Loss of biosphere integrity: A Call to Monitor habitat degradation and Manage natural reserves in Southwest China, Yunnan

Target recipient:
Minister of Ecology and Environment of the People's Republic of China (PRC)
Mr. Huang Runqiu

Karis Chung
Department of Global Sustainable Development
University of Warwick
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A. ***Executive Summary:***

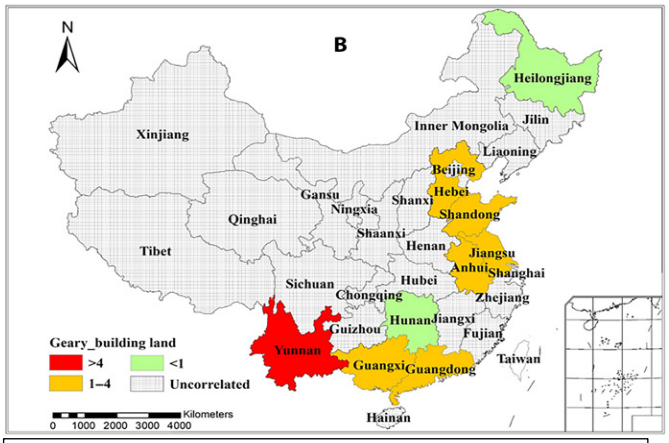

Fig1: Local Geary cluster map of construction land and biodiversity-loss species
(The red zone: Yunnan)
Reference: (Lu et al., 2020)

Yunnan is one of the poorest regions of China and is also the province with the richest biodiversity in China. With rapid urbanisation and industrialisation, urban lands increase from 18.64km2 to 36.81km2 to enhance economic development, but the expanding constructions and pollutions led to decreasing ecosystem services which worsen ecosystem functioning. Biodiversity-wise, Yunnan is biologically abundant with a vast territory with diversified nature reserves. This 'Wildlife Kingdom' has a rich biodiversity of more than 1800 high plant species (51.6% of China's total) and 1836 vertebrate species (54.8% of China's total).(Yang et al, 2004). However, Yunnan's biodiversity is experiencing the menace of massive exploitation of resources and extinction of species like Yunnan snub-nosed monkey caused by the activities of an expanding human population.

Rapid urbanisation affects the provision of ecosystem services for biodiversity conservation, reducing the full-range benefits human obtain from nature. The regulating and supporting services like continuous nutrient cycling deteriorate, negatively impact *the functional and genetic biodiversity* in Yunnan.

Moreover, in terms of natural reserves (NRs), there are 161 NRs in Yunnan, which consists 7.6% of the province's land area, and these NRs provide valuable repositories for native biodiversity.(Qiu et al., 2018) From the 1990s, native biodiversity is threatened by population expansion around NRs, fragmentation and loss of habitat due to logging.

With the situation aforementioned, it is urgent to take actions. Policy suggested focus on three aspects: mandatory, monetary and voluntary. In the policy below, it will target on monitoring habitat degradation on human behaviour and management in natural reserves regionally. By authorising government officials to establish more statistical researches for effective management in biodiversity conservation and promoting more community involvement in ecological conservation.

B. ***Foundation Science: Discussion & Analysis***

1. *Current Yunnan's biodiversity*

Yunnan is one of the poorest regions of China (Hipsher, S. 2017) and with richest biodiversity in China. Yunnan has a vast territory with diversified and unique nature resources. Yunnan accounts for only 4.1% of the total land area of China, but contains more than half of all higher plants, or 19,333 species, which belong to 3,084 genera and 440 families. (Qian et al,2020)

Taxa	No. in Yunnan	No. in China	Yunnan/China (%)	No. in the World	China/World (%)
Mammals	304	613	49.6	4181	14.7
Ares	810	1244	65.1	9040	13.8
Reptiles	170	376	45.2	6300	6.0
Amphibia	120	284	43.0	4010	7.1
Pisces	432 (FW)	3862 (1000 FW)	54.0 (FW)	21400	18.1
Insects	12000	51000	23.5	920000	5.5
Angiospermae	15000	30000	50.0	260000	11.5
Gymnospermae	100	270	37.0	900	30.0
Pteridophytes	1500	2600	57.7	12000	21.7
Bryophytes	1500	2200	68.2	23000	9.6
Fresh algae	800	9000	8.9	25000	36.0
Fungi	7000	8000	87.5	69000	11.6
Bacteria	300	500	60.0	3000	16.7

Fig2: Known species numbers in Yunnan, China and the World
Reference:(State Environmental Protection Administration,1998)

The province has special geographic location forming diverse ecosystem and habitat that are responsible for the abundant biotic resources. As seen in table1, ***high abundance(%) of known species*** are inhabited in Yunnan, which shows a rich biodiversity. (Yang et al, 2004)

However, after vast infrastructure development and government policies on urbanisation, Yunnan experiences severe biodiversity loss. Of 3,767 threatened species (IUCN Categories include Critically Endangered, Endangered, and Vulnerable) in China, 1,426 species are distributed in Yunnan. The number of threatened species in every category has remained high in China since the red list was published in 2013. (Qian et al,2020)

2. *Habitat degradation: Extinction of species, snub-nosed monkeys, in Yunnan*

In advert to the Anthropocene, humans have increased the rate of species extinction by 100–1000 times the background rates that were typical over Earth's history. (Rockstrom, J. et al. 2009) The rapid economic development in Yunnan incubated the conversion and use of land for agriculture and pasture. Development directly contribute to the habitat degradation, which is processes of human origin that make habitats less suitable or less available to cetaceans (Iwc.int, 2018).The human-induced climate change affects Yunnan biodiversity,

ecosystem forced to fluctuate along with the regional climate and would threatened many species. In the previous 40 years, the suitable habitat for Yunnan snub-nosed monkey has decreased by 30%. (New England Primate Conservancy, 2018). They became an endangered species, by biodiversity loss. (Long et al., 1994)

In terms of functional biodiversity, key ecosystem functioning like nutrient cycling and biomass production decreased with the loss of species and reduced competitions. With increasing urbanisation and industrialisation, leading to habitat retreat and high proportion of mammals are threatened. (Lu et al., 2020) ***Commercial timber species*** are abundant in Yunnan, and logging for city development is responsible for widespread deforestation. The logging that took place before the regulations and the boundary effect of roads and rivers resulted in the local extinction of *snub-nosed monkey* in some potentially suitable areas. (Xia et al., 2020)From 1960s to 1980s, the sediments increases from 0.61 to 1.24kg/m3, bringing 1.3 billion tons of soil into Yunnan's Jinsha River. (Xu and Wilkes, 2004), which changes the density and structure of forest in patches, affecting the functional biodiversity in Yunnan.

Aforementioned, ***deforestation*** is the main threat to species. Within Yunnan Province, over 80% of the Yunnan snub-nosed monkey population is found, covering about 3000km2 of fir-larch forest between Yangtse and Mekong. (Fig3) The forest is targeted for logging and about 200,000m3 of commercial logs are removed from the area. (Long et al, 1994) The snub-nosed monkey habitat and living environment is threatened with severe deforestation and logging.

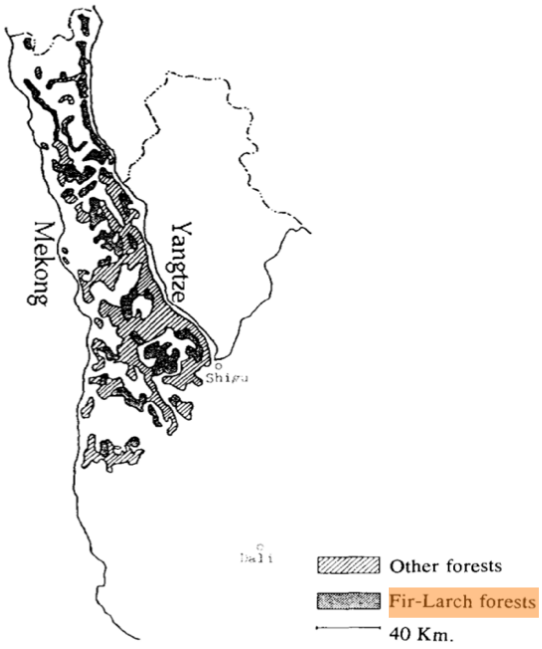

Fig3: Forest distribution map in the distribution area of Yunnan snub-nosed monkey in Yunnan
Reference: Wu et al, 1987

In terms of genetic biodiversity, populations in isolated forest in Yunnan has lower genetic diversity due to inbreeding and reduce gene flow, the lack of genetic variation of snub-nosed monkeys affects its selective breeding system, increased the extinction risk of its population. (Soh et al., 2019)

Understanding that both functional and genetic biodiversity is essential for conservation of species, less human activities should be placed to reduce biosphere integrity.

3. *Natural reserves (NRs) exploitation: Encountering monumental human disturbance and pressure*

Massive population growth and drastic land-use and land-cover change (LUCC) are the main drivers of human pressures that decreased conservation and management of regional biodiversity protected areas. (Qiu et al., 2018) Agricultural expansion drives global biodiversity loss and often caused rivalry between regional biodiversity conservation and socio-economic development. High human land use pressure affected the management effectiveness and even resulted in a certain degree of NRs' degradation.

C. ***Assessment of Existing Governance***

The establishment of Ministry of ecology and environment (MEE) is a milestone of China's environmental governance in 2018, making a positive change in the reform. The purpose of the establishing MEE is to integrate hitherto fragmented ecological environmental protection responsibilities and to unify supervision and enforcement responsibilities. (Yong, 2018). In the existing governance, the unification of decentralised responsibility works well in fostering the co-ordination between different agencies, as well as the authority to implement environmental legislation and regulations with greater efficiency and consistency across China. (Wang. J,2018)

1. Inadequate protected area network for biodiversity conservation:

In the China Biodiversity Conservation Strategy and Action Plan (2011–2030), measure like protected area network is implemented to integrate biodiversity protection and social development. There are a variety of conservation efforts ongoing throughout the province, with a protected area network covering 7.2% of the province widely dispersed across Yunnan.(Zomer et al., 2015) However, in a study based on species modelling and the identification of high priority biodiversity conservation areas within 7 floristic regions(Fig4) , found that the current protected area network did not adequately reflect true conservation priorities for Yunnan (Zomer et al., 2015) Even of species richness and high abundance of species diversity in Yunnan, biodiversity offsetting occurs when the natural reserve conservation is not prioritised and provision of ecosystem services are not optimised.

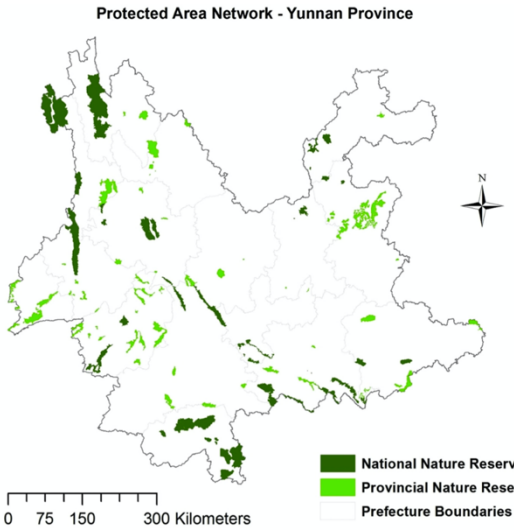

Fig4: Map of protected area network in Yunnan Province, China, showing distribution of national and provincial nature reserves
Reference: Zomer et al., 2015

2. Lack in protection of Yunnan snub-nosed monkey:

The Yunnan snub-nosed monkey was designated in the "first-class protection", (Harding and Han,2018) the highest level of protection for endangered species in China, since 1997. Unfortunately, the monkey has *received more protection in theory than practice*. Human activities like hunting and logging continues, often with official complicity. (Harding and Han,2018) Areas set up to protect the monkey are *poorly planned and managed*. For example, the Tianchi Nature Reserve, set aside expressly to protect the monkey is in fact outside the range of the species. No snub-nosed monkey has ever been found in the reserve. (Long, et al, 1994)

3. Ineffective governance in protecting natural reserves: massive timber logging extraction in Yunnan:

In Yunnan, there are 21 National, 38 Provincial and 56 Municipal Nature Reserves. Out of 129 counties in Yunnan, 109 have at least one nature reserve (Qian et al,2020) The higher-level nature reserves cover almost all the biodiversity hotspots in Yunnan. But, even though 84.5% of counties in Yunnan have nature reserves, there are still *many conservation gaps or unprotected areas* that harbor threatened species (Qian et al,2020)

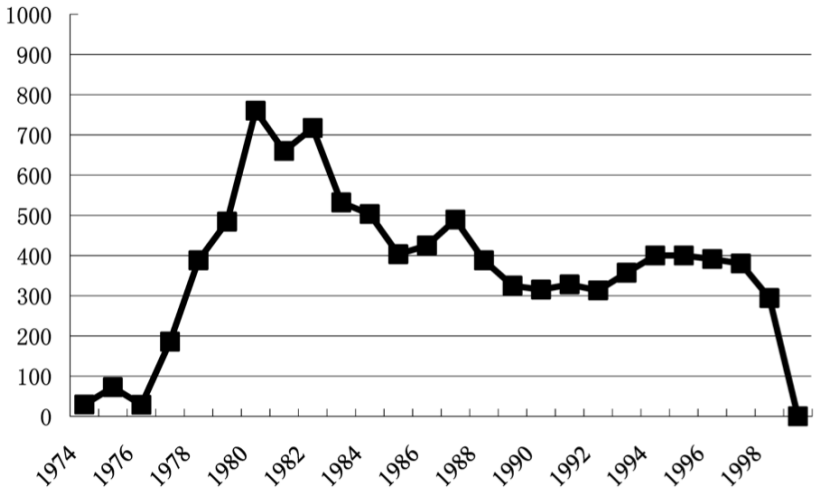

Fig5: Trend of timber logging extraction in NW, Yunnan, 1974-1999
Reference:(Xu and Wilkes, 2004)

The human activities like logging in mid-1970s resulted in unreversible habitat loss for wildlife and endangered species. Mono-culture forest plantation by the state, agricultural cash crop plantation by farmers, and conversion to pasture land by pastoralists after logging suppress the natural regeneration of forests, further contributing to biodiversity loss. (Xu and Wilks, 2004)

D. Governance Recommendations

Mandatory:

1. Authorise officials to improve database for species information in Yunnan

    - Biodiversity database stores information of patterns in biosphere by measuring the rate of extinction of species and degradation. The digitalisation of database provides opportunities for researchers, BUT (1) resources are distributed in various articles which is *hard to retrieve and update*; (2) *data overlap, regional bias* occurs (Wang, Zhang and Zhang, 2017)
    - *Specimen documentation framework* for big database storage eases research process, including information, photos and unpublished species diversity.
    - Strengthened research on all taxa, given access to biodiversity researchers and officials foster efficiency on collecting data
    - high transparency of data can monitor and update when new research is found.

2. Conservation in situ and ex situ

    - *In situ* protected area systems, the core of which is the natural reserve (NR), are the most direct and effective modes of biodiversity conservation, but established protected areas have encountered increasing human disturbances and pressures, directly influencing their management effectiveness. (Qiu et al., 2018)

    - Develop and optimise management strategies and policies on in situ and ex situ conservation
    - Enforcement mechanism and prohibition to increase protected areas, avoid local ethnic groups from trading endangered species to earn high revenue.
    - Provide training to support various public facilities for conservation such as *botanic gardens, zoo museums and visitor centres of tourism sites in Yunnan.*

3. Improve transboundary management between Yunnan province and adjacent countries

    - The management of import and export concerning wildlife is very difficult since the borderline between Yunnan and Myanmar, Laos and Vietnam runs very long. (Pu et al,2007). Certain people often secretly trade rare wildlife species of national protection together with criminals at home and abroad for staggering profits.
    - In order to enforce *environmental governance*, regular check-ups of government officials are required, monitor the corresponding unit on

managing the biodiversity conservation efficiently with good communication between provinces.
- Natural reserves can be preserved with local ethnic groups discipline and effective management of government officials.

Monetary:

4. Well-utilisation of indigenous expertise with modern technology in the planning and management
   -
   - Invest on *modern technology like natural resource information system (NRIS)* for effective monitoring, decision and management.(Pu et al,2007).
   - With the help of NRIS, palliation of species extinct rate can be emphatically studied. It can help investigate the minimum size for a liveable population viability of various wildlife species. The greater intensity of breeding within a small population can increase the fitness of the population. It is to monitor extinction dynamics and population survivorship in Yunnan.
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5. Investment on training for the workers in conservation for snub-nosed monkey
   - The snub-nosed monkey quickly escape in response to the researchers, which indicates that they are frequently disturbed by human activities and the current habitat quality may far from optimal (Wang et al,2019)
   - Professional workers and conservationists can monitor the populations and ecological behaviour by studying monkeys' behaviours and habitats, trained to oversee their survival status.

Voluntary:

6. Community involvement of biodiversity conservation : reduce over-harvesting of wild plants and animals

   - Education provided by the state for reducing certain agricultural activities, recommend concerted and multifaceted measures from both supplier and consumer side to achieve sustainable use of species. (Chen, Liu and Heinen, 2019)

   - Educate citizens that conserving wild plants and animals also has potential to improve socioeconomic conditions of rural populations.
   - Implement the development concept of ecological priority setting for biodiversity and ecosystem services.
   - Encourage citizens being *ontologically objective*, citizens seeking to understanding the generics or reproduction of species and protect them with concrete biological knowledge.

- Ideas like establishing co-management and agreement regulations; establish green label and organic label registration system for products and setting higher prices for quality guaranteed (Yang et al., 2004)

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