Enhancing Biodiversity – Identification of conservation corridors in a plantation dominated landscape in the Mekong region

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Background

The rapid expansion of rubber tree plantations (Hevea brasiliensis) and cash crops across southern subtropical China puts high pressure on natural forests and their biodiversity. Xishuangbanna Prefecture in the South of Yunnan Province (Fig. 1) is particularly affected as here rubber monoculture plantations currently cover about 440,000 ha and have replaced large shares of traditional land use systems and natural rainforests over the past 40 years. Today, contiguous blocks of mature natural forest are confined to the prefecture's seven nature reserves which are, however, isolated. Further, the ongoing transformation of the lands surrounding the reserves and the encroachment of plantations into them, continues to increase the separation of reserve dwelling plant and animal populations, impeding movements and interactions between them. In order to reconnect isolated populations, it is necessary to establish wildlife corridors that prepare the grounds for the dispersion of organisms.

Study Area

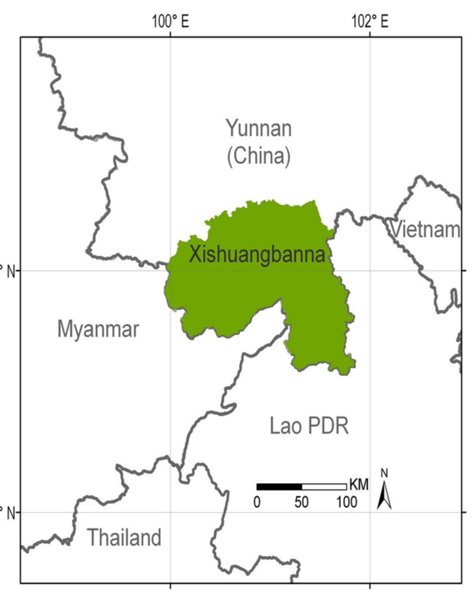

Fig. 1: Location of Xishuangbanna (Chen et al., 2016)

Due to the mountain - valley topography of Xishuangbanna (Fig. 2) and the prevailing typical tropical monsoon climate, its original vegetation comprises five different primary forest types. The unique combination of geography and climate has formed a transition zone between flora and fauna of tropical Southeast Asia and subtropical, temperate China, making it the region with the highest bioddiversity in China. However, the rapid intensification of agriculture and rubber cultivation have put so much pressure on the remaining primary forests that their area has been drastically reduced (even at elevations of above 1000 m asl, see Fig 2 & 5) with the consequence that natural habitats became more and more fragmented and that many species became endangered or even extinct.

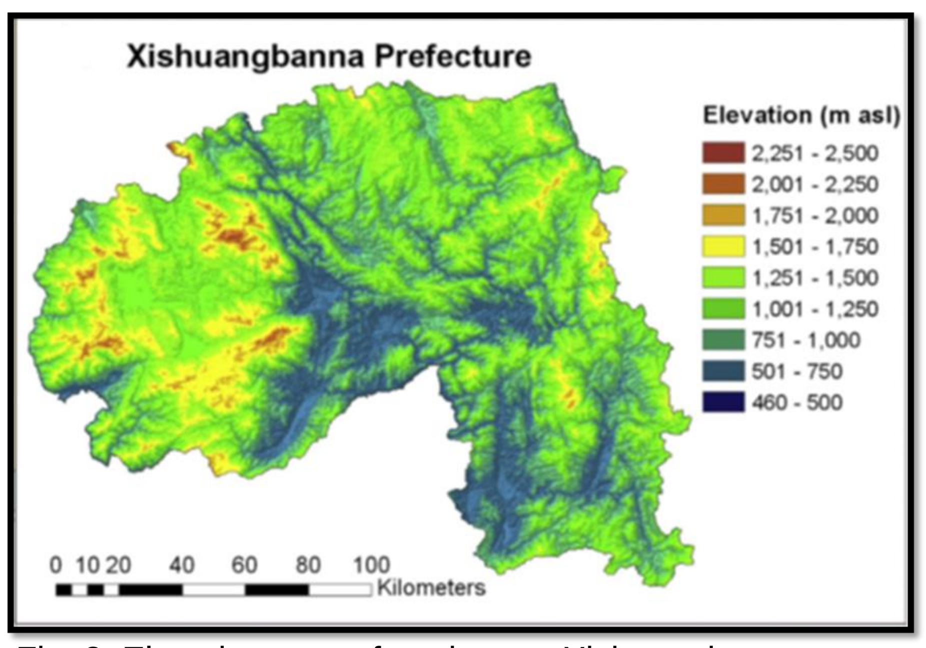

Fig. 2: Elevation map of study area Xishuangbanna (Zomer et al., 2015)

Objective

Identification of potential corridors to enhance structural (Fig. 3) and functional (Fig. 4) connectivity between nature reserves, focusing on biophysical and ecological factors and options.

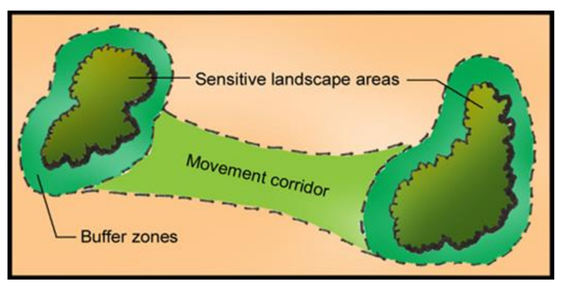

Fig. 3: Structural corridor (HAT Media Ltd., 2017)

Fig. 4: Functional elephant corridor (National Agroforestry Center, 2017)

Methods

Cost-based corridor models

→ analysis of landscape resistance and determination of the most cost-effective route between a source and a destination

→ costs = landscape resistance values (difficulty or unwillingness of an organism to move through a particular land cover type)

Input data:

- Source and destination areas (GIS vector data)
- Target species or species groups

→ Group F 1: Large mammals (elephants, buffalos)

→ Group F 2: Primates

→ Group F 3: Birds

- Identification of influencing landscape features and conditions

→ Land cover and slope

- Weighting and determination of resistance values of influencing factors (Tab. 1); values between 0 and 100 (GIS raster data)

Applied tools:

- Least cost path analysis (LCPA) & Least cost corridor analysis (LCCA)
  → Distance tool of Spatial analyst toolbox in „ArcGIS 10.0"
- Linkage Mapper (LM)
  → Free GIS tool designed to support regional wildlife habitat connectivity studies

Tab 1: Resistance values for functional groups depending on influencing factors (based on a literature review and expert interviews, e.g. Lin et al., (2008) & Warren-Thomas et al.,(2015))

Functional Group	Forest	Rubber	Banana	Agriculture	Tea	Urban	Shrubs	Bamboo	Water
1	1	50	60	70	61	99	10	1	30
2	1	30	40	60	55	99	20	1	80
3	1	10	20	30	35	90	5	1	40
Functional Group	**0–10°**	**10–20°**	**20–30°**	**30–40°**	**40-50°**	**50–60°**	**60-70°**	**70–80°**	**80-90°**
1	1	1	2,5	5	10	15	20	25	30
2	1	1	1	1	2,5	5	7,5	10	12,5
3	1	1	1	1	1	1	1	1	1

Results

The identified least cost paths clearly display the high degree of isolation of all reserves since none of the routes connects two reserves on the shortest way (Fig.6). Instead, the model primarily proposes detours integrating fragmented forest remnants into the corridors. Conservation corridors for large mammals correspond mostly with those for primates, solely the corridors for birds differ (Fig. 5). The corridors for primates have most similarities with both other groups and are therefore suggested to be appropriate for the greatest variety of species.

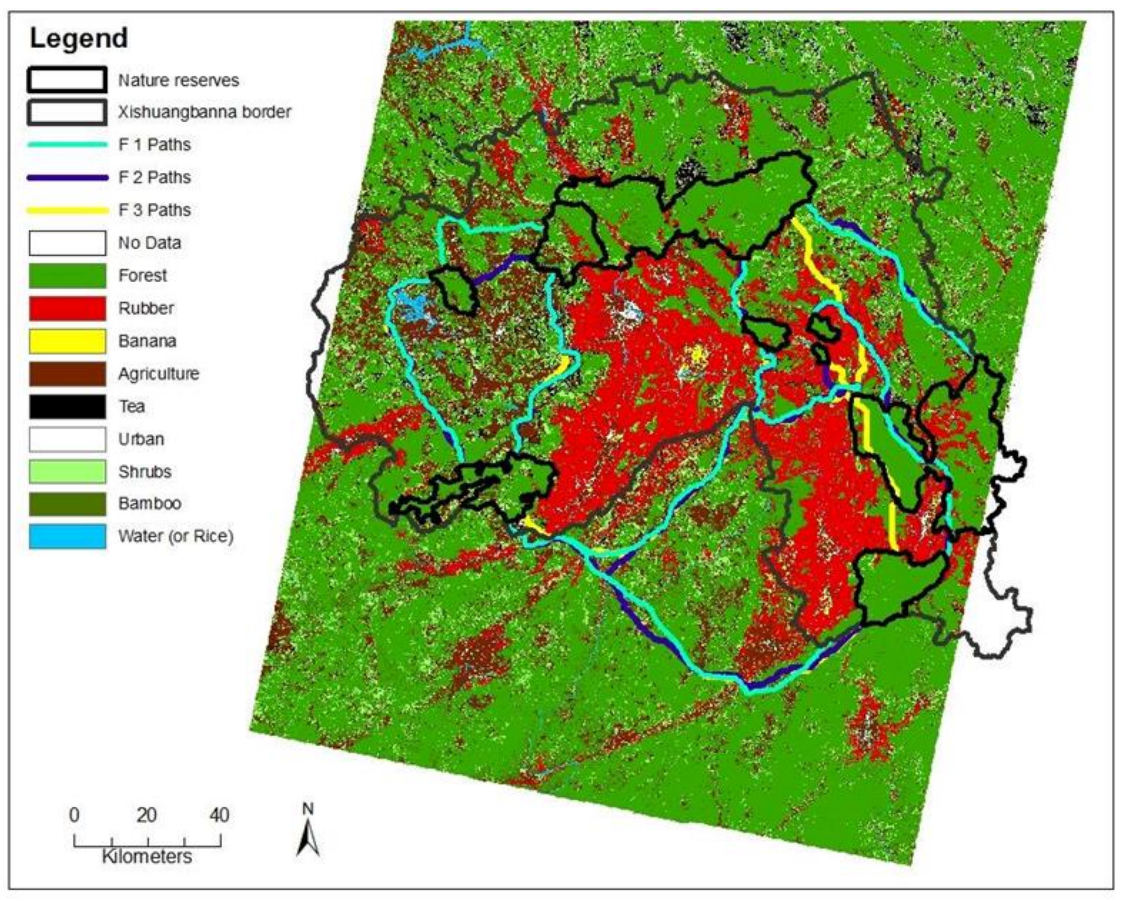

Fig. 5: Linkage Mapper least-cost paths between all nature reserves for each respective functional group (produced with ArcGIS, 2016)

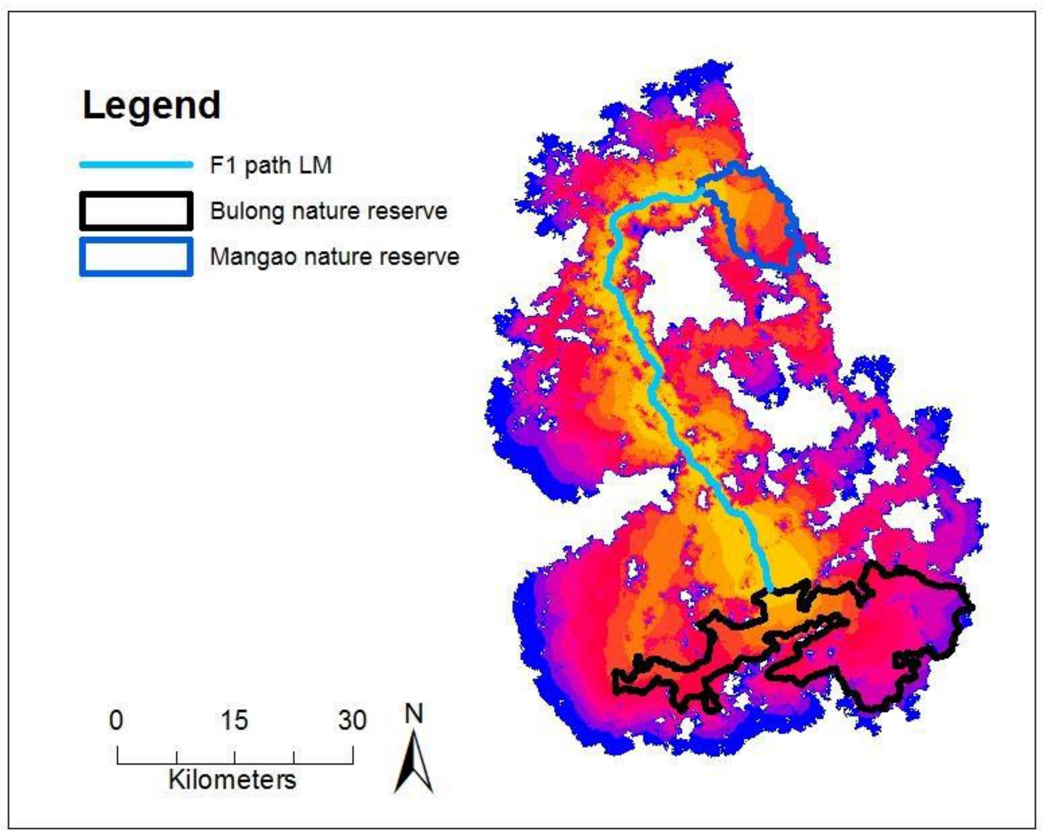

Fig. 6: Spatial analyst least-cost corridor and Linkage Mapper least-cost path between two nature reserves for group F1 (mammals) (produced with ArcGIS 2016)

Discussion

The results confirm the urgent need of reconnecting the reserves through corridors in order to protect, preserve and enhance the remaining biodiversity and counteract the ecological threats from the expansion of rubber plantations. However, changing conditions (such as climate change and future development of land use distribution and rubber cultivation) have to be considered and incorporated. Further, many additional information are required such as:

- Present animal species and their particular behavior/requirements
- Historical migratory behavior
- Effects of human activities on different species
- Accordance of corridor-habitat with preferred breeding area and feeding ground (if migration lasts longer than one generation e.g. corridor dwellers)
- Present and implementable possibilities of corridor implementation → Incorporation of social, cultural and economic factors
- Reliability and practicability of least-cost methods

→ Will the "best" corridor be sufficient and indeed be used by target animals?!

References

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