Conservation of Valuable and Endangered Tree Species in Cambodia, 2001-2006: A Case Study

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Preface

Natural forests of Cambodia represent major national assets in contributing to poverty reduction and sustainable livelihoods, national economic development, and biodiversity and environmental conservation. However, rapid degradation and loss of the resource base is resulting in diminishing access and low value forest products. Implicit for the future, is the erosion of genetic resources of many economically, and potentially valuable, indigenous tree species and a subsequent loss of quality planting material for use in tree plantings.

Within Cambodia, several indigenous tree species are listed by IUCN as vulnerable or endangered, and in particular, many distinct populations are threatened. The Royal Government of Cambodia has embarked on forest gene conservation involving the identified target species and their populations in a carefully planned network of designated and managed gene conservation areas, which in the future, will also serve as seed sources. To this end, the Cambodia Tree Seed Project funded through DANIDA, has been assisting the Forestry Administration since 2001, focussing on institutional strengthening and capacity building, achieving impressive results in a short period of operation, and in a newly emerging sector.

This case study documents the achievements in what is considered to be one of the few examples in the tropical part of the world, where the complete forest gene conservation process, from planning to implementation, has been successfully undertaken. It presents approaches taken and experiences gained from priority species identification, through the preparation of a forest gene conservation strategy and supportive legislation and regulations, implementation of conservation activities, to the initiation of a National Forest Gene Conservation Programme.

The case study was written as part of a collaborative partnership between the Forestry Administration (FA), Cambodia Tree Seed Project (CTSP), and Forest & Landscape Denmark (FLD). It is published within the FLD Development and Environment series and it is the hope, that the case study will inspire other countries to initiate gene conservation programmes.

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Cambodia is one of the few countries in the tropics to have initiated a systematic forest gene conservation programme. In recognition of the achievements, and their value for other countries, this case study documents the approach adopted, experiences of implementation, the focus on training and raising awareness, and directions for institutionalisation.

Sincere thanks go to the authors, Mr. Soren Moestrup, Special Consultant, FLD, Mr. Arvid Sloth, Danida Technical Advisor, and Ms. Sarah Burgess, Consultant, for raising Cambodia's experiences in forest gene conservation to an international audience. Thanks are also due to staff of the Cambodia Tree Seed Project for their contributions, comments and suggestions, in particular, Mr. So Thea, Project Manager, and Mr. Uon Somol, Project Officer; and to Mr. Sok Srun, Administrative Officer, for his ongoing assistance to mapping and layout.

None of this could have been accomplished, of course, without the high level of commitment of these officers, advisors and consultants, working in a sometimes challenging, environment.

Abbreviations

APSARA	Authority for the Protection and Management of Angkor and the Region of Siem Reap
CBD	Convention on Bio Diversity
CFA	Community Forestry Agreement
CTSP	Cambodia Tree Seed Project
DANIDA	Danish Agency for International Development Assistance
DFSC	Danida Forest Seed Centre
FA	Forestry Administration
FLD	Forest & Landscape, Denmark
FMP	Forest Management Plan
FWSRI	Forest and Wildlife Science Research Institute
IPGRI	Internal Plant Genetic Research Institute
IUCN	World Conservation Union
MAFF	Ministry of Agriculture, Forestry and Fishery
MoE	Ministry of Environment
NTFP	Non Timber Forest Products
RGC	Royal Government of Cambodia
US$	United States Dollar
WWF	World Wildlife Foundation

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1. Introduction

Natural forest accounts for almost 60% of total land cover, according to official forestry statistics for Cambodia, but is under threat from a number of pressures including encroachment, over-logging, land conversion, and other human activities. However, a recent forest resource assessment by FAO (2005) indicates Cambodia to have lost more than a quarter of its remaining primary forest since 2000 (6.7% per year), and ranks the country third in the world for primary forest loss. Within this process, many indigenous species have been, and are continuing to be exploited and are listed as vulnerable or endangered. In particular, many distinct populations are threatened with extinction.

Whilst the forest of Cambodia may be disappearing faster than ever before, there is a recognised need for appropriate forest management to ensure sustainable development, guided by national policies and plans.

Forest gene conservation is fundamental to sustainable forest management. The Royal Government of Cambodia, through the Forestry Administration and Cambodia Tree Seed Project, supported by DANIDA, embarked on a forest gene conservation strategy in order to conserve the genetic diversity of useful and economically important tree species. A favoured method is to increase their use in tree planting activities, which will ease the pressure on natural populations and contribute to environmental conservation. A well-managed forest resource may contribute towards economic and social welfare, thus enhancing local and national development.

The National Forest Gene Conservation Strategy identifies and prioritises endangered tree species, defines conservation methods, defines the number of required conservation stands per species and their locations in the country, as well as management plans and protection measures required. Its implementation ensures that seed and planting material of desired tree species will be available, when a planting need arises in the country. And a planting need **will** arise, if not before, then when all the natural forest has gone!

Such a comprehensive and systematically prepared forest gene conservation programme has not been done in many tropical countries before. This case from Cambodia can serve as a guide for any country wanting to prepare and implement a forest gene conservation programme.

The situation in Cambodia regarding the disappearance of the natural forest and the need for forest gene conservation is not unique - many other developing countries are in similar situations with a profound need for starting conservation of forest tree genes.

This report tries to document the process, the activities, the outcomes and the costs related to the forest gene conservation work done in Cambodia 2002-2006. This is in order to support other countries initiating forest gene conservation activities.

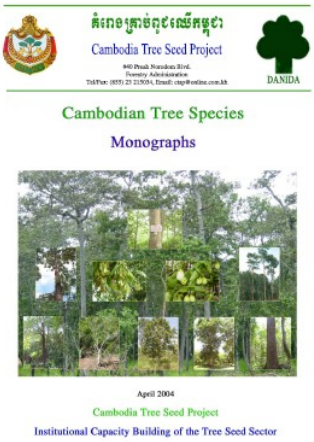
2. Approach for Preparation of a National Forest Gene Conservation Programme

CTSP initiated forest gene conservation activities in 2002 following the planning approach as outlined in Danida Forest Seed Centre (DFSC), 1997, Technical Note No.48: Planning National Programmes for Conservation of Forest Genetic Resources. The planning approach is elaborated further in FAO/IPGRI/DFSC, 2004, Volume I. Forest Genetic Resources Conservation and Management.

CTSP facilitated the following sequence of activities:

- Selection of priority species
- Assessment of their genetic variation
- Assessment of their conservation status
- Identification of conservation method
- Organisation and planning of conservation activities
- Preparation of management guidelines for the conservation areas
- Preparation of management agreements with stakeholders
- Institutionalisation of the activities in the government structure

The products below were prepared as outcomes of the activities. Their preparation and use, as well as training/awareness raising requirements, are described in the following chapters.



Species Distribution Maps

3. Developing a Gene Ecological Zonation for Cambodia

Information on the genetic variation of the species - within and between geographical areas - is important in establishing an effective network of populations of the species to be conserved. It is normally assumed that similarity of agro-ecological conditions (growth conditions) in a given geographical area implies similarity in genetic constitution of flora in the same geographical area. In other words the establishment of an agro-ecological map of Cambodia will be identical to the establishment of a gene ecological map of Cambodia.

Definition of Gene Ecological Zones:

> **"An area with uniform ecological conditions that produces distinctive phenotypic or genetic characteristics within a tree species."**

A gene ecological zone is an area that exhibits ***uniform ecological conditions and limited degrees of gene flow between surrounding regions***. Each gene ecological zone should be circumscribed in a manner that reflects the genetic homogeneity of plant populations.

3.1 Preparation of the Gene Ecological Zonation Model

A gene ecological zonation system can be prepared as one common system for all species considered, groups of similar species, or single species. Factors mostly used for zonation are natural vegetation, topography, climate and soil, as well as natural barriers to pollen flow and seed dispersal.

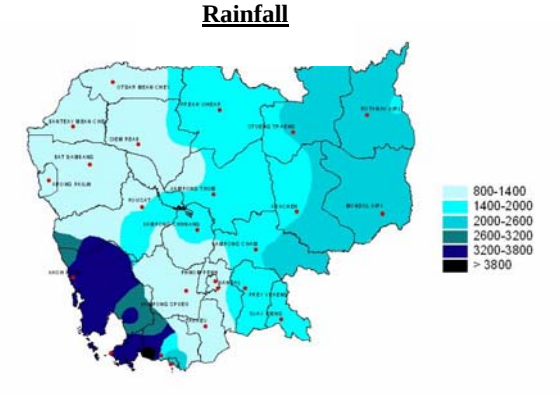
In Cambodia, the Gene Ecological Zonation System was created from a variety of environmental data-sets, including several that are based on records and interpolations from 123 meteorological stations within and around the country (i.e., averages and ranges in temperature, rainfall, and length of dry seasons). This information was then correlated with databases that describe the topography of Cambodia, the age and chemical composition of its soils, soil fertility, and the natural distribution of vegetation types. As it appeared that many of these data sets were much too detailed to use in the delineation of gene ecological zones, the Cambodia Tree Seed Project has chosen to emphasise information that is most directly relevant to the processes of natural selection in the context of plant populations. These include the following environmental factors:

- Annual rainfall (using 200 and 600 mm range classes)
- Period of dry months (< 40 mm rainfall/month over a 4-month period)
- Temperature of coldest month (<16.5º Centigrade)
- Geological distribution of basalt, sand-silt stone, alluvial deposits, gneiss and schist, and complex substrates
- Soil fertility (low, medium and high)
- Vegetation and land use (agricultural lands, shrub land, deciduous forest, evergreen forest and inundated/mangrove forest)

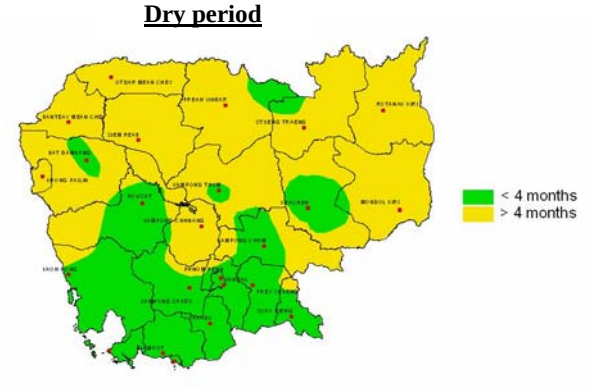
In order to visualise these multivariate factors in a geographical context, each measurable environmental parameter, according to a biologically relevant interval, was presented on maps of the same scale.

Figure 1. Data Maps used for Delineation of Gene Ecological Zones

Rainfall

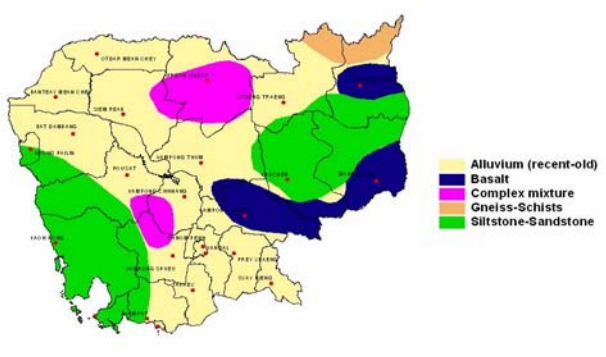


Dry period

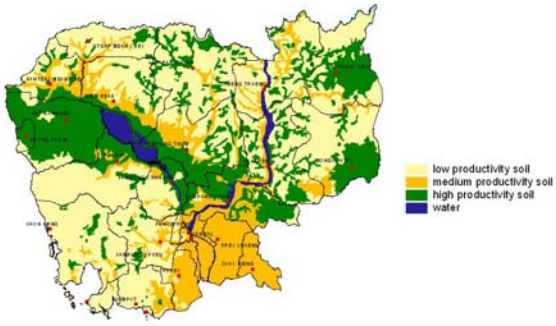


Low temperature regions

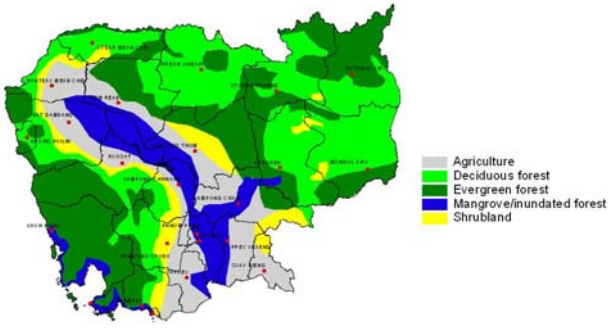
Simplified geology of Cambodia



Generalised geology

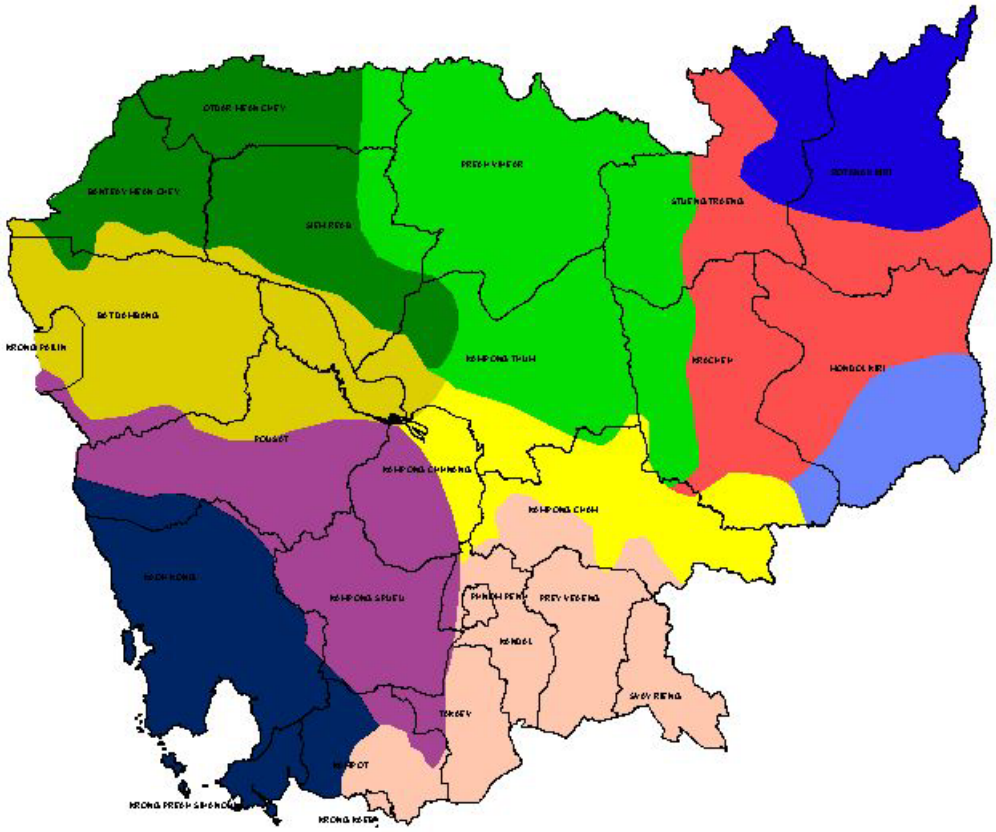


Vegetation distribution



These six simplified maps were overlaid and extrapolated electronically using the ArcExplorer software. The draft was discussed among the most qualified people in Cambodia representing the technical topics given by the six maps. These discussions led to some changes of the borders of the gene ecological zones. Relating computer extrapolation to empiric knowledge and experience is very important, as in the landscape there often exist physical features that the map will disregard, which the experienced technical officer will be aware of. After several computer extrapolations and discussions between the technical experts the final gene ecological map of Cambodia could be printed.

Figure 2. The Final Gene Ecological Map of Cambodia



The 'Gene Ecological Zonation of Cambodia' manual includes brief descriptions of the ten gene-ecological zones of Cambodia, including comments on the geographical, geological, climatic, and biological character of each zone. The descriptions include a listing of high priority tree species that occur in each zone and a summary of species distributions across gene ecozonal boundaries.

3.2 Use of the Gene Ecological Zonation Model.

The gene ecological zonation model was developed in order to gain an overview of the genetic variation of forest tree species to be included in the Forest Gene Conservation Strategy prepared later. Also, it will serve as a practical guideline for seed and seedling transfer.

Based on the gene ecological zonation, CTSP could ensure sufficient genetic variation of the species to be conserved by selecting conservation stands in appropriate ecological zones.

The system of gene ecological zonation and gene conservation stands can be used for many other purposes:

- Availability of seed
- Matching seed source to planting site
- Planning tree improvements activities
- Botanical studies
- Silvicultural 0-plots
- Ecological plots

- Phenological plots
- Hydrological plots
- Extension/education plots

The computer software (ArcExplorer) generates information about specific locations that can be selected using series of queries, and exported to Excel or visualised on a screen. Much of the information relates to maps, and can be accessed or printed out in this format.

Specific Costs for the Preparation of the Gene Zonation

	US$
• Manpower, FA	15 000
• Adviser process, meetings, technical facilitation	20 000
• Consultants	30 000
• Utilities/meetings/data	8 000
• Printing	4 000
• CD-roms	1 000
• Distribution	1 000
Total	79 000

Information regarding annual average rainfall (classes: 200mm/600mm/average), length of dry seasons (4 month intervals), minimum temperature (lower or higher than 16.5^{o}C), soil fertility (low, medium, high), geology (sand-siltstone, gneiss-schists, basalt, old/new alluvium, complex mixture) and types of vegetation (agricultural land, shrub land, deciduous forest, evergreen forest, mangrove/inundated forest), as well as the number of inhabitants and size of the administrative area, can be studied at province, district and commune level.

There are a total of 8220 specified areas in the model.

4. The National Forest Gene Conservation Strategy

Before the gene ecological zonation was finalised, CTSP began preparation of the forest gene conservation strategy (2001). The strategy is based on the overriding principle 'conservation by use through a participatory approach'. This resulted in the identified conservation stands also being considered as potential seed stands. Mother trees were identified and marked in each conservation stand. When no tree planting takes place, no seed is needed and the stands will mostly function as conservation stands. When tree planting starts in Cambodia, seed can be collected from the same areas for direct use in nurseries, or to establish additional seed stands for larger scale seed production.

Tree species are best conserved within their natural habitat, but in some circumstances the natural forest cannot be protected. Therefore, it may be necessary to establish conservation stands outside present distribution ranges.

Responsibility for forest management lies with the Ministry of Agriculture, Forests and Fisheries (MAFF), and the Ministry of Environment (MoE, for protected areas). MAFF/Department of Fisheries manages flooded forests. The implementation of the forest gene conservation strategy rests with MAFF.

The regulatory framework for the forest gene conservation strategy includes the Sub-Decree on Forest Concession Management (1999), National Forest Sector Policy Statement (2002), Forestry Law (2002), National Biodiversity Strategy and Action Plan (2002), Sub-Decree on Community Forestry Management (2003), and the Forestry Action Plan (2006).

4.1 Preparation of the Forest Gene Conservation Strategy

It was decided that the strategy should be developed in collaboration between stakeholders to better reflect the national development goals in relation to biodiversity, environmental, and socio-economic issues.

The first meeting on the Forest Gene Conservation Strategy was held in September 2001. It established a multi-disciplinary working group to develop the strategy, and identified future steps for action.

All members of the Working Group were officially appointed by RGC:

- MAFF: Forestry Administration/Cambodia Tree Seed Project (6)
- Danida forestry advisor (1)
- Ministry of Health (medicinal plants) (1)
- Ministry of Environment (2)
- Royal University of Phnom Penh (2)
- Royal University of Agriculture (1)
- IUCN (1)
- WWF (1)
- Concern Worldwide (1)
- Danida Forest Seed Centre, as consultant (1)

4.2 Selection of Priority Species

Based on available information, potential uses, and IUCN conservation criteria, the working group identified 34 indigenous species as endangered or threatened. The 34 species were ranked and allocated priority status for forest gene conservation.

Table 1. Priority Tree Species for Gene Conservation

Nº	Priority Tree Species	Assessed Level of Threat
1	*Dalbergia oliveri* Gamble ex Prain	5
2	*Aquilaria crassna* Pierre	5
3	*Dalbergia cochinchinensis* Pierre	5
4	*Gardenia angkorensis* Pit.	5
5	*Afzelia xylocarpa* (Kruz.) Craib	5
6	*Pterocarpus macrocarpus* Kurz.	5
7	*Dysoxylum loureiri* Pierre	5
8	*Diospyros crumenata* Thwaites	5
9	*Lasianthus kamputensis* Pierre ex Pit.	5
10	*Diospyros bejaudii* Lecomte	4
11	*Fagraea fragrans* Roxb.	4
12	*Dasymaschalon lomentaceum* Finet & Gagnep	4
13	*Shorea cochinchinensis* Pierre	4
14	*Hopea helferi* Brandis	4
15	*Pinus merkusii* Jungh & de Vriese	4
16	*Garcinia hanburyi* Hook.f.	4
17	*Cinnamomum cambodianum* Lecomte	4
18	*Sterculia lychnophora* Hance	4
19	*Cananga latifolia* Finet & Gagnep.	4
20	*Albizia lebbeck* (L.) Benth.	4
21	*Hopea odorata* Roxb.	4
22	*Tarrietia javanica* Blume	3
23	*Diospyros pilosanthera* Blanco	3
24	*Hopea ferrea* Lanessan	3
25	*Xylia dolabriformis* Benth.	3
26	*Fibraurea tinctoria* Lour.	3
27	*Shorea hypochra* Hance	3
28	*Shorea vulgaris* Pierre ex Laness.	3
29	*Diospyros nitida* Merr.	3
30	*Cassia garretiana* Craib	2
31	*Dipterocarpus alatus* Roxb. G. Don	2
32	*Anisoptera costata* Korth.	2
33	*Melanorrhoea laccifera* Pierre	2
34	*Artocarpus chaplasha* Roxb.	1

Information on the distribution, biology and protection status of a species is essential to define effective conservation measures. Such information was not readily available in Cambodia and the working group initiated a comprehensive literature search, workshops, and many working sessions with selected experts to collect empiric data and experience which was analysed and compiled, for each priority species. Information is available on:

- Distribution and habitat
- Ecological zonation
- Botanical description