Advancing Methodologies for Integrating Indigenous Knowledge and Culture in Mountain Ecosystem Service Assessments: A Case Study from Taiwan

John F. Harrison [a,*]

[a] National Cheng Kung University, Taiwan, International Master's Program in Interdisciplinary Sustainability Studies, 11202027@gs.ncku.edu.tw

* Corresponding author

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Abstract:

Mountains play an important role in offering environmental, social, and economic benefits to societies. Around the world, there has been a substantial decline in biodiversity, which has led to degraded ecosystems and lowered the capacity of the related ecosystem services (Chen et al, 2020). Ecosystem services (ES) valuation of different ecosystems is a concern because much of the disputes in the methodologies and types of service are valued and are not comprehensive across disciplines (Costanza et al. 2014). Challenges are evident with GIS datasets derived from remotely sensed data, which depend on interpretations of above-canopy land cover while being unable to assess under-canopy land cover or land use. Close-range sensing has yet to become a dependable source for in situ land condition information, unlike conventional field inventory methods (Liang et al. 2024). Further challenges in ecosystem service research remain in integrating cultural values into assessments (Calcagni, 2019). Mountain ecosystem service assessment strategies have focused on the regulation, provision, and support while not focusing enough on the cultural classification of components (Diaz et al. 2019). Improving the representativeness of these assessments requires a new approach that integrates cultural ecosystem services with a focus on Indigenous knowledge (IK) of the mountain environments.

With 16 distinct indigenous groups primarily residing in mountain environments of Taiwan, there is an urgent need to integrate a mountain culture approach. This enables Taiwan to align with integrating nature-based solutions through the opportunity to involve key stakeholders in future ecosystem service assessments. Specifically, land use/cover classification remains a significant limitation on ecosystem service assessments. The research questions of this two-year study include: (1) What is the spatial variability of ecosystem services at the selected study site? (2) What opportunities exist to integrate Indigenous Knowledge (IK), GIS, and science-based inquiry into sustainable mountain development? (3) How can under-canopy mountain ecosystem services be identified, mapped, and validated through improved parameter classification in a GIS-based modeling system?

The study uses field surveys of three Rukai communities to identify the cultural classification components and further enhance the analysis of the results into a more comprehensive ES tool that is more inclusive of indigenous groups. Stakeholder mapping is conducted in this research to engage the Rukai indigenous group within the study area fully. Stakeholder engagement has been initiated early in this research to engage the Rukai indigenous group within the study area during the entire study phase. The research location is Maolin District, South Western Taiwan, with geographically, ecologically and culturally distinctive traits. It is located in the front ranges of the central mountain ranges, which is highly susceptible to geohazards and fits the criteria of a part of Taiwan that requires immediate attention. The study is currently in the Year 1 phase of implementing Mountain Ecosystem Services (MES) assessment strategies, which include GIS-based approaches, mixed-methods research, and ecosystem services modelling trials. This phase focuses on dataset collection, verification, and analysis to support the development of an inclusive and spatially grounded MES framework.

To examine under-canopy ecosystem services, this work tests methods for applying mini-drones for under-canopy mapping and land cover assessments. Integrating mini-drone photogrammetry methods and smartphone-based processing apps offers the potential for rapid, low-cost canopy ground cover assessments. Similarly, extensive indigenous-led field surveys are to be conducted to thoroughly represent the actual land conditions at the study site. The ongoing fieldwork includes identifying indigenous sacred sites, hunting grounds, culturally important spaces, river channel morphology surveys, biodiversity counts, water quality testing, and lithological cover assessments. ArcGIS Survey123 is used to

collect data from Maolin District residents, within three distinct tribal villages (Dona, Wanshan, and Maolin). ArcGIS Survey123 tool enables residents to actively participate in identifying place-based features and sharing local ecological knowledge. In addition, ArcGIS Field Maps is tested to improve ground surveys of land use and land cover, supporting accurate spatial data collection. The platform allows for storing vector and raster spatial data, creating workgroups, giving group members specific permissions, conducting simple spatial analyses online, and creating maps (Nowak et al. 2020). From the three study perspectives, an integrated and updated mountain ecosystem service assessment is under development for discussion and further analysis. With these results, this study identifies the processes that influence land cover changes in the study site and use the results to engage scientists, researchers, government officials, students, and the public to promote the inclusion of Indigenous groups in the broader discussion of sustainable land use and governance.

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