

Some Thoughts on Conservation and Development in Forestry

L. C. A. de S. Wijesinghe

Deputy Secretary-General, National Science Council of Sri Lanka

With the rapid clearing of natural forests that has been taking place the world over, it is not surprising that there is now a growing and well-informed body of persons which strongly opposes the uncontrolled felling of forests. It is now widely recognized that the continued destruction of natural ecosystems can cause global disasters, such as adverse and permanent climatic changes, large losses of genetic material (both faunal and floral), desertification, and so on. Other more localized deleterious effects are soil erosion, disturbance of the water regime of a region and local climatic changes. So, whereas forests were once looked upon as a storehouse of timber and as unused land available for development, now their intrinsic value in protecting the environment is widely appreciated. For fulfilling this protective function, it is necessary that forests be conserved, while for the production of timber, a very important commodity in the world today, the forests have to be felled. One of the biggest dilemmas the forester, particularly of a developing country, has to face is to reconcile these two requirements which appear to be in conflict with each other.

Major Ecosystems of Sri Lanka

To examine these two concepts, protection of the environment and supply of timber and other products, in the context of Sri Lanka, it is necessary to make a brief reference to the major natural ecosystems in the country. Though it is a small country, Sri Lanka possesses a number of distinct bio-climatic zones, and corresponding to these zones, there are different natural climax ecosystems. In the low and mid-country Wet Zone, characterized by an year round high temperature and a heavy and well distributed rainfall, the climax ecosystem is the Tropical Rainforest or Wet Evergreen Forest. Though once extensive, the area of Rainforest has now dwindled to about 250,000 acres in a land area of about 3 million acres.

In the Dry Zone, that broad and extensive peneplain covering about 5/8 of the land area of the country, the natural climax ecosystem is the Dry Mixed Evergreen Forest. In certain parts of the Dry Zone, notably in Bibile, Ekiriyanakumbura and Amparai, there are large tracts of savannah vegetation containing scattered fire resistant trees (Aralu, Bulu, Nelli, Kahata, etc.) with a thick undergrowth of the inflammable grass, Illuk. The Dry Mixed Evergreen Forest is not primeval in the sense that, for example, parts of Sinharaja forest of the Wet Zone are, for in centuries past, almost all of the Dry Zone had at one time or another been under agriculture, and the Dry Mixed Evergreen Forest that had since developed is the product of the slow, natural succession after the cultivations were abandoned.

At the beginning of this century, the Dry Zone was extensively covered by forest. Selective exploitation

of the better species (eg. Satin, Halmilla) was being carried out to supply timber for local consumption and export. In the last few decades, selective exploitation was intensified, and shifting cultivation and the opening up of land for settlement and agricultural development projects increased sharply. These activities have made severe inroads into the Dry Zone forests, and it is doubtful whether today there is even a million acres of reasonably good natural forest in this zone. But if the areas of very low quality forest, the scrublands and the abandoned chenas are aggregated, they would together make up over double the extent of high forest. The degradation of the original forest ecosystem and its replacement by scrub, etc. is due to human activity.

In the wet region of the highlands, the highforest climax ecosystem has been preserved over relatively large areas, notably in the Forest Reserves of Pidurutalagala, Peak Wilderness, Agra Bopatalawa and Kikiliyamana. It was mainly because of an edict passed in 1850, that no forests at elevations of over 5,000 ft should be cleared that many of these upcountry forests remain to this day. These forests situated as they are in the highest elevations of the country are extremely important for protecting the watersheds of the major rivers.

Three major ecosystems of Sri Lanka have been referred to above. Natural climax ecosystems such as these have a vital role to play in maintaining the stability of the environment. These ecosystems represent the balanced interaction between the biota (living things), the edaphic (soil) factors and the climate. When natural disasters strike and disrupt these systems, equilibrium is generally restored again in a few years. But man's activity where he has cleared enormous extents of forests in pursuit of development and carried out shifting cultivation and selective exploitation at an alarming rate particularly in the tropics, can in no way be compared to natural disasters. Such activities cause irretrievable damage to natural ecosystems over large areas. Here in Sri Lanka, uncontrolled clearing has resulted in the degradation of what were once highforest into scrublands, grasslands and other such inferior vegetation types. This type of misuse of land has alerted us to the imperative need to conserve what is left of our natural forests. How then does the forester solve the problem of retaining the forest or, rather, what is left of it, for protecting the environment on the one hand and exploiting it for the production of timber, fuelwood, etc., on the other? It must also be remembered that, in preparing his programme of action, the forester has to work within the limitations imposed by natural and economic factors.

Natural factors like climate and soil will determine the growth and reproduction of species, while economic factors will determine the financial limits to which the forester could go in planning his forestry activities.

Current and Future Strategies

By forest conservation we do not mean the absolute protection of the forest (except in very limited areas). Conservation, if it meant absolute protection, would be a very sterile concept, and forestry would have no place as a profession, for all that would be required of a forester is to police the forest. The essence of forestry is to manage the forests in such a manner that they would be of optimum and sustained benefit to society. The forester trained in all the multifarious facets of forestry (silviculture, utilization, forest protection, soil science, forest economics and so on) has to strike a balance between the optimum benefit to society, both through protection of the environment and production of timber.

What broad strategy should the forester adopt in regard to forestry conservation and development in Sri Lanka? Let us take in turn the three climatic zones referred to earlier. In the low country and mid country Wet Zone there are at present about 250,000 acres of natural forest in scattered blocks, situated mostly in steep and inaccessible terrain. Since this area represents only a very small percentage of the land area of the region, and as the region is susceptible to environmental hazards like floods and soil erosion, it is absolutely necessary that this small extent of residual natural forests be retained as such without being given over to any other form of land use. However, this does not mean that the entire area of 250,000 acres should be left untouched as a 'nature reserve'. Our country cannot afford this luxury. Except for certain clearly defined areas which could be absolutely protected, controlled felling could be carried out in the rest of the area. The system of timber harvesting adopted in the Wet Zone natural forests, ideally consists of the felling of trees individually selected for their size (as an index of maturity) and utility value. In this way, no more than 2 or 3 trees are felled per acre. Suitable silvicultural operations will also have to be carried out to obtain regeneration of the better species in preference to the inferior ones. In this method of forest management (practised to perfection in Switzerland), the forest will never be laid bare at any time.

The natural forests of Sri Lanka, particularly those of the Wet Zone, contain a large number of species of plants that are endemic to the country (i.e. found nowhere else in the world), and it is of the utmost importance that forestry practices should in no way threaten the extinction of any such species. Certain areas of natural forests (including a good part of Sinharaja), have therefore been set apart as absolutely protected reserves where no human activity of any kind is permitted.

In the Wet Zone, there is also an extent of about 200,000 acres of derelict land (in scattered areas) that was once under forest but is now under grass, fern or scrub. Most of these lands are unsuitable for permanent agriculture, and are now unproductive except for sporadic grazing by a few head of cattle or the occasional cultivation

of small plots mainly with manioc. The bulk of this area is therefore available for forestry development, and an intensive reforestation programme, mainly with *Pinus caribaea*, is being carried out. The *Pinus* plantations are intended primarily for the paper industry. *Pinus*, like Teak and many other species used for reforestation in Sri Lanka, is not a plant that is indigenous to the country. The forester is often taken to task for selecting exotic species for forestation in preference to indigenous ones. The question may be asked like this: "The indigenous forest trees grow majestically in the natural forests so why select other alien species for reforestation in preference to the well adapted local ones?" A brief reply to this query will be attempted here but the author has given a more comprehensive answer in another paper.*

What is not often appreciated is that the Tropical Rainforest, evolved over millenia, and forming such a rich and complex ecosystem, is nevertheless a very delicately balanced system. The soils of regions such as the Wet Zone of Sri Lanka are inherently poor in plant nutrients, and the forest is sustained by a rapid absorption of the plant nutrients released by the decay of plant and animal debris. If such a forest is felled and the area chena cultivated, in two years or so the soil would have lost all the nutrients received from the chena burn, and in this impoverished site the trees of the highforest cannot get re-established. Hence, for reforestation of such sites, species that tolerate the degraded conditions will have to be selected. *Pinus caribaea* is one such species, and it is propagated widely in tropical regions. Admittedly, from the environmental and aesthetic point of view, it would have been preferable to have retained the natural forests, but once these are destroyed, raising forest plantations of adaptable species is better than allowing these areas to remain in their derelict condition.

Turning our attention to the Dry Zone, this is the region where there will be maximum development of both agriculture and forestry in the future. It is estimated that the area of forest and scrubland in the Dry Zone is about 40 per cent of the land area of the Zone. A good part of this area will be used for development within the next decade or so, and not more than two to three million acres will eventually be available for permanent forestry. Since the nineteen fifties, it has been increasingly realized that the natural forests of the Dry Zone, which had at one time held the wealth of the timber resources of the country, would not be able to continue to serve our timber needs other than to supply a small fraction of the demand. Hence the reforestation programme that was going on at a minuscule scale was rapidly expanded. At present, the rate of reforestation in the Dry Zone is 15,000 to 20,000 acres each year, two-third of the extent being in Teak. Almost certainly the rate of reforestation with Teak will be increased in the future (despite the temporary problem caused by the widespread destruction of Teak plantations by elephants), and the present plantation estate of about 160,000 acres will be greatly expanded within the next few decades. The production from the plantations will

*Wijesinghe, L. C. A. de S. (1978) Why are Exotic Species used for Forestation *Economic Review* 4: 2-3.

be quite substantial. An indication of what could be expected is seen from the large stocks of Teak that have reached the market only from trees — most of which are well below optimum size — damaged during the 1978 cyclone.

With his preoccupation with reforestation in the Dry Zone, the forester should not lose sight of the importance of retaining adequate areas of natural forest in the region. Without question, these natural forests are more effective than plantations for conserving soil and water and stabilizing the environment, and moreover they are needed for protecting the indigenous gene pool. Eventually, it is expected that about 1.5 to 2 million acres (including the areas of the National Parks) would be retained in natural forests in the dry Zone.

The Montane Forests are best retained as such for environmental protection. However, limited extents have to be felled to supply the firewood needs of the area (including the demands of the tea factories), and the areas so felled are planted with high-yielding firewood species. But apart from the natural forests of the Montane Zone, there is considerable scope for developmental forestry in other areas of the upcountry and midcountry region. The Montane Grasslands or Patanas where there is little or no indigenous tree growth are excellent for afforestation with species of *Pinus* and *Eucalyptus*. Besides forming shelter-belts so badly needed in the Patana grasslands, the plantations established on the Patanas are highly productive (timber, fuelwood and pulp wood). In addition to the Patanas, there are large tracts of derelict and totally unproductive tea plantations and these, too, are being transformed into plantations of great potential value.

The current forestation programme, though considered adequate when it was drawn up some years ago, now needs to be expanded. One of the areas that received very little attention in national forestation planning in the past, is the question of fuelwood supplies. That this should have been so despite the fact that over 90 per cent of households and many industries (eg. tea, bread, bricks and tiles, tobacco, etc.) use fuelwood, is due to the fact that the organized supply of fuelwood from State forests account for only a very small fraction of the demand. Rubberwood (from rubber estates being taken up for replanting), trees from private lands, agricultural residues and unrecorded collection from the State forests make up the vast bulk of the fuelwood that is consumed. Recently, two factors have brought into sharp focus the question of fuelwood supplies. One is the world fuel crisis which has, in Sri Lanka, dispelled any possibility of a mass scale switchover from fuelwood to oil. The other is the rapid depletion of natural forests and the largescale settlements associated with the Mahaweli Project, which will require that an organized fuelwood resource be built up in an area where once the collection of fuelwood posed no problem. A national forestation programme for fuelwood production is therefore a matter of the greatest urgency, and it is in fact being accorded high priority by the authorities concerned.

Conclusion

It is important that the public should understand and place in the correct perspective the role of forestry in national development. This is all the more important as, unlike in the case of agriculture, the continuing benefits that society derives from sound forestry practices are not easy to appreciate fully. It is with this in mind that I have briefly outlined some of the criteria and strategies in regard to conservation and development in forestry.



The Fruitless Exploitation of Sinharaja

H. N. S. Karunatilake

Senior Deputy Governor, Central Bank of Ceylon

In the last 2½ decades, extensive cutting down and destruction of forests of the dry zone and the wet zone have taken place, unprecedented in the history of the country. In earlier years, i.e. before the forties, forest exploitation was limited and in British times, very little of the forest cover was touched and that was mainly for chena cultivation. The country depended on imports of timber for a good part of its requirements. It is important to recall that the British imported timber from other Asian countries such as Burma and Thailand, because they realised the value of preserving forests and were of the view that unlimited supplies could not be obtained from the forests in Sri Lanka. After the country gained Independence, a clear-cut policy on the exploitation of forests and reforestation has not been laid down and economic development policy itself paid little or no attention to the conservation of natural resources. Plans prepared so far for economic development have not dealt with the urgent problem of conserving existing forest resources and rapidly introducing a nation-wide program of conservation and reforestation.

In the fifties and after, much less attention was paid to this aspect, because there was a school of thought in the Island that there were adequate forest reserves both in the wet and in the dry zones, particularly in the former, to meet the country's requirements of timber, as fuel, for railway sleepers, for building construction, plywood making and other uses. In relation to the size of the population in the period before the forties, the level of industrial and agricultural development of the country and the requirements of fuel, it is presumably correct to say that the forest reserves then available, were adequate. But since then the extent of exploitation has gone up considerably. After the commencement of river valley development schemes that started with the Gal Oya project, extensive areas of the dry zone forests were cleared for land alienation to the peasantry and to increase the availability of land for domestic agriculture. Every successive river valley development scheme has resulted in the extensive clearing of dry zone forests, in addition to the continuing destruction of forests for chena cultivation.

It is presumably a correct estimate that today approximately two-thirds of the wet zone and dry zone forests no longer remain. From the point of view of timber yields, the dry zone forests provided only limited quantities of economically useful timber. According to an estimate made in 1961, out of a total forest area of 6.12 million acres, 5.3 million acres are in the dry zone. However large this area is, the quality of the natural forest in the dry zone is far inferior to that in the wet zone. According to the Forest Inventory of Ceylon (1961), 96 per cent of the dry zone forest is categorised as low or unproductive.

The most popular varieties of timber from the dry zone forests have been species such as satin and halmilla. The natural regeneration of these varieties have been extremely slow and it has not been possible for man to propagate these species in plantations.

In the late fifties, the Hunting Survey Corporation estimated the area of wet zone forests at 619,800 acres, and in 1970 the estimate of the Forest Department was 557,000 acres. But these seem to be overestimates considering the phenomenal destruction of forests that have taken place. In the case of the wet zone, the removal of a good part of the forest cover in this region has taken place since the early fifties. The main factor behind this has been alienation of land to peasants and the opening up of land for agriculture. Since the mid-sixties, however, the major factor behind the reduction of the wet zone forest cover has been the exploitation of the limited timber resources in this region for the two plywood complexes of the Plywood Corporation located at Gintota and Kosgama. Had the Plywood Corporation not proceeded with the manufacture of plywood and timber products, it is very likely that a considerable part of the wet zone forests may have still been preserved, despite the fact that land alienation for settlement and for cultivation purposes went on indiscriminately from the fifties onwards.

The establishment of the second plywood factory at Kosgama, resulted in the mechanised logging of the oldest primeval forest in Sri Lanka, the Sinharaja forest. To feed the first plywood factory, established in the 1940-45 period at Gintota, the State Timber Corporation and the Plywood Corporation had proceeded with the exploitation of other rich wet zone forests at Kaneliya, Dediagala and Nakiadeniya.

The exploitation of these forest groups in the wet zone were based on wrong estimates and false notions about the availability of timber. The correspondence between ministries and government from 1965 to 1970 clearly shows that certain bureaucrats had a vested interest in giving incorrect estimates and wrong advice to the authorities because they were anxious to proceed with the expansion of the Gintota factory and the establishment of the elaborated wood working complex at Kosgama. The Kosgama factory which has been referred to as the largest plywood and woodworking complex in Asia obviously had to tap the richest sources of timber in the Island. Although at that time, the Sinharaja forest covered about 25,000 acres, the impression given to the authorities was that this 25,000 acres could on a continuing basis feed the large complex at Kosgama, whose main object was to make the country, in the first instance, self sufficient in plywood for tea chests and also to make a wide range of other products from the timber that was used for the plant.

The proposal to exploit the Sinharaja forest should have, from the outset, been looked upon in the context of Sinharaja as a unique national asset not to be touched by man but handed down to posterity and to the world at large as one of the few remaining tropical rain forests. Quite rightly, this proposal engendered much controversy and tremendous opposition from the public, and the government in power at that time, took little heed of the public outcry that arose from the decision to exploit the Sinharaja forest.

The Sinharaja forest consisted of about 25,000 acres of tropical rain forest and it is situated in the regions of the Southern and Sabaragamuwa Provinces which receive over 200 inches of rainfall every year. The forest itself is unique and a visitor to this forest is impressed by the distinctive characteristics of the vegetation found nowhere else in the Island. Most of the trees stand well above 100 to 150 feet, and unlike trees in other forests they have very straight trunks with an average girth in most cases in excess of 8 to 10 feet. The rich vegetation at the bottom is so dense, that people cannot easily walk through the forest. Villagers in the area have cut little known paths through the forest to get from the Kalawana and Veddagala side of the forest to the southern parts bordered by Deniyaya and Morawaka and to a few isolated hamlets on the fringe of the forest.

The proposal made by the Plywood Corporation in 1966 was to set up the second plywood factory at Kosgama with the object of producing 60 per cent of the 4 million tea chests required by the country, while the balance 40 per cent would be produced by the expanded Gintota factory. The estimates then made indicated that the Gintota factory would require 1.2 million cu ft of timber and the second Kosgama factory would require 1.8 to 2 million cu ft of timber making a total of approximately 3.2 million cu ft. In the integrated second mill, the waste timber consisting of cores and waste veneer would be converted into chip board. Other off-cuts of timber would be used to make battens for plywood chests and furniture.

This proposal was made by officials of the Plywood Corporation, who had in earlier years worked in the Forest Department as specialists. Apparently a controversy developed at this time between the Forest Department officials, who were more knowledgeable about the forest resources in the country and who were conservationist oriented, and the Plywood Corporation officials who were primarily keen to build up a huge industrial empire. The plywood could not only feed the tea export industry but also be used to make a variety of other wood products. These could easily be exported if the domestic market could not absorb them.

Throughout 1967, the Forest Department cautioned the officials in the Plywood Corporation who had given advice to the Ministry of Industries and Fisheries, that adequate raw material was not available to feed the gigantic Kosgama factory. The Forest Department virtually advised against embarking on a new project which

would require additionally some 1.8 to 2 million cu ft of timber, annually. The latter requirement was in addition to the growing demand for timber both from the wet and dry zone forests for building construction, railway sleepers, other woodwork and as fuel. By the end of the sixties, the timber requirements for all these purposes had gone up rapidly mainly due to the increase in the size of the population and the progressive diversification of economic activities which involved a more extensive and wider use of timber. Despite this, the Ministry of Planning and Economic Affairs had been in favour of this project as far as the manufacture of plywood chests was concerned. The Ministry of Planning and Economic Affairs however, repeatedly pointed out that the Kosgama site for the factory was unsuitable since the bulk of the raw material had to come from the wet zone forests and because of the heavy additional cost of transporting timber.

In a memorandum addressed to the Permanent Secretary of Land Irrigation and Power, dated February 1960, the Chairman of the Plywood Corporation at that time indicated that he had obtained approval for an integrated plywood complex and that he would proceed to establish this factory which would go into production by 1970. Apparently, at this point, even a World Bank report had given support to this project. This Report had recommended "Erect a new plywood plant (near timber supplies) which would be double the size of the expanded Gintota, provide adequate capacity for the production of battens and install a chip-board unit". The Ministry of Planning and Economic Affairs, however, was keen on ensuring that the project should be restricted to the manufacture of plywood and chipboard, which would curtail timber requirements, because the Ministry of Planning seems to have been aware that timber was inadequate to feed the proposed complex.

With regard to the exploitation of Sinharaja forest, the Ministry of Industries and Fisheries in July 1967, requested that the Sinharaja forest should be handed over to the Ceylon Plywood Corporation to supply the new mill. At the same time, the Chairman of the Plywood Corporation in February 1968, requested the release of this forest to the Plywood Corporation or that the Plywood Corporation work as a contractor for the Forest Department for the supply of timber. The request of the Plywood Corporation for the release of the Sinharaja forest was not accepted.

In October 1968, the Plywood Corporation had put forward a further proposal to increase the all round capacity of the project. But the Ministry of Planning and Economic Affairs repeatedly advised against increasing the scope of the project and particularly the establishment of the furniture plant. With the proposed increased capacity of the mill, the timber requirements of this project which was originally estimated to be in the region of 2 million cu ft went up to 4 million cu ft per year and what was intended to be the second plywood factory by then had turned out to be a massive woodworking complex.

With a view to meeting the timber requirements for the Island, the State Timber Corporation had in 1968, requested Canadian aid for the establishment of a logging project for timber supplies. This request resulted in a team of Canadian consultants arriving in Sri Lanka in November 1970. They submitted a report entitled "On Site Study and Plan of Operation for a Mechanised Logging Project in Sinharaja Forest, Ceylon". Soon after, a loan agreement was signed between the government of Sri Lanka and the government of Canada, in February 1971, to assist financing the project. This was followed by the signing of a contract between the State Timber Corporation and Messrs Reid Collins Associates of Canada on 1st November 1971 for carrying out the mechanised logging project, and the agreement indicated that the exploitation of the forest would start in October 1972.

By the time the mechanised logging had commenced at Sinharaja, the total timber requirements of the Ceylon Plywood Corporation had gone up to 5.5 million cu ft. This was in addition to the large quantity of timber required for other purposes such as housing construction, railway sleepers and fuel. The timber required by the Plywood Corporation to feed its two factories at Gintota and Kosgama had to be supplied from the wet zone forests because there was no timber available in the dry zone and furthermore, the species available in the dry zone being hardwoods were not suitable as raw material for the plywood factories. By this time, i.e. in 1972, over 70 per cent of the harvestable timber in the wet zone had already been exploited and these included smaller forests such as Kaneliya, Dediyaigala, Ruhunukanda, Morapitiya and Nakiadeniya. Of what remained, Sinharaja was the largest unexploited forest in the wet zone.

Arguments were presented by interested parties that unless Sinharaja was exploited it would not be possible to provide the timber requirements of the Kosgama complex. The government in power at that time, seems to have accepted this view. While the Canadians who were overenthusiastic about the conservation of natural resources in their own country did not consider it wrong to enter into a contract with the State Timber Corporation to start a logging project in the only remaining primeval forest in Sri Lanka.

The irony was that while the Kosgama complex alone required 4 million cu ft of timber, the maximum amount that could be harvested from Sinharaja under intensive exploitation was only 3 million cu ft and to ensure the balance requirements further cutting down of the other denuded wet zone forests, such as Dediyaigala, Ruhunukanda and Morapitiya, had to be undertaken. All this resulted in plans for the more intensive exploitation of Sinharaja. Had the production of the plywood complex at Kosgama been limited to the manufacture of plywood only about 1.4 million cu ft of timber as planned originally would have been required. In which case, the proposal for logging Sinharaja could have been confined to modest dimensions and the project itself could have been spread out over a much longer period.

The Canadian logging contractors indicated that Sinharaja like other wet zone forests that were being exploited would not be clear felled and that trees would be cut down according to the felling rules of the Forest Department. This means that felling would not be permitted on either side of streams within 2 chains and trees of only 4 feet in girth and above would be felled and extracted. Furthermore, an adequate number of seed trees of large size as well as all trees with a girth of less than 4 feet would be left unfelled. The Forest Department throughout its long history has adhered to its own rules; and up to this time hardly any wet zone forest had been exploited by mechanised means. In fact, visits to the Kaneliya, Dediyaigala and Nakiadeniya forest reserves, showed that elephants were being used in harvesting timber and this had been done very systematically with minimum damage to the rest of the forest cover. Vehicles have been used only for the transportation of timber from the site to the factories.

Repeated visits to Sinharaja showed that the Canadian methods of exploitation were not only most unsatisfactory but that if proceeded further, in ten years it would result in the clear felling of the entire Sinharaja forest complex. For the first time, mechanised logging on an extensive scale was practiced in the Sinharaja forest. The Canadians used power driven chain saws to cut down trees and these were hauled away by timberjacks which weighed from 7 to 8 tons and each having driving wheels which were about 5 feet in diameter. The first destructive element in the felling operation came with the felling of the larger trees sometimes 12 to 15 feet in girth and standing more than 120 feet clear of the base. Since the foliage in the Sinharaja was very dense, and large trees stood close to each other, the felling of the huge trees resulted in extensive damage to trees that were of less than 4 feet in girth which were not cut down under the terms of the contract, and those that were earmarked as seed bearers.

Furthermore, once the trees fell on the ground, the second generation of the plants which were coming up were completely crushed and destroyed. For the operation of timberjacks, an extensive network of logging roads and skidder tracks had to be carved out. The operation of the timberjacks had serious ecological effects and tended to destroy ecosystems that had existed for centuries. For one thing, the heavy machinery tended to compress the soil, thus inhibiting rapid regeneration of the forest. Furthermore, the mechanical dragging of the huge logs, sometimes 25 feet in length resulted in enormous gullies and furrows. The extensive network of roads and skidder tracks precipitated heavy erosion and the removal of the rich top soils which had been responsible for nurturing the unique vegetation. The gullying and the furrowing effect of the rains resulted in a complete imbalance of the natural ecosystem and resulted in a progressive change in the character of the forest with very low prospects of the natural regeneration of indigenous species of trees.

The streams of Sinharaja before the Canadians started logging operations used to be quite clear, free of sediment and one could see the bottom of the streams with pebbles and fish, even at times when it rained very heavily. With the mechanised logging the streams for the first time, became muddy carrying away large quantities of mud, gravel and suspended material into the main rivers. The skidder tracks and roadways turned into new streams which tended to greatly reduce the absorptive and water retentive powers of the forest, discharging much larger quantities of water rapidly into the Kaluganga, Nilwala and Ginganga causing flash floods in the lower reaches.

The original plan was to exploit the whole of Sinharaja on a selective basis to feed the Kosgama complex over a period of 10 to 12 years and then to rest the exploited areas for the next 10 to 15 years. Knowing well of the disastrous consequence of this program, the Ministry of Agriculture and Lands which was in overall charge of the exploitation of Sinharaja, indicated that it would take action to demarcate a 1000 acre reserve within Sinharaja under the International Biological Program and this block was to be kept free of exploitation and would be left intact as a part of Sinharaja in its natural condition. It later indicated, that it was willing to extend this area to 2500 acres and this was on the basis of representations made by the Wild Life and Nature Protection Society. Professor Ashton of Aberdeen had also pleaded for a reservation of at least 2500 acres.

By the time the mechanised logging project had commenced in 1972, the original estimated acreage of Sinharaja of about 25,000 acres had got reduced to something like 20,000 acres. This was because the villages in the vicinity, both on the Kalawana, Veddagala side and the Deniyaya, Morawaka side, had encroached into the forest with their chena and other cultivations and the perimeters of the forest had rapidly receded. To those outside the few villages on the periphery of the forest, before 1970, Sinharaja had not been accessible because there were only a few little known jeep tracks and paths but the Canadian contractors before they commenced the logging project built an enormous highway some 40 feet wide from Vedagala, which in turn was linked to the Colombo Ratnapura road, into the heart of the forest. This road was so wide, that buses and cars in good weather could have cruised into the center of the forest at 40 m.p.h. This road was built to facilitate movement of heavy machinery into the forest, including timberjacks, tractors, mechanical loaders and for the 60 feet long Hayes timber carriers that carried the harvested logs through Veddagala to Kosgama.

The accessibility to the heart of Sinharaja through this all weather road, resulted in a large number of visitors into the forest, quite apart from the contractors and officials of the Timber Corporation. Along with these visitors, the original vegetation and the

ecological balance came to be upset. For the first time, man had taken with him species of plants and creepers which were not found in the ecological systems in Sinharaja but was found in the rest of the country. Biologically and ecologically, this was one of the most serious adverse affects of the opening of Sinharaja, because natural vegetation in the area came no longer to be preserved but foreign, and non-indigenous species took firm root. What was more, approximately 8.5 per cent of the exploited area, consisted of skidder tracks with its hard compressed soils initially, which with the onset of heavy rains became the beds of new fast-flowing streams.

Since more than 10,000 acres of Sinharaja were exploited by the Canadians, the conclusion is inescapable that the forest that will regenerate itself, now that the logging program has been belatedly terminated, would not have the same characteristic as the original forest which was inaccessible to man. Furthermore, the Forest Department which was partly responsible for the replanting of exploited areas started to plant species like mahogany and jak which were not at all indigenous to Sinharaja.

The present Government took early steps to terminate the Canadian project, but in the preceding 4 to 5 year period, intensive exploitation of Sinharaja had taken place and not more than 5000 acres of the original forest presumably remained unscathed. The writer who was a member of the George Rajapakse Committee, that reported on the Sinharaja forest and the Kosgama Woodworking complex in an unpublished report to the Committee in 1972, stated "I am not sure what the views of the other members of the Committee are, but as for me I am totally opposed to the exploitation of Sinharaja in any form. This is not based on sentiment but on a much broader, economic understanding of the problem."

As the writer anticipated in 1972, the economic gains from the Kosgama complex have been minimal, if not negative. A shortage of timber, despite the exploitation of Sinharaja, in the period 1974 to 1977, has plagued the Kosgama complex. The latter has not been able to work even to 50 per cent capacity. The writer had stated earlier "Even if Sinharaja is exploited, there is no guarantee that adequate timber supplies will be available to feed the complex, after the sixth year. The Canadians will be exploiting more than 75 per cent of Sinharaja in the first four years; thereafter, the 25 per cent of the forest left over may be sufficient for a further two years only. This will be all that will be left for the Ceylonese to do." After the fruitless project on Sinharaja and its prudent termination, though belated, Sri Lanka is perhaps left only with much less than 25 per cent of the original majestic forest, and that too, is bereft of the best species of trees and the very best examples of large flora which Sri Lanka was proud to possess before the foolish expedition to Sinharaja was approved by an ill-advised administration.

The Conservation of Fauna

K. D. Arudpragasam

Professor of Zoology, University of Colombo

Barry Commoner, the American ecologist has enunciated what he calls the First Law of Ecology — 'Everything is connected to everything else'. All the animals, all the plants, all the non-living substances in an area are interconnected and exist in a finely balanced dynamic state. Together, they constitute what is called an ecosystem, examples of which include small units like a pond, a marsh, a forest, a grassland and ultimately the largest unit of all — the entire biosphere itself.

Therefore, it should be clear that while for purposes of convenience we may discuss the problem of the conservation of fauna separately, the animals of any area, large or small, cannot be considered in isolation from the wider ecosystem to which they belong. In effect, this means that fauna cannot be conserved unless we conserve the total habitat in which the species can live. Thus the conservation of the fauna of an area requires the maintenance in natural form of an extensive range of different functional ecosystems.

Too often, especially in countries such as ours, ideas of conservation are centred round the protection of certain endangered species of large animals — mammals and birds and some of the other vertebrate animals. Most people are familiar with such animals and their observation in the natural environment has become a popular pastime. However, the major problems of faunal conservation have their focus elsewhere. There are, at least, about two million species of organisms living in the world today. Obviously not all of these are essential for the continuation of life on this planet. Some of these organisms are even harmful to man. But we do not know, for certain, which species are essential and which are not. We also have no knowledge about which part of the genetic heritage embodied in existing species will be most valuable for future evolutionary processes. We have no alternative, therefore, but to ensure the continued survival of the specific constellations of fauna which are presently characteristic of various natural habitats.

The importance of inconspicuous invertebrate animals in nature's schemes can be illustrated graphically by reference to two examples. Everyone knows what an earthworm is, but few understand the immense contribution that these animals make to the living-world. In fact, Charles Darwin said, "It may be doubted whether there are any other animals which have played such an important part in the history of the world as these lowly organised creatures." Earthworms live in burrows in the soil and eat rotting plant material. In the process of feeding and making burrows, they swallow soil and pass it out, after processing, as casts. Casts, which may amount to over 10 tons per acre per day, are much more fertile than unprocessed soil. Moreover, the burrowing of earthworms make soil more porous to air and water.

The importance of conserving earthworm populations cannot be minimized. The second instance of the importance of the smaller components of a fauna is that of the dung beetle. Dung beetles feed on cow pats, as also do their larvae. The activities of these animals help to intergrate the cow pats into the soil and make the soil more fertile. In Australia, there are native beetles that live on kangaroo dung, but none that live on cow pats. So cow pats can last for years and cover pasture ground making it unproductive. Therefore dung beetles are being introduced into Australia specifically to process cow pats.

From the fore-going discussion, it should be evident that there are two major aspects to the problem of faunal conservation. The first, and perhaps the less important, is the problem of conservation of large species of animals, mainly vertebrates. The second and more fundamental problem, is that of conservation of the totality of faunal constellations of given areas in as extensive and as unmodified a form as is practicable. Unfortunately, much less thought, publicity and expense has gone into the second than into the first problem.

The stage of animal evolution is littered with the fossils of millions of animal species that are no longer extant. These are forms that appeared at some time in the past, lived for greater or lesser periods of time, and died out. This cycle of emergence, existence and expansion and final extinction, is a natural phenomenon which is an integral part of the world of life.

One has only to remember the great hordes of dinosaurs that ruled the earth for many millions of years and finally disappeared about 70 million years ago. The mammals, themselves, are said to be past the peak of their expansion. Many giants among the mammals, like the woolly mammoth and the ground sloth, have become extinct without man's helping hand. However, while we may accept the inevitability of natural processes, it is alarming that man has gone out of his way to remove large numbers of animal species, especially of birds and mammals. It is estimated that in the last 300 years, man has wiped out over 200 species of mammals and birds. The rate of destruction has accelerated during this century and it is suggested that perhaps one species becomes extinct somewhere in the world each year. It is true that in many cases the extinction of these species does not affect the continuance of life as a whole on earth but there can be no doubt that mankind is the poorer for the loss.

Some examples of extinction or near extinction of fauna may be quoted. In most cases these can be attributable, in the early years to ignorance of consequences but increasingly in recent years to man's greed for material gain.

(1) The northern fur seal *Callorhinus ursinus* breeds on the Pribiloff Islands in the Bering Sea. Herds of several million seals were discovered there in 1786. Twenty years of indiscriminate killing reduced the species to near extinction. Regulations were introduced but populations declined to about 125,000 by 1911. Further conservation measures succeeded in saving the seal and by 1958 populations had risen to nearly two million, in spite of controlled cropping.

(2) The blue whale 100 feet long and 160 tons in weight is the largest animal that has ever existed on earth. But three whaling nations Japan, Norway and the Soviet Union have brought these wonders of nature to near extinction. Catches of blue whale have declined from 5231 in 1950 to none in 1967. Populations of other types of whales have also declined alarmingly.

While it is possible to quote a number of cases where various animal species have been wiped out or brought to near extinction, there is certainly a concerted effort among many nations to take effective corrective measures. Perhaps the best examples of strict conservation measures are those afforded by countries like Australia, and New Zealand. Australia, having been isolated from the rest of the world for a very long time, has a unique collection of fauna. The native mammals are all marsupial or pouched mammals, unique to the island continent. Within Australia, these animals play the part in the ecosystems which, elsewhere, are carried out by placental mammals. Rigorous conservation and protection measures have kept this unique fauna reasonably intact.

The fauna of Sri Lanka is not by any means an exceptional one, when compared to the fauna of Australia, New Zealand and Madagascar. Sri Lanka separated from the Indian sub-continent in late Miocene times, the south-western section being the first to separate. The fauna of Sri Lanka, therefore, bears considerable affinity to that of India. This applies especially to the fauna of the Dry Zone areas. The fauna of the wet hill zones is more distinctive though there is some affinity with the fauna of the Malaysian tract. (Crusz, 1973).

The Sri Lankan fauna includes some 628 known species of terrestrial vertebrates including 84 mammals, 379 birds, 133 reptiles and 32 amphibian species. (Crusz, 1973). Eisenberg and McKay (1970) in their check list of recent mammals of Ceylon list the following mammal species as endemic.

Endemic species confined to the hill zone:

Shrews — *Feroculus feroculus*, *Solisorex pearsoni*, *Crocidura miya*

Rodents — *Rattus montanus*, *Rattus ohienis*
N.B. *Feroculus* and *Solisorex* are endemic genera.

Endemic species more widely distributed in the island:

Primates — *Presbytis senex*

Carnivores — *Paradoxurus zeylanicus*

Rodents — *Mus fernandoni*, *Mus mayori*

In their study of mammalian distribution in the island, Eisenberg and McKay (1970) have recognised seven vegetational zones as proposed by Mueller — Dombois and Sirisena (1967) and other authors. These are listed as follows:

Monsoon Scrub Jungle — extreme north and northwest
— extreme southeast
Monsoon Forest and Grassland
Intermonsoon Forest
Rain-forest and Grassland

— below 3000 ft.
— above 3000 ft.
— above 5000 ft.

Much of the endemic vertebrate fauna of Sri Lanka are confined to the rain forest with about 25% confined to elevations above 5000 ft. Commenting on the great number of sub-species of mammals identified for Sri Lanka, Eisenberg and McKay (1970) indicate that their status is uncertain. They suggest that clinal variation from highland wet zones into lowland monsoonal rain forests may account for much of the variation on the basis of which many of the sub-species have been defined. They state that further study of this phenomenon will undoubtedly eliminate many forms now defined as valid sub-species.

Compared with South India the recent Sri Lankan fauna is less diversified. However, it was much more varied during the Pleistocene. Fossil or sub-fossil remains indicate that the island once had a hippopotamus *Hexaprotodon*, two species of the genus *Rhinoceros*, the Indian lion *Panthera leo*, the red dog *Cuon javanicus* and the gaur *Ribos gaurus* (Deraniyagala, 1958). It is a well known principle that diversity of a fauna and especially of large mammals, is related to the size of the land area occupied. Under natural conditions the island has not been able to retain many of its larger mammals. Today, we are left with but a few which include *Elephas maximus*, *Melursus ursinus*, *Axis axis*, *Cervus unicolour*, *Bubalus bubalis*, *Sus scrofa* among the terrestrial forms and *Dugong dugong* among the aquatic animals. Taken as a whole these do not form our exceptional assemblage of mammals but they are all we have got and it becomes all the more important that we should make every effort to ensure their continued existence.

In pre-civilisation, man was just one member of the fauna. His impact on the environment was no greater than that of any other species. With the advance of civilisation, development of agriculture, industry and urbanisation, man has now to be regarded as an epidemic disease which is rapidly destroying the environment, making it inhospitable, both for his own species and all others. In our own country, the human population load is already in excess of that which the environment should be called upon to support. It is increasing further.

Massive agricultural development projects have to be implemented and extensive industrial development has to be undertaken in order to support the demands of this expanding population. Inevitably, the natural environment is affected. Land areas under natural vegetational cover with their supported fauna, vertebrate and invertebrate, large and small, will be rapidly eroded to give place to agricultural production. Natural waters, both fresh and brackish as well as the sea will be increasingly subjected to pollutants of various sorts. In addition, the human population that will continue its expansion in numbers and into land space, will tend to take a direct and heavy toll on the already limited fauna.

Much has been written and spoken about the Ceylon Elephant and its protection in the recent past. It is not necessary to restate the entire case here but this species is a classic example of the havoc that can be wreaked on a valuable national asset by improperly planned clearing of natural environments. The elephant thrives in regions where green food and water are plentiful — regions like the southwest and central regions of the island. However, they have been displaced from these regions into drier, inhospitable areas. The animal needs extensive acreages for feeding and for migrations. These have now been severely restricted. The elephant is a slow breeder with a gestation period of 22 months and unfortunately, it rarely breeds in captivity. Losses sustained by existing populations cannot be easily recouped. Taken all in all, prospects seem to be bleak for the Ceylon Elephant. It is even more important to realise that the fast disappearing elephant, while being a cause for alarm in its own right, is symbolic of the disappearance of a whole complex of faunal elements, which though less imposing are ecologically the more fundamental.

How do we set about devising solutions to the overall problems of faunal conservation? It is not possible to cry halt to all development activity. Also, as indicated at the beginning of this article, conservation of fauna is, in practical terms the preservation of whole ecosystems. A well planned, integrated and sustained programme is urgently required. The components of such a programme would be the following:—

1. A documentation of natural ecosystem country — wide on the basis of which firm decisions must be made that certain designated areas must be preserved in their natural form. These would not include forests only, but also natural areas such as grasslands, mangroves, marshes, sea coast and so on. For instance, there is now general agreement that Montane forests and forests like the Sinharaja must remain inviolable.
2. It is not enough to mark out National Parks, Strict Reserves and Intermediate zones. It is essential that sound and extensive ecological studies must be made in these areas. Information gathered from such studies can then be used for sound management of the Parks. As natural environments become increasingly restricted, the management of those that remain is a matter of paramount importance. The Department of Wild Life does a herculean job at the moment with very limited resources of equipment and personnel. It is very essential that the trained scientific cadre of the Department must be increased manifold. It is not a matter for pride that we are largely dependant on visiting teams of scientists for basic information on our wild-life and parks. To some extent we have taken steps to rectify this short-coming. In 1978, a corporate effort was made to study some of the problems of the Yala Park by scientists from the University of Aberdeen, the University of Colombo and personnel of the Wild Life Department. (Joint Aberdeen and Colombo, Universities Expedition in Sri Lanka 1978).
- A similar study will be made this year and it is hoped that the National Science Council will support extensive continuing ecological studies which are basic to proper management of our National Parks.
3. The habits, the movement, the problems of our larger mammals have to be closely monitored. Recently, a herd of elephants in the Mahaweli Development area was driven into a new home range. The progress of these animals needs to be closely followed on sound scientific lines. This calls for additional staff and facilities for the Wild Life Department and close collaboration between all departments and agencies which have anything to do with forests.
4. It is necessary to apply very stringently all existing regulations relating to forests and fauna and to tighten up where these are ineffective.
5. It is necessary to impose a total ban on exports of fauna from this country, at least until such time

as a broad assessment is made of the inroads that have been made into our natural heritage by uncontrolled export. The concept that it is sufficient, to stop the killing or removal of 'endemics' and endangered species alone is wrong.

6. It is necessary in all future development programs to make adequate provision for planned protection of the existing ecosystems as part of the initial planning process.

In conclusion, it is necessary to emphasise that the time has come for us to base our planning and decisions on the conservation of the environment on sound scientific information. The Departments and Institutions that have the capability of collecting this must be strengthened. The cadre of such departments must include well trained scientific officers. As the natural environment shrinks, it becomes increasingly valuable. Let us treat it as a national heritage that has to be very carefully nurtured.

REFERENCES:

- Crusz, H.—(1973) — Nature Conservation in Sri Lanka—In Biological Conservation 5 (3), 199-208.
- Deraniyagala, P. E. P. — (1958) — The Pleistocene of Ceylon —Ceylon National Museums, Natural History Series — 164 pp.
- Eisenberg, J. F. & McKay, G. M.—(1970)—An annotated checklist of the recent mammals of Ceylon with keys to the species—Cey. J.Sc. 8 (2), 69-99
- Joint Aberdeen and Colombo Universities Expedition in Sri Lanka—(1978)—University of Aberdeen, 193 pp.
- Mueller — Dombois, D. & Sirisena, U. A.—(1967)—Climate map of Ceylon; Surveyor-General's Office, Colombo 5, Sri Lanka.

Conservation of Fisheries

Rodney Jonklaas

Former Superintendent of Brackish Water Fisheries, Dept. of Fisheries

The question of fisheries and its importance in a needy and growing economy is increasingly significant to Sri Lanka. It needs hardly be stated that the nation looks more and more to its fisheries for food and material for export.

Since Independence, the role of fisheries has grown in importance, and whereas earlier, only the Department of Fisheries with a meagre staff handled all matters relating to fishing, now, there is a Corporation, a Harbours Corporation and a greatly expanded Department, all under a separate Ministry.

To the increasing dismay and alarm of conservationists, the subject of the conservation of fisheries has been given little attention, if at all, resulting in the present condition, which can only be described as grave. The fishing resources of the country are still regarded as inexhaustible. This is a most disturbing state of mind, and unfortunately, it is often the slogan of the uninitiated in high places who voice it in public.

More significant is the rapidly expanding fishing population of the country, totally uncontrolled, and all intent on the exploitation of anything and everything of value from our waters, coastal and inland. The existing regulations which could control the more destructive forms of fishing are not only inadequate but almost impossible to enforce. The increase in fishing intensity has not been kept pace with by an increase of preventive staff and more stringent legislature.

Few places exist inland which can be regarded as total sanctuaries for indigenous aquatic fauna. The two great Game Reserves are, unfortunately, in the drier areas and so cannot protect the majority of aquatic fauna and flora. Worse still, the haphazard and hasty introduction of proven competitors of our indigenous fishes has further depleted the variety and numbers of indigenous fishes in these Reserves.

The rapidly escalating cost of fish, and other marine products has served to intensify fishing effort. The lucrative export market which pays premium prices for certain items like lobsters (*Panulirus*) and shrimps (*Penaeus*) is another incentive towards the decimation of existing stocks.

Unless stringent and effective means of conservation are adopted in fresh, brackish and marine waters, in that order of importance, it is certain that a condition of near-extinction of most economically important fauna and flora will result.

Such exploitation is not confined to edible species; the pet fish export business which still flourishes with no restriction whatever on choice of species, threatens to exterminate a few species of endemic fishes and water plants of the Genus *Cryptocoryne*. A law well over 30 years old still exists in the Fisheries Ordinance which requires permits to be issued in respect of the following endemic species of freshwater fishes:

1. *Rasbora vaterifloris*
2. *Puntius titteya*
3. *Puntius nigrofasciatus*
4. *Puntius cummingii*
5. *Belontia signata*

More than 15 years ago, leading exporters fought for and won their right to export these in any numbers. It is reliably known that some or all of these species have disappeared completely, from their haunts and that field collectors now operate in very remote areas for their supplies, even intruding on Forest Reserves (e.g. Kottawa, off Galle).

Since the discovery of the above fishes, a few more endemic species have been named, viz:

Aplocheilichthys wernerii, *Lepidocephalus jonklaasi*, *Gobius jonklaasi*, *Malpulutta kretseri*, and a species of *Puntius* commonly known as the "Asoka barb".

Because of their rarity and endemic status, they fetch higher prices and so are over-exploited.

It is a very real possibility that one or more of these species may face extinction unless measures are adopted to protect them. Under British rule, there existed fairly effective regulations governing the use of certain nets in inland waters. But since the introduction of the over prolific *Tilapia (Sarotherodon) mossambica*, these could not be enforced.

A prolific and competitive introduction, *Tilapia*, speedily overpopulated many tanks and lagoons to such an extent as to almost eliminate indigenous species and then, unable to survive in drought conditions, die and pollute the water. It was found necessary to relax the laws and permit gill-netting and even seining in confined areas. These operations had severe effects on flora, other fauna and bottom conditions and there now exists a completely unnatural condition in our major irrigation tanks.

Hence, it is now a common practice to find professional fishing-camps in any inland body of water which can lend itself to gill netting. The side-effects have yet to be fully determined, such as the greater increase of piscivorous avifauna and diminution of insectivorous and herbivorous species causing imbalances which could have severe future repercussions.

All this points to the immediate and urgent need for a sound Conservation Policy which would cover all forms of fishing and fisheries. And even at the initial stages, unless provision is made for effective enforcement, such laws would be ineffective, as are those recently framed to protect and conserve the Spiny Lobster (*Panulius*).

The most necessary and primary move is to establish sanctuaries in specific areas which could serve to preserve stocks.

Outside of the sanctuaries (which are themselves subject to coastal and offshore professional fishing activity) no bodies of water are protected from fishing and fishermen. The rivers and streams, canals and inland waterways are particularly badly overfished.

In spite of frequent agitation, we have yet to declare as a **Strict** Sanctuary or National Park, any area of our coastline. The Coral Islets Sanctua which exists on paper, covers a mere group of rocks off Hikkaduwa originally intended to preserve sea-birds. For years, attempts have been made, always violently opposed by politically-motivated fishermen, to add to this an area of sea with its corals and fishes. But still nothing really effective has been done.

A similar scheme hopes to preserve Pigeon Island and its environs off Nilaveli, not only subject to excessive fishing, trapping and tropical fish collecting, but also, to explosive-fishing with dynamite.

Any National Parks or Sanctuaries to preserve aquatic life must be **totally** inviolate from **all** forms of fishing and exploitation.

A natural form of relief from fishing is provided during monsoon months, and in the past, with the majority of fishermen operating with simple craft and gear this served to conserve stocks to a great extent. But now with the modernisation of fishing craft and gear, the monsoons are no longer the "close seasons" they used to be and except in areas very close to shore, the seas are increasingly exploited and the lagoons and inland waters, even more than during the inter-monsoonal periods.

It would be beneficial, if not imperative, to impose strict close seasons in some areas and for some species, as is done on land with certain forms of mammalian and avian wild life. For instance, a season during which fish migrate up-river to spawn should be determined and efforts made to prohibit fishing in these specific spots during the critical period in order to ensure a greater harvest.

Many species should have size limits, a system that is very strictly enforced and successful in countries like Australia, South Africa and America. In Sri Lanka, any size of a species which cannot escape through the mesh of a net is taken. Few fishermen ever throw back an undersized fish, and in only a very few areas do the fishermen themselves observe any regulation governing mesh sizes of nets. Consequently, countless undersized specimens, which could well have been left to grow to economical weight are needlessly destroyed. The main offenders are the owners of beach-seines who are increasing steadily, and whose nets with small mesh size in the cod-end gather undersized fishes of *Caranx*, *Scomberomorus*, *Chorinemus* species which venture close to shore in their fingerling stages. Because of the Sprat (*Stolephorus*) fishery, it is impossible to impose any restrictions of mesh size in beach seine nets, but the need for Sanctuary beaches, is all the more necessary because of this.

Over-effective fishing methods need careful appraisal and control. A notoriously effective one is the "Ja-kotuwa", a form of fish-trap which stretches across channels and canals in lagoons and almost decimates fishes which seek to traverse these stretches. Lagoons where "Ja-kotuwas" are still in use after decades, are singularly poor in their fish populations, for example Moratuwa/Bolgoda lake. Although it may be not possible to ban this form of fishing altogether, it may be practical to limit the size and locations of these effective traps and also the mesh-size of the end-chambers.

Another wasteful form of effective fishing is the laying of nets on reefs for Spiny Lobster. Many of the nets are entangled and torn in such spots and left there by the fishermen who get such good prices for what they catch, that they are prepared to sacrifice part of their gear almost every night. The abandoned nets, made of nylon, continue to entrap not only Spiny Lobsters, but also other fishes which simply rot there or are eaten by predators like octopuses. 'Blind netting' for Spiny Lobsters is the most wasteful and destructive form of fishing and should receive immediate attention with a view to control or total ban.

The final form of conservation involves the protection of specific fish, invertebrates or plants

which are endangered. Marine and brackish species are for the most part similar to those found over much of South-East Asia, but freshwater forms in many cases are endemic and can never be replaced.

Until such time as competent observers can declare them safe for **controlled** exploitation, the following species, are in the opinion of the author, deserving of consideration for protection.

Marine — *Balistoides niger* (*Conspicillum*)
Chaetodon ornatissimus
Chaetodon ephippium
Chaetodon benetti
Forcipiger longirostris
Pomacanthus imperator
Paracanthunus hepatus
Epinephelus flavocoeuleus
Chaetodon rafflesi

(all the above have been greatly reduced in numbers by intensive and skilled tropical fish collecting and also trapping with wicker traps.)

Brackish — *Toxotes chatareus*
Vaimosa balteata
Ethirawa fluvialilis

Fresh — *Puntius titteya* (three varieties)
Puntius nigrofasciatus
Puntius cummingii (two varieties)
Puntius sp (Asoka barb)

Belontia signata
Rasbora vaterifloris
Aplocheilichthys werreni
Gobius jonklaasi
Lepidocēphalus jonklaasi
Malpulutta kreiseri
Tor tor
Horadandiya atukorali

There is already legislation to conserve the Spiny Lobsters (*Panulirus*) but a crustacean that may soon become scarce due to over-fishing and capturing of undersized specimens, is the Mangrove crab (*Scylla serrata*) in which case, at least a size-limit is most urgently required.

It is already almost too late to redeem the former potential of many forms of fishes, but, an effort can be made to conserve and increase their diminishing population.

* * * * *

Prohibition of Inland Fishing during Breeding Seasons

Regulations prohibiting inland fishing during the breeding seasons are expected to be gazetted shortly by the Fisheries Minister Festus Perera. The breeding seasons are between October and December. This prohibition will apply, initially to the Vavuniya and Mulativu districts.

Only persons who have obtained a permit for fishing in the particular fish ponds and tanks, will be allowed to fish. According to Ministry sources, such permits will be issued by the Government Agents of the district under which the particular fish ponds come.

The Natural Environment

L. H. Cramer

National Herbarium, Peradeniya

Introduction

The natural environment, or the virgin landscape with its complexity of ecosystems, is rapidly being modified or fast disappearing in Sri Lanka. The phenomenon is much the same in other developing countries — e.g. Indonesia. But in Sri Lanka it reveals the ingredients of a crisis, a potential danger to national security. Various development projects with their demands on new virgin land, illicit forest clearings for extraction of timber and the wanton destruction of coastal marine life have precipitated a dwindling of our natural resources; the vegetation cover, in particular, stands in proximate danger of being completely exterminated imperilling the existence of what tropical forests and grasslands yet remain. Despite this danger the establishment has not yet developed the machinery, not to say a policy, for the proper management of the environment. Appeals for a Central Authority for Environmental Management and a Department of Environment only evoked indifference.

The government has now suddenly awakened to the prospect of the impending catastrophe to the environment. Warning the nation against the unrestrained destruction of forests the Minister of Finance and Planning, Mr. de Mel, stated: "At the rate things are happening the frightening prospect of having a desert in this country is not very far off!" (3)

The consequent damage done to the productivity of the country's biological systems, notably the forests, grasslands and fishing coasts, is not a peripheral issue of concern to environmentalists. It touches the very national economy. Hence the note of disturbance today in the Ministry of Finance and Planning. Our forests and allied areas of vegetation, for example, support a vast and varied arsenal of biological, chemical and wood potential. The coastal aquafauna is a never-failing source of foreign exchange at least through their appeal to tourism. Anything, therefore, that reduces the viability of these systems erodes the national economy. In more general terms, any deterioration in the natural environment represents a weakening of the human prospect in Sri Lanka. The various ecosystems, therefore, must be judiciously managed as the national insurance against disaster and the rightful heritage of the generations to come.

A dilemma

The parlous condition of the environment in Sri Lanka reflects a practice of prodigious waste uncontrolled by a lack of planned management. An aerial reconnaissance of the island in February 1978 by Arthur Norman, Chairman of the World Wildlife Fund, showed the extent of impoverishment of our forest estate. Against a former knowledge of our forests, he remarked:

"Where are your rich forests? It is evident you have lost a very great deal of your tropical rain forests." The following statistical data on the acreage of forests underline this sense of alarm:

Year	Source	Wet Zone	Dry Zone	Interm. Zone	Total Acre.
1961	Canada-Ceylon Project	562,260	6,197,790	320,830	7,114,890
1966	F A O	560,000	5,624,211	315,789	6,500,000
1972	SLAAS Report	532,000	5,200,000	300,000	6,032,000

In the 10-year interval (1961-1972) the extent of forest has diminished by 1,082,890 acres.

Another aspect of this state of affairs is indicated by the vast amount of coral mined from the reefs. Statistics are not available on the quantities removed. But the vast mounds of coral heaped by lime kilns along the coasts from Balapitmodera to Gintota or from Batticaloa to Valaichchenai alone reveal only too clearly the colossal damage done to this living bastion of our environment.

There is, however, some justification for such exploitation of the environment. This will be discussed at some length in the following chapter. Here it is sufficient to say that to the general economist, the exploitation of the environment appears to be the only way out to a developing country to attain higher standards of material well-being. The pressures of urbanization and the various industrial and agricultural expansion projects, so linked to development, necessarily relate the environment as a factor subservient to national production. Hence it is that wild land around the rural areas, such as that in the North Central Province, has had to be the immediate targets of this short-term outlook. And drifting amid the opposing currents of soaring world prices and increasing food problems the country cannot but succumb to the need of utilizing yet more virgin land as the only alternate to drowning economically. The blue-print of the Mahaweli Diversion Scheme is a paradigm of this economic necessity.

On the other hand the natural environment has been impoverished so considerably that further losses from it will cause serious detriment to the productivity of its ecosystems. Warns Odum (4): "For our own safety and protection some definite percentage of the landscape should be occupied by more or less natural communities. Just what this percentage should be in different climatic zones is unknown. But we do know that when man thinks only of production he goes too far in stripping the landscape In many cases a shortage of water seems to have been the final cause of disaster for mankind." Odum's underlying reasoning is evident. The wild landscape amidst the diversity of habitats is the natural preserve of the biological productivity of ecosystems and represents the

limiting factor on whose survival agricultural and industrial development depend. Hence it is that the very pressures of development also stress the need to manage and control the important preserves of the environment. Else, its natural resources will dwindle and thus pave the way to economic want. The search for ayurvedic herbs in the Galle district, for example, has stripped the once famous Rumassala Kande of the medicinal plants which grew there years ago; and the hill is now nothing more than a sparse undergrowth of colonizing species.

The country has reached an impasse where two conflicting aims demand attention — one economic, of utilizing the natural environment for maximum production, the other ecologic, of ensuring the survival of its ecosystems with their potential of organic resources. This is precisely the dilemma in regard to the environment. At this juncture the situation demands careful handling in a spirit of give and take. It calls for more knowledge to determine new action on maintaining the balance between the quantitative capacity of the environment which concerns production and its qualitative capacity which concerns conservation. To contribute to this knowledge some data must be provided in the ensuing chapters.

Need for exploitation

The dominant factor creating overall pressures on the environment is the demographic problem. It is common knowledge that the population explosion in Sri Lanka has reached phenomenal proportions. Illustrating this phenomenon are the following census statistics (5) for the period 1965 — 1975 :

TABLE 2.

Year	Total Population	Birth Rate
1965	11,164,000	3.3%
1970	12,516,000	2.9%
1975	13,514,000	2.7%

During this period the average growth rate recorded an increase of c. 2.7% at a period when the crude death rate had markedly fallen to a steady average of 0.8%. Sri Lanka is, in fact confronted with what Goutrou (6) styled "une natalité du Moyen Age en face d'une mortalité moderne." Given the present rate of birth increase the population will reach over 25,000,000 in 1985. This will give rise to yet further food requirements than those in existence.

(b) Cultivation intensity

The demographic problem immediately creates demands for more food production. The demand has constantly induced a progressive expansion of the total area under cultivation. This emerges from the following statistical data on cultivation for the period 1963 — 1973: (5):

TABLE 3

Year	Total area under cultivation
1963	4,013,502 acres
1973	5,031,362 acres

The correlation between the acute demographic problem and cultivation trends necessarily leads to more alienation of wild land. This is seen in the progressive decrease in acreage under forest for more or less corresponding years. No environmentalist would deny this phenomenon as a necessity of a developing country.

(c) Land hunger

The other influence responsible for the diminution of the forest acreage is an allied social factor — land hunger. Stemming out of the population explosion, it reflects a need of holdings as a security in life. Out of it a new peasant mobility has emerged particularly in the wet zone. This expresses itself initially in encroachments of State lands and finally results in some form of settlement or colonization. Referring to this phenomenon in the Dry Zone, Farmer (7) points out to the resultant increase in the amount of illicit encroachments. According to latest investigations by the Ministry of Lands and Land Development over 50,000 acres of land, including forest reserves, have been poached upon in the past few decades. Underlying such illegitimate forms of land alienation is a social need for some priority for land. In acceptance of this need the Mahaweli Development Project has outlined a colonization scheme for the Dry Zone as one of its objectives.

(d) Industrial demands

The demographic problem with its accompanying phases of village expansion, colonization and local urbanization has also created industrial demands. These, in fact, coincide with the needs of development plans in the country. Factories of all types, research institutes and cottage industries exemplify the pace of this development. All the demands of such projects converge on the natural resources of the environment for fulfilment. A denial of the needed opportunity would invariably tax the reserves of foreign exchange.

The commonest natural resource in demand is the timber potential of our forests. The erection of new buildings everywhere creates stresses on this resource for meeting the increasing supplies of construction material and furniture. On an average yield from our forests, the State Timber Corporation gets c. 9,000,000 cu ft of wood a year; and even this volume falls short of the country's requirements.

Firewood for domestic consumption is an added need. The present oil crisis makes it the more significant today, especially when unlike most industrial countries Sri Lanka has no alternative source of fuel such as coal. The forests, therefore, become the only dependent means

of obviating the growing crisis. This is seen at Dolosbage, for example, where big extents of forest are being systematically denuded for wood fuel to feed the engines of the adjoining tea factories.

With the growing importance of ayurveda, a bigger search is on for medicinal herbs in forests and allied areas of vegetation. The Ayurveda Research Institute at Nawinna will require these plants for experimental and curative work. While providing these requirements, the natural vegetation at the same time will be advancing scientific endeavour in native medicine and illustrating a good use of the environment.

An island such as Sri Lanka needs not only the land resources of the environment. It depends equally on the resources of the sea. Among legitimate forms of a good use of the sea, every environmentalist will endorse those such as coastal fishing for food and the selective collection of sea weeds and coloured fish for export.

The varying needs outlined above have exerted admissible pressures on the environment. These all emerge from the travails of a country geared to development. In the context of the present situation, therefore, a certain degree of exploitation of the environment is justifiable; and no enlightened environmentalist will grudge the country its own resource requirements towards economic progress. Ecologists, indeed, would be ready to own that a certain selective exploitation of the environment for national development can be beneficial to its conservation.

Need for conservation

In the face of making a good and sustained use of natural resources for economic development due account must also be taken of conserving important preserves of the environment. To ignore this necessity would be tantamount to committing economic suicide. The natural environment, in fact, with its biological systems offers the only indigenous reservoir of the food, medicinal, and industrial products needed for national development. Its over-exploitation and misuse, therefore, will only erode this potential and hasten the dawn of complete economic instability.

(a) Terrestrial Ecosystems

Among the preserves of the environment meriting conservation, paramount attention must be attached to zones of natural vegetation. Vegetation forms the major component of the ecosystem, the vital pivot of the environment. An undisturbed zone of natural vegetation such as a forest or scrub represents a closed system of interrelationships between the various communities and the habitat. Any small change in one part of this zone is likely to be felt and compensated for eventually throughout its ecosystem. The least damage to a zone of vegetation, therefore, immediately alters the species structure of the ecosystem, creates an imbalance in its diversity and consequently reduces the pace of its biological productivity. This sensitivity of ecosystems where the vegetation is the predominant biotic factor emphasizes the

necessity of conserving entire, significant areas of natural vegetation. To keep the ecosystem alive, then, stability through diversity is essential. This was the fundamental argument adduced by biologists to convince the former government to conserve the full expanse of Sinharaja Forest. "The more interdependencies in an ecosystem, as in a tropical rain forest, the greater chances there are that it will be able to compensate for changes imposed on it." (8)

(i) Forests

The wild life population, notably of elephants, deer and birds, forms another significant component of the ecosystem; and the vegetation provides the only natural habitat for this population. The denudation of such habitats in areas around Mahiyangana and Unichchai has been the ultimate cause of the emigration of elephant herds to the open country and of their menacing presence to cultivated fields. On the other hand, the parks of Yala and Wilpattu where the vegetation is fairly stable have confined the movements of wild animals to their forested habitats.

If, therefore, because of the stability of a zone of vegetation, precautions must be taken to preserve the greatest possible diversity of its flora and fauna, this must be done particularly to the more important forests such as those at Hiniduma, Gilimale and Gunner's Quoin. The argument holds more weight for the wet zone forests, particularly the tropical rain forests. Their rich floristic constitution amid a diversity of life forms renders them unique exemplars of efficient ecosystems.

The tropical rain forests especially, in the words of van Steenis (9), "form an expression of the greatest morphological diversity of a tropical flora." This is a reflection of a greater amount of speciation in their genera. The rain forests, such as those at Sinharaja and Gilimale, bring out this fact in many families such as the Dipterocarpaceae, Ebenaceae and Orchidaceae. This speciation is rendered more possible by the diversity of ecological niches. These, in fact, by their selective action rendered more fortuitous in area by geographical isolation have effected an evolutionary differentiation of species within certain endemic genera such as **Doona**.

In an analogous degree the same may be said of the montane forests. With an amount of habitat diversity amid a geographical isolation limited to the highlands these forests have evolved typical genera such as **Kendrickia**, **Leucocodon** and **Hortonia** which are endemic not only to the island but also to the highlands themselves.

These forests of the wet zone support a fair amount of endemism amidst the variety and abundance of plant life. The endemic taxa, in fact, in these and other areas of vegetation account for c. 24% of the total flora. The figure is relatively high in relation to the surface area of the island, and confers a remarkable distinction on the related vegetation. So remarked Trimen (10) "On the endemic species the individuality

and interest of any flora depends." It is probable that research might reveal yet other endemics. Thus Kostermans is presently investigating the probability of a new endemic family in our flora — the Dichilanthaceae !

In the endemic flora, in addition, every new taxon is unique because it bears an identity of its own and is thus irreplaceable. Endemic plants, in other words, increase the diversity of organic life in the environment. They are, therefore, a heritage which neither the country nor the scientific world could afford to lose!

The richness and diversity in our flora further confers on the natural vegetation a degree of biological productivity. For every new genus or species marks an invaluable contribution to the total gene pool of plant material. The significance of this will be treated further down.

The representative flora endows the natural vegetation with another characteristic of rare significance. This derives from the existence of quite a number of genera which give evidence of a former land connection with the southern part of the Indian mainland in the recent, geologic past. The genera *Sterculia* and *Vitex* of the dry lowlands and others of the montane region such as *Strobilanthes*, *Impatiens* and *Michelia* commonly occur in India and underline a close affinity with the south Indian flora. Many of these genera are large in size and distribution. If one is to follow Willis' theory (11) these must be considered old. And Wait (12) maintains that the old elements of our flora are descendants and survivals of their Indian counterparts which migrated to Sri Lanka during the pleistocene epoch. From the point of view of evolutionary biology, therefore, the natural vegetation which supports an Asiatic flora of a geologic past as ours cannot be allowed to be destroyed without dire consequences to science.

(ii) Mangroves

Worthy of attention though of less floristic diversity and significance are the mangroves. Their uniqueness and complexity can best be studied in situations such as at Mangrove Island, Trincomalee, and around the Negombo and Batticaloa lagoons. Here, they show a mosaic of vegetation zones from algae and prostrate halophytic herbs to the tall sedges (*Cyperus* sp.), and then through the shrubby herbs such as *Acanthus ilicifolius* to the trees such as *Avicennia marina*. And because of the variety of plants and the saline water of the habitat the mangrove environment harbours a wide range of aquatic organisms from plankton to large numbers of fish, crabs and shell-fish. Such complexity of organization in this ecosystem is still an uncharted field of scientific investigation. Yet the abundance of food alone it offers can, if husbanded on a scientific, sustained yield, afford a boon to the fisheries sector.

(iii) Patanas

No less important are the patanas or tussocked grasslands. They are not so widespread as forests; and being a unique type of ecosystem not commonly found in other parts of the world they merit with all the more reason to be conserved. With a floristic composition of their own the wet, black patanas, for instance, form a conspicuous and inseparable part of the montane vegetation, often extending for acres beside patches of montane forest. Since they are probably the products of a long period of evolution, to completely destroy their representative areas would create a permanent lacuna in the evolution of the indigenous flora; and without the patanas the attempt to assess the montane vegetation would be a monstrous piece of classification. And this would be the inconvenient impact to science were all patana land to come under cultivation.

The patanas, in addition, perform an invaluable function in their respective environments. Because of the high proportion of their biomass they possess a larger extent than do the montane forests, of the dead and decaying organic matter of the soil. Their herbaceous cover, besides, modifies the physical properties of the environment. According to Mueller-Dombois (13) during the monsoon seasons, the wet, black patanas intercept much more precipitation than the adjoining forests. Through the action of their heavy humous soils, these patanas serve as large sponges absorbing continuous quantities of water which are passed on to the water table and finally feed the streams originating from nearby. This is well seen at Horton Plains. Interference with important sections of these patanas, therefore, will seriously affect the country's agro-economy and be equally a disfavour to national science.

Reasons for conservation

The forests, mangroves and patanas are, then, workshops of floristic and ecologic diversity which strengthen the stability and biological productivity of the natural environment. They are also habitats of a long process of microevolution. Keeping representative samples of these ecosystems alive is meaningful conservation — it secures their good use for the future of science and the national economy. The destruction of important ecosystems such as those at Sinharaja or Horton Plains or the Batticaloa Lagoon will compromise the intrinsic wealth of the country and spell the end of million of years of evolution. All this evidence summarises the pure scientific argument for the conservation of the terrestrial ecosystems.

There is on the other hand the economic argument, equally forceful and perhaps more so than the scientific one. Foremost in this argument stands the recognition of the wide diversity of plant potential in the natural vegetation. Collectively, this forms the base of the **gene pool** and bears great significance to agriculture and pharmacology. A wild species, for example, might provide the base of genetic resistance

to some fungal, viral or bacterial disease in a related crop plant, or the source of some steroid alkaloid to medicine. The significance of any wild species therefore to applied science cannot be disregarded. In this context Hegnauer (14) points out "it will never be possible to forecast the potential value of a taxon to different branches of science or to future plant utilization."

The related importance of the indigenous vegetation to such agricultural ventures as the Mahaweli Scheme is indisputable. If the vast areas of monoculture farming envisaged in the Scheme are to be viable it is important to preserve them from the ravages of plant diseases and pests. The earlier discussion made it clear that the natural vegetation remains the indispensable base against such disaster.

In addition to its genetic value the vegetation lends an insulating effect against heat and excessive transpiration to agricultural crops in the dry zone. It gives rise, further, to natural **crop barriers** against the translocation of disease and pests from one monoculture field to another.

The natural diversity of the wild vegetation, then, becomes the essential prerequisite for the efficient functioning of agricultural schemes in the country. If properly managed and conserved within its total ecosystems, the vegetation could lessen the necessity of insecticide and pesticide controls and diminish the danger of soil pollution, while at the same time lowering strains on foreign exchange. To completely clear the vegetation around agricultural areas is therefore, an abuse of an asset of the natural environment. It is up to the government, however, to take cognizance of this warning for the long-term benefit of this Scheme.

The other aspects of the economic importance of the environment emerge from the treatment of forests and fisheries. Particular attention, however, must be paid here to the natural vegetation as a means of controlling the country's water resources. If this natural resource is not to be lost it is important to maintain in perpetual flow the many streams which originate from the hills. This supply can be ensured only if the related vegetation is conserved. The validity of this argument is well illustrated by the denuded forests at Dolosbage. The absence of a vegetation cover there has given way to ugly gaps of soil erosion and dried up its streams for good.

The same argument reinforces the significant impact of the hydrological forests of the Peak Wilderness, Horton Plains and Namunukula on the management of catchments and watersheds of the big rivers. By regulating stream flow, this dense cover prevents the risk of flash floods in the lower reaches of these rivers and checks soil erosion. Hence the wisdom of Joseph Hooker in advising the Colonial Government in 1873 to keep undisturbed all montane forests above the 5,000 ft. contour. The recommendation deserves

serious attention today against the disclosure by the Chief Conservator of Forests (15) that only 8.5% of the total catchment area in the montane region is under forest cover. The catchment vegetation in these areas is, therefore, vital if the physical infrastructure of the Mahaweli Scheme is not to founder.

(b) Marine Ecosystems

An important aquatic ecosystem which concerns national security are the stretches of coral reefs around our coasts. Together with our tropical rain forests, these colonies represent the maximum organization of a balanced ecosystem in that more species and kinds of organisms together with a larger number of individuals inhabit a given amount of space than any allied ecosystem.

Reasons for conservation

The corals form a complex hive of numerous species of varying fantastic forms and hues. For this aesthetic reason alone, they merit to be conserved. Their additional value lies in their habitat, the home of curious coral fish, molluscs, crayfish and lobsters. With many of these, the coral polyps live in symbiotic relationships.

Because of the peculiar sociology of these coelenterates, our reefs are a paradise to the enterprising collector and tourist alike. They also offer the marine biologist a fertile field of research. Their importance is further enhanced by the natural protection their colonies afford the island's coasts against wave action and sea erosion especially in seasons of strong monsoons.

In spite of the fact that the polyps are very active and their colonies form endless reefs along our shores their rates of regeneration are very slow. According to Jonklaas (communicated) the Staghorn Coral grows to no more than 22 cm high a year, while the Sea Fan may take as much as 35 years to attain a height of about 1.25 m.!

This regenerative rate is slackened by changes in the intensity of wave action. The mining of coral is, then, not only destructive of entire colonies but also lessens the pace of their regeneration by the removal of the very barrier against wave action. The consequent effects on the marine ecosystem are obvious. The repercussions on fishing and tourism invariably follow.

These valid reasons underline the necessity of husbanding and conserving the coral reefs as very sensitive and useful bastions of the environment.

Destruction of Environment

National science knows only a bare fraction of the technical, mechanical, biochemical and medicinal properties of the hundreds of species of animals and plants of the environment. It is ironical, however, that many sectors of the environment have been destroyed for good before their potential could have been adequately

explored! The reduction of forests alone is an index of the situation. Whereas in 1961 (Canada-Ceylon Project) 44% of the total area of the island was forest, today barely 20% (unofficial estimate) remains of it, far below the minimum standard requirements of forestry.

Losses such as these have produced a diminution in the population of animal and bird life. An index of this appears in the increase in the number of protected species. Concomitant aspects of destruction are seen in the enormous quantities of coral quarried from reefs for quick-lime.

Results

The consequences of such destruction are revealing. The disappearance of the diversity of animal and plant life immediately causes the erosion of the genetic bank with the breakdown of available resources. Reduction of the tropical wet zone forests has thus caused a rarity of important timber species such as *Diospyros quaesita* (Calamander) and *Canarium zeylanicum* (Kekuna). Valuable species such as *Cryptocoryne walkeri* are threatened with extinction while yet others such as *Verbascum chinense* are now extinct! With the disappearance of endemics such as these, national science will soon lose a unique part of its flora and the economy a rare source of genetic material.

On the other hand, deforestation has let loose in places an aftermath of erosion with its attendant risks to soil stability and water storage. Obviously such effects damage the development stage of the country as seen around the catchment areas of the Mahaweli, and in the enormous silting of Lake Gregory, Nuwara Eliya.

Solutions

Any precautions taken to obviate the damage to the environment of a technico-agricultural culture will depend ultimately on political decisions. If our ecosystems are really a vital asset to national development and if environmental policy is finally a political decision, then the basic philosophy for resolving this difficult issue must rest on the recognition that the aims of conservation of the environment cannot be discarded as only incidental to a national land use policy. These must be incorporated into such a policy. Towards securing this end the following solutions are proposed.

(a) Environmental policy

The implementation of the rights of ecosystems cannot be achieved without a national environmental policy. The Biosphere Conference (1968) stressed this recommending that "member states of all the United Nations Organization develop comprehensive and integrated policies for the management of the environment."

Upholding the natural environment as the primary resource of national development this policy will situate the rights of ecosystems as very

valid to national land use planning. To be proof against errors, the policy must formulate a system of proper environmental management based on sound physical and biological surveys. To render it effective, the policy must be supervised by a Department of Environment set up under the Ministry of Finance and Planning. This department must be vested with statutory powers to assess the requirements of any project for new virgin land in relation to the quality of the natural environment.

(b) Land Alienation

An environmental policy will not be complete if it is not correlated with planned land allocation. This is important in the context of a rapid increase of population amidst a scarcity of employment opportunities; and as a result landlessness has emerged as a social need.

Landlessness however, inevitably leads to encroachments; from these follow illicit fellings, soil erosion and the destruction of forests. All these are foreboding dangers to the environment. While it is opportune to control alienation of wild land it also remains a necessity to make land allotments to keep people away from wild land. It will assist conservation measures if these allotments are restricted to marginal lands and are strictly supervised by the Department of Land Development.

(c) Nature Reserves

Against the present state of the environment, the safest way of preserving valuable ecosystems are nature reserves. Their value to science lies in the fact that they not only circumscribe in restricted areas the existing species of animals and plants but also serve to retain for future generations representative samples of biological diversity and resource material.

These reserves serve a relevant need today. National science, for instance, has hardly probed the biological processes of ecosystems that are functional to man. To safeguard this opportunity for science IBP plots have been established in the country. Some of these have been interfered with. There is urgent need therefore, to have these plots supervised by the Department of Wild Life.

Too rapid deforestation in the country renders the creation of more reserves an urgent necessity. These should be located in the more important ecosystems. Meijer (16) recommends the establishment of reserves of 200—300 acres in the more southern rain forest areas and in the highlands above the 5,000 ft. contour, inclusive of the Peak Wilderness.

(d) Field Stations

The lack of complete surveys of animal and plant diversity brings out a great need for biology field stations. This becomes all the more obvious from the fact that biology is learnt not in the lecture hall but in the field.

A field station of the kind will at once provide the requisite base camp from where explorations and collections could be made in a particular locality. The feasibility of such field activities will only stimulate research, particularly among university graduates, and have it based on first-hand observations and critical study. Beside securing this end, biology field stations will attract foreign scientists to come and work on our ecosystems and help in the exchange of information with local scientists.

Conclusion

The collective evidence of the preceding account leads to the inevitable conclusion that the environmental situation in the country is alarming. The depletion of some of the notable preserves of the environment is well known; and there is danger that the enthusiasm for development might capitalize on what viable sectors of the ecosystems yet remain. Hence the grave concern in regard to the environment and the need for restraint in its management.

The restrained use of the natural resources and their conservation are, in fact, two concomitant processes of national development. Its basic requirements are not only the indigenous resources of the natural environment;

they also include the preservation of the very physical and biological systems which produce such renewable resources, to render the former yet viable for the future. There is need, therefore, for maintaining a reasonable balance between the excessive expansion of technology and agriculture into the environment and the conservation of its ecosystems.

The country, unfortunately, has failed to maintain this balanced attitude. In spite of repeated warnings from the scientific community, administrators and politicians have unwittingly allowed sections of the environment to be exploited before the claims of various projects and popular demands, relegating the conservation of ecosystems to the future on the grounds that there are other matters of greater urgency.

If, against the alarming situation this attitude continues to prevail the country will be engulfed before long in an economic vacuum created by its own misuse of the environment. Fresh thinking, then, is needed to formulate an enlightened land use policy reinforced with sanctions against violations of its laws. Its foundation can be laid only by a strong policy of environmental management. It should be the duty of biologists of all specializations to ably assist such an environmental policy by their technical expertise and experience.

REFERENCES .

1. National Science Council of Sri Lanka (1976). *Man & His Environment. Report of a Seminar.* Colombo.
2. Cramer, L. H. (1976). Overdue — a department of environment. *Ceylon Daily News*, 30 November.
3. de Mel, R. (1979). Address to Land and Water Resources Development Conference.
4. Odum, E. P. (1963). *Ecology.* New York.
5. (Edited) (1978). *Statistical Abstracts of the Socialist Democratic Republic of Sri Lanka.* Colombo.
6. Gourou, L. (1948). *Les Pays Tropicaux.* Paris.
7. Farmer, B. H. (1957). *Pioneer Peasant Colonization in Ceylon.* London.
8. Weaver, J. E. & F. E. Clements (1938). *Plant Ecology.* New York.
9. van Steenis, C. C. G. J. (1969). Plant speciation in Malaysia with special reference to the theory of non-adaptive saltatory evolution. *Biol. J. Linn. Soc.* 1 : 97—133.
10. Trimen, H. (1885). Remarks on the composition, geographical affinities and origin of the Ceylon Flora. *J. Roy. Asiat. Soc. (Ceyl.)* 9(2) : 139—159.
11. Willis, J. C. (1922). *Age and Area.* Cambridge.
12. Wait, W. E. (1933). Nature's Workshop in Ceylon. *Spolia Zeyl.* 18 (1) : 165—179.
13. Mueller-Dombois, D. (1972). Nature vegetation and agricultural development in the hill country of Ceylon. *Loris* 12 (5) : 262—263.
14. Hegnauer, R. (1975). Secondary metabolites and crop plants. In "*Genetic Resources of Plants.*" Oxford.
15. Perera, W. R. H. (1975). *Administration Report of the Conservator of Forests.* Colombo.
16. Meijer, W. (1972). Conservation of primary forests in Ceylon. *Loris* 12 (5) : 227—230.

Coast Conservation

S. R. Amarasinghe

Director, Division of Coast Conservation, Ministry of Fisheries

Since earliest times, the coastal zone has increasingly nurtured and shaped a developing civilization in Sri Lanka. By man's increased demand for the available resources of the coastal zone, the very area which is vital for the wellbeing of man is itself being placed in danger. The fragile nature of the coastal ecosystem necessitates careful management of its resources in order to maintain the stability of its environment.

Although degradation of the coastal environment was accepted hitherto by the national planning process in the last few decades, it is interesting to note that conservation or planned utilization of resources is not really a new idea to the people living in the maritime provinces of Sri Lanka. The Englishman, Robert Percival who visited Ceylon in 1803 mentions that Pearl Oyster fishing from Mannar southward off Arippe, Condatchy and Pomparippu was highly regulated by Government through a procedure where fishing was permitted for just 6 weeks in an year, whilst extensive surveys were also carried out to assess the reserves of the oyster beds.

The coastal areas support more than 50% percent of Sri Lanka's population. Increasing population concentrations in these areas in the future will increase the environmental stresses already perceived. Demands on coastal resources consist of (1) sea ports and commerce providing for port facilities, trade, industry and oil wells, (2) commercial development which includes beach resorts, fishery harbours for mooring and repair of fishing vessels and facilities for processing fish, (3) waste disposal for sewage outfalls and chemically polluted inland waterways, (4) brine intakes for salterns, (5) mineral extraction for commercial purposes, (6) public access and transportation (7) recreation for which clean beaches and warm, unpolluted coastal waters are essential ingredients, (8) natural resources contributing to productive areas for marine life where the total environment needs conservation, (9) residential development for private dwellings and (10) coastal protection to hold the diminishing frontiers from the ravages of the sea and the destructive activity of man. It would follow therefore, that the coastal zone cannot be treated in isolation but needs to be perceived as a part of the total environment. There is no doubt that an island eco-system cannot neglect the conservation of the coastal environment. In this context the effective and speedy conservation of Sri Lanka's fragile coastal zone cannot be postponed any longer.

Background

In the last decade substantial investment has been made on activity located in areas within the coastal zone. For example, about Rs. 350 million has been invested in the beach-oriented hotel industry, about Rs. 120 million in the provision of fishery harbours and shore facilities,

about Rs. 50 million in port development and about Rs. 15 million in the development of salterns. In contrast, during the same period, little or no investment was made on conserving the very area vital to support this development. The Government has now established a separate organisation viz. the Coast Conservation Division of the Ministry of Fisheries, from January 1978, for the preservation, restoration and development of the natural resources of Sri Lanka's coastal zone.

Coastal areas had been subject to considerable environmental degradation due to erosion, pollution, unplanned exploitation of coastal resources and ad-hoc coastal schemes of work usually located without resolution of use conflicts. Some factors contributing to such degradation consist of adverse sea conditions, reef destruction, sewage and industrial effluent discharge, coral and sand mining, poorly designed harbours and estuary outfalls, ad-hoc coast protection structures, disposal of dredged soil in near shore areas, off-shore discharge of oil from bilge tanks of ships, the dynamiting of fish, and high density use of beach resources for the tourist industry. In particular, reef destruction is caused by removal of reef material for commercial purposes, sediment settlement on corals, the effect of sewage and industrial effluent on reef communities, and the accelerated run-off of fresh water during floods.

Erosion has caused parts of the Hikkaduwa coast to retreat inland by about 1000 feet in the last sixty years representing a loss of over Rs. 10 million of land value alone along a stretch of 2 miles of coastline. With respect to coral mining it is estimated that a quantity of coral in excess of 10,000 tons per year is removed from the coastal zone and a quantity of over 300,000 cu. yds. of sand is removed from the South-West coast alone. The coast based lime production industry with a turnover in excess of Rs. 10 million per year needs to be carefully planned in order to ensure the availability of lime for the building industry, whilst at the same time safeguarding the natural defences from the ravages of the sea. The location, assessment and extraction of lime supplies from non-traditional areas, and restriction of the extraction of sand to outfalls, lagoons and selected off-shore areas are an urgent necessity.

Realising the need for a planned programme of coast conservation, the Government initiated action in 1972 to establish a separate organisation and to formulate necessary legislation for this purpose. Consequently, a limited programme for the training of personnel was undertaken and a Coastal Engineering Research Centre was established in 1975.

Present Status

Positive steps for a planned programme of Coast Conservation were taken in November 1977 with the decision to establish a Division of Coast Conservation in the Ministry of Fisheries from January 1978. A new Coast Conservation Law was drafted to ensure a comprehensive policy on coast conservation in relation to the total environment. This new Law is expected to be presented in Parliament shortly.

To achieve the aims of this programme, the Coast Conservation Division is structured to provide for Coastal Research, Coastal Works and Coastal Resource Development. Consultancy on coastal problems for the state and private sectors is provided by the Coastal Engineering Research Centre, whilst the design and construction of coast protection structures on an expanded scale are to be undertaken by the Coastal Works Unit. The Coastal Resource Development Unit will be responsible for the planned development of the coastal zone and in particular the implementation of the Coast Conservation Law. For this purpose, surveys and studies are being carried out (i) to assess present coral mining and sand mining activity and to locate alternative sources of supply, (ii) for the preparation of a coastal resource inventory and (iii) to assess the environmental impact of effluent discharge, reef destruction and beach pollution on the coastal zone. Socio-economic surveys of people engaged in activity contributing to the degradation of the coastal environment are also being carried out. The initial phase of the new programme of Coast Conservation is directed to infrastructure development capable of meeting the needs of a comprehensive programme of Coast Conservation in the future, whilst at the same time undertaking limited conservation work within the present organisational resource potential.

Legislation

Legislation for sea-shore protection is contained in Part VII of the Crown Lands Ordinance. This legislation merely provides for the granting of permits for developments affecting the foreshore and prohibiting and regulating by license the removal of material from the foreshore. Past experience indicated that these provisions were inadequate to deal with the rapidly increasing demands for coast conservation. It was therefore decided to draft separate legislation for this purpose with the repeal of the relevant sections of the Crown Lands Ordinance. With this in view, draft legislation was presented in the N.S.A. in October 1976 but could not be taken up due to prorogation and subsequent dissolution of Parliament. When the position was reviewed in 1977, it was decided to re-draft this Law to take into account the requirements of the total coastal environment. It was found that there existed a number of other Laws which had some concern over coastal development under relevant ordinances, viz. (1) local authorities had the power to control developments, in the coastal zone, (2) the Department of Town and Country Planning prepared land use plans for a number of coastal areas, (3) beach-fronted tourist

hotels needed the approval of the Ceylon Tourist Board, (4) factories were subject to the licensing jurisdiction of the Ministry of Industries and Scientific Affairs as well as the Ministry of Labour, (5) the construction of sewer outfalls was regulated by the Water Supply and Drainage Board, (6) prospecting and mining in the coastal zone were under the control of the Geological Survey Dept., (7) other developments were within the purview of the Colombo Port Commission, Ceylon Fishery Harbour Corporation and related organisations. In the drafting of the new Coast Conservation Law therefore, provision had to be made for suitable amendments to these Ordinances. The new Law was drafted to provide for the following requirements:— (1) The new act should facilitate comprehensive Coastal Zone Management. (2) The legislation should establish a comprehensive coastal zone planning mechanism. (3) The legislation should address itself to the social consequences of better coastal management. (4) The new bill should define "Coastal Zone" more broadly than the 1976 Bill. Provision has now been made for this zone to extend 2 km. seawards of the foreshore and 300 m. landwards of the foreshore (for planning purposes upto 2 km. landwards). (5) The new Bill should include an appropriate environmental impact assessment provision. (6) A contingency Plan is needed in order to protect the coast from threats of major oil spill catastrophes. This is being provided for in the new marine pollution legislation being drafted in the Ministry of Shipping and Trade. (7) The new legislation should ensure the proper coordination of all Governmental development activities in the coastal zone. (8) An increasing need to control coastal pollution, including river borne pollution carried to the coast from inland sources. It was felt that this could be met through a mechanism whereby the Director of Coast Conservation notifies the appropriate Authority that pollution from an inland source is adversely affecting coastal water and which requires the appropriate authority to take remedial action. This is even more important today, now that industrialization is being encouraged on a much larger scale through the development of a free trade zone. A case in point is the possible environmental effects on the Negombo Lagoon of industrialization in the adjacent areas.

Conclusion

There is today a greater awareness of the environment than in the past, and it is hoped that concerned organizations, individuals and the Government would make a concerted effort to preserve, restore and improve the coastal environment for this and succeeding generations. To achieve this it is necessary, apart from government inputs, to obtain the active participation of coastal dwellers through a publicity and propaganda campaign to increase public awareness of the consequences of coastal environmental degradation. Success in this regard could only be achieved through the cooperation of related Governmental Institutes and private organisations, bearing in mind that the coastal environment is only a part of the country's total environment.