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The Exploitation of Forests

The disharmony between mankind and the natural world is nowhere better illustrated than in the study of forest ecosystems. Since prehistoric times the removal of forest cover in temperate areas has led to retrogressive processes in vegetation and this form of destruction is now accelerating in the tropics, possibly creating global problems. The stewardship demanded of us in Genesis requires that we seek alternative ways of deriving sustenance from the forests that permit sustainable harvesting.

Key Words: Forest, natural resources, ecology, conservation, stewardship, dominion of nature, sustainable harvests.

Human beings have always looked upon the natural environment as their support system—and rightly so. Indeed, the directive in Genesis 1 to ‘rule over’ nature (NIV) is an encouragement to the Christian to regard the natural world as a provision of God for the support, strengthening and comfort of mankind. As humanity has increased in numbers and in its capacity to modify the environment, it is inevitable that local over-exploitation has resulted—the outcome of inefficient stewardship. And in our modern times when population expansion is ever increasing, it is also inevitable that previously local problems are rapidly becoming global.

The range of climates experienced over the earth’s surface has resulted in a variety of major habitats, or biomes, developing. These vary from tundra, dominated by dwarf shrubs and perennial herbs, to the equatorial rain forests, in which trees of up to 40m in height comprise the dominant life form. Between these two extremes lie temperate and tropical grasslands, broad-leaved and evergreen forests, and the deserts.¹ All such biomes have been used by human groups as support systems and all have been modified in attempts to channel energy into human consumption. These efforts have met with varying degrees of success, both in terms of the total energy that can be extracted from the system and the changes, often retrograde, resulting from energy extraction.

Some biomes have proved more efficient, more robust and more resilient than others. The temperate grasslands, for example, seem ideal for human exploitation for they have short food chains in which a productive herbaceous vegetation directly supports large herbivores that can be cropped as meat, or animal products such as milk and wool. Alternatively, the natural diversity of grassland plants can be replaced by domesticated grasses (cereals) and can feed man directly, which is considerably more

¹ Cox, C. B. and Moore, P. D. (1985) *Biogeography: An Ecological and Evolutionary Approach*. 4th Ed. Blackwell Scientific Publications, Oxford.

efficient in energy terms. But even such grasslands can be strained beyond their capacity to cope and soil degradation may result, as in the case of the North American Dust Bowl experience.

Forests are not as simple as grasslands in their physical structure or in their patterns of energy flow. They are consequently more difficult for human beings to exploit. In a beech forest, for example, only about 4% of the net primary production (the spare energy produced by the plants after their photosynthetic and respiratory activity) is consumed by herbivores (mainly insects), while in a grassland under the same climatic conditions about 25% passes into the grazing food chain. Most of the remaining energy goes into the detritivore and decomposer food webs where it is effectively lost to humans. Cattle, pigs and deer are the natural large herbivores of temperate forest, but it was found even in the early days of domestication that the cow could be managed more efficiently in an open landscape, so forest clearance and replacement by grassland proved more attractive in energetic terms than farming cattle in a forested environment. There are still many parts of the world, however, where cattle are maintained as forest browsers, as in the foothills of the Himalayas. Pigs were more amenable to a domestic life in the forest and have traditionally been used as exploiters of mast and acorns beneath a tree cover. They do, however, have an adverse effect on tree regeneration. Even the hunting of wild deer can be difficult in a forest setting, so the opening of the canopy to provide glades and parkland is often practiced by deer hunting communities. For this reason, hunter-gatherer communities of prehistoric times opened up the forest and subjected it to burning even before the advent of agriculture.

The productivity of the forest has proved of less direct value in providing human food requirements than grassland. Relatively few forest products can be consumed directly, although woodland may have considerable value as a source of building materials, firewood and medicinal products. But growing human populations demand food and the forest is not very good at providing this commodity in the quantities needed by dense modern populations. The outcome is inevitable—forests are cleared.

History of Forest Clearance

Forest clearance by hunter-gatherer cultures, even prior to the advent of domestication, is well documented, using the technique of pollen analysis of ancient lake sediments and peat deposits. Fire was evidently used to open the canopy of woodlands to increase shrub growth and to provide glades in which game could be more easily hunted. Sediments dating back some 9000 years in Britain show layers of charcoal resulting from such fires. In some locations the forest clearance was accompanied by changes in the soil that created new problems for tree seedlings. For example, on the Pennines of northern Britain² and in the uplands of South Wales, the

2 Jacobi, R. M., Tallis, J. H. and Mellars, P. A. (1976) The southern Pennine Mesolithic and the ecological record. *Journal of Archaeological Science* 3, 307-320.

activities of Mesolithic hunters, coupled with the wet climate, led to the development of moorland and blanket bog, on which the regeneration of forest proved impossible, especially under conditions of continued grazing and firing.³ At one site near Llandovery in South Wales, much of the forest had been cleared by 6000 years ago and extensive blanket peats already clothed the hillsides.⁴ In southern England also the use of fire in forest clearance led to the formation of some heathlands even before domestic animals had been introduced. The idea, still prevalent in some quarters,⁵ that pre-agricultural man lived in sweet harmony with nature does not tally with the archaeological evidence.

Pressures on the forest became even more severe with the arrival of agriculture. Pastoralism, in particular, led to intense pressures on upland forests, and many areas were cleared of forest in Neolithic and Bronze Age times (about 5500 to 3000 years ago), often leading to the development of blanket bogs and moorland. By Iron Age and Roman times, the extent of forest in southern Britain was severely reduced as a consequence of the spread and the intensification of arable agriculture.

In ecological terms these changes must be regarded as retrogressive in the sense that they involve a reduction in overall productivity, a reduction in biomass, a lowering of the total nutrient capital of the ecosystem, and reduced biological diversity. The changes also result in microclimatic and hydrological modifications resulting in increased leaching and run-off and increased risk of soil erosion. Nevertheless, looking at the situation from the point of view of the agriculturalist, the management system allowed an increase in those aspects of productivity which could be channelled into feeding human beings. What we might now regard as environmental deterioration was in fact permitting higher densities of human beings to survive.

The development of energy demanding industrial processes placed new pressures on forests, for the tree is a cheap and easily harvested source of energy for combustion. In areas where coal was scarce, such as in south-east England, men looked to the forest for the provision of large quantities of energy. Many of our forests in Britain suffered badly at this time, especially in Scotland, but there is an increasing body of evidence pointing to a more rational approach to forest conservation and management than has previously been supposed during the industrial development of southern England. The Weald of Kent, Surrey and Sussex, for example, was the centre for an iron industry, fed mainly by wood fuel, but pollen analysis of the sediments of 'hammer ponds' in the area shows that forests were not stripped off wholesale, but were cropped regularly by coppicing and

3 Moore, P. D. (1975) Origin of blanket mires. *Nature* 256, 267-269.

4 Smith, A. G. and Cloutman, E. W. (1988) Reconstruction of Holocene vegetation history in three dimensions at Waun-Fignen-Felen, an upland site in South Wales. *Philosophic Transactions of the Royal Society of London*. B. 322, 159-219.

5 Tudge, C. (1989) Exploitation and the art of survival. *New Scientist* 123 (1672), 73-74.

pollarding to provide a renewable supply of the energy needed to smelt iron (Andrew Evans, unpublished data).

Throughout Europe, and later North America, however, the general story of temperate forest history, both deciduous and coniferous, is one of clearance of trees and the redirection of energy flow into the production of grain, milk and meat for human consumption.

Tropical Rain Forests

The story of the temperate forests is now being repeated in the tropics, but with a greatly increased degree of speed and efficiency. According to Dr. Norman Myers⁶ the area of tropical rain forest cleared in 1988 in the Amazon Basin alone was approximately 50,000 square miles (about 3.6% of the forest of that region). For a number of reasons this rate of forest loss is causing concern around the world, though it is mainly the insatiable demand and the financial aid of the developed world that have led to the exertion of these pressures on the tropical environment. The demand for timber is one such pressure, the worst offender being Japan,⁷ but even more important in the Amazon Basin is the demand for beef, which has led to the clearance of forest for the development of beef-producing grasslands.⁸ Ecologically, this can be regarded as a latter day repetition of the history of the British uplands: food energy can be more easily channelled into human consumption by grasslands rather than through forest ecosystems.

The rate of clearance is disturbing, but the developed, deforested nations can hardly be regarded as occupying moral high ground when they complain to the forested developing nations about their misuse of resources. As we read in Psalm 104:14, '(God) makes grass grow for the cattle and plants for man to cultivate—bringing forth food from the earth'. The provision of food for mankind is clearly an important function of creation and by implication involves the modification of the natural world. There are many aspects of the rain forest controversy, however, that elevate it to a particularly high level of concern. The current rapid destruction of the rain forest could have global repercussions. But it is unreasonable for the developed, deforested nations to expect the developing, deforesting nations to desist from the exploitation of their natural resources without adequate compensation from the developed world. The means by which such compensation could be made, whether by debt swaps, or taxation on carbon dioxide generation, is still in dispute.

There are many reasons, however, why the tropical forest should not be carelessly destroyed. These include aesthetic reasons, the beauty of the forest and the need for people to know that there are wild places left on earth. To the Christian such arguments should rate highly, for the creation

6 Myers, N. (1988) Tropical fires of disaster. *The Guardian* 18th October, 1988.

7 Swinbanks, D. (1989) Japan no help to rain forests. *Nature* 338, 606.

8 Myers, N. (1984) *The Primary Source: Tropical Forests and Our Future*. Norton, New York.

must remain a source of wonder if it is to convey something of God's glory. The creation is itself a revelation of God (Romans 1:20), displaying his power and divine nature, so the destruction of any part must entail the risk that the natural revelation of God is consequently being lessened.

When God gave the command to 'Fill the earth and subdue it', (Gen. 1:28, NIV), he cannot have intended that we should literally subject our planet to overpopulation and destructive exploitation. The command is amplified in Genesis 2:15, where we read that 'God took the man and put him in the Garden of Eden to work it and take care of it'. Here mankind is presented as a steward rather than a conqueror. The desire of God is thus that we should both manage and take food from our environment ('work it'), and at the same time have respect for it and conserve it ('take care of it'). This is precisely the attitude to nature we see in Jesus, who ate meat and rode upon an ass, but set high value on both the sparrow and the lily.

The idea that we should act as stewards of the earth implies that our aim should be to pass on our environment to our descendants in at least as good a condition as that in which we found it. Environmental deterioration, even if it were gradual, cannot be acceptable to the Christian, for it represents a failure in our stewardship responsibilities.

Mankind as a whole, however, may not be impressed by such arguments, especially if their implementation results in the restriction of the economic growth of developing nations. Other arguments, especially those that show how the development of global human culture, or even the survival of mankind, could be adversely affected by rain forest destruction, are more likely to be heeded. There are three main arguments against rain forest clearance that directly impinge on human welfare; these are the loss of the world's animal and plant diversity, the likely economic gains of long-term forest management, and the possible impact of forest clearance on global cycles.

Biodiversity

The rain forests of the Amazon Basin contain over half of the total known forms of animal and plant life (some 4.5 to 5 million species).⁹ So diverse is the forest that a hectare may contain up to a hundred species of trees alone. Biologists argue about the causes of this extraordinary diversity^{10,11} and many factors are probably involved. The rain forest has the highest productivity of any biome, so there is more energy available for the diversity of living things. The tree canopy provides a complexity of architecture that offers many opportunities for specialist animals and

9 Myers (1988) Threatened biotas: 'Hotspots' in tropical forests. *The Environmentalist* 8 (3), 1-20.

10 Longman, K. A. and Jenik, J. (1987) *Tropical Forest and its Environment*. 2nd Ed. Longman Scientific, London.

11 Moore, P. D. (1987) What makes a forest rich? *Nature* 329, 292.

plants. As many as five layers of canopy are stratified in the aerial environment¹² and many animals spend their entire life in the tree tops, never needing to touch the ground. There is a constant turnover of trees, growing and dying, rotting and regenerating in any given location. The dynamics of the forest gaps and the disturbances due to river meanderings and storm damage may add to the temporal diversity.^{13,14}

The past history of the forest may also have contributed to its diversity, though biogeographers and palaeontologists argue incessantly about precisely how. At one time it was believed that the rain forest has had a long and uninterrupted history, undisturbed by the climatic changes that caused glacial advances and retreats in the high latitudes. It has been argued that this would reduce the levels of species extinctions and permit the development of high diversity. But palaeoecological work in the tropics suggests that drought episodes have interrupted the climatic history of the forest and caused it to become fragmented into forest 'islands' so that diversity was increased when they fused once more. Whatever the history, theoreticians can construct explanations of diversity from it.

The loss of forest will undoubtedly involve the extinction of species.¹⁵ But is extinction really important, or should we look upon it as an unfortunate statistical side-effect of the manipulation of nature? Perhaps the most worrying aspect of extinction is that it is irreversible. Burning the rain forest is rather like burning the National Gallery; there is a short term release of energy, but in the long term there is irrevocable loss. John Donne, in his much quoted sermon denying the insularity of the individual man pointed out that 'Any man's death diminishes me because I am involved with mankind'. How much more are we diminished by the loss of a species. There is a strong theological argument for the conservation of species and for the maintenance of biodiversity. Jesus underlined God's care for the details of operation of the creation by expounding his Father's concern for the death of a sparrow (Matt. 10:29). How much more must be his concern for the loss of a species. To diminish the creation diminishes the Glory of God revealed within it. The implication for the Christian is that the species has an intrinsic value of its own in the sight of God, quite apart from its potential value for mankind.

There is also an ecological argument for maintaining diversity. The loss of one species often causes a cascade in which many other species are lost. Sometimes as many as 20-40 species can be involved in the flush of extinctions following the loss of one keystone species. One example of such dependence is the plant *Calvaria* from Mauritius. Its seeds failed to germinate and the plant faced extinction until it was found that the seeds needed to pass through the crop of a large bird, such as a turkey, before

12 Richards, P. W. (1952) *The Tropical Rain Forest*. Cambridge University Press, Cambridge.

13 Rasanen, M. E. Salo, J. S. and Kalliola, R. J. (1987) Fluvial perturbation in the western Amazon Basin: Regulation by long-term sub-Andean tectonics. *Science* 238, 1398-1401.

14 Colinvaux, P. A. (1989) The past and future Amazon. *Scientific American* 260 (5), 68-74.

15 Iker, S. (1982) Islands of life. *Mosaic* 13 (5), 25-30.

they would germinate. Perhaps the current failure of their seeds to germinate in nature is because the most famous of all extinct creatures, the dodo, is no longer available to process them in their gut.

There is also an argument that no human being can resist, namely the possibility that a species may one day prove useful. This should not be regarded as an inferior argument simply because it savours of self-interest. The Biblical view of nature is unashamedly man-centred, for God told Noah that 'everything that lives and moves will be food for you. Just as I gave you the green plants, I now give you everything'. It is acceptable, therefore, that we should seek uses and applications in the advancement of human welfare for all living creatures. The plants and animals of the rain forest already provide the basis of much modern medicine and pharmacology. Those ancient plants, the cycads, are a source of dopamine, a valuable compound in the treatment of Parkinson's disease. The alkaloids in the Madagascar periwinkle have proved an efficient treatment for Hodgkin's disease by preventing cell division. The steroids from yams can be used in the treatment of rheumatoid arthritis. It is impossible to tell what opportunities and blessings are lost when a species disappears from the face of the earth.

Ecologists are able to provide some advice on the size of forest reserves or parks that would be necessary to keep extinction to a minimum. In work on birds it has been estimated that a minimal area of 2500 square kilometres is necessary to keep extinction rates down to 1% per century. Smaller reserves have higher rates of extinction; a 1400 hectare reserve, for example, lost 14% of its breeding bird species within a year of its isolation. Thus large, unfragmented areas of forest are needed to ensure that species are conserved adequately (Iker 1982).

Economic Value

Many aspects of the environment are difficult to evaluate in economic terms, but in the case of forests it is possible to place a monetary value on their timber resources. In the tropical rain forests these resources are usually regarded as a single cash crop with the possibility of subsequent cultivation or beef production. The timber itself is thus similar to a mineral resource that can be extracted and exploited with no hope of renewal. A rational use of the forest must depend on sustainable yields, either from selective timber removal, or by the harvesting of other products from the forest, such as fruits, oils, latex, fibres and drugs. But if this strategy (which is closer to the Genesis recommendation of 'work and care') is proposed, some attention must be given to the economic yield for those people dependent on the rain forest for a living.

This type of evaluation has recently been attempted for an area of tropical rain forest along the Rio Nanay in Peru,¹⁶ assessing the value of

16 Peters, C. M., Gentry, A. H. and Mendelsohn, R. O. (1989) Valuation of an Amazonian rainforest. *Nature* 339, 655-656.

the standing timber plus the income from subsequent cattle ranching (less the costs of fencing, etc.), compared with the annual income that could be expected from the sustained exploitation of other forest products (such as fruits from aguaje and cocoa, and latex from rubber trees), ignoring timber extraction. The timber value per hectare worked out at about 1000 dollars, plus 150 dollars per hectare per annum from cattle. Renewable, non-tree resources, on the other hand, could provide a sustainable revenue of 700 dollars per annum. The fact that forest clearance continues suggests that the faster return on investments is more attractive, and perhaps it is easier to find an international market for the timber and beef products. Sadly, even where the exploitation of fruits and latex takes place, it often leads to tree destruction since this may be the cheapest and easiest method of obtaining the crop.

Global cycles

The writer of Ecclesiastes was deeply impressed by global cycles. 'All streams flow into the sea, yet the sea is never full. To the place the streams come from, there they return again' (Eccl. 1:7, NIV). Admittedly, he found such repetitive cycles rather bleak and boring, but in fact they are essential to the functioning of the planet. What is currently being realized is that the equatorial forests play an important role in this cycling process.

The rain forest canopy operates both as a pump and an umbrella. Water evaporates from the leaves and is thus drawn up out of the ground. Turbulent, saturated air masses rising above the canopy are cooled with altitude and drop their water load once again. The falling rain is intercepted by that same canopy, thus preventing the impact and erosion of the underlying soils and the excessive run off which would result. The overall effect of the canopy is thus to maintain high atmospheric humidity and to reduce the erosive effect of the surplus water which would otherwise be present. The removal of the forest takes away both of these protective devices, resulting in increased surface run-off, massive erosion and subsequent flooding downstream. Forest removal can increase stream discharge by up to 40% in temperate areas and may be even more harmful in the tropics. Many of the flood disasters in Bangladesh can be related to forest removal from river catchments.

Bare soil surfaces exposed to direct sunlight are rapidly desiccated. Their reflective properties are very different from those of the forest canopy and such changes in reflectivity can modify the climate of the area by changing the entire energy balance of the vegetation, soil and atmosphere.

Tropical soils have a very limited capacity to retain nutrients. Most of the nutrient capital within the forest biome is actually locked up in the living plants and is recycled through the organic litter deposition of falling leaves. Cleared areas lose their nutrients very rapidly. This can be alleviated by careful management of the logging programme in which strips of forest are cropped along the hill contours, allowing the lower strips to gather any

nutrients released. But most clearance schemes are careless of the nutrient dynamics of the exploited system.

Much attention is currently given to the effects of rising carbon dioxide in the atmosphere as fossil organic materials are combusted for their energy content. This carbon dioxide contributes to the greenhouse effect—the process whereby the heat retention properties of the atmosphere are increased and the temperature of the earth thus raised. Some commentators give the impression that the tropical rain forests are a sink for carbon, absorbing some of the excess gas that we humans are releasing. But this will only be the case if the forests are increasing in their biomass, binding the carbon into their own woody bulk. If the forests are in a state of equilibrium, neither growing nor shrinking, they will not influence the overall budget of atmospheric carbon. If, on the other hand the forest area is declining, which is undoubtedly the case at present, then it becomes a source of atmospheric carbon rather than a sink.

Estimates of the quantities involved are still speculative, but Myers has proposed that about 5 billion tons of carbon are discharged annually into the atmosphere by the activities of mankind in burning fossil fuels.⁶ A further 2 billion tons results from biomass degradation, largely the result of forest destruction. The main sink for carbon is the ocean, which may absorb as much as 4 billion tons. This still leaves about 3 billion tons of carbon dioxide accumulating year by year in our atmosphere, causing its concentration to rise by around 1 part per million (ppm) per year. It is estimated that atmospheric levels of carbon dioxide in 1850 were about 265 ppm, whereas they now stand at 350 ppm. To balance the earth's carbon equation we would need not only to cease the present destruction of biomass, but also to replant large areas of forest, perhaps over a million square miles of it. But even then, the new forests would act as a carbon sink only for as long as they were growing in bulk. Once they reached a stable maturity their role in carbon cycling would be neutral in overall balance terms.

Conclusions

The destruction of the tropical forest is a repetition on a grand scale and at high speed of the history of the temperate forests, but its consequences are likely to be even more devastating in ecological terms. The control of such destruction makes sound financial sense for a number of reasons. In slowing down the acceleration of the greenhouse effect it could reduce the spread of desert (which might soon threaten the grain belt of the United States), reduce the rise in sea level resulting from melting ice caps, and reduce the suffering and expense caused by increasing numbers of floods in the lowland tropics. Rational use of the forests, on the other hand, could provide a renewable resource of high quality timber and a great range of chemical and pharmaceutical opportunities. Up to now, only a very small range of the plants available have been brought into domestication and

exploited rationally. The opportunities for such development are vast if the raw materials, the species themselves, are not lost before their value is recognized.

The teaching of Genesis makes man's responsibility in the care and nurture of the planet very clear. It also makes clear the effects of the Fall on the natural world, for the whole of nature now lies under a curse, a consequence of which is the disharmony involved in human interactions with the environment (Genesis 3:18). The outcome of this lack of harmony was clearly stated by the prophet Micah: 'The earth will become desolate because of its inhabitants, as the result of their deeds' (Micah 7:13, NIV). Isaiah, speaking of Satan, asks, 'Is this the one who made the world a wilderness?' The Bible paints a picture of a world beset by dark forces that operate through the medium of human greed to despoil the glorious creation of God.

The process of destruction is accelerating and forests have come to the foreground in recent times simply because they have not yet been totally despoiled. Their richness in species makes their conservation all the more a matter for concern. Christians have an extra dimension to their awareness of the value of this resource and the next few decades will provide Christians with an opportunity to demonstrate their preservative properties as the salt of the earth. We have a duty to keep informed about such issues and to use our democratic, political influence to express our concern. All shades of political parties are sensitive to the opinions of their electorate, and only international action, particularly in economic terms, can begin to solve these problems. Global environmental awareness is growing and it is the responsibility of Christians to take part in this process.

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