Determinants of rural household livelihood dependence on non-timber forest products: A case study from Inanda Community, KwaZulu-Natal, South Africa

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Natural forest resources are the most accessible sources of services, products and incomes for many adjacent rural communities. However, the declining resilience of forests and agricultural sectors particularly in South Africa is concerning and a real public policy challenge. Little is known about the determinants of rural community dependence on natural forests, and the importance of this dependence to rural livelihoods and environmental outcomes. This study investigated factors affecting rural household level of forest dependence and the contribution of natural forests to rural household livelihoods in the "KwaZulu-Natal Sandstone Sourveld (KZNSS)" ecosystem. Employing survey data from 150 forest-dependent households and a logit-transformed Ordinary Least Squares (OLS) model, the study found that there is significant level of forest dependence in the study area. The empirical findings showed that the contribution of forest resources to rural livelihoods is significantly influenced by off-farm incomes, employment incomes, forest vouchers received from the "**Wildlands Project**" in exchange for planting trees, values of household assets, changing of time and dates in visiting the forest for the collection of forest products, and perceived changes in temperature. These findings imply that institutional arrangements for programs like the "**Wildlands Project**" need to be developed from the beginning with the participation of all pertinent stakeholders for everyone to accept it and understand the regulations. Additionally, legislative changes are needed to help rural residents sustainably support their livelihoods and diversify their sources of income to build resilience and ease pressure on natural forests.

KEYWORDS

NTFPs, rural livelihoods, forests dependence, Wildlands Project, climate change

Introduction

Forest resources continue to play an important role to rural communities in developing countries in terms of services, products, and incomes. They have demonstrated to economically dis-advantaged households that they can satisfy everyday necessities such as energy, shelter, medicine, cash incomes, and employment (Kaoma and Shackleton, 2015; Ofoegbu et al., 2017; Opperman et al., 2018; Xu et al., 2019; Leaver and Cherry, 2020; Dalu et al., 2021). Most of such common natural forest resources are referred to as Non-Timber Forest Products (NTFPs), including wild spinaches, fuelwood, charcoal, wooden utensils, grass fodder, thatching materials, medical plants, edible fruits, construction poles, bark, roots, tubers, leaves, flowers, seeds, resins, honey, and mushrooms (Gautam, 2009). However, the declining resilience of forests and agricultural sectors particularly in South Africa is relatively problematic and a real public policy challenge (Xulu et al., 2018; Marunda et al., 2020). Among the reasons for such decline is a continuously adverse impacts of climate change and other evolving challenges related to natural forests. Some of the most important impacts of global climate change is being felt among all sectors of society, predominantly in developing countries (Aksoy and Kaptan, 2020; Chapagain et al., 2020). Their vulnerability to climate change stems from a combination of factors, including their predominantly tropical location and numerous socioeconomic, demographic, and regulatory tendencies that limit their ability to adapt to the many changes (Vogt et al., 2016; Sonwa, 2018; Nembilwi et al., 2021). The relatively higher damages are predicted to be high in the forest and agricultural sectors in sub-Saharan Africa because the regions already endure high heat and precipitation (Ofoegbu et al., 2017; Makondo and Thomas, 2018). Thus, the forests regenerated today will have to cope with the future climate conditions of at least several decades, often even more than 100 years (Fekete et al., 2017; Krofcheck et al., 2018; Nevins et al., 2021).

In response to the existing forest management and land use challenges, KwaZulu-Natal's EThekwini Municipality in South Africa, implemented the "**Wildlands Project**" to rehabilitate the forest ecosystem at Inanda Mountain, which includes the roll-out of the project's well-established "Indigenous Trees for Life Programme" (ITFL). This programme assists unemployed people in setting up small-scale indigenous tree nurseries at their homes. Moreover, the tree seedlings are traded for any form of financial assets such as credit notes or commodity money, which can be used to obtain food, basic goods and pay for school fees, at regular "Tree Stores" that are held in the participating communities. The project's fundamental objective was to create a balance between sustainable forest resource-based management and sustainable livelihoods of rural communities within EThekwini Municipality.

According to Carney (1998) and Ellis (2000), the definition of livelihood is "the capabilities, assets (natural, physical, human, financial, and social), and activities essential for a means of living and considered to be sustainable when it can survive and recover from stress and shocks and maintain or boost its capabilities and assets both now and in the future, while not undermining the natural resource base" (2000). A livelihood also includes having access to and reaping the rewards of state-provided social and public services including those in the areas of education, health, transportation, and water (Babulo et al., 2008). People, their capacities, and means of subsistence, such as food, income, and possessions, make up livelihoods (Chambers Conway, 1992). Sustainable livelihoods are ones that can withstand stresses and shocks, recover from them, maintain and improve the local and global resources that support them, and leave opportunities and bequests for future generations (Ellis, 2000). The idea of sustainable livelihood has been conceived in this study as a component and extension of general rural livelihoods. This is so because a sustainable way of life emphasizes how a society makes use of its resources to meet basic needs. Since NTFPs are considered natural resources, this study not only looks at the factors that determine rural forest dependence and how those factors are likely to change over time, but it also offers some recommendations for increasing the role that forests and forestry play in achieving sustainable livelihoods, improving household food security, and reducing rural poverty.

Natural forests are an integral part of biodiversity and livelihoods in rural communities of developing countries (Gautam, 2009; Xu et al., 2015; Rode et al., 2016; Johansson et al., 2020). However, the role of forest products in sustaining rural economies of developing countries has been under-estimated because of inadequate policy recognition (Shackleton and Shackleton, 2004; Jensen, 2009; Pandey et al., 2016). Although scholars now know the significance of biological diversity, less is known about its economic value and the socio-economic costs of losing it. Costs of environmental damage and depletion of natural resources have frequently been disregarded (Liu and Faure, 2018). For instance, communities using woods as sources of food, fuel, and farming put strain on the area (Tadele et al., 2020). To the extent that rural people's livelihoods are dependent on natural forests, poverty, food insecurity, and population pressure, all contribute to the loss of forest cover, locking rural residents in a cycle of permanent poverty. While millions of individuals continue to cut down trees to improve their living conditions, large-scale agribusiness, which is driven by increasing consumer demand, is becoming a major cause of deforestation (Ordway et al., 2017).

The economic value of natural forests has been the subject of numerous studies around the world, particularly in developing countries (see, for example, Xu et al., 2015; Gbedomon et al., 2016; Mugido and Shackleton, 2017; Rasmussen et al., 2017; Suleiman et al., 2017; Vrabcová et al., 2019; Amadu et al., 2021;

Dalu et al., 2021). These studies have focused more on the socioeconomic and ecological effects of community-based forest management, as well as livelihoods in shifting agriculture-forest landscapes. Additionally, increased attention has been paid to comprehending how people perceive and use forest resources, as well as how NTFPs affect distant forest communities' cash and non-cash income.

Despite the importance of natural forests, little is known about the level and determinants of forest dependency in rural households in the context of South Africa. Therefore, this study aimed to examine the factors affecting rural household forest dependence specifically within the KwaZulu-Natal Sandstone Sourveld (KZNSS) ecosystem. Many studies in the past (Start and Kirk, 2018; such as Chakraborty et al., 2018; Ali et al., 2020; Uhl et al., 2020; David et al., 2021) took the dependent variable as the income generated from the forest products. This was traditionally explained using socio-economic and institutional factors. Most of the studies used forest income as a proxy for household welfare. However, in the present study, dependence on natural forest resources is represented by the proportion of income derived from the forest to the total household income. The share of forest income in the household better captures the role of the forest to rural livelihoods. This is one of the innovative dimensions of the paper. Given the variation in forest dependence among different socio-economic groups geographically or otherwise (Babulo et al., 2008; Bwalya et al., 2013; Chakraborty et al., 2018; Ali et al., 2020), each community has to be studied and understood separately. In addition, Soe and Yeo-Chang (2019) also emphasized the importance of understanding how much people depend on natural forest resources for their livelihoods and identifying the factors affecting this dependence. Such knowledge will foster policies on sustainable forest management and create a balance with rural sustainable livelihoods.

Theoretical framework

The Sustainable Livelihood Approach and its Framework was used in this study. One of the concepts that is most frequently utilized in development practice was created by the DFID and is called the "Sustainable Livelihood Framework" (SLF). In 1997, the framework was added to its program for development cooperation. The concept of a livelihood used by DFID is adapted from Chambers Conway's (1992) work, which states that a livelihood consists of the skills, resources, and activities necessary for a means of subsistence. When a way of life is sustainable, it can withstand stresses and shocks, recover from them, and retain or improve its capacities and resources both today and in the future without compromising the natural resource base (DFID, 2000).

The primary determinants of people's livelihoods, typical interactions between those determinants, and potential

adaptation solutions are all shown in the sustainable livelihoods framework in Figure 1 along with the desired outcomes. According to this idea, in order to maintain sustainable livelihood outcomes and strategies, one must have access to capital assets or livelihood resources (such as natural, human, physical, financial, and social capital assets). The ability of households to self-insure and manage risk in the face of catastrophe is determined by assets in the form of physical and human resources, human capital, and social networks, which in turn, affects their susceptibility to shocks (World Bank, 2001). People must therefore combine therefore, capital endowments/assets that they have access to and control over and on which they draw when pursuing various livelihood strategies to develop and sustain livelihoods (Xu et al., 2015, 2019).

The conceptual framework

A demand for NTFPs in rural economies is basically to fulfill their household needs as they do for various goods and services in the market. However, a demand for NTFP is different from usual market-based demand decisions because these decisions are not always backed by observable monetary prices that are determined by the factors exogenous to the household (Senaratne et al., 2003). In this study, the focus was on NTFPs as it was observed to be heavily harvested and consumed as compared to timber products. This is because NTFPs offer convenient and useful foods, substances, materials and/or commodities obtained from forests other than timber and are mostly used by the majority of rural households in the world (Sardeshpande and Shackleton, 2019). It is also conceptualized that to create livelihoods, people must combine their capital endowments/assets that they have access to at their disposal and control over, and on which they draw when pursuing different livelihood strategies. By doing so, different socio-economic and institutional factors influence rural communities' dependence on NTFPs.

Empirical methods

Description of the study area

The study area selected, Inanda, is a small town under eThekwini Municipality, KwaZulu-Natal Province, South Africa. It is located 24 kilometers (km) northwest of Durban, a port city. The shaded region on the map of the eThekwini Municipality, which is a portion of the KwaZulu-Natal Sandstone Sourveld, in Figure 2 below, represents its position.

Inanda Community Forest offers households the chance to earn money or vouchers from the "**Wildlands Project**"

The sustainable livelihoods framework. Source: Adapted from Babulo et al. (2008).
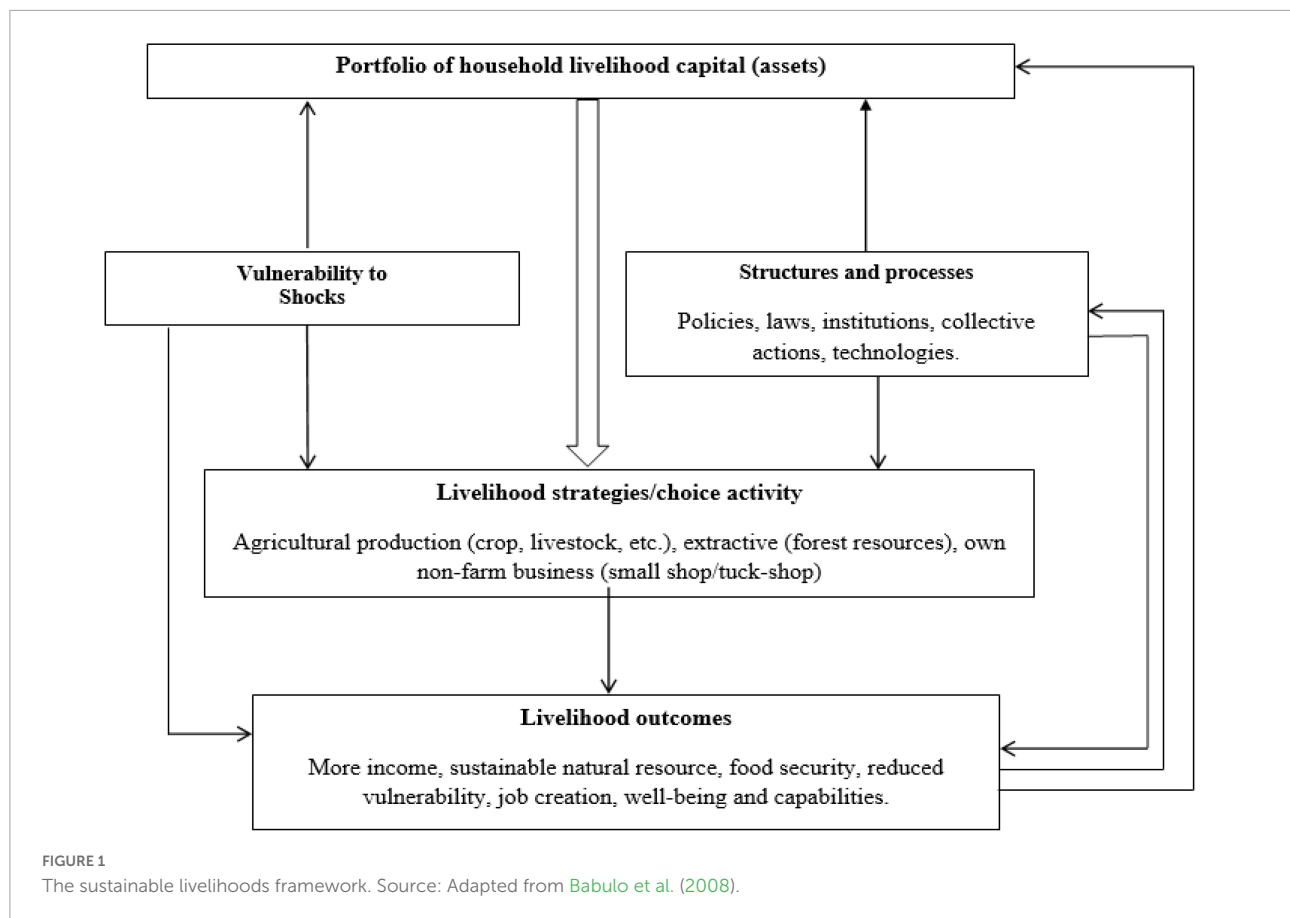
to apply toward food purchases. Forest employment was defined as "cutting invasive alien plants with the "**Wildlands Project**," "seed exchange with vouchers from the "**Wildlands Project,**" "extracting non-timber forest products (NTFPs)" and "extracting firewood, traditional medicine, construction poles, wild spinach, wild fruits, wild honey, and bush meat" for sale or domestic use. The primary means of subsistence for the study communities, primarily made up of low-income households, can be categorized as mixed crop and livestock subsistence farming. Rural people in Inanda often cultivate maize, beets, beans, spinach, onions, bananas, butternuts, groundnuts, potatoes, tomatoes, carrots, and cabbage. More than half of the families surveyed reported having cattle, goats, or poultry as their primary livestock. Given that the region is frequently hot and dry, rain-fed agricultural cultivation is said to provide difficulties. The sample and data collection techniques are described in the following subsection.

Sampling procedure and sample size

Data was gathered over the course of 4 weeks by a group of five enumerators who are fluent in isiZulu, the local language in the area. A list of households from the two chosen locations

was provided by traditional chiefs, headmen, and the ward councilor. The surveyed areas were selected after preliminary visits of the entire Inanda Maphephetheni villages (Bhekuphiwa, Mgangeni, Ngcukwini, and Mbozamo) to gather information on the communities' dependence on natural forest products. This led to the conclusion that households in Bhekuphiwa and Mgangeni areas were the ones most dependent on the forest products. Due to distance, terrain and the transaction costs of passing through the Inanda dam, Ngcukwini and Mbozamo areas were less dependent on the Inanda Mountain forest products. A random sample of 150 households was then drawn from the two areas (Bhekuphiwa and Mgangeni) using the probability proportional to size method. Table 1 below reports the sample size for each location.

A comprehensive draft of a structured household questionnaire was created, pre-tested, and amended after the pre-test. The questionnaire included basic socio-economic household characteristics, livelihood strategies and dependence on forest resources, and adaptation strategies when that dependence is threatened. Focus group discussions and key informant interviews were held to gather some contextual data to complement the survey questionnaire. The community's teachers, ward councilors, "**Wildlands Project**" personnel, traditional leaders, and participants in forest community

FIGURE 2
Inanda, eThekwini Municipality, KwaZulu-Natal, South Africa.
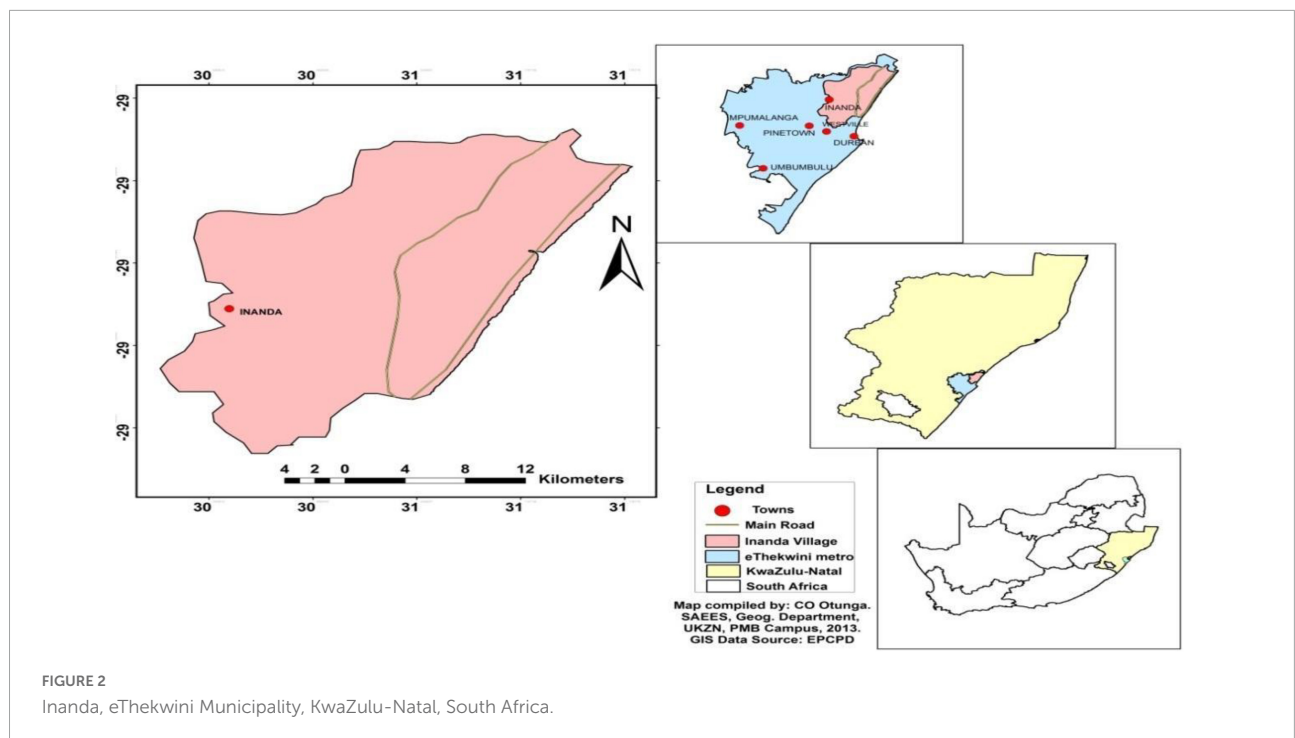
programs served as the key informants. An old villager, a teacher, "**Wildlands Project**" officers, a traditional leader, headmen, and several other locals participated in the group discussion. The rest of this section presents and justifies the method of data analysis employed.

Empirical method of data analysis

Livelihoods in the study were defined as the range of economic activities used to generate income for rural households to maintain their living. The sources of incomes considered are farm (crop and livestock production), unearned income, and employment income (temporary, contract and permanent). Unearned incomes include old age pension grants, child support grants, and remittances from relatives and migrants. Forest income was estimated as the sum of the market price of the total forest products harvested during

TABLE 1 Sampling framework adopted in the respective study sites.

Sample/Population	Mgangeni	Bhekuphiwa	Total
Total number of households	390	330	720
Percentage (%)	54	46	100
Proportional to size (390/720 and 330/720)	0.54	0.46	1
Total number of sampled households interviewed	81	69	150

Source: survey data.

the data collection (two consecutive months i.e., April and May. The demand for incomes from forest resources depends on household capital endowment (human, social, physical, financial, and natural). For instance, poor households without electricity have a particularly high demand for cooking energy from wood. The ratio of revenue derived from the forest to total household income then serves as a proxy for dependence on natural forest resources. The household's share of revenue from the forest more accurately reflects the contribution the forest makes to rural livelihoods.

Ordinary Least Squares (OLS) has been used to explain proportion variables (Start and Kirk, 2018; Uhl et al., 2020; David et al., 2021). However, the prediction of OLS would be outside the proportion range. That has motivated the use of Logit-transformed OLS in this study. The logit transformed model is used to empirically examine the determinants of rural household dependence on NTFPs. Total forest income (TFI) is the estimated sum of all cash incomes generated from the forest products (measured in Rands). For many of the households the value of forest products used by the household has been very small. Relative forest income (RFI) is a measure of the share of estimated income obtained from the sale of forest products in total household income (TI). This is derived as:

$$RFI = TFI/TI \qquad (1)$$

Following this, the logit transformation procedure was used to generate a variable that was then used as a response variable in the OLS model (Gujarati and Porter, 2009). The proportion of

forest income to total household income (RFI) was transformed as below:

$$\text{Trans RFI} = \ln\left[\frac{\text{RFI}}{1 - \text{RFI}}\right] \qquad (2)$$

The dependent variable is the natural log of the transformed proportion variable i.e., the contribution of income from forest extraction to total household income (Trans RFI). The OLS regression model following the transformation is specified in general form as:

$$\text{Trans RFI} = \beta_0 + \beta_1 X_1 + \ldots + \beta_n X_n + U_t \qquad (3)$$

where β_0, β_1. β_n, $X_1 \ldots \ldots \ldots X_n$, and U_t designate intercept of Trans RFI, coefficients of the respective explanatory variables, and the *error* term, respectively.

An ordinary least squares regression was run on the transformed proportion of forest income against household characteristics, asset endowment, and other contextual variables. After OLS, Stata's "*protab*" option was used to predict the effect of the significant variables on the proportions. Data were analyzed using both SPSS (version 21) and STATA (version 15.0). Table 2 summarizes the list of variables, their measurement and expected signs.

Choice of explanatory variables

The choice of the explanatory variables below (Table 2) was informed by field observations.

Marital status of the household head (MARIT) is an important socio-economic factor influencing the ability of rural households to access natural forest products (Sunderland et al., 2014; Mohammed et al., 2017). This variable determines the availability of a household head entitled to collect, use and market the natural forest products. Married household heads tend to have better access to the collection of forest products because of better labor endowment when it is in high demand. Given that the collection of forest products is a labor-intensive activity, it is hypothesized that marital status has a positive relationship with dependence on natural forest products.

Gender of the household head (GENDER) is another important socio-economic factor influencing the dependence of rural households on natural forest products. Female-headed households may be more likely to engage in informal activities such as collection of natural forest products. This is because NTFPs are often collected by women (Mamo et al., 2007; Eneji et al., 2015) which increases their dependence.

According to Vedeld et al. (2004) and Zhu et al. (2017), the educational level of the household head (EDUC) affects the opportunity cost of his/her time and influences the collection of forest products and, hence, dependence. This was because the opportunity cost of labor is relatively high for better educated household members due to better access to greater diversity of employment and income opportunities. Therefore, in this study,

TABLE 2 Description of variables and the expected signs.

Variable		
Dependent variable	**Description and measurements**	**Expected signs**
TRANS_SHR	Transformed proportion of forest income to total household income generated from NTFPs (Rand)	
Explanatory variables		
GENDER	Dummy: 1 if household head is male and 0 otherwise	+
MARIT	Dummy: 1 if household head is married and 0 otherwise	+
EDUC	Dummy:1 if household head went to school (educated) and 0 otherwise	−
AGE	The age of household head measured in terms of number of years	−
DPNDT_RATIO	Members who depend solely on forest income but excluded in the collection of the natural resources and economic activities (continuous)	±
EMPLYINC	The level of employment income generated by household head (Rand) (categorical)	−
FARMINC	The level of farm income generated by household head (Rand) (categorical)	−
UNEARINC	The level of income generated by household head from any of these sources: old age pension grant, child support grants, disability grants, and remittances (Rand) (categorical)	−
NMBERINC	Number of income sources of household head	−
VOUCHER	The value of voucher received by household head (Rand)	±
ACC_LAND	Dummy: 1 if household head has access to land and 0 otherwise	−
DISTANCE	The walking distance from household to the forest, measured as time taken to get to the forest (in minutes)	±
ACC_MRKT	Dummy:1 if household head has access to market and 0 otherwise	+
ASSTS_V	Average value of productive assets owned by household head (Rand)	−
LVSTCK_V	Average values of livestock owned by household head (Rand)	−
CHNG_VST	Dummy: 1 if household head changes visiting dates and time to the forest and 0 otherwise	−
RAINFALL	Dummy: 1 if household head has perceived changes in rainfall in the last 30 years and 0 otherwise	−
TEMPERATURE	Dummy: 1 if household head has perceived changes in temperature in the last 30 years and 0 otherwise	−

it was expected that the higher the level of formal education attained by the household head, the lower the dependence of the household on NTFPs. Also, another factor which was included in the analysis was AGE. Higher age of rural adult members

was assumed to be linked to greater indigenous knowledge of usable NTFPs and appropriate skills and wisdom related to their extraction (Dash and Behera, 2016).

Dependence ratio is another important socio-economic factor influencing the dependence of rural households on natural forest products (Lee et al., 2017; Sharma, 2019). The variable (DPDNT_RATIO) reflected the total sum ratio of dependents within the household (disabled household members, household members below 15 years and above 55 years of age) to the adult working members engaged in the collection of forest products. Dependence ratio was hypothesized to have a negative relationship with household dependence on NTFPs.

Employment income (EMPLYINC) and farm income (FARMINC) are also important socio-economic factors influencing the dependence of rural households on natural forest products (Abdullah et al., 2016). Households with better options for allocating human capital to lucrative endeavors won't spend money on low-yield forest activities. Forestry operations, however, are frequently the only source of financial income for lower-income people (Vedeld et al., 2004). It was thus expected that access to these incomes will reduce household dependence. However, unearned income (old age pension grant, child support grant, disability grant and remittances), (UNEARDINC), is also an important factor affecting dependence on forests in the rural areas. All income sources were expected to have a negative relationship with dependence on natural forest products.

Diversification of income sources (NUMBERINC) is an important factor that will influence the dependence of rural households on natural forest products (Htun et al., 2017). It is expected to have a negative relationship with the level of dependence on NTFPs.

Another variable which has been found relevant in the context of the study area is vouchers from the "**Wildlands Project**" paid to local community members in exchange for collecting seeds/seedlings and planting trees (VOUCHER). The average value of vouchers the "**Wildlands Project**" pays in exchange for planting trees of the sampled households in Inanda was estimated to be R125 per bundle of trees. However, there were members who reported that they just started whilst there were others not aware of the barter exchanging activities. None of the studies reviewed has captured this variable as it emanated from "**Wildlands Project**" implemented in the study area. The inclusion of this variable is one of the aspects that distinguishes this study.

The distance from the homestead to the forest (DISTANCE) influences the dependence of rural households on natural forest products. This variable was captured as walking distance (in minutes) from each household homestead to the forest. The collection of forest products by the household becomes costly (transaction-wise) if households are located further away from the forest. Studies conducted by Mamo et al. (2007) and

Hogarth et al. (2013) have shown that distance from the forest has a negative relationship with forest dependence. However, Sharaunga et al. (2013) found the exact opposite as households further away from the forest had higher resource scarcity and better access to markets to sell NTFPs. For that reason, the relationship remains unpredictable.

Productive assets value (ASSTS_V) and the value of livestock owned by the household (LVSTCK_V) influence the dependence of rural households on natural forest products (Abdullah et al., 2016). Households with more productive assets are regarded as being relatively wealthy and have the incentive to engage in crop and livestock production rather than the extraction of forest products. That is why a negative relationship is expected. Both the values of household assets and livestock were captured at average current market prices reported by sampled households.

Access to markets (ACC_MRKT) in this case refers to the ability of households to participate in the market for harvested forest products (Pandey et al., 2016; Suleiman et al., 2017). Market access is expected to encourage more extraction of forest products for commercial purposes. Another factor is access to land (ACC_LAND) which facilitates agricultural production (crop and livestock) for sustainable rural livelihoods. Rural households with better access to land are less dependent on NTFPs extraction (Kaskoyo et al., 2017; Chechina et al., 2018).

Perception of household head on climate change components (rainfall and temperature) influences rural household dependence on natural forest products (Rahman and Alam, 2016; Khan and Conway, 2020). Households' perceptions of variations in rainfall and temperature are captured by the variables (RAINFALL and TEMPERATURE). Alarima (2011) pointed out that awareness and experience are both prerequisites for perception. Dependence on natural forest products was predicted to be negatively correlated with these two characteristics. Field observation also has shown that the decision to change time and dates of visiting the forest by household members (CHNG_VST) due to change in climatic conditions influences the dependence of rural households on natural forest products. Those household heads who reported change in the time and dates of their visit to the forest due to their expectation in climatic conditions are more likely to cut on their future visits. For that reason, it was expected to have a negative relationship with natural forest product dependence.

The results and discussion

Socioeconomic characteristics of the sampled households

Low-income households made up the majority of the sampled households. The three main crop kinds planted by the sampled households in the region were maize, vegetables,

and roots/tubers. More than half of the families surveyed said that their livestock operations consisted mostly of cattle, goats, and poultry. However, the vast majority (80%) were growers of maize. Male household heads made up about 56% of the sampled households. On average, the age of household heads was 55 years, and there were 9 people living there, which is more than the 3 people that make up the national average household size (Statistics South Africa, 2019). With an average of 0.94 hectares, the largest land area managed by the studied household heads was 6 ha. The estimated mean market value of productive assets (such as a hoe, tractor, and fork) reported by studied families is R894.63, whereas the mean value of animals per household was R8,958.00.

Household income sources

In total, 56 percent of the studied families made money from selling forest products (Table 3). The average percentage of forest resources in the sampled households' overall income was 26%. For more over 70% of the respondents, the two most significant non-agricultural income sources were employment revenues and child-support grants. But the findings revealed that farm revenue (28%) was the most significant source of income, followed by old age pensions (45.3%) and remittances (9.3%). The sources of income for the sampled households are listed in Table 3 below.

Types of forest products used by sampled households

Fuel wood was gathered by nearly all sampled families (97%) while, building poles and traditional medicinal herbs, respectively, followed at 64 and 42% (Table 4). As a result, it can be inferred that the majority of the sampled households rely (in terms of income or otherwise) on forest resources for their daily needs. Forest items that aren't made of wood, such as mushrooms, wild fruits, and wild spinach, are also significant. Sampled households reported that firewood is the main source for cooking and construction poles for building houses, while some sampled households reported that they collect NTFPs to supplement their income to use for food purchases.

Model estimation results

Both multicollinearity and heteroscedasticity were examined in the model. Variance Inflation Factors (VIFs) were used to evaluate multicollinearity. According to the results values, all of the VIFs had average values below 2, or 1.31. The results are far lower than the threshold of 10 (Gujarati and Porter, 2009). There was no heteroscedasticity

TABLE 3 Household sources of income ($N = 150$).

Income sources	Received or not	Frequency	Percentage (%)
Farm income	Received	42	28
	Not received	108	72
Forest income	Received	84	56
	Not received	66	44
Remittances	Received	14	9.3
	Not received	136	90.7
Old age pensions	Received	68	45.3
	Not received	82	54.7
Child-support grants	Received	107	71.3
	Not received	43	28.7
Employment income	Received	111	74
	Not received	39	26
Other sources of income	Received	20	13.3
	Not received	130	86.7

Source: survey data.

TABLE 4 Forest product types collected by sampled households ($N = 150$).

Forest product types	Frequency	Percentage (%)
Fuel wood	146	97
Construction poles	96	64
Traditional medicinal herbs	62	42
Mushrooms	30	20
Wild fruits	44	29
Wild spinaches	51	34
Honey	3	2
Hunting	2	1

Source: survey data ($N = 150$).

because the estimated $\chi 2$ value (0.29) was significantly lower than the tabulated $\chi 2$ value (3.38) at the 5% significance level and one degree of freedom. The OLS regression model's F-statistic had a goodness of fit (R^2) value of 0.45, which was statistically significant at the 1% level of significance. The model's specification error was found using the linktest for model specification. The P $hatsq$ test is not significant (see Table 5), demonstrating that it was unable to prove the model's misspecification. The empirical findings of the logit-transformed OLS for the variables (described in the section "Theoretical framework") influencing rural people's reliance on natural forest products are presented in Table 5 below.

The findings in Table 3 indicate that household dependency on natural forest products is negatively influenced by employment income, indicating that households with access to these wages are less reliant on natural forest products. Stata's "protab" option suggests that as employment income increases from 0 to greater than 4,000, the proportion decreases from 0.40 to 0.17. Based on the empirical evidence from earlier studies [such as Oli et al. (2016) and Gatiso (2019)], relatively

TABLE 5   Logit-transformed OLS results of determinants of forest dependence.

Variable	Coefficient	Robust standard error	T	P > t
MARIT	−0.0007	0.16	0.00	0.996
GENDER	−0.0857	0.19	−0.46	0.646
EDUC	−0.1359	0.20	−0.69	0.493
VOUCHER	0.0002***	0.00	2.43	0.017
AGE	−0.0039	0.04	−0.1	0.917
DPDNT_RATIO	−0.0554	0.06	−0.91	0.366
FARMINC	−0.1167	0.12	−1.00	0.319
NUMBERINC	−0.0855	0.10	−0.90	0.373
UNEARDINC	−0.3724***	0.10	−3.65	0.000
EMPLYINC	−0.2045***	0.04	−5.71	0.000
ACC_MRKT	0.1806	0.18	1.00	0.322
ACC_LAND	−0.1585	0.28	−0.58	0.567
ASSTS_V	−0.0007*	0.00	−1.67	0.100
LVSTCK_V	−0.000004	0.00	−0.75	0.455
DISTANCE	0.0262	0.07	0.36	0.716
CHNG_VST	−0.2418*	0.14	−1.72	0.089
RAINFALL	0.258096	0.21	1.24	0.220
TEMPERATURE	−0.4242*	0.22	−1.91	0.060
CONSTANT	1.3858	0.52	2.67	0.009
F.sig			5.41	0.000
R^2				0.45
P_hatsq				0.483

Source: survey data.

The dependent variable is TRANS_SHR. * and *** mean statistically significant at the 10, 5 and 1% levels, respectively.

poor households get a greater proportion of their income from forests. Improved off-farm work prospects and access to financing reduce forest clearance as a gap-filling activity, as demonstrated by Vasco et al. (2020) and Mushi et al. (2020). The empirical results also show that unearned incomes (social support grants, remittances, and old age pension) negatively influence household dependence on natural forest products i.e., unearned incomes reduce household incentives to collect and use of forest products. This implies that as unearned income increases from 0 to greater than 1,500, the proportion decreases from 0.38 to 0.17. According to Hogarth et al. (2013), unearned incomes increase the opportunity cost of engaging in the collection of forest products. Fisher (2004) has demonstrated how the presence of social grants, subsidies, and other unearned incomes have negative impacts on the gathering of forest products in rural areas. These results support earlier hypotheses and other research' conclusions that a decrease in household reliance on natural forest products results from a rise in off-farm incomes (Suleiman et al., 2017; Härtl et al., 2019; Ali et al., 2020). Hogarth et al. (2013) contend, however, that specific social transfer programs, particularly community-based and public work programs, improve the

operation of the labor market and employment in rural areas of developing countries. Furthermore, Heubach et al. (2011) have demonstrated that the chance of natural forest dependency in the home economy decreases with the likelihood of using other accessible revenue sources.

The findings also imply that households with less productive assets are often more reliant on forest revenues, with the value of productive assets being negatively and significantly linked with the proportion of forest income. The average ratio of forest revenue to total household income falls from 0.23 to almost 0 as the average Rand value of household productive assets rises from 0 to 895. This is consistent with the findings of earlier research by Barbier and Hochard (2018), for example. This result highlights the significance of measures that help farmers develop productive assets to decrease their reliance on forests.

Farm household heads who have reported change in the times and dates of their visit to the forest (CHNG_VST) due to their expectation in climatic conditions are more likely to cut on their future visits and be less dependent on natural forest products. This implies that there is sufficient evidence to say that changes in visiting time and dates result in rural households deriving less income from the forest. Also, the parameter estimates for the change in the temperature level (TEMPERATURE) is negative and statistically significant. This implies that rural households who perceive increase in rainfall and temperature are generally less dependent on natural forest products, resulting in the change in their frequent use and harvest of forest products. Such households derive a cascading forest income. The coefficient for the variable capturing barter exchange activities through the "**Wildlands Project**" voucher is positive and statistically significant. Such households depend more on natural forest products for their livelihoods. As the voucher income increases from 0 to 125, the proportion of forest income increases from 0 to 0.43. However, the value of the voucher depends on the amount of seeds or trees the household collects and plants. This encourages rural households to plant the seeds or trees as it would mean receipt of voucher of more value.

Conclusion and implications for policy

The forest sector in developing countries has the potential to provide ecosystem services, contribute to economic growth in the rural areas through the available forest products. This has been confirmed in the case study examined. The dependence of rural communities on natural forests is correlated with household socioeconomic attributes. The time in response to their expectation in climatic conditions, distance from the forest to homestead, and the perceived increase in temperature reduce local peoples' dependence on natural forest products. It can be concluded that climate change is impacting the

interaction of natural forest dependent societies with natural forests. The greater the possibilities of making use of alternative income sources, the greater the chance to reduce the pressure on natural resources dependence. Households with alternative livelihood opportunities, despite having physical access to the Inanda forest, did not collect but bought forest products from others. This is because alternative livelihood opportunities have made the opportunity costs of harvesting from natural resources too high for them to invest time and resources in the extraction of NTFPs.

The study has shown that vouchers paid to local community members (in exchange for planting seeds or trees) through environmental projects (such as the "Wildlife Project") would improve the income and livelihoods of low-income rural households. This, in turn, contributes to reducing pressure on natural forests and their sustainable management. However, such projects have double-edged sword impacts as these schemes could also encourage rural households to extract more voucher-related forest products. The above-mentioned statement can be attributed to the fact that the number of voucher-related seedlings harvested or collected was directly proportional to the amount of voucher in exchange. Despite the potential role of voucher receipts, few sampled households received them as most of them either had just started using them, whilst others were unaware about their existence.

The study suggests creating non-farm jobs and including forest earnings in all analyses of rural income to widen rural residents' sources of livelihood and promote development and sustainability. In this regard, there will be a need for policies that recognize the importance of natural forest resources or NTFPs for local livelihoods and even to the national economy. Strengthening rural community-based resource management institutions is also important. To improve natural resource participatory management and to safeguard impoverished people's rights to utilize and access such resources, extensive policy interventions are needed. Community forest management programmes should be implemented in such a way that the resources can make significant contributions to poverty reduction whilst preventing over-harvesting and forest degradation. It would be challenging to incentivize local communities to own and maintain the forest without providing chances for local people to use and benefit from the forest. Collective action is found to be playing an important role in ensuring that the community makes collective decisions on the rules and regulations that are implemented for the best use of their natural forest resources.

Furthermore, there is a need to monitor the nock-on effects, strengthen this system, and scale up its operations in other areas for stronger impacts both to rural livelihoods and natural resources outcomes. Additionally, this study suggests that in order to significantly contribute to poverty reduction for sustainable rural lives, exchange activities with initiatives like the "**Wildlands Project**" need to be well organized, adopted, and the regulations understood by all community members.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, upon requests.

Ethics statement

The studies involving human participants were reviewed and approved by the University of KwaZulu-Natal, Ethics Committee, South Africa. The patients/participants provided their written informed consent to participate in this study.

Author contributions

MN collected and analyzed the data, and prepared the initial draft. EW and EM reviewed the first draft, re-analyzed the data, and interpreted the results. All authors contributed to the article and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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