ASSESSMENT OF FUEL WOOD CONSUMPTION AND ITS EFFECT ON FOREST DEPLETION IN DRY DECIDUOUS FOREST OF HALIYAL TALUK, UTTAR KANNADA DISTRICT

Abstract:

Forest plays a significant role in extending wood and non-wood resources around the world (briefly state the significant role), however the increasing demand and pressure on forest resources majorly like fuel wood lead to degradation of forests. Hence it is important to assess the fuel wood consumption and its impact on the forest is essential for sustainable management of resources (this statement needs reworking for better comprehension. In the present study,Haliyal taluk is selected, surrounded by dry deciduous forest and the people living in that area depend on forest for fuel wood consumption (why is Haliyal taluk selected?).The study examined fuel wood collection among different farmer categories: large, medium, small, and landless. Results from the survey(what type of survey?) revealed that medium farmers collected the most fuel wood. The total fuel wood consumption in Haliyal taluk was 5232.2 tonnes, with an average household consumption of 2.60 quintals per year (what is quintals?). Major preferred tree species for fuel wood were *Xyliaxylocarpa*, *Terminalia tomentosa* and *Lagerstroemia lanceolata*, which are valued for their high energy content, favourable burning characteristics and availability. For estimation of forest degradation Randomized Block Design was used and the study classified the forest vegetation into four crown density classes: Very Dense Forest (T_1), Moderately Dense Forest (T_2), Open Forest (T_3), and Scrub (T_4). Data was collected from 20 plots (20 x 20 m each) across these classes to measure forest depletion, including parameters such as stump diameter, cut stumps, cut branches and fallen/dead wood. The results showed significant differences in degradation levels, with the highest depletion (31.56 m^3/ha) in very dense forests followed by moderate depletion (6.75 m^3/ha) in moderately dense forests and the lowest (2.4 m^3/ha) in scrub forests (what was the benchmark, reference to previous studies, used to show how significant these results were?). This pattern reflects greater anthropogenic pressures and higher fuel wood availability in more dense forest types.Protecting these forests is crucial for biodiversity conservation and carbon sequestration.

Key words: Forest depletion, forest types, fuel wood, farmers, landholding

1:INTRODUCTION

Forests are one of the most important components of the terrestrial ecosystems. They are the storehouse of biological diversity. Crown canopy is a significant regulator of forest, affecting microclimate, soil conditions and having an undeniable role in a forest ecosystem. Dry deciduous forest is a biome dominated by deciduous trees which shed their leaves seasonally during dry winter and spring month (cite this definition, if it is not yours). These are most wide spread forests of India (author?). Found in Madhya Pradesh, Maharashtra,

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AndraPradesh, Karnataka, Tamil Nadu, Gujarat and Rajasthan. These forests are categorized by extremely variable climates, low rainfall, 5-6 dry months within the annual cycle and nutrient poor soil (state source). Dry Deciduous Forests receives the rainfall between 70 to 100 cm commercially important tree species like Teak, Sal, Sandal, Bamboo, Terminalia, Acacia species are found are found (Yadav, 2006).

Forest canopy density refers to the proportion of an area in the field/ground that is covered by the crown of trees and is expressed in percentage of the total area (is this your definition/idea?If not, then reference it). For the better management of forest, changes of canopy density should be considered. Forest canopy density is one of the useful parameters to consider in the planning and implementation of rehabilitation program (reference/s, provide references/cite author/s). It is possible that there isn't any change in the area of forest during the time but the density of forest canopy is changed (provide brief explanation of the phenomenon). Crown density is used to estimate the percentage of crown volume that contains biomass (why, state reason/s and cite the source). Trees with below average crown densities are expected to have reduced growth compared to trees with full, symmetrical crowns (provide reason/s with source/s).

Western Ghats, an orographic feature extending from Kanyakumari in the South to Tapti in the North, cover six states in the Western India. The Western ghats of Uttara Kannada district is known for their dense forests which cover about 80% of the area of the district. The total forest of Uttara Kannada is about 8, 29,151 ha. And the per capita forest is about 0.77 ha**.** The forests of Uttara Kannada can be classified into 3 categories based on density as partially open forest (20-40% density), Medium density forest (40-80% density) and closed forest(above 80% density~~).~~). Concepts, classifications and figures should be backed by credible citations, if they are not widely available knowledge that have been tested and proven over the years. Based on this classification Uttara Kannada district has about 1388.89 km^2 of partially open forest, 1646.16 km^2 of medium density forest and 714.55 km^2 of closed forest(Banavasi and Koppad, 2018). Depending on phenological conditions and other ecological factors, the forests of Uttara Kannada are broadly divided into two types namely Moist and Dry types. The moist type may be sub-divided into evergreen, semi evergreen and moist deciduous. The dry type can be divided into dry deciduous and thorny forest.Provide in-text citation/s

Depletion of forest on the extensive scale was carried out in the colonial period (source? State the years within the colonial period). The beginning and expansion of railways during this period led to the destruction of huge chunks of forests (When was the beginning of the expansion of the railways in that area? How huge was that chunk of forest?. In independent India, clearing of forest land for the purpose of cultivation has also led to the depletion of forest cover in country (give brief reason/s). Timber has become an important commercial resource (Why?). It is used for building and making of furniture (what about its other uses and applications?). The felling of trees for the purpose of obtaining timber is important causes of reduced forest cover in India. Many forests have been cleared for building large scale dams in country. Rapid industrialization, urbanization and expansion of cite has also led to the destruction of forest cover in country. Animal grazing, collection of fire wood in rural areas are some of reason of forest depletion. According to the National Forest Inventory, about 60% of the total fuel wood demand in India is met from forests (Which National Forest Inventory? What was the year?). In 2010-2011, India's annual fuelwood consumption was estimated to be 216.421 million tonnes of this, 27.14% came from the forest sector (where can this data and information be found?). Many people regard the practise of shifting cultivation also a reason of destruction of forest cover (Why? Many people can be

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3, 10, 100, 1000,000,…, provide unambiguous data and information to avoid guess work). Keeping these points in view, the present study on Assessment of forest depletion and its causes in dry deciduous forest was carried out with following objectives: **a) Assessment of fuel wood consumption patternand; b) Assessment of forest degradation**

I. Your introduction, in which the literatures reviewed for this study can be found, has not provided enough academic arguments in this field of study.

II. There were only two in-text citations in this section, extremely low, considering this era of widely available information.

III. The review is too descriptive and lacks philosophical arguments that are important both theoretical and empirical studies.

IV. Gap/s has/have not been identified in the review to prompt the reasons for undertaking this study

V. The problem that gave rise to this study has not been adequately stated

2: MATERIALS AND METHODS

2.1:Study area

The investigation on assessment of forest depletion and its causes in dry deciduous forest was carried in the dry deciduous forest of Haliyal taluk in Uttar Kannada district, Karnataka(Fig 1 (Figure 1)). The experimental site is situated at 15° 16' N latitude and 76° 37' E longitude, with an average elevation of 473 m above mean sea level (How did you get these bearings or from which source?). The area experiences south west monsoon (Reason, Source?).The average mean annual rainfall is 2500 mm (Source?). The climate of Haliyal region is moderate except during the rainy season. The mean maximum temperature varied from 25 °C to 33 °C. The soils of Haliyal area aremixed lateritic soils. The forest types like evergreen to semi evergreen and moist deciduous to dry deciduous forest type are present.(every statement taken from elsewhere should be referenced)

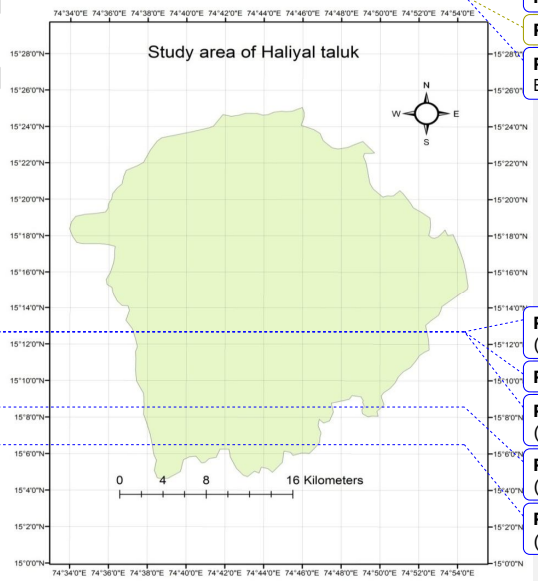

Fig 1. Study area map (Source?)

2.2: Methodology

a. Assessment of fuel wood consumption pattern

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In order to assess the fuel wood consumption pattern in Haliyal taluk a semi structured questioner survey was prepared. Questioner survey was carried to total 40 farmers which were classified based on the land holding into large (>8 acre) medium (4-8 acre) small (<4 acre) and landless farmers.The information like name of the farmer, landholding, and quantity of fuel wood collected from forest, major tree species preferred by farmer/local for fuel wood etc. were collected.

b. Assessment of Forest Degradation

The forest vegetation was classified based on the crown density classes. Very dense forest, moderately dense forest, Open forest and Scrub. The total treatments are 4 based on crown density classes and 5 replication (Table 1). In each forest type 5 plots of 20x20m each were laid (Fig. 2 Figure 2). Total 20 plots were laid in total forest area and following parameters were recorded. For statistical analysis was followed the Randomized Block Design (RBD) to reduce systematic error(this statement needs reworking.Provide the name of the statistical tool/s used and reason/s for doing so)

Table 1. Classification of forest types based on canopy classes

Treatments	Forest types	Canopy density (%)
T_1	Very Dense Forest	Canopy density of 70% and above
T_2	Moderately Dense Forest	Canopy density between 40% to 70%
T_3	Open Forest	Canopy density between 10% and 40%
T_4	Scrub	Having canopy density less than 10%

(Source:?)

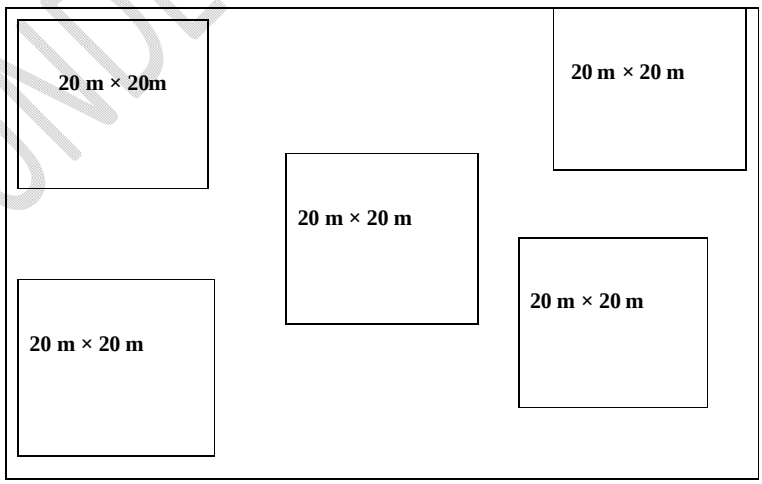

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Fig 2Figure 2:-Layout of plot in forest area (Source?)

Observations recorded:

Fallen, dead and cut trees are estimated and following measurement were recorded

Table 2. Parameter recorded for estimation forest degradation and instruments used

Si no	Observation recorded	Instrument used
1	Stump diameter (cm)	Measured by using measuring tape
2	Length of cut stumps (m)	
3	Length of cut branches (cm)	
4	Length of fallen /dead wood (m)	

Some photos should have been provided for better grasp of the methods used and how recordings were obtained. How can credibility of this study be ascertained without basic research tools like, photos and tools/equipment?

Volume of stumps: Volume was calculated by using formula

Volume (m^3) = B.A (m^2) × H (m) × F.F

Where,

F.F = Artificial Form Factor (give brief explanation of FF)

B.A = Basal Area ($g^2/4\pi$) (What is Basal Area?)

H = Height (m). (height of what?be specific)

3: RESULTS AND DISCUSSION

3.1: Fuel wood consumption pattern

The quantity of fuel wood collected by the different category of farmers from the different forest area is represented in the(Table 3). Among the four categories of farmers, highest fuel wood was collected by medium farmers followed by small farmers, landless farmers and large farmers which is expressed in the quintal (this statement needs to be reworked, not clear enough). This variation in fuel wood collection across farmer categories reflects underlying socio-economic and land use dynamics (Why?). The medium farmers collected the most fuel wood can be attributed to their relatively larger landholdings. This category of farmers typically has more access to forest areas compared to small and landless farmers. Larger landholdings provide these farmers with greater opportunities to gather fuel wood from their own land or nearby forested areas (Sunderlin*et al.*, 2005 – is this in support of your results or runs contrary to it?). Medium farmers often have better resources and infrastructure to manage and exploit their land effectively, which can enhance their capacity to collect and utilize fuel wood (Source?). Small farmers, while having less land compared to medium farmers, still collect a

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substantial amount of fuel wood (what is substantial? State volume of wood collected). Their ability to collect fuel wood is influenced by the proximity of their land to forest areas and their need to supplement their energy requirements (Chambers *et al*., 1989, provide recent studies as well, and state whether they are in agreement or disagreement with the results of this study). The lower amount of fuel wood collected by landless farmers could be due to additional challenges such as limited means to transport or gather fuel wood effectively. Large farmers, despite their significant landholdings, collected the least amount of fuel wood. This might be due to better access to alternative energy sources, reducing their dependence on fuel wood. Additionally, the efficiency of large-scale agricultural practices might make large farmers less reliant on traditional fuel wood collection.

The amount of fuel wood consumption pattern in Haliyal taluk was assessed through the questioner survey (Table 4), the average fuel wood consumption per household was found to be 2.60 qt/yr. The total fuel wood consumption in Haliyal taluk was found to be 5232.2 tonnes and the total volume of dead wood was found to be 6, 64,261.89 m^3/ha. (Provide some explanations for this consumption)

The major tree species preferred by different category of farmers for fuel wood consumption is represented in (Table 5). All the category of farmers preferred *Xyliaxylocarpa* (Jambe), followed by *Terminalia tomentosa* (Kari matti) and *Lagerstromialanceolata* (Nandi). The widespread preference for *Xyliaxylocarpa* suggests that this species is highly valued for its fuel wood properties (What are these fuel properties?). Jambe is known for its high energy content, which makes it an efficient and effective choice for fuel. Its wood burns slowly and produces a lot of heat, making it a reliable source of energy (Banavasi and Koppad, 2018). Additionally, Jambe wood is dense and durable, which may contribute to its preference as it lasts longer and provides sustained warmth. *Terminalia tomentosa* is also a popular choice, likely due to its favourable burning characteristics. Kari matti is known for its good combustion properties, producing steady heat with minimal smoke. Its availability and ease of collection might also make it a convenient option for farmers. This species is commonly found in many forested areas, which makes it accessible and a practical choice for fuel wood (Source? Is it one of the results of this study? If not, provide source for this statement.

3.2: Forest degradation

The data represented in the (Table 6)shows the quantification of forest degradation in different crown density classes (m^3/ha). The significant difference was observed among the T_1 and other treatments *i.e*,T_1 is significant over T_2, T_3 and T_4 whereas T_2, T_3 and T_4 are on for each other (How was these significant figures obtained? State statistical method used, with tables where necessary).The results indicates that degradation and deforestation of forest is higher in very dense forest with 31.56 m^3/ha fallowed by degradation of forest with 6.75 m^3/ha in moderately dense forest and least degradation was found in scrub forest 2.4 m^3/ha. This may be due to the availability of more fuel wood the in adjacent forest area and the more anthropogenic activities (Koppad and Tikhile, 2012). Several studies have highlighted that dense forests are particularly vulnerable to degradation due to their higher ecological and economic value, which often makes them prime targets for deforestation and exploitation (Geist and Lambin, 2002: provide recent studies as well). Dense forests typically possess a complex structure and high biodiversity, making them more susceptible to disturbances that lead to significant degradation (Is this part of your result? If not, then provide reference/s). The high level of

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degradation observed in very dense forests could be attributed to factors such as illegal logging, land conversion for agriculture, and infrastructure development, which are often more prevalent in these areas (Nepstad *et al.*, 2006: Provide recent studies included ones before 2006 to help in showing how long degradation has been going on).Moderately dense forests, while still experiencing some level of degradation, are less affected compared to very dense forests. This could be due to their relatively lower economic value and possibly better management practices compared to more intact, dense forests. The intermediate level of degradation (6.75 m^3/ha) in these forests may reflect a balance between ecological pressure and conservation efforts. It is also important to consider that moderately dense forests might still support a significant amount of biodiversity and ecosystem services, though less than very dense forests.In contrast, scrub forests, characterized by the lowest level of degradation (2.4 m^3/ha), exhibit the least amount of forest degradation. Scrub forests generally have a lower canopy cover and reduced biodiversity compared to more dense forest types, which may result in less pressure from human activities and lower rates of deforestation (Rimal*et al.*, 2019).

The preference for these species reflects their practical benefits in terms of energy efficiency, availability, and ease of use. The choice of tree species for fuel wood is influenced by their burning quality, the convenience of collection, and their abundance in local forest areas. Farmers tend to select species that offer the best balance between energy output and resource availability.

Sources for tables 3, 4, 5 and 6 were not provided, and they should have been embedded within this section or previous ones, except if it is the requirement of the journal to place them after the reference list.

4: CONCLUSION:

Forest depletion is more in very dense forest due to human intervention and anthropogenic activities. Major tree species used for fuel wood consumption were *Xyliaxylocarpa,Lagerstroemia lanceolate, Terminalia tomentosa*.Overall, the data reinforces the need for targeted conservation strategies that address the specific needs of different forest types (this reads more like a recommendation). Protecting very dense forests from further degradation should be a priority due to their critical role in biodiversity conservation and carbon sequestration (Recommendation?). In contrast, efforts in moderately dense and scrub forests might focus on maintaining their current state and preventing further degradation through sustainable management practices (Recommendation?).This section needs reworking to reflect a better written conclusion

? FUTURE SCOPE

Establish long-term monitoring programs to track changes in fuel wood consumption patterns and forest health over extended periods. Evaluate. The adoption and impact of alternative energy sources (e.g., LPG(what is LPG?), biogas, solar cookers) on fuel wood consumption and forest health that will help to determine the effectiveness of these alternatives in reducing dependency on fuel wood. The effectiveness of existing policies related to forest management and fuel wood collection needs to be regulated based on current scenario.

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Just nine (9) references, in this era of widely available studies are not enough for this study

There are credible data and information, globally, on this field of study, which should be reviewed and included in this study

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Table 3: Quantity of fuel wood collected by different category of farmers

Category of farmers	Total fuel wood collected (quintal)	Average fuel wood per family (quintal)
Large farmers (>8 acre)	**21.5**	**2.15**
Medium farmers (4-8 acre)	**38.5**	**3.21**

Small farmers (<4 acre)	**21**	**2.63**
Landless farmers	**24**	**2.40**

Table 4: Total fuel wood consumption pattern in Haliyal taluk

Average fuel wood consumption per household	2.60 qt/yr
Total no of households in Haliyal	20124
Total fuel wood consumption in Haliyal	52322.4 qt/yr
	5232.2 tonnes
Total area of Haliyal taluk(ha)	85840
Percent of forest area	68.33
Area under forest (ha)	58654.472
Total volume of dead wood (m^3/ha)	664261.895

Table 5: Major tree species used for fuel wood consumption in Haliyal taluk

Large farmers(>8 acre)	**Medium farmers (4-8 acre)**	**Small farmers(<4 acre)**	**Landless farmers**
1) Xyliaxylocarpa(jambe)	*1) Xyliaxylocarpa*(jambe)	*1) Xyliaxylocarpa*(jambe)	*1) Xyliaxylocarpa*(jambe)

2) Lagerstromialanceolata(nandi)	*2) Terminalia tomentosa*(karimatti)	*2) Terminalia tomentosa*(karimatti)	*2) Terminalia tomentosa*(karimatti)
	3) Lagerstromialanceolata(nandi)	*3) Lagerstromialanceolata*(nandi)	
	4)Albizialebbeck		
	5) Bauhinia purpurea		

Table 6: Quantification of forest degradation in different crown density classes (m^3/ha)

Treatment	Replication					Average
	R_1	R_2	R_3	R_4	R_5	
T_1	17.664	34.621	23.593	19.529	62.403	31.562
T_2	9.725	1.186	8.769	8.246	5.851	6.7554
T_3	4.469	9.309	1.479	4.065	3.439	4.5522
T_4	3.442	4.981	2.958	0.698	0.088	2.4334
					CD @ 5%	12.803
					SEm (±)	4.2

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