Policy brief: Conservation of vulnerable timbers in REDD

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Introduction

The rosewood trees *Dalbergia cochinchinensis* and *D. oliveri* are highly valuable timber species endemic to Indochina. Demand for their red colored and very durably wood, which is used for luxury furniture, unfortunately fuels a high level of illegal logging and trade of the species. This unsustainable level of use together with alarming high levels of deforestation in the region has caused both species to become rare and in risk of local extinction. The design and implementation of effective conservation strategies for these species has however been limited by the lack of adequate tools and knowledge.

The immediate objectives of this project was to develop novel tools for conservation planning and monitoring of timber trade, by the use of new molecular methods made recently available by advances in DNA sequencing technology. The project included capacity building and workshops in Cambodia and Vietnam.

The overall aim was to support development of a strategy for future conservation and use for the two *Dalbergia* species, and provide the molecular resources from which a practical timber tracking tool can be developed.

Figure 1. Left: Habit of *D. cochinchinensis*, middle: forest managers standing on illegally logged *Dalbergia* stump, Cardamom Mountains, Cambodia, upper right: confiscated timbers at local forestry administration station, Sre Noy, Cambodia and lower right: bed made from *Dalbergia* timber, observed in Pursat, Cambodia. Photos: Ida Hartvig.

Background and methods

This project was conducted in partnership between University of Copenhagen, Forestry Administration, Cambodia and Vietnam Academy of Agricultural Sciences, and in collaboration with research institutions in Laos and Thailand.

The project builds on many years of cooperation with institutions within the region, including the work initiated by DANIDA Tree Seed Projects and is aligned with national forest and species conservation programs.

We collected leaf, seed and cambium samples from natural populations of *D. cochinchinensis* and *D. oliveri* across their distribution area in Cambodia, Vietnam, Thailand and Laos from 2010-2014 and extracted DNA from the samples. Novel molecular markers (microsatellites and SNPs) were developed based on a subset of the collected samples and then used to genotype all collected samples. The data was analyzed and the results and their implementation were discussed with research partners and relevant stakeholders during research stays in Denmark and workshops in Cambodia and Vietnam in 2015.

Results

We developed nine and eight microsatellite markers for *D. cochinchinensis* and *D. oliveri*, respectively, and 40 SNP markers for *D. cochinchinensis* and used the markers to assess the level and structure of genetic diversity in the two species.

During fieldwork we observed that both species are becoming exceedingly rare and that logging is present in almost all population, even those strictly protected within national parks. The genetic data revealed that both species are highly capable of reproducing clonally from root suckers as well as resprouting from stumps left from logging, and that the closer trees are to each other the more likely they are to be clones.

Both species showed overall medium-high level of genetic diversity, which indicated that the recent high levels of logging and deforestation have still not seriously degraded the level of diversity. A lower level genetic diversity for *D. cochinchinensis* indicate lower levels of gene flow for this species, which might make it more vulnerable to logging and fragmentation in the long term, as well as to climate change.

We found that both species show a very high level of differentiation among geographical regions, meaning there is considerable genetic variation among populations from different regions. Higher levels of genetic diversity was found within the center of the distribution area, primarily in mountainous regions in SW Cambodia, central Annamites in Vietnam and the Dangrek mountain area on the border between NW Cambodia and Thailand.

Figure 2. Left: Root suckers from large individual of *D. oliveri*, middle: Conservation stand of *D. oliveri* in Prey Viehear, Cambodia, identified during the DANIDA Tree Seed Project and included in present study, right: Map of Indochina. Photos: Ida Hartvig, Map: Ida Hartvig & Patrik Karlsson Nyed.

Conclusions

The presence of clonality in most monitored populations is important to consider when designing and sizing conservation stands. The actual number of unique trees may be lower that the simple number of trees in a conservation stand, because some of them can be genetically identical rametes from the same original trees. It also means that there is a risk of overestimating natural regeneration, because some of the small plants simply may be rametes of a larger individual. The resprouting ability on the other hand mean that it is possible to restore a heavily logged population, because of the previously logged trees may resprout and time develop into new mature trees.

The high level of genetic differentiation found in both species has two important implications. Firstly, conservation plans should aim at conserving several populations within each geographical region, as they are distinct and most likely locally adapted, a fact that should also be considered if establishing seed production for breeding programs. Secondly, the high level of geographic variation detected with the molecular markers make these excellent as tools for inferring the geographic origin of traded timber. The genotypes of the sampled individuals thus constitute a reference database, to which samples of traded timber can be matched and the geographic origin determined. Tests showed that any given sample of *D. cochinchinensis* was correctly assigned to its geographic origin with a success rate of 90%.

Figure 3. Forestry Administration staff and local guides conducting fieldwork in Cambodia 2010-2012.

Implications

The results of the genetic assessments were presented to and discussed with local and national stakeholders during two workshops in Cambodia and Vietnam, co-organized with local research partners, and guidelines for future management and conservation of the species were developed and made available to stakeholders. The main conclusions are as follows:

To ensure future genetic resources of the species and high survival in their natural habitats, it is important to include both *in-situ* and *ex-situ* conservation methods in the management strategy. *In-situ* conservation stands representative of the different genetic regions should be identified within the distribution area and strictly protected. These key areas can provide material from which local seed source stands could be established. To

avoid sampling clones, seeds should be collected from trees growing min. 50 m apart. The seed source stands could serve both as *ex-situ* conservation stands as well as provide material for breeding purposes.

Given the high level of genetic differentiation it is recommended to use local material for commercial plantation and forest restoration programs.
When deciding specific conservation stands, priority should be given to highly diverse regions and to unique populations specifically vulnerable to climate change.

This study has provided molecular markers and a corresponding extensive reference database, from which a practical timber tracking tool can be developed and used in enforcement of national and international protection measures.
The knowledge and experiences gained from this project further assisted to support the listing of *D. cochinchinensis* on CITES App. II in 2013, and of all *Dalbergia* species in 2016, and has also lead to updated IUCN red list assessments for both species, with both species being categorized as CR (critically endangered).

Recommendations
It is recommended that regional conservation stands, both *in-situ* and *ex-situ*, corresponding to the revealed patterns of genetic diversity, are established urgently. To address the widespread problem of illegal logging a practical timber tracking tool should be implemented using the resources provided in this project. The study showed that several genetic regions of high priority span national borders and it is therefore important with regional focus and cooperation on conservation plans.

Figure 4. Workshop participants in Cambodia 2015.