens or barriers; (ii) sound-proofing of buildings; (iii) traffic control, etc.

61. Annoyance to people living near airports caused by the noise of jet takeoffs and landings has become a psycho-physiological and economic problem of enormous magnitude and complexity. As a result of the expansion of air traffic, airports tend to occupy large land areas with multiple runways, and large airspaces for in landing and takeoff procedures. At the same time, under the pressure of population, communities tend to expand toward airports and thus to enter into zones of higher noise. At present, aircraft noise affects people near airports, but an increase in the use of verticle and short takeoff and landing aircraft and of the SST is likely to affect a much wider population.

62. Noise not only threatens health, disturbs or annoys, but can also impair the efficiency of work, damage structures, and affect the output of farm animals: although there are few data on animal behaviour towards noise, poultry are not adaptable to sounds, particularly to unexpected loud sounds; noise can disrupt egg production and can affect mating (61). These are all effects that result in a direct monetary cost, even though it may not be measurable. It has frequently been suggested that noise has an adverse effect on worker efficiency. The hypothesis is based primarily on the assumption that noise is a distraction, tending to reduce attention to work and/or increase the rate of fatigue. Numerous studies have been devised to test this hypothesis, with ambiguous results. To estimate the cost to the economy of whatever the overall decrease in efficiency might be is an extremely complex and uncertain undertaking. Yet potentially these costs can be very high. The total cost of accidents, absenteeism, inefficiency and compensation claims due to industrial noise has been estimated in the United States of America at $4 billion in 1971 (62). Estimates of the cost of aircraft noise (flyover easements, which are payments to property owners who suffer the unpleasant effect of aircraft operation, etc) varied between $4 billion and $18.5 billion for 1968 and $6 billion and $27.7 billion for 1978 (47). The cost of land acquisition and relocation of families in areas affected by noise from surface transportation has been estimated at $2.7 billion for an area of 268,000 acres (62).

63. Since the days of the early Romans, when chariot racing at night was prohibited, man has managed from time to time to introduce regulations to control community noise. This response to the old adage "there ought to be a law against it" was slow in the case of community noise laws. However, with the development of modern industrial machines, many citizens have voiced their objections to the rising environmental noise pollution encroaching on their lives. Many of the laws currently in existence, especially in developing countries, were developed primarily to restrict unpleasant or annoying sounds

that are not easily measured or are difficult to control. These laws are useful in controlling boisterous parties, unnecessary automobile horn blowing, animal noise, and the like. Typical wording in nuisance-type ordinances includes... such phrases as "unreasonably loud, disturbing, unusual... unnecessary noise detrimental to the life or health of any individual or causing discomfort or annoyance to a reasonable person of normal sensitivity". These subjective criteria are difficult to enforce, since they require a decision as to what is unreasonable, what is unnecessary, and who is a person of normal sensitivity. In recent years, performance standards in zoning codes, which specify maximum allowable noise limits at fixed points, have been introduced in developed countries to strengthen noise ordinances. Also, some laws now place allowable noise emission levels on transportation vehicles, construction equipment, and other major sources of noise in the community. Environmental health criteria for noise have recently been formulated by WHO (63). The OECD countries have drawn up a strategy to reduce noise through technological, legislative and incentives measures (64). However, the acceptance and effectiveness of all these measures depend, in the first place, on public awareness of the detrimental effects of noise and on public co-operation.

V. TOURISM AND ENVIRONMENT

64. Tourism 3/, with its different categories - international, intraregional and domestic - has become a major industry dependent on the continued availability of a number of generally renewable resources. There are certain basic characteristics of these resources which are distinctive and which in turn give a special character to tourism and its problems. First, there is the varied nature of the resources - pleasant climate, beaches, mountain scenery, wildlife, historic towns and villages, museums, art galleries, cultural events, the way of life of the people, etc. Secondly, there is the geographically diffuse nature of the resources. Certain parts of a country may be more generously endowed with resources and as a result contain the bulk of the tourism industry, but all parts of a country have tourist resources and to a greater or lesser extent tourism is present generally throughout a country. Thirdly, tourist resources are rarely the resources of the tourist industry alone - the terrain which as scenic landscape is a tourist resource is also the resource for agriculture; coastal and inland waters have economic uses; historic towns and villages are homes and places of work of local people.

3/ According to the definition of the International Union of Official Travel Organizations (IUOTO), which became the World Tourism Organization (WTO) in 1975, a "tourist" is a temporary visitor staying at least twenty-four hours in the country visited and the purpose of whose journey can be classified under one of the following headings: (65)

(i) Leisure (recreation, holiday, health, study, religion, sport).

(ii) Business, family, mission, meeting.

65. Tourism, by its diverse and diffuse nature, is so integrated into the life and fabric of a country that developments within the industry affect, for better or worse, society, the economy and the environment generally. The planning of tourist development, therefore, requires a comprehensive approach which will consider the various aspects of tourism as they act and interact within the industry; and tourism itself as it affects, and is affected by, society, the economy and the environment in the national, regional and local context.

66. International tourism has grown in scale from 140 million tourist arrivals in 1967 to 243 million arrivals in 1977 (65, 66), an increase of about 75 per cent in 10 years, and is expected to continue to grow in the years ahead, probably by at least 4 per cent per year (67). International tourist receipts 4/ showed an increase from $18,200 million in 1970 to $38,800 million in 1975, i.e. slightly more than double in five years. In 1977 they reached $54,500 million (i.e. 5 per cent of international trade). It should be noted that most of this tourism is concentrated in Europe and the Americas, and that about 80 per cent of it is intraregional.

67. Developing countries have recently attracted an increased share of international tourism, and are now receiving about 12.6 per cent (67). About 25 to 70 per cent of the total international tourist arrivals in developing countries are intraregional, although the percentage varies markedly from one region to another. Domestic tourism varies greatly from one country to another; on a global scale it is estimated to be four times the number of international tourist arrivals (67). For some countries international tourism receipts amount to a small fraction of foreign exchange earnings, and are low in relation to the gross national product. For a few such receipts rank as the first or second most important source of foreign exchange.

68. In any country, developed or developing, the tourist industry involves a wide range of economic activities. The tendency to under-estimate the diffuse way in which the industry is linked with the rest of the economy, and to concentrate on certain of its principal facets, has often obscured both its costs and benefits. This is especially true in developing countries, where conditions vary to a great extent. In particular, their physical and labour resources, their geographical situation, their state of economic development and indeed their development objectives, are highly varied. Each country must set its objectives, evaluate its resources and the alternative options for using those resources, and adapt its tourism development strategy to meet those objectives.

4/ International tourist receipts are the receipts of countries in the form of consumption expenditures, i.e. payments for goods and services, made by foreign tourists out of foreign currency resources. These exclude international fare receipts. (65).

69. Although tourists' expenditure contributes to the national income, it should not be considered as "net" income since a part of the foreign exchange must account for: (a) the cost of importing goods and services used by tourists; (b) foreign exchange costs of capital investment in tourist amenities, such as hotels, vehicles, etc.; (c) payments due to foreign travel agents, royalties, etc.; (d) promotion and publicity expenditure abroad. Moreover, it is argued that tourist's patterns of expenditure tend to influence consumer expenditure of residents of tourist-receiving countries. Therefore, the overall balance of payments contribution of the tourist industry varies from one country to another and is generally difficult to determine accurately.

70. Tourism has undoubtedly contributed to, and can help very significantly in, providing jobs. The degree to which it should be supported in any particular country, with a view to job-creation and at the expense of investment in other sectors, must depend on the individual circumstances and resources of that country. One highly significant characteristic of the tourism industry in most countries is its seasonality - the wide difference between the high and low tourist seasons. The corresponding variation in employment levels is, however, much less marked. The proportion of labour that is laid off in the off-season varies widely from country to country (as does the length of the season itself), but the average appears to be up to 25 per cent of the total employed during the peak period. Those affected are principally the lowest paid and least skilled workers. There is an increasing tendency for labour legislation to limit the degree to which seasonality in tourist visits is reflected in employment levels.

71. There can be no doubt that the infrastructural cost of the tourism sector constitute the heaviest burden for the country. Infrastructural facilities and services include ports, airports, roads, water and electricity supply, public health, sewage disposal and so forth. An efficient tourism sector, catering principally for visitors from more developed countries, has to provide infrastructural services that are comparable with those in the tourists' countries of origin. Consequently, investment on infrastructure is more likely than is generally the case in developed countries to be incurred, primarily, to meet tourist industry needs. At the same time, much of it profits other sectors and, especially in the case of basic transport improvements, may contribute significantly to higher output by those sectors. Allocation of costs and benefits to particular sectors is then far from straightforward. It is easier, for instance, where a complete region or area is being developed primarily for tourism, or when a specific tourism infrastructure, such as a road used only by tourist traffic, is being installed.

72. Tourism development may, in certain circumstances, contribute to pressures on the general level of prices. The potential overall impact of the industry on other sectors depends primarily on the scale of tourism in relation to national income, while the structure of the industry's demand determines the areas that may be affected. The inflationary effect of tourism varies considerably from one country to another. Although the main effects are encountered in the accommodation sector, in some countries they may extend to basic items (food, clothing, etc.), creating local socio-economic problems.

73. The main factor in determining the social effects of tourism is the very presence of visitors in the country. The impact of their numbers varies according to the size of the population and of the country or area actually visited. While some areas ranking as important tourism destinations receive tourists numbering no more than 1 or 2 per cent of their populations, a few others receive as many as 5 or 10 times the number of their inhabitants. On the positive side, it is argued that, apart from tourism being generally beneficial in improving mutual understanding, the contact involved contributes socially to economic development by generally encouraging "development-mindedness". This is not, of course, easily evaluated, and any evaluation is likely to be influenced by the view taken about what is the "correct" path to development (see, e.g., 68, 69, 70).

74. On the other hand, some social disadvantages may emanate from tourism. The "demonstration effect" may set standards for desirable change, but the presence of tourists in large numbers tends to encourage consumption patterns that are often inappropriate for the population as a whole. It is chiefly those most closely involved in the tourism industry who are led to have such expectations, it is argued; and they may tend, by their income levels, expectations and life style, to accentuate social cleavages in the country. In more general terms, it has been argued that tourism has, in the case of many developing countries, helped to undermine social standards, through the behaviour of tourists (71) and through the demands that are imposed by tourist trade. The question is also raised whether a large-scale industry, often partly foreign-owned and devoted to meeting the needs of manifestly richer foreigners, may cause resentment.

75. But such undesirable social influences may be - and often are - produced in the absence of a large tourism industry. Inappropriate patterns of expenditure and behaviour can be effectively advertised and introduced through the media and through other forms of contact with more developed countries.

76. Like other major sectors of human activity, tourism can have both positive and negative effects upon the physical environment. Positive effects include the considerable conservation measures that have ensured the protection of physical features of the environment, of historic sites and monuments, and of wildlife. These features are in themselves tourist assets, whose preservation is necessary for the successful development of the industry.

77. There are many specific examples of the direct support which tourism can bring to heritage protection. In the Central African Empire, the opening up to visitors of the Saint-Floris National Park permitted the effective protection of the wildlife, in that the income from tourism allowed the proper maintenance of the trails and rangers' camps, and the very presence and movement of tourists kept poachers effectively at bay. In Benin, it has been found that the non-exploitation for tourism of the Pendjari park would risk destruction of the future possibility of its development (72). In a similar way, tourism can inspire or assist the preservation of the historic heritage. The cultural heritage that determines the attractiveness

of a country to tourists encourages the authorities to protect it, and because of this, the examples of cultural salvage operations stimulated by tourism and sponsored by UNESCO are many (73, 74, 75).

78. Several villages and health resorts were created, or improved, for the purpose of tourism. Examples in Britain, are the sea-side resorts of Eastbourne and Brighton and the spa towns of Bath, Cheltenham and Buxton, whose architectural quality and spacious charm which have made them a recognized part of the country's historic heritage (76). A project at Ixtapa, on the Pacific coast of Mexico, involves not merely the creation of a new tourist resort (complete with international airport), but the comprehensive environmental improvement of the adjoining town. This improvement includes the installation of water supplies and a sewerage system, paved roads and electricity supplies, tree-planting, coastal protection and mosquito control, which form the basis for a marked improvement in local levels of health, sanitation and amenity. Similar programmes of comprehensive planning and improvement from a starting point of tourist development are taking place in six tourist-destination towns in Tunisia; at Kotu on the coast of Gambia, at La Petite Côte in Senegal; and in the Kyongju province of Korea. This Korean project illustrates a further dimension of the link between tourism and the environment, in that the project includes creation of a new reservoir which will not only serve the town and tourist development in Kyongju, but will also provide irrigation for nearby farming areas.

79. The counterpart to these positive effects is the negative impact which tourism can have on the physical environment. Tourism involves the actual movement and accommodation of people, often in large numbers, and is thus a major cause of transport development and urbanization. Mass tourism necessitates the development of access roads, hotels, restaurants, shopping and entertainment facilities and other services. In the process, the major tourist sites are inevitably transformed: at best only their natural attractiveness or innocence will be lost, as they become pampered and regulated tourist "sites", capable of absorbing and "processing" large numbers of tourists. At worst, major and often irreversible environmental damage will be caused by a rush to build tourist facilities on the most attractive sites, by speculative land and building booms and by major inroads into the local ecology through the development of tourist infrastructure and services. Countless hotels, roads and other facilities provided for the tourists ruin the beauties of the sea coast, disturb the peace of the country, and rob the mountains of their serene grandeur. In such cases, tourist development can be self-destructive, in that it destroys the very landscape quality which attracts it in the first place (77).

80. Inhabitants of historic cities and old villages are often distressed to find their narrow streets choked with tourist traffic, and their picturesque squares and market places turned into car parks for visitors. Parts of the Mediterranean coasts of Spain and Italy and Southern France are considered by some to have had their natural charm and character brutalized by the massive and standardized tourist development. In many countries, the building

of corniche roads has led to the ribbon development of highly scenic coastlines (78). In Ireland, the United Kingdom, Denmark and the Netherlands, recreational pressure of domestic tourists has caused erosion of dunes and heavy loss of coastal vegetation. Most seriously threatened, perhaps, are the fragile ecosystems of some of the islands in the Caribbean, the Pacific and the Indian Ocean, which have recently been opened for tourism. Tourism can also add to the pollution of coastal waters, through the increase of sewage disposal from tourist resorts with inadequate infrastructure, through oil effluents from the thousands of motor boats and cars, etc. (79).

81. The environmental problems connected with the development of tourism and recreation in mountain areas have been the subject of much discussion. It is recognized that tourism plays a major role in the economy of many mountain areas, but in some instances the damage to ecosystems has reached a critical level, thus impairing the future of tourism development unless effective counter-measures are taken (79). The physical impact consists in serious detrimental effects to the mountain systems - vegetation, wildlife, water balance - and in the degradation of the original local communities. Another problem is the rapidly increasing natural hazard potential due to inadequate planning of new buildings and communication systems, which are often constructed in areas subject to avalanches, landslides and rockfalls. The change from mountain economies, based entirely on agriculture and forestry, to economies relying on tourism and industrial development has been accompanied by the growth of villages and settlements, and heavy traffic even in the remotest valleys. Furthermore, the gradual neglect of the primary trades has had secondary effects not only on ecological conditions, e.g. soil conservation, but also on cultural-social value systems.

82. Historic monuments and sites constitute a particular category of man-made resources for tourism development. They share with many natural assets the characteristics of having a limited capacity which cannot be exceeded without destroying the fabric that constitute their attraction. Uncontrolled mass tourism is in this respect a serious threat. Damage to a number of historical sites due to mass tourism has been reported in Greece, the United Kingdom and other countries (77, 80). It is increasingly being realized that careful management policies are required to safeguard these assets. Experience seems to show that the preservation of historic quarters and sites can as a rule only be viewed against a background of broader planning which treats them as integrated parts of the whole urban and rural environment in which they are situated

83. The foregoing analysis reveals a very complex picture, in which negative and positive impacts are in counterpoint to each other. What factors, then, determine whether tourism's impact on the physical and socio-cultural environment of the receiving country or area is beneficial or damaging? The most important factors are perhaps: (a) the nature and the carrying capacity of the receiving area; (b) the type, intensity and pattern of tourist development; (c) the approach to planning, design and management; (d) the ideology and types of tourists.

84. Where environmental damage has been caused by tourism developments, it is most often due to poor planning of individual tourism schemes and of the overall growth of the industry. In some cases the growth in the number of visitors has outpaced the development of infrastructure and other facilities, or exceeded the socially acceptable level in relation to the area available or the local population. Such damage is ultimately counter-productive for the industry itself. Authorities have sometimes been inclined - perhaps under commercial pressure, perhaps from inexperience in tourism planning - to take a short-term or limited view of planning, with the result that a later generation or a particular segment of society pays an undue price in environmental damage. As for any other sector, it is the responsibility of the Government and the public authorities to ensure, by proper planning, the adoption of development plans, and general supervision, that profits for the industry are not made at the cost of environmental loss.

85. A key principle advocated by those who seek a balance between tourism and the environment is that the type and scale of tourist development and activity should be related to the carrying capacity of tourist resources (79, 80, 81). Such an idea has an obvious relevance to, say, the airlines or water supply systems serving a particular tourist resort. But the principal applies equally to the social system and to the physical or cultural resources which may form the basic attraction to the tourist. The social system - i.e. the population and its workforce - may absorb and serve a certain number of tourists before strains begin to appear. The physical resources, such as beaches, ski slopes or African game reserves, may take a certain load of tourist activity, but show signs of deterioration if that load is exceeded. Assessment of carrying capacity, and the balancing of levels of tourist development and activity with that capacity, are thus crucial means of preventing environmental damage, protecting resources and securing the continuance of tourism itself on a "sustained yield" basis.

86. Tourism is no longer a marginal issue: it has become a major and integral part of world economic, social and physical development. Its impact on the physical and socio-cultural environment is already substantial and widespread, and can be expected to increase. The prime initiative must rest with Governments, which are in the best position to appreciate the needs, interests and resources of their countries and to ensure that tourism is kept in balance with them. But the international nature of tourism and the world-wide interest in the physical and socio-cultural heritage add an international dimension. This will take the form of cross-border collaboration between neighbouring Governments where tourist resources cross national boundaries, collaboration on a regional scale, as in tackling Mediterranean pollution or wildlife management in Africa and efforts on the global scale to help Governments in the search for a balance between tourism and environment.

References

1. The State of the Environment, 1974 (United Nations Environment Programme, Geneva).

2. The State of the Environment, 1975 (United Nations Environment Programme, Geneva).

3. The State of the Environment, 1976 (United Nations Environment Programme, Geneva).

4. The State of the Environment: Selected Topics, 1977 (United Nations Environment Programme, Geneva).

5. The State of the Environment: Selected Topics, 1978 (United Nations Environment Programme, Geneva).

6. Schistosomiasis Control (WHO Technical Report Series No. 515, Geneva, 1973).

7. A. Abdallah, ed., Proc. Intern. Conference Schistosomiasis, 1975 (Cairo, Ministry of Health, 1978), vol. I.

8. Unpublished data, World Health Organization, Geneva, 1978.

9. S.G. Cowper, A Synopsis of African Bilharziasis (London, H.K. Lewis and Co., 1971).

10. P. Jordan and G. Webbe, Human Schistosomiasis (London, Heinemann Medical Books, 1969).

11. G.H. Ree, "Schistosomiasis", A World Geography of Human Diseases, G.M. Howe, ed. (London, Academic Press, 1977).

12. T.P. Pesigan and N.G. Hairston, "The effect of snail control on the prevalence of S. japonicum in the Philippines", Bull. Wld. Hlth. Org., vol. 25 (1961), p. 479.

13. Snail Control in the Prevention of Bilharziasis (World Health Organization, Geneva, 1965).

14. Epidemiology and Control of Schistosomiasis (WHO Technical Report Series No. 372, Geneva, 1967).

15. E.A. Malek, "Chemical and Environmental Control of Schistosomiasis with Emphasis on Side Effects of Schistosomiasis", Proc. Intern. Conference Schistosomiasis, 1975 (Cairo, Ministry of Health, 1978).

16. A. Abdalla and T.S. Nasr, "Evolution of a New Molluscicide Bayer 73", J. Egypt. Med. Assoc., vol. 44 (1961), pp. 160-170.

17. R. Connert, "Results of Laboratory and field trials with the molluscicide Bayer 73", Bull. Wld. Hlth. Org., vol. 25 (1961), p. 483.

18. R. Meredith, "The assay of molluscicide: nicrosamide" Bull. Wld. Hlth. Org., vol. 46 (1972), p. 404.

19. C.J. Shiff, N.O. Crossland and D.R. Millar, "The Susceptibilities of Various Species of Fish to the Molluscicide N-tritylmorphine", Bull. Wld. Hlth. Org., vol. 36 (1967), pp. 500-507.

20. C.A. Wright, "Some views on biological control of trematode diseases", Trans. Roy. Soc. Trop. Med. Hyg., vol. 62 (1968), pp. 320-324.

21. W.R. Jobin, R.A. Brown, S.P. Velez and F.F. Ferguson, "Biological control of Biomphalaria glabrata in major reservoirs of Puerto Rico", Am. J. Trop. Med. Hyg., vol. 26 (1977), pp. 1018-1024.

22. F. Frandsen and N.O. Christensen, "Effect of Helisoma duryi on the survival growth and cercarial production of Schistosoma mansoni-infected Biomphalaria glabrata", Bull. Wld. Hlth. Org., vol. 55 (1977), pp. 577-580.

23. J.P. McMahon, R.B. Highton and T.F. de C. Marshall, "Studies on biological control of intermediate hosts of Schistosomiasis in Western Kenya", Environmental Conservation, vol. 4 (1977), pp. 285-289.

24. F.S. Barbosa, "Possible Role of Biological Control Measures and General Manipulation", Proc. Intern. Conference Schistosomiasis, 1975 (Cairo, Ministry of Health, 1978).

25. H. Van der Schalie, "Using Ambient Temperature for Bilharziasis Control", Proc. Intern. Conference Schistosomiasis, 1975 (Cairo, Ministry of Health, 1978).

26. T.P. Pesigan, N.G. Hairston, J.J. Jauregui, E.G. Garcia, A.T. Santos, B.C. Santos, and A.A. Besa, "Studies on Schistosoma japonicum infection in the Philippines, 2. The Molluscan host", Bull. Wld. Hlth. Org., vol. 18 (1958), pp. 481-578.

27. M. Yokogwa, The decline of Schistosomiasis in Japan (WHO/Schisto/74, 1974).

28. G.O. Unrau, "Design of Irrigation Projects to Minimize the Risk of Schistosomiasis, Proc. Intern. Conference Schistosomiasis, 1975 (Cairo, Ministry of Health, 1978).

29. M. Yokogawa, "Control of Schistosomiasis in Japan", Proceedings of a Symposium on the Future of Schistosomiasis Control (Tulane University, New Orleans, 1972), pp. 129-132.

30. "Report of the Sub-committee on Chemotherapy of Human Schistosomiasis", Proc. Intern. Conference Schistosomiasis, 1975 (Cairo, Ministry of Health, 1978).

31. "Immunology of Schistosomiasis", Bull. Wld. Hlth. Org., vol. 51 (1974), p. 553.

32. P. Jordan, "Schistosomiasis - Research to Control", J. Trop. Med. Hyg., vol. 26 (1977), pp. 877-887.

33. T. Cheng, "Schistosomiasis in Mainland China", Amer. J. Trop. Med. Hyg., vol. 20 (1971, pp. 26-53).

34. R. Anderson, "The recent history of parasitic disease in China: the case of schistosomiasis, some public health and economic aspects", Int. J. Health Services, vol. 6 (1976), pp. 53-68.

35. Schistosomiasis Control Leading Group, "Destroying snails by storing water within low embankments", Chinese Medical J., vol. 2 (5) (1976), pp. 347-352.

36. Report on study tour to control schistosomiasis in the People's Republic of China, 1975 (United Nations Environment Programme, Nairobi).

37. D.L. Watson and A.W. Brown, Pesticide Management and Insecticide Resistance (London, Academic Press, 1977).

38. The development and application of integrated pest control FAO/UNEP meeting report AGP: 1974/M/8, FAO, Rome, 1975).

39. J. Busvine, "Pest Resistance to Pesticides", Pesticides and Human Welfare, D. Gunn and J. Stevens, eds., (Oxford, Oxford University Press, 1976).

40. Report of first session of FAO Working Party of Experts on Resistance of Pests to Pesticides, FAO Meeting Rep. PL/1965/18 (1967).

41. Report of third session of FAO Working Party of Experts on Resistance of Pests to Pesticides, FAO Meeting Rep. PL/1967/M/8 (1968).

42. Report of the first session of the FAO Panel of Experts on Pest Resistance to Pesticides and Crop Loss Assessment, FAO Plant Production and Protection Papers No. 6 (1977).

43. Resistance of Vectors and Reservoirs of Disease to Pesticides, WHO Technical Report Series No. 585 (WHO, Geneva, 1976).

44. FAO Global Survey of Pesticide Resistance (FAO Report AGP: 1976/17/10, 1977).

45. M.S. Mulla, "Resistance in Culcine Mosquitoes in California, Countermeasures", Pesticide Management and Insecticide Resistance, D.L. Watson and A.W.A. Brown, eds. (New York, Academic Press, 1977).

46. D.L. Gunn and J.G.R. Stevens, Pesticides and Human Welfare (Oxford, Oxford University Press, 1976).

47. I. Valcic, "The Medical Aspects of the Prevention of Noise and Vibration", Noise and Vibration in the Working Environment, International Labour Office, Geneva (1976).

48. Protection of workers against noise and vibration in the working environment, ILO Code of Practice, ILO, Geneva (1977).

49. G. Bugliarello, A. Alexandre, J. Barnes and C. Wakstein, The Impact of Noise Pollution (New York, Pergamon Press, 1976).

50. A.R. Nøller, "Occupational noise as a health hazard: Physiological viewpoints", Scand. j. work environ. and health, vol. 3 (1977), pp. 73-79.

51. K.D. Kryter, "Impairment to hearing from exposure to noise", J. Acoust. Soc. Am, vol. 53 (1973), pp. 1211-1234.

52. A. Bell, Noise, an occupational hazard and public nuisance, Public Health Programme No. 30 (WHO, Geneva, 1966).

53. Report to the President and Congress on noise. (U.S. Environmental Protection Agency, Washington, D.C., 1971).

54. London noise survey (HMSO, London, 1968).

55. Urban traffic noise (OECD, Paris, 1970).

56. Noise pollution control , Report 418 (California: Stanford Research Institute (1970).

57. Les difficultes quotidiennes des banlieusards (Institut Francais d'opinion Publique, 1970).

58. Motor vehicle noise (OECD, Paris, 1971).

59. Urban traffic noise (OECD, Paris, 1970).

60. Noise emission standards. Motor Carriers (U.S. Environmental Protection Agency, Washington, D.C., 1974).

61. P.F. Cunliff, Environmental noise pollution (London, John Wiley, 1977).

62. Public hearing on noise abatement and control, vol. III (U.S. Environmental Protection Agency, Washington, D.C., 1971).

63. Environmental health criteria for noise (WHO, Geneva, in preparation, 1978).

64. "Reducing noise in OECD countries". Env., vol. (78) 1 (OECD, Paris, 1978).

65. Regional Breakdown of World Tourism Statistics (World Tourism Organization, Madrid, 1977)

66. Digest of Tourist Statistics, No. 8. (British Tourist Authority, 1977).

67. I. Aguirre, Tourist Saturation and the Distribution of Tourist Flows, (WTO/IATA Conference on Tourism and Air Transport, Mexico 1978).

68. F.E. Manning, Tourism and Bermuda's Black Clubs: a case of Cultural Revitalization (UNESCO/IBRO Seminar, 1976).

69. R.H. Green, Towards Tourism Planning in African Countries (UNESCO/IBRD Seminar, 1976).

70. C. Saglic, Tourism for discovery: a project in four villages of Lower Casamanca, Senegal (UNESCO/IBRD Seminar, 1976).

71 D.J. Greenwood, Tourism employment and the local community: a case study of Fuenterrabia, Spain (UNESCO/IBRD Seminar, 1976).

72. M. Peters, Developpement du tourisme en relation avec la faune et les parcs nationaux dans le nord du Benin (FAO, Rome, 1978).

73. A. Sessa, Elementi di Sociologia e Psicologia del Turismo, (Rome, 1974).

74. R. Lonati Dimension culturelle du Tourisme, (Revue de l'A.I.T., Monaco, 1969).

75. J.M. Thurot, Impact of Tourism on Socio-cultural values, (report prepared for UNESCO by Centre d'Etudes du Tourisme, Aix-en-Provence, 1975).

76. Resorts and Spas in Britain (BTA, with the English, Scottish and Wales Tourist Boards, British Tourist Authority, 1975).

77. E. Cohen, "The Impact of Tourism on the Physical Environment", Annals of Tourism Research, vol. V, no. 2, (April/June 1978).

78. Tourism and Conservation: Working Together (ETC/European Travel Commission/Europa Nostra, 1974).

79. Planning and Development of the Tourist Industry in the ECE Region (United Nations (ECE) New York, 1976).

80. Hadrian's Wall: a strategy for conservation and visitor services. (Countryside Commission for England and Wales, DART (Darlington Amenity Research Trust), 1976).

81. M. Dower, Fourth Wave: the challenge of leisure. (London, Civic Trust, 1965).

- - - - -