vironmental Management Guidelines, No. 9

ENVIRONMENTAL GUIDELINES FOR

Afforestation Projects

UNITED NATIONS ENVIRONMENT PROGRAMME

AFFORESTATION PROJECTS

Environmental Management Guidelines

1. Pesticide Use on Industrial Crops
2. Irrigation in Arid and Semi-Arid Areas
3. Watershed Development
4. Pulp and Paper Industry
5. Hides and Skins Industry
6. Coastal Tourism
7. Formulation of National Soil Policies
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AFFORESTATION PROJECTS

Prepared by UNEP in consultation
with UN specialized agencies

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FOREWORD

It has been our concern, shared by other bodies and agencies within and outside the United Nations family, that development projects and programmes should take account of basic environmental parameters and constraints. It is clear that broad-based sustainable development is not feasible, especially in the long-term, without sound environmental assessment and management.

There are many pitfalls to be avoided in initiating development activities and many opportunities that can be utilised without much additional cost. Experience during the last ten years has shown that remedial measures must be incorporated, if they are to be effective, in the conception and design stage of projects and planning procedures. Later attempts may prove to be only cosmetic, as ecosystems are fragile and complex and may not recover from the stresses to which they are exposed.

Prepared by UNEP, in close consultation with the United Nations specialized agencies concerned, the first six guidelines were jointly financed by UNEP and UNDP. They were adopted by UNDP and distributed to the UNDP Resident Representatives. The remaining guidelines in the series have been prepared by UNEP to cover important areas of concern.

The remedial or preventive measures outlined are meant to be illustrative rather than exhaustive in character: there are no substitutes for local experience, foresight and prudence. We have only attempted to draw attention to the kind of considerations which must be kept centrally in mind. The objectives for which we strive in these guidelines for afforestation projects are numerous and interrelated, requiring a formidable array of diverse technologies and disciplines. Although the guidelines are essentially national in nature and scope, international co-operation and co-ordination to bring into play the different inputs required, may often be necessary.

I sincerely hope that they will be acceptable and meet practical needs, particularly in developing countries. Additional sectors will be examined and further guidelines prepared in collaboration with the UN specialized agencies, UNDP and other multilateral and bilateral development financing institutions, taking fully into consideration comments and advice which we expect to receive regarding this set of guidelines.

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PREFACE

At an informal meeting held in Rome in September 1978 the Designated Officials for Environmental Matters (DOEM) of the United Nations Administrative Committee of Co-ordination recommended, on the basis of a report prepared by a consultant, Mr. O.M. Ashford, that UNEP undertake, in close collaboration with the UN specialized agencies, the preparation of environmental operational guidelines to assess and minimize the possible adverse environmental impacts of development activities. The report of the meeting states "that priority should be given to the preparation of guidelines aimed at improving the consideration of environmental aspects at all stages in the planning and execution of projects". It was recognized that the level of sophistication in such guidelines would depend on the audience for which they were intended. Much of the available material was of a general nature which would mainly be of interest to universities and senior international and national officials. At the other extreme, detailed guidelines based on in-depth studies of specific projects would be very useful for specialists but difficulties were foreseen in obtaining the necessary information for such analyses, which would take a long time to complete. The meeting agreed that the primary need was for guidelines which would be useful at the operational level. For this purpose each of the major categories used in the consultant's report (e.g. agriculture) would have to be broken down into a number of subareas (e.g. crop pest control and rangeland management). A first list of subareas on which guidelines should be prepared soonest was agreed on as follows:

1. pesticide use on industrial crops
2. irrigation in arid and semi-arid areas
3. watershed development
4. pulp and paper industry
5. hides and skins industry
6. coastal tourism

At a subsequent meeting the DOEM determined that the operational guidelines should "avoid undue technicalities. They should be clear-cut statements of the environmental concerns, parameters and constraints arising in the area of interest. A distinction should be made between what would be useful for informed laymen, such as UNDP resident representatives or officials in the ministry of planning or ministry of economic affairs of a developing country, to reach a decision on the need for and nature of environmental considerations in a given project at a very early stage of its formulation on the one hand, and the analytical tools required by engineers, economists and other scientific consultants in the form of coefficients, etc., to implement a project on the other. The latter should not be a part of the operational guidelines but in manuals of implementation." In the event, the guidelines that have been prepared vary in the nature of the material assembled and the technical details analysed. This has been done deliberately.

In order to afford an opportunity to assess the practical utility of different approaches to the preparation of guidelines, it was considered necessary to establish models which could be compared and evaluated in terms of practical utility. UNEP would gratefully receive views on the analytical frameworks and approaches adopted in the different guidelines as well as suggestions for their improvement or amendment.

The environmental operational guidelines in this series are not intended to be prescriptions for corrective action or constraints on the methods, nature and scope of development activities. They are presented in the belief that dynamics and change induced by development aims are not without environmental hazards and risks. It is necessary to identify such hazards and risks where they arise and take early steps, in so far as circumstances permit, to contain or reduce them. It is necessary to take early steps, because later attempts at remedial action may be illusory, more costly than preventive action taken at the outset, and, in some cases, may be so costly as to bring into question the overall economic viability of the project.

We acknowledge with gratitude the contribution received from the UN specialized agencies, particularly the Food and Agriculture Organization (FAO), for preparing the guidelines. Without financial assistance from UNDP, the operational guidelines could not have been completed effectively within the time available. We are also dependent upon the assessment of the Resident Representatives and the Head-

quarters staff of UNDP on whether the guidelines meet specific needs in the field.

Within UNEP, a number of colleagues have assisted in the preparation and editing of the operational guidelines. I wish to thank in particular Mr. Nay Htun (for the guidelines on the pulp and paper industry and on the hides, skins and leather industry) and Mr. Mohamed Tangi (for the guidelines on coastal tourism). Ms. Merran Van der Tak, Ms. Shahida Chaudhary and Mr. Mark Aeron-Thomas have assisted in the research and editing of the series.

UNEP's decision, to produce further guidelines, on issues currently on the international agenda for environmental action, has resulted in subsequent guidelines in the series and the two latest ones are on afforestation projects and agricultural mechanization. Like the earlier guidelines, they are based on consultations with FAO and other agencies.

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INTRODUCTION

The environmental and socio-economic importance of afforestation projects has grown increasingly in recent years and they are now high on the international agenda for action.

These operational guidelines are designed to enhance awareness of the environmental constraints and benefits associated with afforestation projects. It is hoped that such awareness will promote a more practical approach to solving the specific problems associated with afforestation projects and provide opportunities for anticipatory action to be more fully exploited.

The results of afforestation projects are related to the ecosystems which they replace and the environment generally, in complex and highly interdependent ways. They cannot, therefore, be considered in isolation. It is necessary to take into account from an early or conceptual stage the various impacts that such projects will inevitably have on the ecological balance of a region, the regional climate and the socio-economic well-being of local inhabitants. It is also important to consider how existing environmental conditions will affect the nature and scope of the projects undertaken. These interrelationships must be kept centrally in mind during the design and implementation of projects.

OBJECTIVES OF AFFORESTATION PROJECTS

Afforestation projects are undertaken for a variety of objectives or combination of objectives. When several objectives are pursued simultaneously, the trade-offs between them depend on the type of project, the nature and purpose of the institution which is implementing it, the point of view adopted, and, of course, the broader political, cultural and economic environment within which the project will operate.

The various objectives of afforestation projects can be divided into two overlapping categories: environmental and economic. Of these, some common elements are:

- To restore and protect degraded ecosystems.
- To conserve soil on tropical mountain watersheds.
- To enhance recreational and aesthetic opportunities.
- To restore fertility and productivity to agricultural land and to promote agroforestry.
- To provide wood for industrial purposes such as the production of gums and resins, oils, paper, textiles, fibres, building materials, etc.
- To provide firewood to urban and rural dwellers.

These different objectives are obviously interlinked. For example, an afforestation project designed to meet the demand for fuelwood will reduce the degradation of natural forests. An afforestation project that emphasizes agroforestry will support degraded forests by reintroducing a system whereby trees, livestock and crops can be properly integrated.

POSITIVE ENVIRONMENTAL IMPACTS

Afforestation projects can have important positive effects on the environment.

Effects on water

As in natural forests, forest plantations can exercise a favourable action on the hydrological balance and the production of water from watersheds. They provide increased opportunities for recharging subsurface flow and ground water:

- Improvement or maintenance of the physical properties of the soil favourable to infiltration, retention capacity and in-depth percolation.

- Alimentation of the water table and natural overflow channels by internal drainage of excess water.

Effects on soil

Forest plantations present important benefits to the soil:

- Reduction of surface flow of water thus reducing sediment movement and delivery.
- Interception and reduction of the kinetic energy of rainfall and obstruction of wind thus reducing erosion.
- Recycling of nutrients and water and the biogeochemical cycling of carbon.

Effects on climate

The affect of forests on regional and perhaps global climatic and atmospheric phenomena is also significant. The replacement of an ecosystem by a forest plantation involves the modification of the plant cover and other physical characteristics: reactiveness, absorption of radiation, roughness of the surface, resistance to winds, and therefore also modifies the fluxes of energy and incidental substances. These are internal and external exchanges that influence regional climates. Any modification of the characteristics of the plant cover will generally, therefore, bring about changes in the regional climates. For example, in the case of atmospheric humidity, a dense, humid, evergreen forest plantation that always has reserves of water at its disposal transpires large quantities of water into the atmosphere. Moist forests produce up to half their own rainfall through a rapid process of transpiration and evaporation. (In contrast, however, even a dense forest formation will, in a sub-humid and semi-arid region, only transpire if leaves are present and if sufficient reserves of water are available in the soil.) In addition to overall climatic and atmospheric influences, forests produce important micro-climatic effects.

NEGATIVE ENVIRONMENTAL IMPACTS

Afforestation projects can produce potentially negative impacts on the environment.

Genetic heritage

The biological characteristics of an ecosystem can be disturbed or damaged by forest plantations. Plantations can destroy ecological niches and biotypes that were particularly favourable to the development of the fauna and flora species of the ecosystem they replaced. They can effectively reduce the richness and variation of the flora and fauna especially if, as is sometimes the case in commercial projects, there is an intervention in well-stocked ecosystems that are not degraded.

Commercial forest plantations can disturb both the micro-climate and the soils of the designated areas. The cyclic return of the critical phase of the harvesting periodically lays bare the soil of the planted areas which can result in erosion and other disturbances. The consequences of this temporary suppression of the forest cover will depend on the period of time that the soil is uncovered, the local conditions, the techniques used for harvesting and the subsequent preparation of the ground for the regeneration of the stands. (In zones where the ground is not too broken and the soil is of a light porous texture, and where the natural regeneration of the coppice is rapid and vigorous, the degradation will be of short duration and without important consequences.) The micro-climate, however, will experience an important fluctuation because the various buffer zones provided by plant cover will have been destroyed.

In afforestation projects of exotic species, adverse influences on the original profile of the soil are sometimes evident. These influences include an accentuation of the acidification of the soil, a deterioration of its structure and a leaching of vital minerals.

Forest plantations in semi-arid to arid zones are often held responsible for consuming large quantities of water to the detriment of other needs considered more important. For example, the supply of water to downstream users and reservoirs is reduced by increased transpiration rates.

Use of fire

Fires are often used to clear areas, either before tree-planting or mechanical preparation of the land. This practice can have several negative impacts:

1. The fires destroy a large quantity of the wood biomass and the litter which has fallen on the soil as well as certain quantities of organic matter accumulated in the upper horizons of the soil. There is, therefore, a reduction in the retention of organic matter in the soil.
2. It destroys a portion of the soil fauna on the surface that could otherwise play an important role in the mineralization and decomposition of organic matter.
3. It leaves the soil stripped and covered with black ash. This results in a much more intense action of the sun's rays which modifies the micro-climatic conditions on the surface and the biological processes at this level. The consequences are a quite important destruction of the humic clay aggregates and of the soil structure as well as a reduction in water infiltration and the temporary risk of surface flows and erosion.
4. It promotes a loss of nutrient elements by internal leaching and by the surface flow of water towards water courses.
5. The above impacts can result in a temporary increase in the retention of chemicals in the water; a modification in the pH; an increase in the turbidity of the water; an increase in sedimentary deposits; and a resulting disturbance of aquatic ecosystems.

Roads, trails and firebreaks

The construction of roads and firebreaks through a forest plantation can concentrate and channel the surface flow of water and cause erosion and other damage. This action, although localized, is nevertheless important in transporting sediments toward water courses.

Fertilizers

Massive use of chemical fertilizers involves the risk of interfering with the quality of an ecosystem. The most important side effect of their use is the eutrophication of streams, lakes and coastal waters. Eutrophication is a process whereby the nutrients (primarily nitrates and phosphates) in the run-off from fertilized fields promote an excessive growth of algae and other water plants. This results in a deterioration of the quality of water and a threat to aquatic organisms. Fertilizers are, however, less dangerous than herbicides and other pesticides.

Herbicides and other pesticides

Chemical products are increasingly being used for controlling adventitious growth and insects in forest plantations. These products are intrinsically very toxic and are dangerous to any ecosystem:

1. They can accumulate in the soil during relatively long periods of time and pass from there into plants.

2. They can be translocated by leaching into subterranean water bodies and contaminate springs.

3. They can be transported directly by surface water flows and severely disturb open aquatic ecosystems.

Harvesting and mechanization

Machines can compact soil unduly and disturb soil horizons. The soil compaction resulting from the passage of heavy machinery reduces the total volume of pores in the soil. This results in poor aeration and causes a considerable reduction in the infiltration and internal percolation of water. The resistance of soils to compaction depends on their texture, structure and humidity and the amount of weight that has been applied. The damaging effects can be quite considerable, even on humid soils. In addition, machines can damage tree stumps and adversely affect coppice regeneration.

EXISTING MANAGEMENT TECHNIQUES

Biological diversity

The replacement of a natural ecosystem by an artifical mono-specific tree plantation can lead to the disappearance of an important number of plant and animal species. Certain measures can be taken to reduce the magnitude of this loss of genetic heritage:

1. Avoid the establishment of excessively large plantations of one species.

2. Avoid planting all of the available land.

3. Maintain the maximum buffer areas inside the wooded zones so that the natural vegetation is conserved and protected.

Fires

Fires constitute one of the major problems of forest plantations and necessitate important methods of control and protection to avoid degradation and destruction of the afforested areas.

The classic system of firebreaks requires large investments and considerable maintenance without offering a guarantee against wild fires. A simpler and less costly method is the use of premature and controlled burning of the vegetation. Intentional fires, lit under certain specific conditions, limit the intensity and the area of destruction:

1. Such fires should be decided on case by case, with special regard given to the fire resistance of the affected species (i.e., trees with thick bark), and should be lit soon after the end of a period of rainfall to allow the fire to spread without getting too hot. The tree crowns should be well above the reach of ground fire.
2. Specialized techniques exist to determine the parameters which ensure that the fires are lit at a time when maximum protection can be obtained with a minimum of negative impacts.
3. The result of these controlled fires should be a mosaic of scarcely burnt areas.

Roads, trails and firebreaks

Roads and paths can concentrate surface water flow and cause erosion. A few simple measures can be taken to minimize the impacts.

1. The network of routes, paths and firebreaks that is necessary for the management and development of the planted areas must be well planned and kept to a minimum.
2. The routes and paths necessary for site preparation and for planting should be constructed in advance of other work to permit stabilization of the soil and to avoid destruction during the first rains.
3. In order to avoid unnecessary road construction, access roads to fire protection systems, such as firebreaks, should be combined with other roads.

4. Trails which require the least excavation, digging and filling work should be chosen. These should be constructed according to the latest designs, with special regard to water drainage.

Fertilizers

Although fertilizers are sometimes indispensable in restoring a minimum level of fertility to very degraded or poor terrain (or when commercial forest plantations are harvested in short rotations, thus reducing the level of fixed mineral elements), massive use of fertilizers can interfere with the quality of an ecosystem. Certain initial measures can minimize possible adverse impacts:

1. Choosing fertilizers with slow solubility and diffusion to reduce the risks of leaching or superficial transfer.
2. Avoiding fertilization during unfavourable climatic periods such as heavy rains. Rains promote surface water flow or leaching to an excessive degree.
3. Fractioning of use over limited periods.
4. Researching/using minimum dosages. The use of correct dosages together with a monitoring of the environmental effects will make curative and anticipatory action easier.
5. Experimenting with the biological fixation of nitrogen in the soil. This method utilizes certain forms of bacteria to increase the nitrate content of the soil. It is both less harmful and cheaper than the use of fertilizers.
6. Monitoring levels of nitrates and phosphates in the ground water.

Herbicides and other pesticides

There is still very little evidence concerning the efficiency of pesticides and the risks associated with their use. It is necessary to pursue in-depth investigations before launching a large scale use of these products. Their utilization requires extreme caution and strict adherence to the recommendations of the producer, as well as specialized and trained personnel responsible for storage, dosage, mixtures and application of the product.

In view of the ecological dangers presented by pesticides it is preferable to:

1. Plant tree species which are resistant to potential pests.
2. Choose species well adapted to the local ecosystem that grow rapidly and vigorously. Many parasites are secondary and only attack species in a poor biological state.
3. Mix blocks of different species and of different ages. Each block should be a small individual area.
4. Examine methods of biological control and means for propagating natural predators of the pests concerned.
5. Use mechanical or manual methods of weeding and cleaning whenever possible; these are proportionately less harmful than pesticides.
6. Use only pesticides that are biodegradable and can be broken down easily in the environment (organophosphates and carbamates).
7. Avoid inappropriate dosages and/or inappropriate techniques of application when resorting to pesticides.
8. Minimize the use of pesticides by adopting an integrated approach to pest management: use a combination of biological, technical and chemical means to combat pests.

Harvesting and mechanization

Avoid disorganized movement of machinery during harvesting; reduce this to a minimum, resorting to winches and cables and careful planning of the operational areas. The superficial layers of the soil should be disturbed as little as possible when harvesting and the slash should not be cleared by fires. The best means of slash disposal is to pulverize the remnants and keep them as a protective mulch until the new shoots appear.

GENERAL CONSIDERATIONS

Choice of tree species

Local tree species have the indisputable advantage of good adaptation to local conditions. Exotic species often have the advantage of producing wood more rapidly, in larger quantities and of a quality more appropriately suited to specific needs. Exotic species can also, if the case requires, be used only as transitory species destined to create a plantation capable of re-establishing the minimal ecological conditions necessary for the reintroduction of local forest species of greater value. The

species one chooses should satisfy the required criteria for their introduction. It is important to define carefully the objectives that one would like to achieve.

Protection choice

Rapidity of growth and density of foliage are desirable qualities to pursue in difficult situations where it is necessary to attain full-stocking as quickly as possible and the establishment of a plant cover suitable for ensuring protection of soils. In arid or semi-arid regions, however, there are often not enough water resources to support the fast growing species upon which so many forest plantations are based. Nor should evergreen trees be planted in semi-arid and arid regions, where their continual evapotranspiration provides competition for water resources. Prolific varieties of drought-tolerant local trees should be researched and developed.

Silvicultural techniques

Several techniques can contribute to ensure effective soil protection:

1. Conserve all the non-competitive elements of the natural regeneration to ensure an abundant, easily decomposed production of litter.
2. Introduce an understorey after a few years.
3. Adopt long rotations instead of short rotations. (Each harvesting brings about a baring of the soil, a leaching of nutritive elements and a certain degradation of superficial layers. The worst impacts will result from plantations harvested in short rotations of three-quarters of a year.)
4. The litter of a mono-specific plantation decomposes less readily than the composite litter of a heterogeneously composed forest. The choice of one adequate species and the introduction of a certain mixture of species in the understorey can solve this problem as can a mixed plantation of at least two species having different rates of development (this will also make the formation less susceptible to pests and disease).
5. As regards the temperature of the soil, a well constituted forest plantation provided with herbaceous plant and shrub strata reacts in a very similar way to that of a dense natural forest. The daily thermic

range of the superficial layers of uncovered soil is extremely high, whereas the variations under forest cover are much lower.

6. Plant tree species that have deep layered crowns. This characteristic permits a plantation structure and architecture that is more complex and results in an internal micro-climate of better quality.
7. A dense multi-storeyed evergreen forest offers good resistance to the penetration of external air masses. This tranquility of the air is an advantage for the maintenance of a high atmospheric humidity and the retaining of a high level of carbon dioxide. The different strata formed by the crowns of trees and bushes constitute a series of screens in the free atmosphere above the forest and within its interior. The result is a more buffered and stabilized internal micro-climate than in the open.
8. The microbial activity, the speed at which litter decomposes, the quality of humus produced and the influence it has on the physical and chemical properties of the superficial layers, depends a lot on the micro-climatic conditions that prevail at ground level. The most favourable conditions are achieved in dense, humid, evergreen formations, but these vary in relation to the state of the plant cover and protection that it offers *vis-à-vis* the external climatic factors.
9. Plant tree species that are able to regenerate by coppice shoots. This guarantees continuity of reforestation and the rapid restoration of plant cover after harvesting.

Silvopastoral management

Silvopastoral activities do not present appreciable dangers to forest plantations. Controlled grazing allows seedlings to receive more of the soil moisture that would otherwise have been used by grasses. A few measures, however, must be kept in mind:

1. Allow only a short duration of pasture to avoid excessive use and destruction of vegetation.
2. Organize grazing within specified boundaries with successive rotations.
3. Close off grazing areas during rainy periods (especially areas with heavy soils) to avoid serious compaction.
4. Determine period of fallow necessary between introductions of livestock.

Agroforestry

Agroforestry, like silvopastoralism, is an important means of integrating the project into the local socio-economic context. The following needs attention:

1. Choice of agricultural crops should favour tree species; they should not rob the soil of valuable nutrients.
2. The tree species should be such that they can withstand competition from agricultural crops.

CONCLUSIONS

Afforestation projects are potentially beneficial to the environment but they can present certain dangers. None of these dangers are unavoidable and with proper management most of them can be circumvented.

A plantation is not completed when all the trees are planted. Proper management is a must. Maintenance, application of appropriate silvicultural treatment, good forest management and protection against predators (man, livestock, wild animals, pests) are the essential factors for success.

It is preferable to establish a small area that is well tended than to establish large areas that are carelessly established and poorly maintained.

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