Spatially explicit threat vulnerability and conservation priorities for Asian Rosewoods

More than half of the predicted distribution of Rosewoods needs urgent conservation and restoration efforts as threats intensify

Conserving Rosewood genetic diversity for resilient livelihoods in Greater Mekong *is a regional initiative implemented in three Greater Mekong Subregion countries (Cambodia, Laos, and Vietnam) from July 2018 to December 2021.*

National project partners are the Institute of Forest and Wildlife Research and Development (Cambodia), the National Agriculture and Forestry Research Institute of Laos and the Vietnamese Academy of Agricultural Sciences.

The project is coordinated by the University of Oxford and funded by the UK Darwin Initiative. The project is implemented in collaboration with the the Alliance of Bioversity International and CIAT, the Chinese Academy of Forestry, and University of Copenhagen.

Rosewoods (*Dalbergia* spp.) are extremely valuable timber species. Over-exploitation through illegal harvesting has significantly reduced most of the species in their natural range. However, the species' populations are also threatened by multiple other threats such as land conversion to agriculture, forest fires, and climate change.

Spatial analyses can complement and help target field research efforts. They also allow predicting future impacts of climate change on species. Here we propose *in situ* and *ex situ* conservation priorities for three endangered Rosewood species based on species distribution modelling and multi-threat assessment. The results inform field surveys and conservation strategies for Siamese and Burmese Rosewood and Burma Blackwood (*Dalbergia cochinchinensis, D. oliveri and D. cultrata*, respectively) across their range in Greater Mekong.

Study methods in brief

- Species occurrence data was compiled from national and international databases and literature
- Data was cleaned and quality-checked for accuracy of coordinates and against the species' known native range
- Species' current and predicted future distributions were modelled using 34 environmental variables, including climate and soil variables
- Resulting distribution maps were validated by species experts
- Threat exposure and vulnerability maps were developed using available global datasets (Table 1), combined with species traits such as growth rate, seed weight and bark thickness

For details on methods, see Fremout et al. (2020), doi.org/10.1111/gcb.15028

Figure 1: Remnant Rosewood trees on a farmland in Central Laos. Credit: Forest Research Centre, Lao PDR

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We mapped the species vulnerability to climate change and to four current threats, namely habitat conversion, overexploitation, fire and overgrazing. Conservation priorities were assigned as follows:

- *In situ* conservation: vulnerability to both current threats and climate change is low
- *Ex situ* conservation: vulnerability to climate change is high
- Restoration: vulnerability to current threats is high and vulnerability to climate change is low
- No single priority: vulnerability to current threats is moderate and vulnerability to climate change is low to moderate. A combination of conservation and restoration actions may be needed

Table 1: Threat indicators and data sources

Key threat	Indicators	Spatial layers
Over-exploitation	Human population density	Human population density (Landscan, 2016)
	Travel time to cities	Travel time to cities (Weiss et al., 2018)
	Presence/ absence of a protected area	Designated protected areas (UNEP-WCMC, 2016), updated with protected areas for Cambodia provided by contributing species experts
Fire	Fire frequency	NASA Fire Information for Resource Management System (FIRMS). MODIS Active Fire Detections from 2013 to 2017 (NASA EOSDIS, 2018)
Overgrazing	Cattle, goat and sheep density	Gridded Livestock of the World v2.0 (Robinson et al., 2014)
Habitat conversion	Percentage of cropland coverage	Land cover share database (GLC-SHARE, 2014)
	Percentage of planted forests and tree crops	Tree Plantations (Harris et al., 2018) for Cambodia
Climate change	Loss of suitable habitat	SDMs projected to future climate conditions (2041-2060 period) using 5 Global Circulation Models (Eyring et al., 2016) with maximized dissimilarity, and three shared socio-economic pathways (SSP126, SSP245 and SSP585), downloaded from the WorldClim website (https://worldclim.org/)

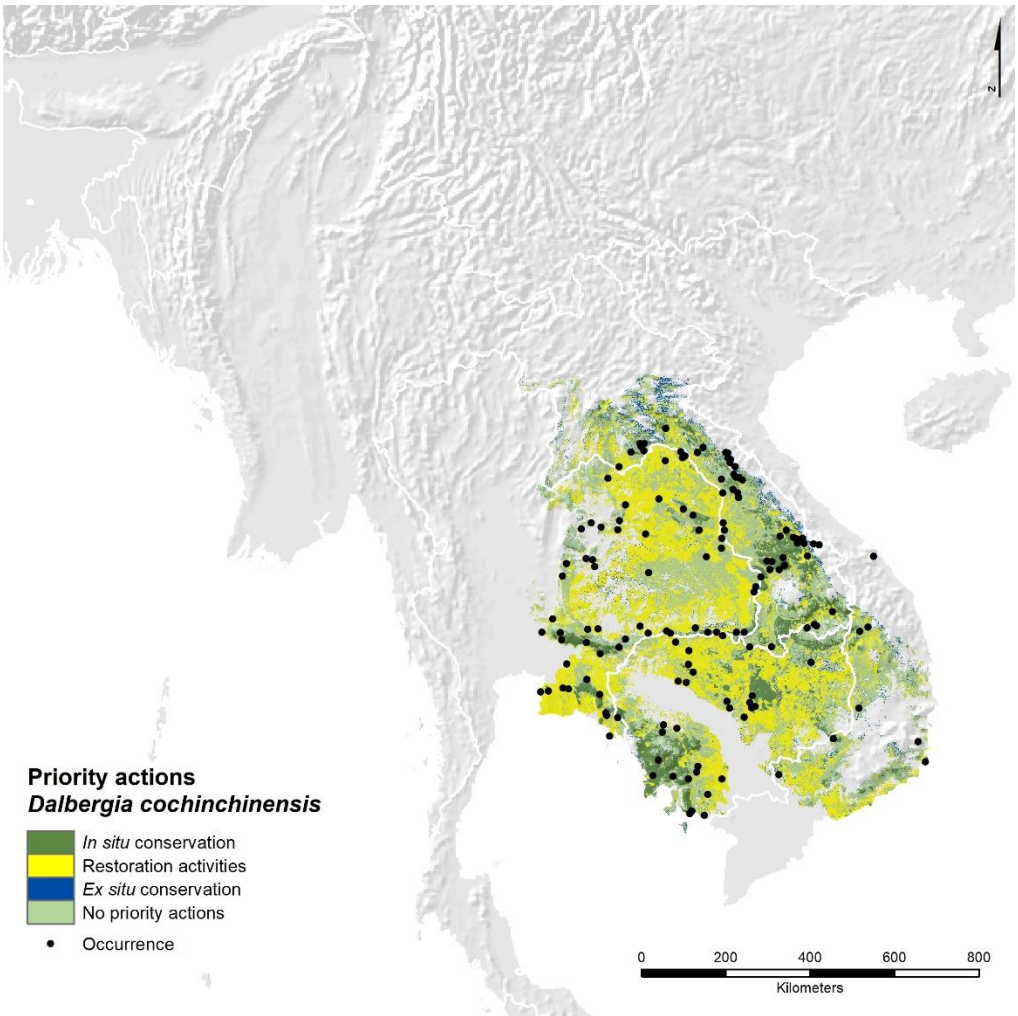

Figure 2: Conservation and restoration priorities for Siamese Rosewood *(Dalbergia cochinchinensis)*

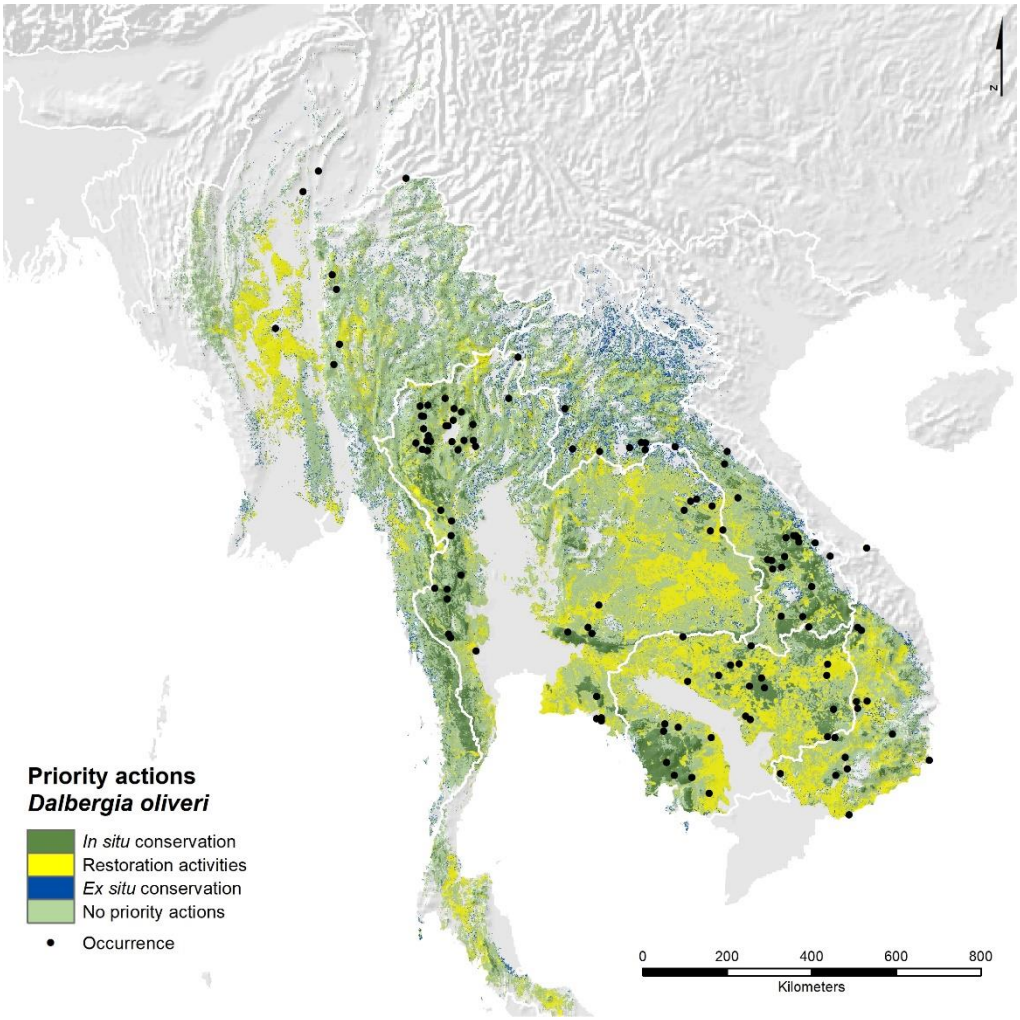

Figure 3: Conservation and restoration priorities for Burmese Rosewood *(Dalbergia oliveri)*

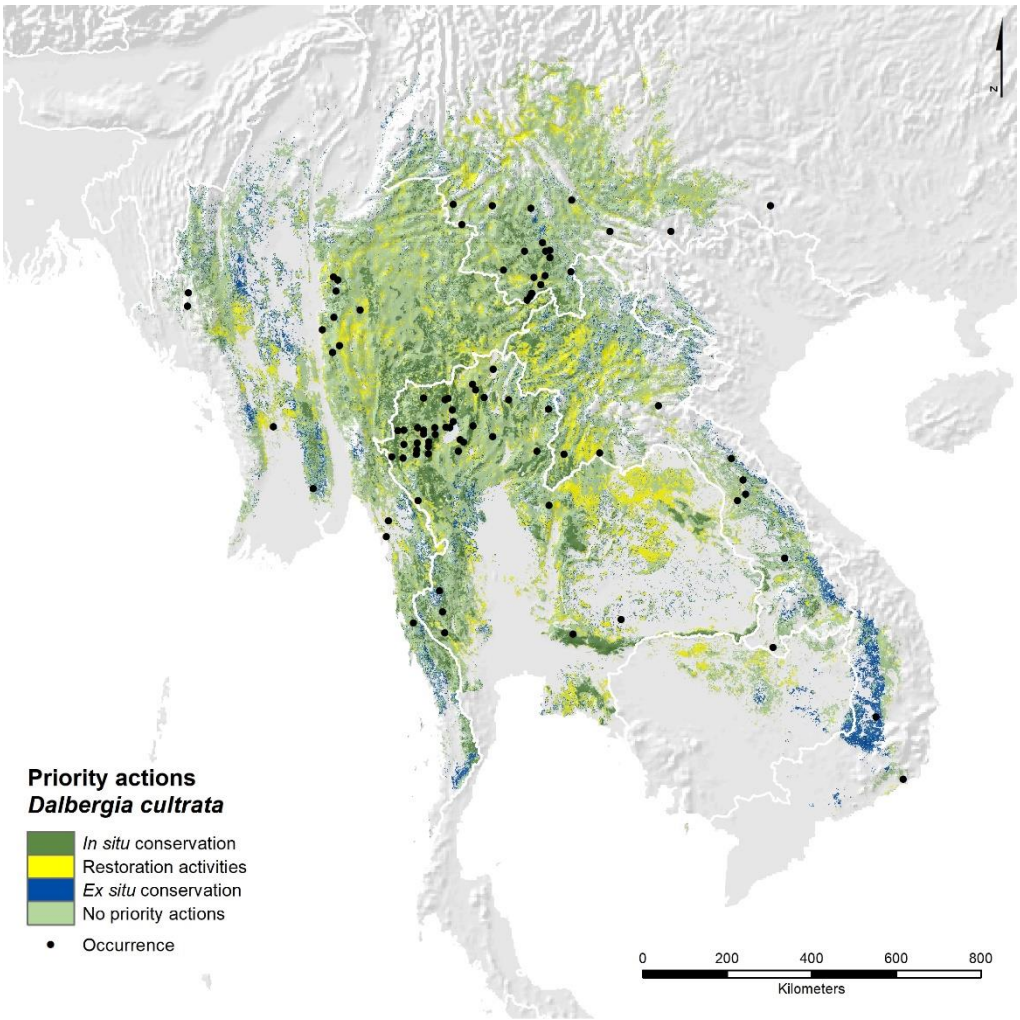

Figure 4: Conservation and restoration priorities for Burma Blackwood *(Dalbergia cultrata)*

Table 2: Proportion of suitable habitat prioritized for conservation and restoration

Species	Predicted suitable habitat (sq.km)	Predicted suitable habitat in protected areas (%)	Prioritised for *in situ* (%)	Prioritised for *ex situ* (%)	Prioritised for restoration (%)
Siamese Rosewood *(Dalbergia cochinchinensis)*	441,912	21	12	3	42
Burmese Rosewood *(Dalbergia oliveri)*	997,383	18	11	7	25
Burma Blackwood *(Dalbergia cultrata)*	871,792	13	12	9	15

Diversity under threat

The results of the assessment indicate severe threats for all three species across their native distribution ranges in the Greater Mekong. The species are vulnerable to at least one of the five threats in about 75% of their natural distribution area (80% of the distribution of Siamese Rosewood, 75% of Burmese Rosewood and 75% of Burma Blackwood). Overexploitation and habitat conversion emerged as the most important threats.

Only a fraction of the current distribution area is readily suitable for *in situ* conservation, characterised by high suitability for the species under both current and future climate according to species distribution models and by low current threats (Table 2). Moreover, for all three species this area is smaller than the species' predicted suitable habitat in current protected areas, indicating that the species are at risk also within protected areas.

Burma Blackwood emerged as the most vulnerable species to progressive climate change. *Ex situ* conservation at facilities or field genebanks appears as the only feasible option in the long term for conserving the species' genetic resources in many parts of its range. These include populations in southern Vietnam, Cambodia, Laos, northern Thailand, as well as central and southern Myanmar (Figure 4).

Targeting and enabling restoration

The results also indicate both an urgent need for restoring the species populations, and challenges for implementing restoration efforts as suitably adapted seed sources for different environmental contexts become increasingly rare and fragmented. The priority action maps can help target restoration efforts to where they are most needed or most feasible. Remaining viable seed sources need to be mapped and protected across the species ranges to enable restoration. Comparing species' predicted distribution with existing seed zone maps can help identify targets for the number and distribution of seed sources needed. Seed orchards can also contribute to conserving genetic diversity of the species while facilitating seed production.

Together, these measures can help prevent and reverse local extinctions of the species and generate socio-economic benefits from the cultivation of the precious Rosewoods.

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