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Research Article

Ecosystem services of Naudhara Community Forest, Lalitpur, Nepal

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Abstract

Ecosystem services are the services provided by the ecological systems that either directly or indirectly benefit human beings. These services, categorized into provisioning, regulating, cultural, and supporting services, are crucial for sustaining economic progress, livelihoods, and human welfare. This research aims to explore the provisioning services and regulating services provided by the forest to the user group of Naudhara Community Forest of Lalitpur, Nepal. For assessing the provisioning services, a questionnaire was administered to 80 households in five locations, and convenience sampling was carried out. Firewood and fodder along with timber were the main provisioning services that the forest user groups were using being influenced by family size with 278.2 Kg/ year/ household firewood utilization with preference for firewood are *Alnus nepalensis, Quercus glauca, Celtis australis* and *Fraxinus floribunda*. Additionally, the availability of other energy sources of LPG has no influence (r = 0.126) on the firewood consumption pattern. While assessing the regulating services in terms of carbon stock, it involved circular plots to measure tree height, diameter at breast height, and calculating above ground biomass using an allometric equation. The total carbon stock of Naudhara Community Forest was calculated to be 854.88 t/ha. Likewise, the standard deviation of carbon stock was found to be 30.16 t/ha, which shows significant variation in carbon stock among different parts of the forests. Understanding the value of ecosystem services, like those provided by Naudhara Community Forest, is crucial for developing countries to conserve their environment and achieve sustainable development. This study highlights the importance of Naudhara Community Forest for the local community and provides valuable information on resource utilization.

Keywords: Community forest, provisioning services, carbon stock, regulating services, Forest User Group

Introduction

Forest provides a wide range of services to human wellbeing (Brockerhoff et al., 2017). Human wellbeing means gaining basic requirements for a satisfied life (MEA, 2005). The concept of ecosystem services, delineated as the advantageous outcomes acquired by humans from natural ecosystems. These services may be categorized as provisional, regulative, cultural or supporting services, also referred to as supporting processes. However, all these services, whether direct or indirect, are essential for human life and the well-being of humans (Costanza et al., 1997, Daily et al., 1997; MEA, 2003; MEA, 2005; Wall & Nielsen, 2012). The wide-ranging assortment of materials and services that ecosystems provide to humanity is commonly known as ecosystem services. Ecosystem Services (ES) play a pivotal role in facilitating human well-being, as well as in fostering the sustainability of economic progress and livelihoods (Acharya et al., 2019).

According to the MEA (2005), ecosystem services are categorized into four main groups: provisioning services include tangible products like food, fiber, and timber directly obtained from ecosystems; regulating services encompass benefits obtained from the regulation of ecosystem processes, such as climate regulation, water regulation, and pest and disease regulation (Smith et al., 2013, Sutherland et al., 2014). Cultural services refer to nonmaterial benefits people derive from ecosystems, including aesthetic values, recreation and ecotourism, and cultural diversity (Rolando et al., 2017). Supporting services are indirect services that are necessary for the production of provisioning, regulating, or cultural services, such as soil formation, nutrient cycling, and photosynthesis (Rolando et al., 2017).

Forest ecosystems have emerged as the primary land carbon sink, housing over half of the carbon stored in terrestrial ecosystems (Hui et al., 2017). Considering the substantial role of forest ecosystems in global carbon cycling, the impacts of climate change on these ecosystems carry significant implications (Hui et al., 2017). The significance of carbon sequestration in forest ecosystems has gained prominence in discussions surrounding the urgent issue of abrupt climate change and ongoing research in forest ecosystem studies (Lorenz & Lal, 2010).

Community forests provide valuable goods and services including carbon sequestration, biodiversity conservation, water quality, fuelwood, timber, and fodder medicinal plants which are important for local and global populations. These forests play a vital role in sequestering and storing carbon, effectively reducing the amount of carbon in the atmosphere and reducing the mitigation of global warming. Moreover, they provide significant hydrological benefits, such as controlling soil erosion and landslides, reducing sedimentation, improving water sources, regulating water flow, and enhancing water quality (Shrestha, 2019).

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In recent years, community forestry and associated approaches to people participation in forest management have become increasingly common (Paudyal et al., 2017). Community forestry programs have potential to improve the livelihood of rural people of Nepal (Thoms, 2008). As the number of forest user groups in Nepal continues to rise annually, the effective management of community forests is vital. Proper oversight ensures that the direct and indirect ecosystem services remain a sustainable resource for local populations (Bijaya et al., 2016) and the services provided by such forests should be assessed in regular manner. Thus, this study aims to assess the provisioning and regulating services provided by the Naudhara Community Forest.

Materials and Methods

Study Area

The Naudhara Community Forest, situated at the junction of Phulchowki (27°33'N, 85°22'E) in Lalitpur, encompasses an area of 174 hectares (Fig. 1). Naudhara, also known as the "nine stone taps," is located within the Godawari Municipality of Lalitpur district. It is located 14 kilometers southeast of the Kathmandu valley, at the base of Phulchowki mountain. The Naudhara Community Forest is a mixed evergreen broad-leaved forest.

Methods of Data Collection

Questionnaire Method

A set of questionnaires was prepared to gather information about the provisioning services provided by Naudhara Community Forest. The survey was conducted using household questionnaires in three locations: Godawari Pati, Godawari Mode Naudhara, and Motichour Godawari, Lalitpur district, Nepal. The households were selected based on convenience, employing a non-probability sampling method. A total of 80 households were included in the questionnaire survey, ensuring representation from various perspectives within the community.

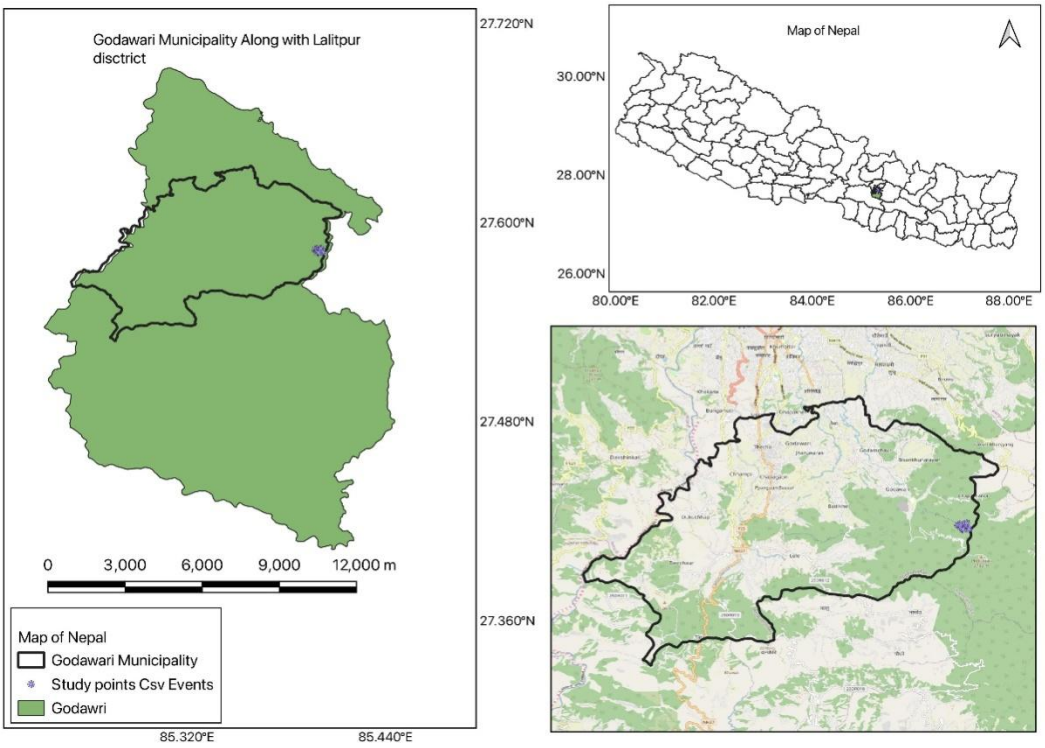

Figure 1 Map of the study area showing location in the Nepal map (upper right), location in the Lalitpur district (left), and boundary of the study area (lower right).

Field Method

Carbon is captured by trees from the atmosphere, which they store as biomass in their roots, stems, and branches (Wang et al., 2024), making carbon stock an essential regulatory ecosystem service (Sharma et al., 2024). To calculate carbon stock, we surveyed in 20 circular plots each with a radius of 8.92 meters. These plots were spaced 50 meters apart. Within each plot, measurements were taken for above ground biomass, tree height, and diameter at breast height (130 cm above the ground) with the help of DBH tape. The tree height was determined by a clinometer (of model SS011104010, PM-5/66 PC OPTI), the above ground biomass (AGTB) and below ground biomass (BGTB) were calculated, which aided in the estimation of carbon stock. Each tree was meticulously recorded with its common name and the scientific name. To calculate AGTB an allometric equation developed by Chave et al. (2005) approved by IPCC and the Nepal Government to implement REDD has been used. As the average annual precipitation of Lalitpur was1858mm, formula for moist region was used (DHM, 2019). Below ground

biomass was calculated as 20% of AGTB following MacDicken (1997).

$AGTB = 0.0509 \times \varrho(DBH)^2H$
BGTB = 20% of AGTB, and
TB = AGTB +BGTB
Where, AGTB = Above ground tree biomass, BGTB = Below ground tree biomass, and TB = Total Biomass

Biomass was converted into carbon stock by multiplying with the standard factor of 0.47 (IPCC, 2006), i.e., TC = TB × 0.47; where, TC = total carbon stock. Mean and standard deviation were used to explore the data. All the analysis was performed by using JASP Team (2025), JASP (Version 0.95.4).

Results and Discussion

General Characteristics of Respondents

Among all the respondents, male and illiterate population was highest in the study area. The major occupation was found to be agriculture followed by business. Other occupation includes housewife, foreign employment, students, and wage labor. The average household size in the study area has 4.7 people (Table 1).

Table 1 General characteristic of the respondents related to the Naudhara Community Forest

Characteristics	Details of the fractions of respondents			
Gender	Male (72.5 %)		Female (27.5 %)	
Age of the respondents	Mean = 44.41 (min = 13, max = 78); SD = 14.98			
Education level	Can't read & write 56.25%	Fundamental 7.50%	Secondary 31.25%	Bachelor 5.00%
Occupation	Agriculture 48 (60 %)	Business 11 (13.8 %)	Service 12 (15 %)	Other 9 (11.3 %)
Family Size	Mean = 4.7 (Min = 1, Max = 9); SD = 1.6			
Land ownership	Own (76.3 %)	Rental (8.8 %)	Squatters (13.8 %)	No land (1.3 %)

Provisioning Services of Naudhara Community Forest

Different types of provisioning services can be found in Naudhara Community Forest. The varieties of provisioning ecosystem services provided by Naudhara Community Forest classified with appropriate examples are listed in tables 2 and 3. The main provisioning services utilized by community forest user group of Naudhara Community Forest were firewood, fodder, and timber (Tables 2 and 3).

Table 2 List of Provisioning Services used by households of Naudhara Community Forest

Provisioning service	Household using the service (%)
Firewood	100.00
Fodder	46.25
Timber	31.75

Major species of trees that are preferred for firewood are *Alnus nepalensis, Quercus glauca, Celtis australis*, and *Fraxinus floribunda* (Fig. 2).

Table 3 List of provisioning services provided by Naudhara Community Forest

Service	Name of the species
Firewood	*Alnus nepalensis* (Utis), *Quercus glauca* (Phalat), *Celtis australis* (Khari) *and Fraxinus floribunda* (Lakuri)
Food and Fodder	*Juglans regia* (Okhar), *Myrica esculenta* (Kafal), *Castanopsis indica* (Katus), *Bambusa nepalensis* (Nigalo Bans), *Rubus ellipticus* (Ainselu), *Tiarella polyphylla* (Sisne Jhar), *Diospyros malabarica* (Teju), *Terminalia elliptica* (Asna)
Medicines	*Rhododendron arboreum* (Guras), *Eurya acuminata* (Jingane), *Fraxinus floribunda* (Lankuri), *Lyonia ovalifolia* (Angeri), *Tiarella polyphylla* (Sisne Jhar)
Raw materials	Timber: *Fraxinus floribunda* (Lankuri), *Pinus roxburghii* (Salla), *Engelhardia spicata* (Mauwa), *Schima wallichii* (Chilaune), *Lagerstroemia parviflora* (Botdhairo) etc.
	Bambusa nepalensis (Bamboo)
	Construction materials: Sand, mud gravel and stone
Energy sources	*Lyonia ovalifolia* (Angeri), *Pinus wallichiana* (Gobresalla), *Quercus glauca, Quercus lamelossa, Quercus semicarpifolia, Rhododendron arboreum, Rhododendron barbatum, Schima wallichii* and *Castanopsis tribuloides* (Musure Katus)
Ornamental resources	*Rhododendron arboreum*
Water	Drinking water, water for irrigation, water for livestock

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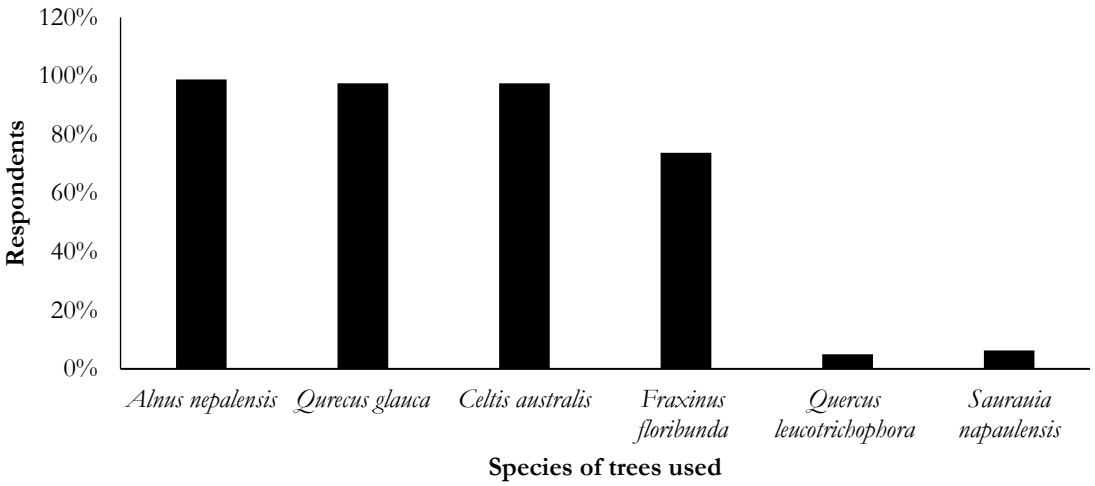

Figure 2 Different species of trees used for firewood

On average each household fetches 278.2 Kg of firewood from the forest with high level of variability (min 35, max 1855 and standard deviation of 293.6 Kg). The amount of firewood used at household level differed significantly [Wilcoxon single ranked test (V) = 3081, $p<0.01$]. The pattern of firewood consumption also differs with family size (Fig. 3) and it has been utilized by every household (Table 2). Additionally, low degree of correlation ($r = 0.126$) exists between the expenditure made on Liquid Petroleum Gas (LPG) and amount of firewood collected from the forest. This indicates that access to firewood does not influence firewood consumption.

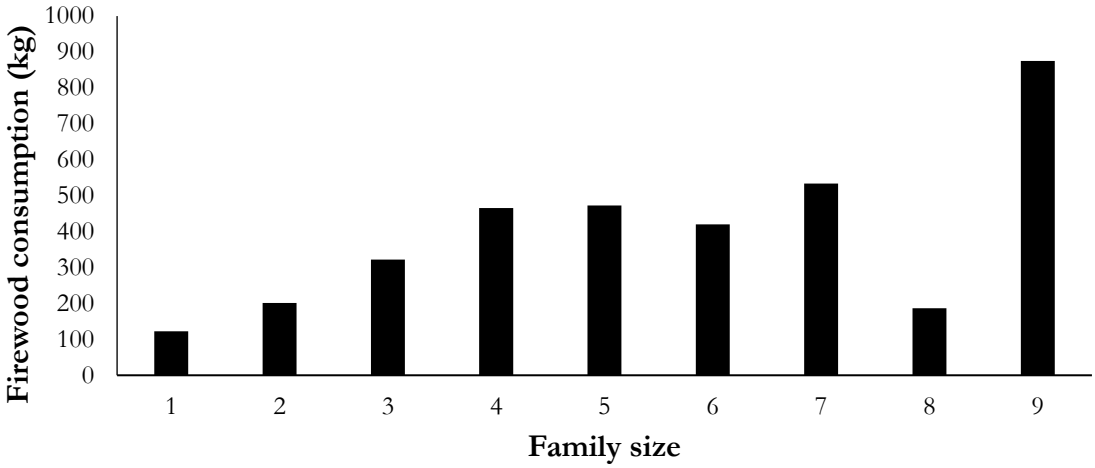

Figure 3 Relation between family size and average firewood consumption among the members of Naudhara Community Forest User Group

Similarly, fodder utilization (by 46.25% household in this study) from community forest is common practices as for household purposes which is similar to the study by Lamsal et al. (2015) where 90% of respondents were using fodder from the community forest in Ghodaghodi Lake complex.

Access to Water

All the respondents acknowledged the access to safe drinking water. Among them 97.5% of the respondents acknowledged that their water sources are within 15 minutes walking distance while two respondents said that they have to travel nearly 30 minutes to fetch water. Among all, 57.5% of respondents indicated that tap water source from the community forest as the major source of water sufficiency throughout the year while for other households' water sufficiency is partially enough (Fig. 4).

Among the ecosystem services delivered, directly beneficial rather than indirect services were found to be higher for the local people. Therefore, the ecosystem services prioritized by them were highly tended to provisioning services. These services are regarded as the set of end products achieved directly from ecosystem and are visible to society (Wallace, 2007). The majority of the households surveyed reported that they use the forest for food, medicine, raw material, energy

resources, ornamental resources, and water. Firewood and fodder along with litter were the main provisioning services that the people of Naudhara Community Forest User Groups were utilizing. People were provided with a few resources for a year, e.g., just firewood and fodder as major resources. The user group committee would take care that it would be distributing the resources in equal amounts to all. Still due to family having more members or user groups were using more resources from the community forest. This has been fluctuating the consumption pattern of firewood and fodder.

Tree Carbon Stored in Naudhara Community Forest

Altogether 14 different species of trees were recorded in Naudhara Community Forest having a total calculated carbon stock as 854.88 t/ha (Fig. 5).

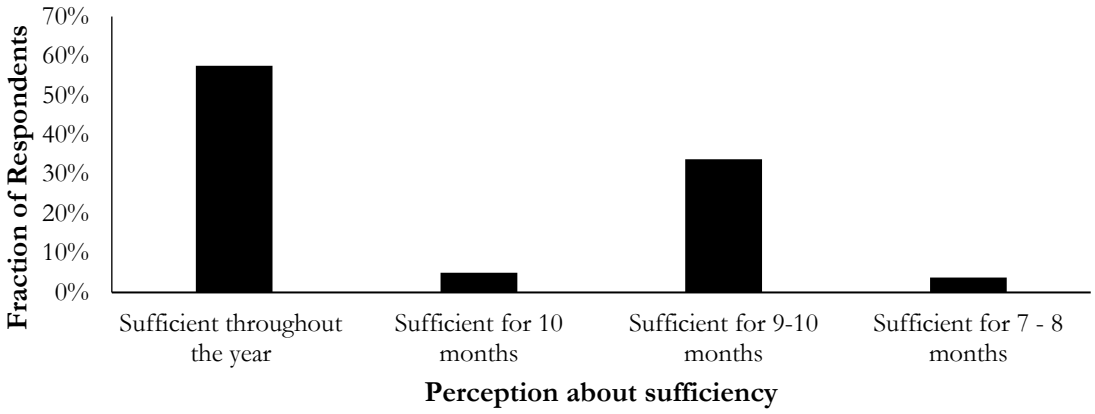

Figure 4 Sufficiency of water to the respondents

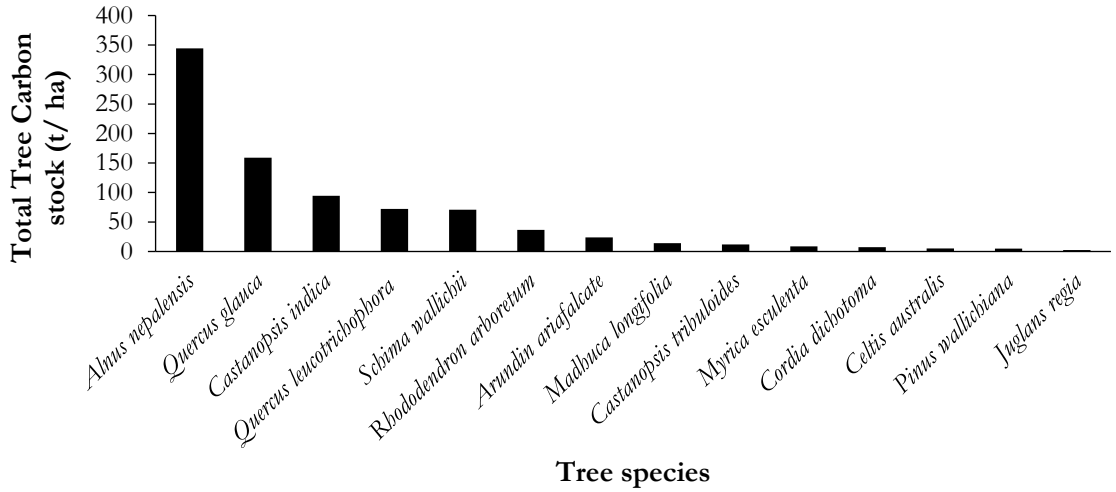

Figure 5 Species wise total tree carbon stock

Among the 14 different species of trees that were found in the community forest, *Alnus nepalensis* was found to have highest tree carbon with 344.29 t/ha storage followed by *Quercus glauca* (158.88 t/ha), whereas *Juglans regia* was found to have lowest tree carbon storage of just 2.47 t/ha (Fig. 5).

Naudhara Community Forest has mean carbon stock of 45.46 t/ha (Range: 10.34 t/ha to 110.95 t/ha), and standard deviation was found to be 30.162 t/ha. Plot level carbon varied from 10.34 t/ha to 110.95 t/ha in Naudhara Community Forest. The calculated value of standard deviation shows the wide range of values across the forest. This higher standard deviation indicates a significant variation in carbon stock among different parts of the forest. This reveals insights into the diversity of carbon stock distribution in Naudhara Community Forest.

Forest carbon stock can be affected by different factors including tree species and their age, density of forest vegetation, the level of disturbance, and the succession stage of the forest (Aryal et al., 2018). Additionally, biomass in the forest shows potential for changes with the forest management as it is directly related to species selection and scheduled activities, such as the planting, harvesting, and collecting of other forest products (Lal, 2005).

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Forest plays a significant role in carbon sequestration and storage through their ability to sequester atmospheric carbon and store it in their biomass (Wang et al., 2024). It is estimated that the total carbon stock in the studied community forest was 45.46 t/ha. The amount of carbon stock obtained in this study is less than the estimation of carbon stock study done by Aryal et al. (2018) in the Jamunadanda Community Forest of Kathmandu. The variation found in the carbon stock among these studies might be due to differences in the physiographic regions and vegetation assemblages. Moreover, the community forests in Nepal are reported to have been successful in increasing greenery and crown cover (Gautam et al., 2002) and many communities are in good conditions having greater potential for carbon storage than the adjoining national forests (Mbaabu et al., 2014).

Previous studies like Brown (1997) and Keith et al. (2014) have suggested that variations in disturbance also affect biomass and carbon content. Similar to them, in this study area, trees near the settlement areas faced more frequent locals for forest products creating varying levels of disturbances within the community forest area. Thus, variation of carbon stock among the trees within the community forest due to varying levels of human disturbances and management practices can be considered as one of the factors influencing ecosystem services in community forests.

In the case of species wise carbon storage, highest carbon storage was found in *Alnus nepalensis*, then *Quercus glauca,* and so was the case in total tree biomass. This might be due to the old trees having higher DBH and height increasing their productivity. The mean carbon stock of Naudhara Community Forest was estimated to be 45.46 t/ha considering the carbon content in trees. This indicates that the forest has a significant capacity for carbon storage, as trees absorb carbon dioxide and store it in their biomass. The estimation emphasizes the forest's role as a carbon sink and highlights the importance of conserving and managing it for climate change mitigation. Although the current investigation shows good carbon storage capacity, it is relatively low while comparing it with a similar study conducted by Lama and Mandal (2013) in Srijana Leasehold Forest of Lalitpur that possesses the highest estimated total carbon stock amounting to 125.493 t/ha. Such difference in carbon stock between the Naudhara Community Forest with other forests can be attributed to various factors. One potential factor being higher density of carbon-rich tree species or the larger presence of older and larger trees. Furthermore, variations in forest management practices, such as selective logging or conservation efforts, may contribute to the observed disparity. Another crucial aspect to consider is the size and geographic location of the forests. Larger forests or forests situated in an area with favorable environmental conditions could have a greater capacity for carbon sequestration. These factors significantly influence the forest's capacity to store carbon. Thus, forests like Naudhara Community Forest help to mitigate climate change through carbon sequestration and offer income generation and nature conservation opportunities. Additionally, by responsibly utilizing resources, such as sustainable timber production, and non-timber forest products, local communities can generate income while preserving the forest ecosystem. This approach promotes a harmonious balance between human livelihoods and biodiversity conservation, benefiting both the community and the environment (Paneru, 2024)

Conclusions

This study emphasizes the provisioning services received from the Naudhara Community Forest and the regulating services as carbon stored in this community forest. Naudhara Community Forest was found to provide a wide array of ecosystem services that includes six provisioning services and two regulating services. The provisioning services offered by the forest encompass the availability of food, medicines, raw materials, energy sources, ornamental resources, and water. Consequently, the forest exhibits substantial economic potential for the community. Likewise, the varieties of tree species and their calculated value of carbon stock have shown that community forests act as good sink of atmospheric carbon. This study would benefit the forest managers and planners to conceptualize the economic and environmental importance of the community forest while making and formulating plans and strategy regarding sustainable forest management. Still other resources and services are yet to be studied, so further studies on the basis of more indicators for other ecosystem services can be performed and used to assess the full potential of ecosystem services provided by Naudhara Community Forest.

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Author contributions: Poonam Dhakal: Data collection, data analysis, manuscript writing; Prakash Chandra Wagle: Conceptualization, editing, supervision.

Conflict of interests: The authors declare no conflict of interest.

Data availability statement: The data can be provided by the corresponding author upon reasonable request.

References

Acharya, R.P., Maraseni, T., & Cockfield, G. (2019). Global trend of forest ecosystem services valuation–An analysis of publications. *Ecosystem Services*, *39*, 100979.

Aryal, S., Shrestha, S., Maraseni, T., Wagle, P.C., & Gaire, N.P. (2018). Carbon stock and its relationships with tree diversity and density in community forests in Nepal. *International Forestry Review*, 20(3), 263-273.

Bijaya, G.C., Cheng, S., Xu, Z., Bhandari, J., Wang, L., & Liu, X. (2016). Community forestry and livelihood in Nepal: A review. JAPS: Journal of Animal & Plant Sciences, 26(1).

Brockerhoff, E.G., Barbaro, L., Castagneyrol, B., Forrester, D.I., Gardiner, B., González-Olabarria, J.R., ... & Jactel, H. (2017). Forest biodiversity, ecosystem functioning and the provision of ecosystem services. *Biodiversity and Conservation*, *26*, 3005-3035.

Brown, S. (1997). Estimating biomass and biomass change of tropical forests: a primer (Vol. 134). Food & Agriculture Org.

Chave, J., Andalo, C., Brown, S., Cairns, M.A., Chambers, J.Q., Eamus, D., ... & Yamakura, T. (2005). Tree allometry and improved estimation of carbon stocks and balance in tropical forests. *Oecologia*, *145*, 87-99.

Costanza, R., d'Arge, R., De Groot, R., Farber, S., Grasso, M., Hannon, B., ... & Van Den Belt, M. (1997). The value of the world's ecosystem services and natural capital. *Nature*, 387(6630), 253-260.

Daily, G.C., Alexander, S., Ehrlich P.R., Goulder L., Lubchenco, J., Matson, P.A., Mooney, H.A., Postel, S., Schneider, S.H., & Tilman, D. (1997). Ecosystem services in decision making: time to deliver. *Issues in Ecology*, 1, 1-18.

DHM. (2019). Climatic records of Nepal. Department of hydrology and Meteorology, Government of Nepal.

Gautam, A.P., Webb, E.L., & Eiumnoh, A. (2002). GIS assessment of land use/land cover changes associated with community forestry implementation in the Middle Hills of Nepal. *Mountain Research and Development*, 22(1), 63-69.

Hui, D., Deng, Q., Tian, H., & Luo, Y. (2017). Climate change and carbon sequestration in forest ecosystems. *Handbook of Climate Change Mitigation and Adaptation*, 555, 594.

IPCC. (2006). *Good practice guidelines for national greenhouse gas inventories*. Switzerland: Intergovernmental Panel on Climate Change.

JASP Team. (2025). JASP (Version 0.95.4) [Computer software]. https://jasp-stats.org/

Keith, H., Lindenmayer, D.B., Mackey, B.G., Blair, D., Carter, L., McBurney, L., ... & Konishi-Nagano, T. (2014). Accounting for biomass carbon stock change due to wildfire in temperate forest landscapes in Australia. *PLoS One*, 9(9), e107126.

Lal, R. (2005). Forest soils and carbon sequestration. *Forest Ecology and Management*, 220(1-3), 242-258.

Lama, T.D., & Mandal, R.A. (2013). Study on carbon stock of leasehold forests of Katakuti VDC, Dolakha District. *The Initiation*, 5, 63–67. https://doi.org/10.3126/init.v5i0.10255

Lamsal, P., Pant, K.P., Kumar, L., & Atreya, K. (2015). Sustainable livelihoods through conservation of wetland resources: a case of economic benefits from Ghodaghodi Lake, western Nepal. *Ecology and Society*, 20(4), 506-537.

Lorenz, K., & Lal, R. (2010). Carbon dynamics and pools in major forest biomes of the world. *Carbon Sequestration in Forest Ecosystems*, 159-205.

MacDicken, K. G. (1997). A guide to monitoring carbon storage in forestry and agroforestry projects.

Mbaabu, P.R., Hussin, Y.A., Weir, M., & Gilani, H. (2014). Quantification of carbon stock to understand two different forest management regimes in Kayar Khola watershed, Chitwan, Nepal. *Journal of the Indian Society of Remote Sensing*, 42, 745-754.

MEA. (2003). *Ecosystems and human well-being: a framework for assessment*. World Resources Institute, Washington.

MEA. (2005). *Ecosystems and human well-being: wetlands and water*. World Resources Institute, Washington.

Paneru, T. (2024). Contribution of non-timber forest products to the livelihood of local people: A case study of Dadeldhura District, Nepal. *Sudurpaschim Spectrum*, *2*(2), 187-200.

Paudyal, K., Baral, H., Lowell, K., & Keenan, R.J. (2017). Ecosystem services from community-based forestry in Nepal: Realising local and global benefits. *Land Use Policy*, 63, 342-355.

Rolando, J.L., Turin, C., Ramírez, D.A., Mares, V., Monerris, J., & Quiroz, R. (2017). Key ecosystem services and ecological intensification of agriculture in the tropical high-Andean Puna as affected by land-use and climate changes. *Agriculture, Ecosystems & Environment*, 236, 221-233.

Sharma, S., Hussain, S., Kumar, P., & Singh, A.N. (2024). Urban trees' potential for regulatory services in the urban environment: an exploration of carbon sequestration. *Environmental Monitoring and Assessment*, 196(6), 504.

Shrestha, P.K. (2019). Assessment of payment for ecosystem services in Shivapuri Nagarjun National Park, Kathmandu. Bachelor Thesis, Institute of Forestry, Tribhuvan University.

Smith, P., Ashmore, M.R., Black, H.I., Burgess, P.J., Evans, C.D., Quine, T.A., Thomson, A.M., Hicks, K. & Orr, H.G. (2013). The role of ecosystems and their management in regulating climate, and soil, water and air quality. *Journal of Applied Ecology*, 50(4), 812-829.

Sutherland, W.J., Gardner, T., Bogich, T.L., Bradbury, R.B., Clothier, B., Jonsson, M., & Dicks, L.V. (2014). Solution scanning as a key policy tool: identifying management interventions to help maintain and enhance regulating ecosystem services. *Ecology and Society*, 19(2), 3.

Thoms, C.A. (2008). Community control of resources and the challenge of improving local livelihoods: A critical examination of community forestry in Nepal. *Geoforum*, 39(3), 1452-1465. https://doi.org/10.1016/j.geoforum.2008.01.006

Wall, D.H., & Nielsen, U.N. (2012). Biodiversity and ecosystem services: is it the same below ground. *Nature Education Knowledge*, 3(12), 8.

Nep J Environ Sci (2026), 14(1), 31-38
https://doi.org/10.3126/njes.v14i1.70851

Wallace, K.J. (2007). Classification of ecosystem services: problems and solutions. *Biological Conservation*, 139(3-4), 235-246.

Wang, Y., Dai, X., Chen, X., Zhang, D., Lin, G., Zhou, Y., Wang, T., & Cui, Y. (2024). Effects of urbanisation and forest type on species composition and diversity, forest characteristics, biomass carbon sink, and their associations in Changchun, Northeast China: Implications for urban carbon stock improvement. *Journal of Forestry Research*, 35(1), 36.