DYNAMICS AND SUSTAINABILITY OF NON-TIMBER FOREST PRODUCTS EXTRACTION

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1. ECOLOGICAL SUSTAINABILITY

Every extraction system affects - at least temporarily - the biological diversity and hence the structure and functioning of the forest. The results of calculating maximum harvesting levels - e.g. by using matrix modelling – are of limited value for forest management. The data produced for this exercise, however, are relevant for maintaining and enhancing resource availability.

Whether the extraction of non-timber forest products (NTFPs) is ecologically sustainable depends on two parameters (Ros-Tonen *et al.*, 1995):
- *availability*: the use of a harvesting intensity and harvesting techniques which secure the future availability of the resource; and
- *biological diversity*: extraction does not interfere with the structure and functioning of the forest.

These two parameters should be considered independently. It is possible for extraction to deplete the resource, while not having a significant impact on biological diversity. This is the case when the target species has no specific function in the ecosystem or when its function can easily be replaced by another species. The opposite is more common: the harvest is sustainable in terms of resource availability, but extraction does affect the biological diversity.

1.1 Securing resource availability

Any extraction of tree products from the forest affects the population dynamics of the target species. Whether it will finally affect population growth and resource productivity is difficult to analyse for long-living organisms such as trees. One way to overcome this problem is to analyse the population dynamics within distinct size classes and calculate the survival, growth and fecundity per size class. Projections of size class-dependent demographic behaviour within matrix models enables us to simulate the future behaviour of the population from the collected demographic data (Caswell, 1989). With these models we can simulate harvest scenarios and calculate the future availability of resources in these scenarios.

Matrix models have limitations, because they reveal an effect rather than an explanation of why the effect occurs. They require a lot of data collected over a time span of several years. Growth data of adult trees, in particular, require long time spans. The matrix of a population, i.e. the set of demographic data used to calculate transition probabilities from one size class to the next, is specific for each population, time and location of the measurements. The question is whether it can be reproduced for other populations at other places and other time spans. Moreover, extraction simulations are theoretical model experiments, which do not take into account changes in demographic

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behaviour resulting from harvesting itself. This is especially the case when harvesting changes the forest structure, as in the case of timber logging. The increased light levels considerably change regeneration patterns. Matrices are therefore different for disturbed and undisturbed forests (Zagt, 1997; Boot and Gullison, 1995). As the harvesting of NTFPs does not alter the structure of the forest at large, matrix models are probably the most suitable tools for analysing productivity and sustainability of their extraction.

An important output parameter of matrix models is the asymptotic population growth rate (lambda) which is equal to one for stable (non-growing) populations, is less than one for declining populations and greater than one for growing populations. NTFP extraction may decrease the population growth rate and cause populations to decline. To date, the effect of NTFP extraction on population growth rates has been used as an important tool in determining whether extraction is sustainable or not, with extraction leading to a population growth rate of less than 1 being considered as not sustainable (Peters, 1996).

There are two important drawbacks to using only population growth rates for this purpose:
1. Following this line of reasoning, no extraction would be possible in naturally declining populations.
2. Population growth rates are rather variable and often do not significantly differ from 1, which makes the estimated maximum sustainable yield unreliable. In addition, this approach leads to yes-or-no answers to the question of whether exploitation is sustainable.

Rather than focussing on the population growth rate, we propose to employ a methodology of determining the effects of NTFP extraction on resource availability which includes an analysis of the transition probabilities within the matrix that are most critical for population survival. Sensitivity analysis reveals the importance of different stages in a population's life cycle for its growth rate and may indicate what phases should receive special attention in forest management (extraction and silvicultural treatments). An example of this can be found in the growth and survival data of pre-adult individuals of a palm species, the reproductive individuals of which are cut for palm heart. If growth and survival appear to be very important in determining population growth, this already indicates that extraction has a major impact on the population growth and future resource availability (Peña-Claros and Zuidema, *in press).* Such techniques for sensitivity and elasticity analysis are well developed and widely applied in demographic studies (de Kroon *et al*., 1986, Caswell, 1989).

1.2 Conservation of biological diversity

In contrast with logging, the extraction of most NTFPs does not alter the forest structure. Whether NTFP extraction in the end affects biological diversity depends on the role of the harvested product in the functioning of the forest ecosystem and the degree of disturbance caused by extraction. Studying the effect of harvesting on biological diversity is utopian rather than realistic. Species diversity in tropical rainforest is often extremely high and species interactions within and between different trophic levels are very complex. Harvesting seeds of species A, for example, can reduce seedling competition on the forest floor, allowing less competitive seedlings of species B to establish themselves. The same seeds might be a key resource for animals living in the forest and reduce the quality of the habitat for these animals. Only a few of these species interactions between trophic levels are known, especially those related to pollination and seed dispersal. Whether extraction of NTFPs like seed dispersers, which play a role in the life history of trees, finally affects the regeneration of tree species depends on the probability of replacing these functions by other species. The high species diversity, the complexity of species interaction and the limited knowledge of these interactions mean that the effects of NTFP extraction on biological diversity are hardly understood. It will be very difficult to carry out research on this issue, as it will touch only a small part of it, even in the most complex model analysing a food web structure.

The best option so far is to study the effects of extraction on the results of some of these species interactions, namely tree regeneration. Tree regeneration is a result of several species-interactions, such as pollination, seed dispersal, seed and seedling survival and growth; processes which are mostly driven by animals. When we observe a change in tree regeneration as a result of extraction - for instance in the number of new seedlings - we still do not know why, as we did not study each of the aforementioned processes. So, although being practical, this approach is not mechanistic and can result in frustrations as systematic patterns can be obscured due to high natural variation. Furthermore, focussing the effect of extraction only on tree regeneration ignores the other species interactions that might be affected and its resulting consequences for biodiversity.

Another option is to simplify and structure the diversity, first by aggregating species into functional groups based on life history characteristics (Condit *et al.*, 1996). Functional groups which share life form, demographic behaviour and reproduction modes might function as indicators for changes in the structure and functioning of the forest. It attempts to help us to look for patterns rather than being diverted by cases. This aggregation of species complexes into functional groups is currently a major research topic for ecologists. It might help us in the near future to analyse the effect of harvesting on biological diversity.

Because of colonisation and the exploitation of forest resources for subsistence, induced by the sedentary nature of NTFP exploitation, densities of one specific functional group - animals - are declining (Redford, 1992; Santivañez, 1998). This harvesting of forest proteins for subsistence might have a much larger effect on the functioning of the ecosystem than the changes in species interactions resulting from the extraction itself.

2. CHANGES IN NON-TIMBER FOREST PRODUCT EXTRACTION

Research on the sustainability of non-timber forest product extraction has three objects: the ***people****, the* ***products*** *involved and the* ***forest*** *itself. Forest-dependent people use non-timber forest products as a vehicle for earning cash income, to escape from the poverty circle and from forest life. A successful non-timber forest product might evolve into a plantation crop, which grows in an agricultural setting. However, the forest remains an arena for innovations of* ***new*** *forest products by* ***other*** *people and* ***other*** *entrepreneurs. Promoting NTFP extraction therefore remains a viable strategy for forest conservation.*

Extraction of non-timber forest products is often considered as a nature conservation strategy because it reconciles conservation *and* development (Broekhoven, 1996), but colonisation and the accompanying disturbance of the forest is a common and well-known concern. In contrast to timber logging, NTFP exploitation is more often associated with permanent settlement. Employment for forest smallholders in the logging industry is, in general, only temporary, as these operations move from one plot to another, to return to the same plot only after at least 20 years. In the case of NTFP exploitation, however, several products can be harvested annually, and even primary processing in the forest is possible, so that from a development perspective, NTFP extraction does contribute to economic development.

Serious doubts have been expressed, however, about this role of non-timber forest products in economic development (e.g. de Jong, this volume; Assies, 1997). Extraction and processing of non-timber forest products require high labour inputs and they are economically feasible only at low costs per unit of labour or at a high price per unit of product. Low costs per unit of labour can be achieved in situations of poverty. This is probably the main reason why Bolivia has now replaced Brazil as the main exporter of Brazil nuts and why extraction of non-timber forest products is considered as an establishment of poverty rather than a relief of it (Assies, 1997). This implies that the extraction of non-timber forest products is not a panacea for economic development. Moreover, extraction economies cannot be considered as stable, as successful NTFPs are replaced by plantations or substitutions, providing a higher output per unit of labour (Homma, 1996). For forest dwellers, extraction is part of a transition process. After they have managed to make money from extraction, they might use this money as a vehicle for escaping from the vicious circle of poverty, to move out of the forest and to start investing in other economic activities such as agriculture, trade or industrial activities. Thus, extraction economies are inherently dynamic (Stoian and Henkemans, 1998).

Nevertheless, non-timber forest products in their totality can serve as a viable vehicle in economic development, as the forest remains an arena for innovations of **new** forest products by **other** people and **other** entrepreneurs. Seen from this perspective - and not from that of the individual products - promoting sustainable NTFP extraction remains a viable strategy for forest conservation.

3. RESEARCH PRIORITIES

In order to estimate the future availability of NTFP resources, properties of the population matrix, such as sensitivities, should be evaluated. Such properties are less case-dependent than the population growth rate. These sensitivities reveal which size class in the population life cycle contributes most to the viability of the population. For sustainable extraction and forest management, it is therefore necessary to focus on these size classes. Methods should be developed to enable a rapid assessment to be made of whether extraction is becoming more or less sustainable.

To assess the impact of NTFP extraction on biological diversity, simple models should be developed to quantify the effects of NTFP harvesting on the regeneration of tree species. Another option for the evaluation of the impact of NTFP extraction on biological diversity is to aggregate species diversity and interactions into functional groups and test whether they can reveal patterns of changes in the forest ecosystem.

With regard to the social aspects of NTFP exploitation, it is necessary to place extraction in the wider context of rural and urban development (Dijkman *et al.,* 1998). The social dynamics of NTFP extraction, in particular, and its transitional nature deserve more attention. Ignoring the place and dynamics of NTFP extraction in the livelihood strategies of forest-dependent people will inevitably result in the failure of strategies to promote NTFP extraction as a vehicle for conservation *and* development.

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