Trees, Forests and People 23 (2026) 101128

Contents lists available at ScienceDirect

Trees, Forests and People

journal homepage: www.sciencedirect.com/journal/trees-forests-and-people

Evaluating non-timber forest product dependence of peri-urban households in a payment for ecosystem service scheme in durban, South Africa

Karabo Donald Munonde [a,*], Edilegnaw Wale Zegeye [b]

[a] School of Agriculture and Science, Discipline of Agricultural Management, University of KwaZulu-Natal, South Africa
[b] Department of Agricultural Economics, Extension and Rural Development, Faculty of Natural and Agricultural Sciences, University of Pretoria, South Africa

ARTICLE INFO

Keywords:
Peri-urban
NTFP dependence
Psychological capital
Cultural worldviews
Durban
South Africa

ABSTRACT

Non-timber forest products (NTFPs) are important for livelihoods. NTFP dependence can lead to deforestation and exacerbate land degradation. Therefore, Payment for Ecosystem Services (PES) schemes, such as the Buffelsdraai Landfill Site Community Reforestation project, initiated as part of landfil restoration and climate change mitigation, become important tools for encouraging communities to adopt land-use practices that improve forest ecosystem services while safeguarding their livelihoods. Most studies have focused on NTFP dependence in a rural context, while few have examined the peri-urban setting in South Africa. Even fewer studies have captured NTFP dependence through actual household subsistence behaviour with NTFPs, rather than using income data, particularly how psychological and social capital constructs and worldviews shape NTFP dependence. Hence, this study investigates how socio-economic, cultural worldviews, and psychological and social capital affect NTFP dependence of peri-urban households in Durban, South Africa. Regression estimates indicate that NTFP dependence increases with the presence of more adults, a better agricultural endowment, access to electricity, and strong social networks. Meanwhile, well-endowed, fatalistic, and egalitarian households are less dependent on NTFPs. Larger households need to be supported in diversifying their livelihoods by starting home food gardens, cultivating economically viable NTFP crop species that can be linked to markets. It is recommended that technical skills training be offered to reduce livelihood dependence on NTFPs. Future studies can assess NTFP dependence by comparing rural and peri-urban areas to understand how rapid urbanisation shapes it.

1. Introduction

In Africa, non-timber forest products (NTFPs) are an important source of livelihood (Shackleton and Shackleton, 2004; Timko et al., 2010). NTFPs comprise biological material other than timber that are harvested from forests and woodlands for consumption, such as fruits, nuts, vegetables, game, medicinal plants, resins, bark, fibers, palms, grasses, minor wood products, and firewood (Belcher and Vantomme, 2003; Heubach et al., 2011). NTFPs account for a high percentage of household income in the developing world, with South Africa having 85 percent of the rural households using NTFPs, contributing between 10 and 33 percent of the total annual household income (Shackleton and Shackleton, 2006; Timko et al., 2010; Heubach et al., 2011; Kaoma and Shackleton, 2015). Several studies refer to this relationship between forests and communities' reliance on NTFPs as forest dependency (Byron and Arnold, 1999; Angelsen and Wunder, 2003; Newton et al., 2016; Nerfa et al., 2020; Wale et al., 2022).

However, the high reliance of communities on forest resources could cause problems such as deforestation, posing a threat to their livelihoods (Arnold, 2001; Beyene, 2011). Deforestation can arise indirectly when NTFP harvesting is unsustainable and unregulated, where the extraction of NTFPs may alter the biological processes of plants by changing their physiology and degrading species, leading to plant loss (Ticktin, 2004; Belcher et al., 2005). Furthermore, increased harvesting can facilitate destructive land uses such as the clearance of forests for the cultivation of marketable NTFPs, altering ecosystem processes important for forest resilience (Belcher et al., 2005). According to Persha et al. (2011) to enhance the sustainability of forest resources while improving socio-economic conditions, local knowledge and community involvement should be incorporated into decision-making processes. Mechanisms to encourage communities to complement their land use practices with sustainable forest management are Payment for Ecosystem Services (PES) schemes (Engel et al., 2008). These are voluntary agreements where a conservation organisation pays a resource user to maintain or

* Corresponding author.
E-mail address: MunondeK@ukzn.ac.za (K.D. Munonde).

https://doi.org/10.1016/j.tfp.2025.101128

Available online 14 December 2025

enhance an ecosystem service, such as clean water, carbon storage, or biodiversity, with payment being made only if the service is successfully delivered (Wunder, 2005). But, typically, ecosystem services are public goods, and are non-excludable and non-rival, which makes it difficult to identify direct beneficiaries and exclude free riders, complicating the design of PES schemes (Muradian et al., 2010). Due to the public good dimension of environmental services, PES schemes generally require government support to ensure suitable payments for ecosystem service providers and encourage continued participation.

Through the provision of alternative income sources for people experiencing poverty, these PES schemes reduce reliance on the direct extraction of forest resources and also improve livelihoods (Wunder, 2008). However, information on the extent to which poorer households benefit from participation is limited, and there is a perception that participants are at least not worse off than they would be without the PES scheme (Engel et al., 2008). An example of a reforestation project utilising the PES scheme approach is the Buffelsdraai Landfill Site Community Reforestation Project in Durban, KwaZulu-Natal Province, South Africa, initiated by the eThekwini Municipality's Environmental Planning and Climate Protection Department (Knowles and Theron, 2010). The project aimed to create a natural carbon sink through reforestation, focusing on rehabilitating degraded sugarcane lands into indigenous forests within a buffer zone around the Buffelsdraai Landfill Site (Knowles and Theron, 2010; Lewis, 2010). Moreover, by engaging local community members as 'Tree-prenuers', the project sought to restore degraded land at the same time contribute to climate change mitigation, biodiversity conservation and provide socio-economic benefits to households through the cultivation and sale of indigenous trees (Viljoen, 2010).

The accomplishment of reforestation projects depends on understanding the extent of forest dependency and ensuring that such projects support environmental restorations and local livelihoods (Chazdon, 2008). Therefore, the study aims to determine the NTFP dependence of peri-urban households adjacent to the Buffelsdraai Landfill Site Community Reforestation Project site (henceforth referred to as 'reforestation project'). To achieve this, the objectives of the study were to 1) determine the level of NTFP dependence using behavioural indicators rather than income data among peri-urban households, 2) identify socio-economic factors and evaluate how psychological capital, other forms of capital, and cultural worldviews shape NTFP dependency. The research questions are 1) how do socio-economic factors, including the role of psychological capital, shape NTFP dependence, as well as the influence of cultural worldviews on household NTFP use?, and 2) amongst peri-households, how does participation in the PES scheme decrease dependence on NTFPs? Following this, it was hypothesised that households with increased psychological capital would depend less on NTFPs, as do those with more financial and physical capital. It is presumed that access to electricity in peri-urban areas will not significantly reduce NTFP dependence due to mixed energy use. This information provides insights into the socio-economic factors that characterise forest-dependent communities, particularly in peri-urban settings. The findings can inform and enable policy and future project designs geared towards sustainable forest use and livelihood planning.

2. Literature review

Poor households in rural and some urban areas with access to natural areas depend on various NTFPs for subsistence, natural remedies, and material sources for home-based industry (Belcher and Vantomme, 2003). Studies have shown that NTFPs are an important means of income generation for poor rural households, either as an additional source of income or as their primary source of cash income. (Shackleton, 2004; Kamanga et al., 2009; Heubach et al., 2011; Nerfa et al., 2020; Wale et al., 2022). Furthermore, forests and NTFPs have a social, cultural and religious significance to communities (Cocks and Wiersum, 2003; Sharaunga et al., 2013). However, NTFP livelihood contribution varies geographically, across time, and among different communities, with this variation extending to the types and amounts of NTFPs utilised (Pandey et al., 2016; Garekae et al., 2017).

Forest degradation, deforestation, and biodiversity loss are significant concerns for forest management in developing countries, where forests play an important role in biodiversity and rural livelihoods (Shackleton, 2004; Pandey et al., 2016). Worldwide interest in NTFPs has increased due to the observation that they play a significant role in improving the livelihoods of households reliant on forests (Pandey et al., 2016). Yet, the significance of NTFPs receives limited recognition and consideration in debates and the design of poverty alleviation or land-use policies, as well as in the budgets of government departments, such as forestry, agriculture, rural development, environment, and energy (Shackleton and Pandey, 2014; Pandey et al., 2016). Nevertheless, the economic significance of NTFPs has grown due to their contribution to rural livelihoods and incomes (Shackleton, 2004; Garekae et al., 2017; Wale et al., 2022). The economic contribution of NTFPs to rural households in South Africa has been well-studied and understood (Twine et al., 2003; Shackleton and Shackleton, 2004; Wale et al., 2022). Therefore, building on research in the rural context, this study examines the contribution of NTFPs to peri-urban households. The peri-urban context, non-urban or rural landscapes adjacent to or surrounding metropolitan areas (Buxton, 2022), are less understood in terms of forest dependence and community livelihoods, as peri-urban areas are transitional landscapes where social, economic, and land-use dynamics differ from those in rural areas, which can reshape the forest dependency patterns of peri-urban communities.

According to Newton et al. (2016), the term "forest dependency" is widely used in various contexts; however, a more well-defined definition of its meaning is needed. Therefore, before measuring forest dependency, a definition of the concept is required (Masozera and Alavalapati, 2004; Illukpitiya and Yanagida, 2008; Heubach et al., 2011). This way, stakeholders, such as donors, governments, project managers, and NGOs, can understand the definitions and context used (Newton et al., 2016). Studies have had different definitions and approaches in assessing forest dependency (Nerfa et al., 2020). For instance, Heubach et al. (2011) refer to a study where the definition of forest dependency focused on specific forest products to serve as forest dependency indicators, whereas Illukpitiya and Yanagida (2008) based their definition of forest dependency on the prominence of a particular forest-based livelihood, looking at the share of income derived from NTFPs to total household income. In another study, Garekae et al. (2017) examined the socioeconomic factors shaping household dependency on forests and measured dependency as the extent to which households relied on NTFPs for their livelihoods, and it was quantified using a forest dependency index (FDI), calculated based on the frequency and volume of forest product collection by each household. Wale et al. (2022) examined the determinants of rural household dependency on NTFPs, measuring forest dependency as the proportion of income derived from forest resources relative to total household income. These studies indicate that the relative forest income method has been used extensively.

According to Nerfa et al. (2020), this approach assigns a monetary value to forest products, making it inappropriate, especially when some households mainly consume rather than sell forest goods, creating a need to address other challenges (i.e., the time required for collection) for households that rely on NTFPs. Thus, an index was used to capture the multifaceted nature of forest dependency. These included livelihood aspects of forest dependence, such as forest products collected, the effort put into NTFP collection, asset-based relative wealth, and non-forest livelihood strategies incorporated into an FDI, which was compared with the relative forest income approach, and showed that the FDI approach offered an understanding of various livelihood aspects of forest dependence. As highlighted above, studies have used income-based indicators to measure NTFP dependence (Kaoma and Shackleton, 2015; Garekae et al., 2017; Leßmeister et al., 2018; Wale et al., 2022). However, previous studies have demonstrated that NTFPs

contribute to household livelihoods through non-monetary direct benefits (Dovie et al., 2002; Shackleton and Shackleton, 2004; Babulo et al., 2009; Ragie et al., 2020). For instance, Dovie et al. (2002) demonstrated that the non-cash benefits of NTFPs accounted for a greater proportion of rural household use values, and that the importance of NTFPs for livelihoods and welfare lies in their consumption at the household level rather than their sale. Additionally, Babulo et al. (2009) measured both cash and non-cash environmental income, indicating that over sixty percent of forest products are derived from subsistence and non-marketed forest products. In most rural households, the direct-use value of NTFPs such as fuelwood, food, and construction material is greater than cash income from forest sales, especially for poorer households with limited market access (Shackleton and Shackleton, 2004; Ragie et al., 2020). These studies suggest that relying only on cash-income measures can lead to the underestimation of NTFP dependence, highlighting the importance of incorporating household NTFP subsistence activities into multidimensional approaches to measure NTFP dependence accurately. Hence, a behavioural approach was adopted in this study, where a regression-weighted NTFP dependence index was created using subsistence indicators of NTFP dependence from NTFP-collecting households in the Buffelsdraai and Osindisweni communities. This approach captures NTFP dependence through households' actual engagement with NTFPs, rather than relying on income data, which, according to Cavendish (2000), is unreliable. Moreover, these indicators reflect the everyday experiences of NTFP use, particularly in situations where NTFPs are consumed rather than sold, and their value is not readily measurable.

NTFP dependence has largely emphasised the rural context. So, there is a gap in understanding how the peri-urban context shapes reliance on forest resources in this setting. Additionally, there is a gap for a multidimensional approach to measuring NTFP dependence through NTFP behavioural subsistence activities. The study draws on these gaps to identify the socio-economic factors that determine NTFP dependence within peri-urban communities.

3. Methods

3.1. Study area

The reforestation project is located approximately 25 km north of Durban, in the KwaZulu-Natal Province, a province located on the eastern seaboard of South Africa (Fig. 2a) (2297km^2 area, 29.5- 30.3 °S, and 30.6- 31.2 °E) (Glenday, 2007; Knowles and Theron, 2010). The reforestation project area is situated in the buffer zone of the Buffelsdraai Landfill Site (Douwes et al., 2017). The Buffelsdraai Landfill Site was established in 2006 as a landfill for waste generated from the northern suburbs of Durban and adjacent areas, and it is managed by Durban Solid Waste (DSW) and located 5 km east of Verulam, the nearest town (Fig. 2b) (Knowles and Theron, 2010; Macfarlane et al., 2011). The mean annual temperature in Durban is 21 °C, and precipitation ranges from 500 mm to 1000 mm, averaging 930 mm (Glenday, 2007). The annual rainfall recorded for Verulam is approximately 766 mm, with a monthly average of 108 mm, and daily temperatures ranging from 22.2 °C to 27.4 °C on average (Knowles and Theron, 2010).

Moreover, the site is 116.2 ha in size and has been separated from the buffer zone by a fence (Douwes et al., 2017). The buffer zone is located between the active landfill and surrounding communities, occupying approximately 787 hectares (Knowles and Theron, 2014). This area is required by law on any landfill site adjacent to communities, as it ensures that these communities are protected from odours, noise, and unsightly operations stemming from the landfill (Whitley, 2012). The project site was dominated by sugar cane fields covering over 40 % of the area. Large areas of natural vegetation types were present before the project's implementation. For instance, areas of indigenous and riparian forests and woodlands existed, with the area size ranging from 33.6 to 95.7 hectares (Macfarlane et al., 2011).

The reforestation project aimed to plant approximately 500,000 trees on 521–580 hectares of transformed or degraded natural habitats to form a continuous and functional forest buffer (Macfarlane et al., 2011; Douwes et al., 2015a). Thus far, over 595,476 trees have been planted, with 532,016 trees planted in the landfill buffer zone and 63, 460 trees planted to form a 'living fence' with planting densities ranging from 125 to 3850 saplings per hectare (Macfarlane et al., 2015; Douwes et al., 2015a). The trees planted under this project were selected based on their suitability for the environment, specifically their indigenous status and alignment with local vegetation types, such as the KwaZulu-Natal Sandstone Sourveld and Coastal forest vegetation types, which are indigenous and considered threatened (Macfarlane et al., 2015). Indigenous tree species were propagated by 'Tree-preneurs,' and selection was made in consultation with the eThekwini Municipality Environmental Planning and Climate Protection Department to ensure seedlings matched the ecological conditions (Knowles and Theron, 2010). Peri-urban communities surround the project area to the west, south, and east, namely Buffelsdraai, Osindisweni, and KwaMashu (Mancebo, 2011). Buffelsdraai and Osindisweni are adjacent to the project site, whereas KwaMashu is located further away from the area.

3.2. Sampling and data collection

This study employed a stratified sampling method to select household heads from two adjacent communities to the reforestation project site, namely Buffelsdraai and Osindisweni. Households in these communities engaged in various livelihood activities such as agriculture, livestock rearing and NTFP collection. The sampling frame was constructed with the assistance of community facilitators and using municipal projects (Mancebo, 2011) for the target communities. According to Mancebo (2011), Buffelsdraai and Osindisweni communities had population sizes of approximately 953 and 396, respectively. Thus, for the Buffelsdraai community, with a population size of 953, a 5 % margin of error, a 95 % confidence level, and a sample proportion of 50 %, the required sample size was determined to be 274. Similarly, Osindisweni had a population size of 396, and the sample size was 196. This resulted in a total sample size of 470 households. However, due to budget constraints, the final sample size for this study was adjusted to 434 households.

Data were collected qualitatively and quantitatively through questionnaires, interviews, and focus group discussions. Moreover, the data collection process included the design of the sampling, determination of the sample size, selection of the field survey, and training of enumerators. In-depth interviews were conducted with key informants, including community project facilitators and officials from reforestation project sites. These interviews provided qualitative insights into the socio-economic and institutional factors influencing NTFP dependency. Key informants were selected based on their knowledge and experience with community dynamics. Focus group discussions were conducted with the project participants involved in the reforestation project and non-project participants. Project beneficiaries (Tree-preneurs) were invited for open group discussions in the Buffelsdraai and Osindisweni communities. Focus groups consisted of 8–12 people per group, with four groups convened from each study area. An isiZulu-speaking moderator facilitated the sessions, which were recorded with participants' consent and assurances of anonymity. Discussions were held to understand their knowledge and usage of ecosystem goods and services, as well as the community's issues, behaviours, and concerns regarding the project.

After gathering contextual information relevant to the research, including through literature reviews, a structured questionnaire was composed, beginning with a statement of the study's purpose and assurances of confidentiality. The questionnaire contained sections on demographic information, asset ownership, income sources, cultural worldviews, psychological and social capital, including multiple aspects of NTFP use such as the types of NTFP collected, frequency of collection and usage, alternative sources of NTFPs, distance to the forested area,

and sale of NTFP, and it was translated into the IsiZulu language. Enumerators were trained to ensure consistency and accuracy in data collection when administering the questionnaire in person. Prior to the main survey, a pilot survey was conducted to pretest the questionnaire with a selected number of households in either area. It provided an opportunity to observe and assess the level of enumerator preparedness in the field and to identify any ambiguities and confusion regarding the questions. Moreover, it helped determine the length of time spent on each questionnaire, identify response bias and fatigue, and refine the wording of questions and the overall layout of the questionnaire for the main survey.

Surveyed households were categorised into two groups based on their NTFP collection status (i.e. collectors and non-collectors) based on their responses to a screening question on whether they collect NTFPs from the planted and natural forested area in and around the Buffelsdraai reforestation project site. The classification was conducted after sampling and was not used as a criterion to stratify. The distribution after classification is shown in Table 1 below for each community.

3.3. Conceptual framework

This study adopted the Sustainable Livelihood Framework (SLF) to understand the determinants of NTFP dependency. SLF provides a basis for evaluating people's livelihoods, especially those of the rural and urban poor (Small, 2007). Moreover, the framework presents a practical and accurate approach to understanding the interactions between factors that constrain or enhance livelihood opportunities (Morse and McNamara, 2013). The study draws from the framework to assess how different features of SLF interact to shape NTFP dependence. The features are presented in Fig. 1, where the maintenance of livelihoods depends on the availability of assets. The five principal assets are natural, human, social, physical, and financial capital (Krantz, 2001). Several household characteristics influence NTFP dependence (Shackleton et al., 2007; Shen et al., 2022), and form part of human, financial, physical and social capital and include age, gender, education, on-farm and off-farm income, social grants, remittance, vouchers, adult equivalents, capital endowment and cultural worldviews (Li et al., 2010; Timko et al., 2010; Heubach et al., 2011; Sharaunga et al., 2013; Garekae et al., 2017; Nerfa et al., 2020; Wale et al., 2022). These characteristics are explained below.

Age, gender, education, and adult equivalents are key indicators of human capital. As concerns age, older people are likely to participate in NTFP collection since the required physical labour is less demanding (Fisher, 2004). The opportunity cost of labour for older households is greater than that of those in a productive age range. Thus, older household members can easily access NTFPs and be more dependent (Fisher, 2004). Then again, younger households tend to take riskier and labour-intensive activities, decreasing NTFP dependency (Masozera and Alavalapati, 2004). There are differences in how men and women rely on and control NTFPs (Timko et al., 2010). The collection of NTFPs is important for women since this activity permits women to partake in income-generation and household chores (Timko et al., 2010; Heubach et al., 2011). Also, most NTFPs are collected by women, making the availability of female labour important in collecting these products, which could mean that if female numbers increase, NTFP use could increase (Illukpitiya and Yanagida, 2008; Kamanga et al., 2009; Heubach et al., 2011). The household's distance to the forested area was included as a predictor variable since studies (Mamo et al., 2007; Sharaunga et al., 2013; Tugume et al., 2017; Shen et al., 2022) have shown a relationship between NTFP dependence and the distance of households to forested areas.

Education levels in rural African communities can affect dependence on NTFPs (Mamo et al., 2007; Timko et al., 2010). Thus, as another feature of human capital, education increases the opportunity cost of time and creates diverse formal employment opportunities with reliable income, decreasing the likelihood of NTFP utilisation (Masozera and Alavalapati, 2004; Kamanga et al., 2009). The adult equivalent variable was considered and captured as the number of equivalent adults in a household, representing labour endowment. Larger-sized households generally have more labour available and organise NTFP extraction and other income-generating activities (Kamanga et al., 2009). This could mean higher forest-based income relative to overall household income.

Financial capital, including social grants, employment, farm income, and vouchers, significantly shapes forest dependence among rural households (Mohammad Abdullah et al., 2016; Wale et al., 2022). Social grants are considered unearned income, which reduces households' dependence on natural forests (Wale et al., 2022). Estimating income provides an understanding of household welfare and forest usage (Shackleton and Shackleton, 2006). Therefore, households with fewer employment opportunities and income sources are more likely to depend on forest resources for their livelihoods, while households with better opportunities to allocate their labour to more lucrative activities are less likely to expend effort on low-yield NTFP collection activities (Wale et al., 2022). Also, households with higher cash access or off-forest income have reduced need for forest-based income (Kamanga et al., 2009). Tree-preneurs, community members who collect seedlings and grow indigenous trees, are given vouchers that serve as a form of currency within the reforestation project (Douwes et al., 2015a). These vouchers are exchanged for essential goods, providing economic incentives for participation in the project while supporting livelihoods (Whitley, 2014). Wale et al. (2022) found that households using vouchers were significantly dependent on natural forest products.

Furthermore, physical capital, including household capital endowment and infrastructure access, has been shown to influence NTFP collection and use (Handavu et al., 2019; Wale et al., 2022) and is included in this study to understand the relationship between the resources that households have and NTFP dependency. Households with higher capital endowments can access other sources of income and resources, reducing household dependency on natural forest products (Handavu et al., 2019; Wale et al., 2022). Access to modern infrastructure by local communities impacts their dependence on NTFPs (Timko et al., 2010). In rural areas, households rely more on forests to meet their basic energy needs (Tanner and Johnston, 2017). However, better electricity connectivity reduces dependence on forests, decreasing deforestation rates in rural communities (Tanner and Johnston, 2017).

Social capital influences households' interactions with natural resources, community organisations and institutions (Barnes-Mauthe et al., 2015). As a multidimensional concept, it involves trust, social assistance, networks and groups, community relationships and engagement (Plummer and FitzGibbon, 2006). It reduces the transaction costs of working together by facilitating cooperation, and individuals are more likely to participate in and engage with collective activities to address environmental issues (Pretty and Ward, 2001). However, this relationship between social capital and natural resources is context-specific, and different dimensions of social capital have varied effects on natural resources dependence (Mbiba et al., 2019). According to Chan et al. (2012a), PES schemes can benefit from considering cultural contexts, particularly initiatives such as reforestation projects. This study included cultural worldviews, drawn from cultural theory, as a unique variable. Cultural theory distinguishes four worldviews: egalitarianism, hierarchism, individualism and fatalism (Hoogstra-Klein et al., 2012). Each worldview shapes households' views about the environment and the degree of resource use (Chan et al., 2012b).

Table 1
Distribution in each study area and NTFP Collection Status.

NTFP collection status	Number of respondents		Total
	Buffelsdraai	Osindisweni	
Non–Collector	98	110	208
Collector	118	108	226
Total	216	218	434

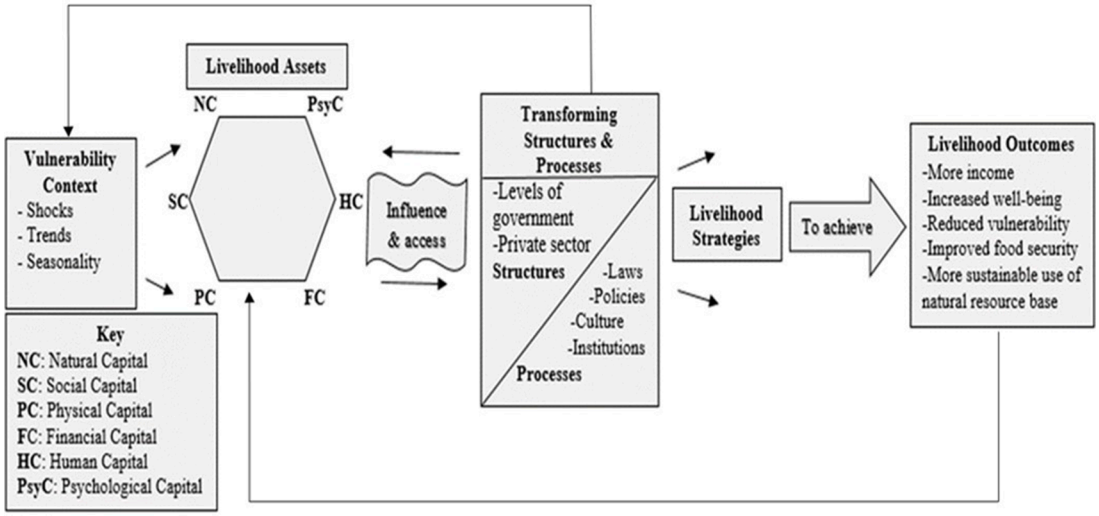

Fig. 1. The extended DFID sustainable livelihoods framework.
Source: Adapted from Krantz (2001).

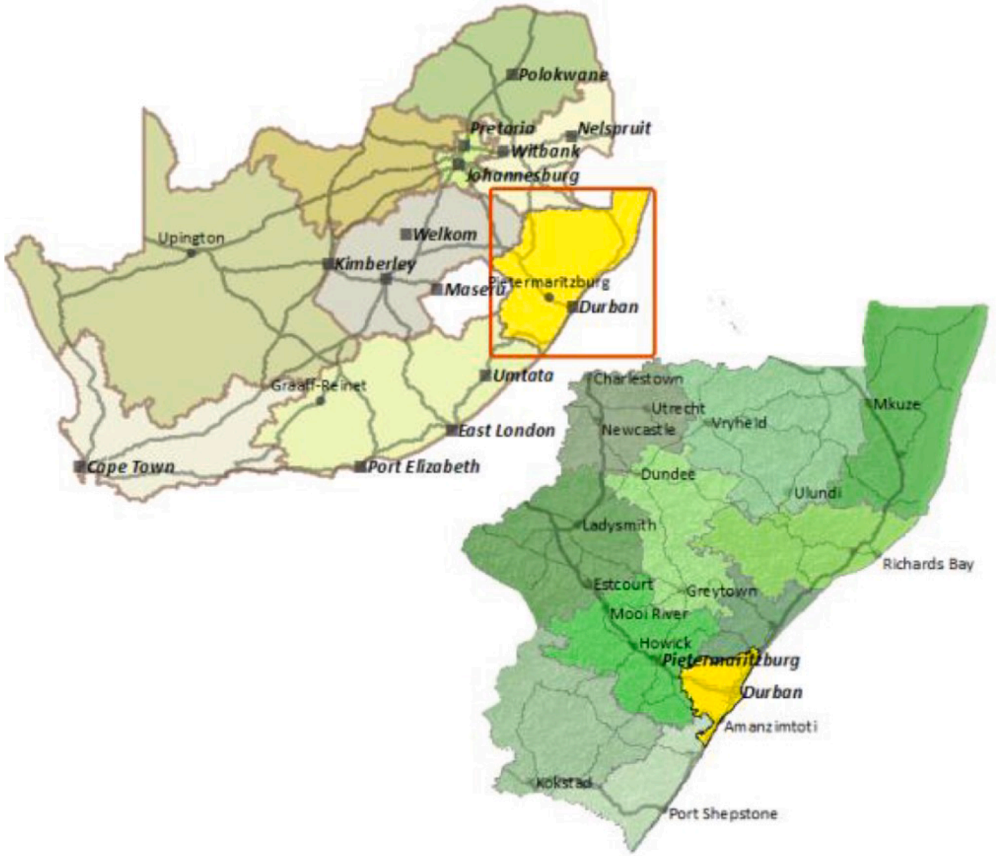

Fig. 2. Location of buffelsdraai and osindisweni communities adjacent to the buffelsdraai landfill site in the eThekwini Municipality, KwaZulu-Natal, South Africa.
Source: Knowles and Theron (2010); Whitley (2012)

Furthermore, beliefs play an important role in shaping social dynamics within families and communities, influencing the distribution of roles and responsibilities, and thereby impacting household behaviour and decision-making (Sharaunga et al., 2013). Therefore, their inclusion in the study will provide insights into whether cultural worldviews drive NTFP dependence in the peri-urban communities.

However, these forms of capital do not exhaustively represent human endowment, and other forms can be identified (Scoones, 1998). Hence, this study considers psychological capital (Fig. 1), denoted as PsyC in the diagram. Psychological capital draws from the field of psychology known as positive organisational behaviour. It focuses on applying people's positive attributes (strengths and psychological capacities) that can be measured, developed, and managed for performance improvement (Luthans et al., 2007). According to Luthans and Youssef (2004),

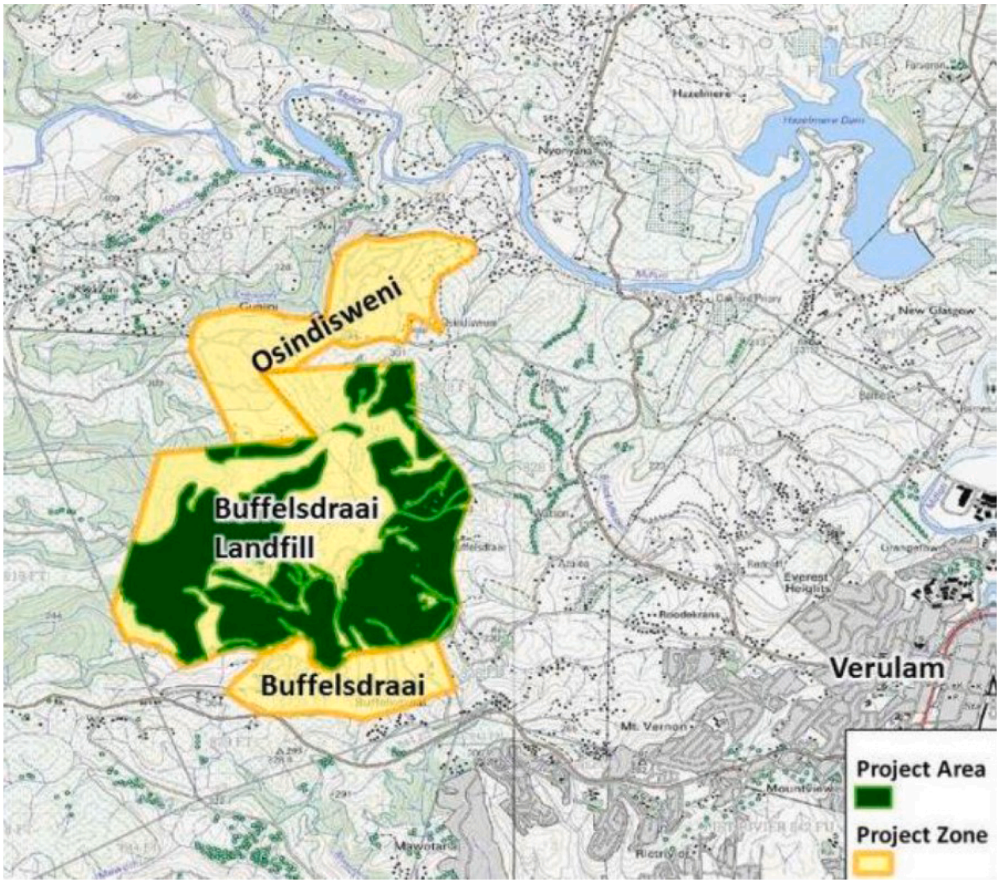

Fig. 2. (*continued*).

the positive organisational behaviour framework comprises psychological constructs such as hope, resilience, optimism, and self-efficacy, which, when combined, represent psychological capital. Unlike other forms of capital stated above, which focus on 'what you know (human capital) and whom you know (social capital)', psychological capital is concerned with 'who you are' (Luthans et al., 2004). A person has self-efficacy when they have confidence in their ability to summon the motivation, mental resources, and actions necessary to execute specific tasks (Bandura, 1997). Hope refers to an individual's ability to accomplish their goals through their sense of agency, and in turn, has the willpower to invest the required energy to achieve those goals (Snyder, 2002). Optimism is an individual's tendency to attribute favourable circumstances to internal and permanent causes and adverse events to external sources (Luthans and Youssef, 2004; Beattie, 2009). Resilience represents the individual's ability to rebound from adversity, uncertainty, and failure (Masten, 2001; Luthans et al., 2006). Therefore, psychological capital, as an additional component of livelihood endowment, will provide insights about the influence of positive psychological constructs on livelihood outcomes. Livelihood outcomes will depend on the optimal combination of these endowments, rather than relying on any single category (Krantz, 2001).

3.4. Empirical approach

3.4.1. Principal component analysis

Most studies generate large datasets, which often makes them challenging to interpret. Hence, a method is required to reduce their dimensionality for a simplified interpretation (Jolliffe and Cadima, 2016). PCA linearly transforms large data into a new, smaller set of uncorrelated variables called principal components (PCs), which, when ordered, typically account for most of the variation in the original variables (Dunteman, 1989). According to Essa and Nieuwoudt (2003), the transformation is as follows:

$$PC_1 = a_{i1}X_1 + a_{i2}X_2 + \ldots\ldots\ldots a_{ip}X_p \quad (1)$$

where PC_1 is the first PC; a_{i1}, a_{i2},……a_{ip} are the coefficients or loadings and X_1, X_2…..X_p are the observed original variables. The first PC, PC_1, captures the largest variance, and the second PC, PC_2, will have the second-largest variance if it is uncorrelated with PC_1 and the selection continues. X_p variables are converted into new uncorrelated variables, which account for as much variance as possible in descending order (Essa and Nieuwoudt, 2003). Therefore, PCA was applied to obtain indices using the indicators of psychological and social capital and values, following (Keshavarz et al., 2017; Chipfupa and Wale, 2018). PCs were obtained, and only dominant PCs, that is, PCs with eigenvalues greater than one, were retained. The Kaiser selection criterion was used to determine the number of PCs extracted, with eigenvalues greater than one selected (Yeomans and Golder, 1982). So, when PC loadings are obtained, the size of each indicates the variable's contribution to the PC's variance (Dunteman, 1989), and loadings greater than 0.4 were used in this study. The first PC typically contributes a greater share of the variation, and subsequently used in analyses, in this study, additional components were included to ensure that relevant and interesting dimensions were not lost.

3.4.2. Regression weights - NTFP dependence proxy

This study proxies NTFP dependence by creating a regression weighted index using Ordinary Least Squares (OLS) to derive weights. This practice has been followed previously (Wagstaff et al., 2007). The derivation expression for the index for each household is:

$$Y_i = \alpha + \sum_{j=1}^{k} \beta_j X_{ij} + \varepsilon_i \quad (2)$$

Where Y_i is the proxy of NTFP dependence, the intercept is represented by α in the regression model, and β_j and X_{ij} are the coefficient and NTFP dependence indicator for variable j in the model, respectively. Then, the index, which is the weighted sum of all indicators considered, is expressed as:

$$NTFPD_i = \sum_{j=1}^{k} \beta_j X_{ij} \quad (3)$$

Each regressor or NTFP dependence indicator, *Xij*, is weighted by the coefficient or marginal contribution to NTFP dependency. The inclusion and construction of the NTFP dependence index were based on relevant and empirically supported NTFP dependence variables. For instance, the frequency of NTFP collection was included to create the index. According to Tugume et al. (2017), frequent collection of NTFPs indicates the importance of NTFPs to rural households. Additionally, Shen et al. (2022) showed that NTFP collection frequency and effort were significantly important to communities adjacent to nature reserves. Regarding usage frequency, a significant number of households use NTFPs frequently to meet daily energy, food and shelter needs, which worsens when income is insufficient, increasing their consumption of NTFPs (Shackleton and Shackleton, 2004; Wale et al., 2022), suggesting that households' usage frequency of NTFPs is important to how they form their livelihood strategies. Apart from obtaining NTFPs from the forested area, opting for an additional source would suggest increased NTFP dependence of households (Wale et al., 2022). According to Wale et al. (2022), access to various forest locations and the collection of different NTFPs are important in sustaining livelihoods. Hence, additional NTFP sources indicate whether households can or have access to similar NTFPs from other areas other than the reforestation project site and were included in the NTFP dependence index. Therefore, the additional NTFP sources in the study indicate whether households obtained NTFPs from various sources, including buying from markets, collecting them from other forested areas, or cultivating them, indicating wider NTFP access and use, and therefore leading to higher NTFP dependence.

According to Tugume et al. (2017), the variety of NTFPs significantly influences the extent of NTFP dependence. Moreover, Shen et al. (2022) highlighted the various types of NTFPs collected over time, which included edible vegetables, medicinal plants, bamboo shoots, fruits, and mushrooms. Likewise, Wale et al. (2022) report on the various NTFPs consumed by rural households, including firewood, construction poles, traditional medicinal herbs, wild fruits and spinach, honey, and hunting activities, which highlights the importance of NTFP diversity and its uses in household livelihoods. The sale of NTFP was included in the index since it has been demonstrated to be an important source of household income. NTFP sales and purchases significantly contribute to household income, particularly among poorer households (Kaoma and Shackleton, 2015), suggesting that selling NTFPs is a key livelihood strategy and influences household NTFP dependence.

3.4.3. Empirical model

This study utilised OLS regression to analyse the relationship between the NTFP dependence and socio-economic variables. OLS regression was selected for its suitability for estimating linear relationships between the dependent variable, NTFP dependence index, and multiple independent variables. Given that the NTFP dependence index combines indicators into a composite score, using coefficients as weights, the index acts as a continuous variable, so OLS becomes an appropriate and practical choice for modelling. The model provides unbiased and efficient estimates under the assumptions of homoscedasticity and no multicollinearity. Even when assumptions such as the constant variance of errors are violated, the method remains robust, as adjustments like heteroskedasticity-robust standard errors can be applied. Following Gujarati (2009), the model is expressed as:

$$Y_i = \beta_0 + X_{1i}\beta_1 + X_{2i}\beta_2 + \ldots\ldots + \varepsilon_i \quad (4)$$

where Y_i is the NTFP dependence index for household *i*, X_i is a vector of socio-economic variables, β_0 is the intercept term, β_i is the coefficient to be estimated, and ε_i is a vector of error terms. For the analysis of NTFP dependence, the empirical model is specified as follows:

$$\begin{aligned} NTFPD_i = {} & \beta_0 + \beta_1(\text{ Age })_i + \beta_2(\text{ Gender })_i + \beta_3(\text{ Adultequivalents })_i + \beta_4(\text{ Education })_i + \beta_5(\text{ Socialgrant })_i \\ & + \beta_6(Off - farmincome)_i + \beta_7(On - farmincome)_i + \beta_8(Voucher)_i + \beta_9(Livestock)_i + \beta_{10}(Householdassets)_i + \\ & \beta_{11}(Agriculturalassets)_i + \beta_{12}(SCap)_i + \beta_{13}(Value)_i + \beta_{14}(PsycCap)_i + \beta_{15}(Distancetoforestedarea)_- + \varepsilon_i \end{aligned} \quad (5)$$

To ensure straightforward interpretation and comparison of the size effects of coefficients, all continuous variables were standardised before estimating the model. This involved transforming each variable into a z-score by minusing its mean and dividing it by its standard deviation. Then the coefficients are interpreted as the change in NTFP dependence when one of the explanatory variables has a one standard deviation. Education and distance to the forest are categorical variables and were included as dummy variables.

4. Results and discussions

4.1. Descriptive analysis of study variables

4.1.1. Measurement of NTFP indicator and socio-demographic variables

Presented in Table 2 below are the descriptive statistics of the variables used to construct a weighted NTFP dependence index from 226 household heads in the Buffelsdraai and Osindisweni communities. The mean frequency of collection per month for a respondent was 3.39, ranging from 1 to 20, suggesting that some household heads collect and depend on NTFPs to varying degrees. Additional NTFP sources had a mean of 1.89 with a range of 1 to 4, indicating that household heads get NTFPs from other sources. The variety of NTFPs used averages 2.86

Table 2
Variables used in NTFP dependence index construction.

Variables	Description of variables	Mean	Std. dev	Min	Max
Frequency of collection	Number of household visits to collect NTFPs per month (continuous)	3.39	2.69	1	20
NTFP source	Additional source of NTFPs (categorical)	1.89	0.66	1	4
NTFP variety	Number of different NTFPs collected (continuous).	2.86	1.49	1	9
NTFP market engagement	Sale of collected NTFPs (categorical)	0.17	0.38	0	1
NTFP usage	Level of NTFP utilisation (categorical)	2.13	0.67	1	3

Source: Household Survey Data (2018).

Table 3
Most commonly collected NTFPs.

Non-timber forest product	Percentage of households
Firewood	96.90
Untreated wooden poles	22.57
Traditional medicines	21.24
Edible plants	15.93
Mushrooms	44.25
Honey	22.12
Wild spinaches	45.13
Hunting animals	4.42
Grass for thatching	3.54
Sand	16.81
Grass for livestock	5.31
Other	1.33

Source: Household Survey Data (2018).

types. Moreover, 17 percent of household heads indicated that they sell NTFPs, as indicated by a mean of 0.17 for the binary variable indicating market participation. Regarding utilisation, the mean NTFP usage was 2.13 on a scale of 1 to 3, indicating that most households use NTFPs periodically during specific times in the year.

Respondents were asked to indicate the type of NTFPs collected in and around the reforestation project site. Table 3 presents the most commonly collected NTFPs and the proportion of respondents who harvest each NTFP. As shown in Table 3, fuelwood was harvested by 96.9 per cent of household respondents, followed by wild spinach, mushrooms, wooden poles, traditional medicine and honey. Fewer households engage in hunting, harvesting edible plants, or collecting grass for thatching or livestock feeding.

Regarding the explanatory variables in Table 4, the mean age of household heads was 49.39 years. The gender distribution revealed that a significant number of households in the communities are female-headed, accounting for 69.4 percent. Education had a mean of 2.24, social grants were R1 385.27 per household per month, and off– and on-farm income averaged R2 594.60 and R253.58 per month, respectively. The values of vouchers, livestock, household and agricultural assets range widely, with a range of up to R 76 500 for livestock and household assets, between R250 and R511 200. Household heads, on average, were 0.58 min from available electricity, indicating that a higher proportion of respondents had close access to electricity. Respondents generally live close to the forest, as the mean distance to the forested area is 2.04.

4.1.2. Measurement of psycho-social variables

Table 5 shows the psychological capital constructs and associated questions presented to community household heads. Measurement of this variable followed Luthans et al. (2007), who used a psychological capital questionnaire (PCQ) comprising 24 questions, each assessed on a 5-point Likert scale. For this study, the PCQ was adapted for use with respondents in a peri-urban context. Household heads were asked 12 questions, which were captured using a 5-point Likert scale. Household heads were asked to rate their level of agreement with a statement that applies to themselves. The results indicate that household heads had a higher mean, above 4, suggesting that they had high psychological capital in the form of self-efficacy, hope, optimism and resilience. The reliability test, as measured by Cronbach's alpha, yielded an overall value of 0.5.

Table 6 presents the household head's worldview constructs and related statements. Respondents were asked to indicate their level of agreement with a statement, captured using a 5-point Likert scale. The results indicate strong egalitarianism among household heads, as evidenced by their support for equal rights, fair wealth distribution, and equal opportunities, with affirmative action being found to be less important. Moreover, results show that for household heads, it is moderately to very important for people to have the freedom to do what they want in life and rely on themselves, but also show low importance on the 'precedence of individual interest over social interest', suggesting

Table 4
Socio-demographic characteristics of NTFP collectors.

Variables	Description of variables	Mean	Std. dev	Min	Max
Age	Age of household head in years (continuous)	49.39	12.38	27	87
Gender	Household head gender: 1= female, 0= otherwise	0.69	0.46	0	1
Adult equivalent	Equivalent adults in the household (continuous)	3791.99	1673.66	1000	8655
Education	Education level: (categorical)	2.24	0.79	1	4
Social grant	Government social grant per month (continuous)	1385.27	1273.79	0	6700
Off-farm income	Off-farm employment income per month (continuous)	2594.60	3810.18	0	19,500
On-farm income	On-farm employment income per month (continuous)	253.58	1428.32	0	15,000
Voucher	Value of voucher received per month (continuous)	765.10	1689.24	0	15,000
Livestock	Value of livestock owned (continuous)	2533.34	7887.77	0	76,500
Household assets	Value of household assets owned (continuous)	52,712.82	73,009.11	250	511,200
Agricultural assets	Value of agricultural assets owned (continuous)	1593.86	16,642.62	0	250,633
Electricity access	Distance to access electricity in minutes (continuous)	0.58	2.12	0	15
Distance to the forest	Walking distance to forest areas (categorical)	2.04	0.75	1	3
Psychological capital	PCA estimated index (see Table 4)	-	-	-	-
Worldviews	PCA estimated index (see Table 5)	-	-	-	-
Social capital	PCA estimated index (see Table 6)	-	-	-	-

Source: Household Survey Data (2018).

that they do not consider themselves people who put their needs and wants before those of society. Furthermore, respondents find the 'authority of hierarchy' moderately important, while 'top-down management', 'patriarchy' and 'technocracy' did not apply. Household heads did not hold fatalistic beliefs, with low scores for 'lack of control over your life' and 'events are predetermined', which suggests that households have a high sense of agency and control over their lives.

Table 7 summarises various social variables utilised to construct the

Table 5
Psychological capital constructs.

Psychological capital variables	Mean	Std. dev
Self-efficacy		
I am confident in raising and making recommendations during public gatherings	4.08	1.13
I am confident in my ability to deal with problems and come up with solutions	3.88	1.22
I am confident in approaching people external to my family and friends to discuss problems	4.28	1.06
I don't believe the government is responsible for the well-being of people in the community	3.02	1.47
Hope		
If I am faced with a problem, I can think of many ways to resolve it	4.43	0.68
I have hope that the quality of work and life will improve for the better	4.40	0.77
Currently, I am pursuing my goals in life	4.41	0.78
Optimism		
I am optimistic about my future	4.32	0.82
I do not give up easily	4.59	0.76
I always look on the bright side of living	4.57	0.56
Resilience		
I can deal with extreme weather events such as floods, droughts, high and cold temperatures, and wind occurrences	3.66	1.16
When I face a setback, I have no trouble recovering from it and moving on	4.45	0.81
Alpha (α)	0.50	

Source: Household Survey Data (2018).

Table 6
Worldviews constructs.

Cultural worldviews variables	Mean	Std. dev
Egalitarianism		
Equal rights	4.38	0.99
Equal wealth distribution	4.19	0.84
Affirmative action	3.79	1.35
Equal opportunities	4.29	1.01
Individualism		
Moral worth of an individual	3.52	1.25
Virtues of self-reliance	4.36	1.06
Value of personal independence	3.99	1.14
Precedence of individual interest over social interest	2.49	1.37
Hierarchism		
Authority of hierarchy	3.44	1.59
Top-down management	1.85	1.16
Patriarchy	1.91	1.42
Technocracy	2.52	1.64
Fatalism		
Lack of control over your life	1.75	1.17
Events are predetermined	2.24	1.58

Source: Household Survey Data (2018).

social capital composite index. Respondents, on average, have been in the communities for 21 years, with a range of 1 to 87 years, indicating that the communities have both new arrivals and long-term members. Trust levels among community members are moderate, with slight variations. Household heads generally have fewer people and family members they can turn to in the community, with some having no one. The results indicate that respondents receive financial and food assistance, with the majority primarily receiving help from family members. Though it is moderate, friends and neighbours also offer financial and food support to households. However, some household heads engage with fewer social or community groups and have low dependence on them, as well as on micro-lenders or banks, for food or financial assistance, indicating that these groups may serve primarily for social interaction or savings. The considerable variation in annual cash contributions to groups is evident. Respondents are generally confident and comfortable participating in community activities. Additionally, most household heads prefer living in the community and are content with

Table 7
Social capital constructs.

Social capital variables	Description of variables	Mean	Std. dev	Min	Max
Community relationships					
Years in the community	Number of years the household has been in the community (continuous)	21.31	15.58	1	87
Trust of community members	Level of trust of the household for community members (categorical)	3.35	1.13	1	5
People you can turn to in the community	Number of people a household can turn to (continuous)	2.45	1.22	0	5
Family members you can turn to	Number of family members a household can turn to (continuous)	3.52	1.64	1	5
Social assistance					
Financial assistance from family members	The level to which the social assistance statement applies to a household (categorical)	2.69	1.47	1	5
Financial assistance from friends		2.72	1.45	1	5
Financial assistance from neighbours		2.67	1.46	1	5
Financial assistance from a group we're part of		2.20	1.49	1	5
Financial assistance from micro lenders or banks		2.39	1.55	1	5
Family runs out of food, and we get it from other family members		3.55	1.63	1	5
Family runs out of food, and we get it from friends		2.48	1.45	1	5
Family runs out of food, and we get it from the neighbours		2.53	1.48	1	5
Family runs out of food, and we get it from a group we're part of		1.42	0.84	1	5
Social networks/groups					
Social groups in households are part of	Number of social groups the household is a part of (continuous)	2.47	1.05	1	5
Cash contribution to groups	Household cash contribution to groups per year (rands)	3375.27	6110.74	0	78,000
Community involvement					
Comfortable and confident in approaching organisations	The level to which the community engagement statement applies to a household (categorical)	4.32	1.14	1	5
Ability to influence events		3.80	1.09	1	5

(*continued on next page*)

Table 7 (*continued*)

Social capital variables	Description of variables	Mean	Std. dev	Min	Max
Informed about local and national matters		3.71	1.03	1	5
Meet public officials and participate in local meetings		3.84	1.01	1	5
Participate in local and national elections		4.66	0.95	1	5
Perceptions about community					
Happy with social customs in the community	The level to which the community perception	3.36	1.24	1	5
Happy with service delivery in the community	statement applies to a household (categorical)	2.89	1.3	1	5
I like living in the community		4.10	1.17	1	5
Not concerned about the level of crime in the community		2.43	1.24	1	5

Source: Household Survey Data (2018).

the social customs. But some are not pleased with municipal service delivery and the level of crime in the community.

4.2. Psycho-social attributes

In Table 8, the PCA of psychological capital constructs yielded four PCs with eigenvalues greater than one, meeting the Kaiser criterion, which explains a cumulative 55 percent of the total variance in the data. The first PC, $PsyCap_1$, accounted for 20.5 percent of the variation in the data, suggesting that household heads had high levels of optimism about the future. The PC had dominant loadings related to hope, indicating that respondents were hopeful about witnessing improvements in the quality of work and life. Additionally, the loadings indicate that household heads are actively pursuing life goals. Further indicating an optimistic outlook and a proactive attitude toward achieving personal aspirations.

For $PsyCap_2$, the dominant component loadings were associated with psychological capital indicators of self-efficacy. In this PC, community members are confident in participating in discussions at public gatherings and in their ability to handle problems and present solutions. This dimension suggests that household heads feel empowered and find it worthwhile to engage others and solve problems. Table 8 shows that with $PsyCap_3$, the negative dominant component loading was on the self-efficacy dimension and positive on the psychological capital dimension, resilience. This suggests that, although respondents are resilient and able to endure extreme weather conditions, they also exhibit lower self-efficacy due to an increasing perception that the government is responsible for their well-being. In the PC, $PsyCap_4$, two positive dominant component loadings were associated with the resilience dimension, and one negative dominant loading was associated with self-efficacy. This component suggests that household heads who experience extreme weather conditions and recover quickly from setbacks tend to show less interest and confidence in engaging with individuals or entities to address their challenges.

In Table 9, following the Kaiser criterion, four PCs for cultural worldviews were derived, each with an eigenvalue greater than one, collectively representing 58 percent of the total variation in the data. The first PC, $Value_1$, explained 17 percent of the variation and exhibited

Table 8
Dimensions of psychological capital.

Psychological capital variables	Principal components			
	$PsyCap_1$	$PsyCap_2$	$PsyCap_3$	$PsyCap_4$
Self-efficacy				
I am confident in raising and making recommendations during public gatherings	−0.077	**0.601**	−0.168	0.081
I am confident in my ability to deal with problems and come up with solutions	−0.144	**0.587**	0.039	−0.185
I am confident in approaching people external to my family and friends to discuss problems	0.149	0.262	0.197	**−0.419**
I do not believe the government is responsible for the well-being of people in the community	0.121	−0.105	**−0.556**	0.236
Hope				
If I am faced with a problem, I can think of many ways to resolve it	0.139	0.368	−0.258	0.012
I have hope that the quality of work and life will improve for the better	**0.420**	0.011	−0.370	0.099
Currently, I am pursuing my goals in life	**0.465**	0.172	−0.004	0.070
Optimism				
I am optimistic about my future	**0.509**	−0.015	0.015	0.013
I do not give up easily	0.305	−0.085	0.321	−0.373
I always look on the bright side of living	0.323	−0.052	0.013	−0.242
Resilience				
I can deal with extreme weather events such as floods, droughts, high and cold temperatures, and wind occurrences	0.034	0.189	**0.403**	**0.596**
When I face a setback, I have no trouble recovering from it and moving on	0.258	0.049	0.391	**0.401**
Eigenvalue	2.46	1.72	1.31	1.12
Percentage of Variation	20.48	14.33	10.89	0.093
Cumulative Percentage	20.48	34.81	45.70	55.03
Bartlett test of sphericity:				
Chi-square	359.33			
Degrees of freedom	66			
P-value	0.000			
Kaiser-Meyer-Olkin (KMO)	0.670			

Note: PC loadings greater |0.4| are highlighted in bold.
Source: Household Survey Data (2018).

dominant loadings in the hierarchism dimension. This suggests that household heads place considerable importance and respect on the authority of hierarchies. Moreover, $Value_2$ has two positive dominant loadings for variables on individualistic and fatalistic values. This suggests that household heads emphasise personal independence, reflecting their individualistic nature. Additionally, they hold beliefs in predetermined events, indicating a fatalistic worldview.

$Value_3$ had two dominant loadings on variables related to fatalism and egalitarianism. The strong positive loading on the 'lack of control over your life' variable indicates that households have limited personal agency or control over their circumstances. A negative loading on the 'equal rights' variable suggests that when households are fatalistic, egalitarianism is lower amongst households. So, community members' worldviews are shaped by feelings of powerlessness rather than a sense of equality. In Table 9, positive dominant loadings were obtained for the virtues of self-reliance and technocracy variables in Value4, indicating a combination of technocratic and individualistic worldviews among household heads. This further suggests that households value technical expertise and professionals and hold individualistic values of independence and personal responsibility.

In Table 10, the first PC, $SCap_1$, contributed 14.69 percent to the variation in the data. Considering PC loadings greater than 0.4, the dominant loadings were associated with variables related to social assistance. This suggests that some respondents in this PC receive

Table 9
Dimensions of worldviews.

Cultural worldviews variables	Principal components			
	$Value_1$	$Value_2$	$Value_3$	$Value_4$
Egalitarianism				
Equal rights	0.243	0.125	**−0.404**	0.063
Equal wealth distribution	0.307	−0.061	−0.183	0.116
Affirmative action	0.392	−0.118	0.095	−0.263
Equal opportunities	0.345	0.059	−0.265	0.100
Individualism				
Moral worth of an individual	0.360	0.297	−0.039	−0.082
Virtues of self-reliance	0.215	−0.039	−0.293	**0.439**
Value of personal independence	−0.122	**0.422**	−0.315	0.294
Precedence of individual interest over social interest	−0.213	0.352	0.047	0.357
Hierarchism				
Authority of hierarchy	**0.422**	−0.107	−0.030	−0.192
Top-down management	0.231	0.278	0.348	0.121
Patriarchy	0.213	−0.348	0.215	0.367
Technocracy	0.023	−0.333	0.167	**0.490**
Fatalism				
Lack of control over your life	0.185	0.146	**0.507**	0.233
Events are predetermined	0.163	**0.479**	0.289	−0.091
Eigenvalue	2.33	2.15	2.00	1.61
Percentage of variation	16.67	15.38	14.30	11.52
Cumulative percentage	16.67	32.05	46.36	57.87
Bartlett test of sphericity:				
Chi-square	706.25			
Degrees of freedom	91			
P-value	0.000			
Kaiser-Meyer-Olkin (KMO)	0.713			

Note: PC loadings greater |0.4| are highlighted in bold.
Source: Household Survey Data (2018).

financial assistance from family and friends. Moreover, $SCap_2$ had a positive dominant loading on a variable related to perceptions about the community, specifically whether they are happy with service delivery. This finding suggests that household heads are generally satisfied with the local government's service delivery. The third PC, $SCap_3$, was dominated by a variable related to social assistance. This suggests that social groups within the community are beneficial for some household heads, as they can turn to these groups for support when food runs out. Regarding SCap5, Table 10 indicates that the dominant loading involves social groups/networks. This shows that groups and public life are essential for respondents, and they value being part of multiple social groups and contribute financially (or otherwise) to these groups.

$SCap_6$ had two dominant component loadings, with positive and negative signs, highlighting community perception and social assistance. The findings indicate that respondents were more likely to seek support from other family members when facing food shortages and expressed dissatisfaction with the level of service delivery within the community. $SCap_7$ explained 6.17 percent of the variation in the data, with a dominant positive loading that highlighted community involvement, suggesting that household heads participate in local and national elections, indicating their engagement in public processes. Furthermore, in Table 10, the dominant loading in $SCap_8$ explained 5.16 percent of the variation in the data, which was negative and related to social assistance. This indicated that household heads were unwilling to turn to social groups they were part of for financial assistance. Regarding the ninth PC, $SCap_9$ had dominant loading with a negative sign related to community perception, suggesting some household heads residing in the community tend to have a negative perception and attitude about living in the community.

4.3. Factors shaping non-timber forest product dependence

This section examines the factors influencing NTFP dependency in the Buffelsdraai and Osindisweni communities. The OLS regression model was estimated using the weighted variable, NTFP dependence, and socio-economic factors. Furthermore, model diagnostics were conducted to assess the model's suitability. Variance Inflation Factors (VIF) were calculated to check for multicollinearity among the variables, and the means of the VIFs were below the threshold of 10, indicating no significant multicollinearity issues (Gujarati, 2009). Additionally, robust standard errors were estimated to account for heteroscedasticity (Table 11).

The findings in Table 11 indicate that the number of adult equivalents has a positive effect on NTFP dependence. This observation is associated with the various components of NTFP dependency, suggesting that larger households with a significant number of active adults tend to utilise a broader range of NTFPs to fulfil their needs. Additionally, larger households are better endowed with labour and are better positioned to maintain collection schedules, further enhancing their reliance on forest resources. Households with more adults often rely on firewood for their energy needs, even with access to electricity, as the latter may be insufficient for cooking or heating. This finding aligns with the conclusions drawn by Heubach et al. (2011), who identified household size as a factor influencing NTFP dependency, particularly in rural contexts. Similarly, Suleiman et al. (2017) showed that households with more adults could provide the labour necessary for accessing and efficiently utilising NTFPs and other forest resources.

The results also show a statistically significant and negative relationship between household assets, indicating that wealthier households are less dependent on NTFPs. Households heads with more assets have better access to alternative resources and livelihood options, reducing their dependence on forests for daily sustenance or income. Asset-endowed households will likely utilise modern energy sources, thereby reducing their reliance on NTFPs for energy (Wale et al., 2022). This finding is further supported by Mamo et al. (2007), who also found that asset-endowed households engage less in NTFP extraction, as these households can invest in higher-income opportunities, such as farming and off-farm employment, and afford substitute NTFPs, like firewood. Furthermore, a statistically significant positive relationship exists between agricultural assets and dependence on NTFPs. Households heads engaged in agricultural activities rely on NTFPs to support farming activities. Wale et al. (2022) emphasise that forests are important agricultural inputs, particularly in resource-constrained rural areas where households rely on forests for energy.

Electricity access had a positive and statistically significant relationship with NTFP dependence. Despite high electrical connectivity (Table 4), the result implies that households still utilise NTFPs. Studies (Kaoma and Shackleton, 2015; Guild and Shackleton, 2018) have revealed that NTFP markets for fuelwood are widespread in areas with good electrical connectivity, suggesting that increased electrical access does not reduce NTFP consumption; households remain strongly reliant due to the high cost of electricity and unstable supply. This indicates that electrical connectivity does not entirely replace NTFP use in Buffelsdraai and Osindisweni, but rather households combine their energy use. According to Shackleton (2015), such households would use firewood for cooking and heating, as well as electricity for lighting and home appliances.

In Table 11, the positive and significant coefficients for SCap1, SCap2, and SCap7 indicate that social capital influences the NTFP dependence of household heads. This suggests that respondents who receive financial assistance from family and friends, have positive community perceptions, and actively participate in civic activities are likely to depend on NTFPs. Financial assistance from close social networks could indicate that household heads with limited income likely depend on NTFPs for subsistence. Moreover, the positive perception of community service delivery could indicate the presence of trusted and engaged local institutions that enable NTFP collection and use through knowledge sharing, increasing NTFP dependence. Additionally, for respondents, being active in civic matters creates stronger social networks that promote information sharing and collective action, enabling them to access forest resources more effectively, which in turn increases their

Table 10
Dimensions of social capital.

Social capital variables	Principal components								
	$SCap_1$	$SCap_2$	$SCap_3$	$SCap_4$	$SCap_5$	$SCap_6$	$SCap_7$	$SCap_8$	$SCap_9$
Community relationships									
Number of years in the community	−0.011	0.029	−0.137	0.312	−0.141	−0.214	−0.247	0.497	0.238
Level of trust of community members	−0.039	0.386	0.133	0.166	−0.041	0.080	0.241	−0.015	−0.265
Number of people you can turn to in the community	0.273	0.185	−0.003	0.124	0.094	0.135	0.088	0.067	−0.276
Number of family members you can turn to	0.261	0.134	−0.381	0.202	−0.142	0.230	−0.020	0.051	0.241
Social assistance									
Financial assistance from family members	**0.432**	0.034	0.023	−0.145	0.131	−0.029	−0.178	0.000	−0.064
Financial assistance from friends	**0.425**	0.038	0.056	−0.158	0.153	−0.041	−0.159	−0.007	−0.063
Financial assistance from neighbours	0.346	0.099	0.147	−0.105	0.060	0.004	0.022	−0.019	0.059
Financial assistance from a group we're part of	0.031	−0.078	0.311	0.362	0.137	0.026	0.043	**−0.429**	0.134
Financial assistance from micro lenders or banks	−0.064	−0.065	0.169	−0.101	0.394	−0.094	0.244	0.385	0.386
Family runs out of food, and we get it from other family members	0.179	0.105	−0.288	0.247	−0.194	**0.433**	0.113	0.019	0.255
Family runs out of food, and we get it from friends	0.353	0.067	0.102	−0.217	−0.096	0.099	−0.063	0.098	−0.088
Family runs out of food, and we get it from neighbours	0.128	0.138	0.366	−0.169	−0.093	0.219	0.318	0.136	0.155
Family runs out of food, and we get it from a group we're part of	0.171	−0.191	**0.438**	0.314	−0.080	−0.045	0.007	0.044	0.095
Social networks/groups									
Number of social groups in households is part of	0.102	0.109	−0.217	0.216	**0.493**	−0.108	−0.057	−0.008	−0.039
Annual cash contribution to groups	0.055	0.048	−0.094	0.359	0.358	−0.087	−0.022	−0.246	−0.079
Community involvement									
Comfortable and confident in approaching organisations	−0.143	0.321	−0.106	−0.301	0.197	0.091	−0.172	−0.161	0.234
Ability to influence events	−0.140	0.273	0.064	0.064	0.343	0.142	−0.186	0.052	0.257
Informed about local and national matters	−0.192	0.194	0.259	0.259	−0.008	0.229	−0.324	0.251	−0.161
Meet public officials and participate in local meetings	−0.167	0.247	0.231	0.231	0.092	0.273	−0.096	0.161	−0.116
Participate in local and national elections to vote	0.000	−0.079	−0.155	0.044	0.209	0.039	**0.625**	0.183	−0.021
Perceptions about community									
Happy with social customs in the community	0.056	0.385	0.061	0.044	−0.131	−0.396	0.165	−0.172	0.205
Happy with service delivery in the community	0.019	**0.411**	0.064	0.047	−0.258	**−0.402**	0.023	−0.063	0.192
I like living in the community	−0.074	0.271	−0.149	−0.067	0.002	−0.201	0.149	0.206	**−0.450**
Not concerned about the level of crime in the community	0.186	−0.134	0.045	0.129	0.078	−0.286	−0.116	0.308	−0.068
Eigenvalue	4.18	2.39	1.69	1.56	1.42	1.32	1.24	1.10	1.03
Percentage of Variation	14.69	7.4	7.37	7.25	6.95	6.31	6.17	5.16	5.14
Cumulative Percentage	14.69	22.09	29.45	36.71	43.66	49.96	56.14	61.30	66.44
Bartlett test of sphericity:									
Chi-square	1807.33								
Degrees of freedom	276								
P-value	0.000								
Kaiser-Meyer-Olkin (KMO)	0.635								

Note: PC loadings greater |0.4| are highlighted in bold.
Source: Household Survey Data (2018).

dependence on NTFPs. These findings align with studies (Agrawal and Gibson, 1999; Newton et al., 2016), which showed that social capital, in the form of trust and a sense of connectedness to institutions, facilitates cooperation and the collective management of natural resources, and that social networks can increase NTFP dependence by increasing access to resources, knowledge, and collective bargaining opportunities.

$Value_3$ is negative and statistically significant, suggesting that fatalistic and egalitarian respondents have lower NTFP dependence. This appears counterintuitive. For example, Sharaunga et al. (2013) found that rural households experiencing marginalisation and a lack of agency often resort to communal resources, such as forests, for their livelihoods. Nevertheless, a likely explanation is that household heads may believe they are disempowered and marginalised, and thus withdraw from NTFP activities, particularly considering the access restrictions on the project site, which eases pressure on the forest and lowers NTFP dependence. This finding aligns with several studies (Masozera and Alavalapati, 2004; Heubach et al., 2011) that have found restricted forest access reduces NTFP activities but raises conflicts and food insecurity among rural households. However, when access restrictions are implemented in consultation with traditional and local government leadership and communities, environmental marginalisation decreases, and forest management strengthens (Angelsen and Wunder, 2003; Fabricius and Collins, 2007). Proximity to urban centres might present respondents with alternative livelihoods, such as wage employment, enabling them to shift from forest-based activities and reduce their dependence on NTFPs. In peri-urban areas, urbanisation grants households opportunities to diversify their incomes through participation in urban markets (Shackleton et al., 2011; Wale et al., 2022).

5. Conclusions and policy recommendations

This study examined the determinants of NTFP dependence in peri-urban communities in Durban, South Africa. Results from the PCA on psychological capital constructs indicated that components with dominant loadings were related to indicators of optimism, proactiveness, and interest in engaging people in resolving problems. However, a negative dominant component loading on the self-efficacy dimension suggests that self-efficacy is limited in some respondents. Therefore, policies should ensure that entry to participation in reforestation activities is easy, to build confidence and feelings of achievement for people with low self-efficacy who might feel incapable of causing any change. Furthermore, participating households should be recognised for their contributions publicly to strengthen personal agency and raise motivation. Regarding cultural worldviews, PCA identified dominant loadings on individualism indicators. PC loadings were also high for the hierarchical dimension, suggesting that household heads place importance on hierarchy and authority. Another component had a dominant loading on fatalism variables. To appeal to the fatalistic, media messaging should emphasise the benefits of reforestation, such as the buffering effects of the planted trees against landfill and the carbon sequestration resulting from the project, to show that tree-planting activities can lead to tangible results. Additionally, media designs should include traditional leaders, ward councillors, and experts so that they can publicly endorse

Table 11
Standardised regression estimates of factors shaping NTFP dependence.

Explanatory variables	NTFP dependence		
	Standardised coefficient	Robust std. errors	$P>\|t\|$
Age	−0.059	0.075	0.432
Gender	0.049	0.063	0.431
Adult equivalent	0.223***	0.081	0.007
Education			
No schooling	0.406	0.399	0.311
Primary school	0.462	0.354	0.194
Secondary school	0.372	0.365	0.310
Social Grant	−0.015	0.083	0.853
Off-farm income	−0.064	0.078	0.414
On-farm income	0.001	0.049	0.978
Voucher	0.026	0.073	0.724
Livestock	0.049	0.056	0.383
Household assets	−0.174***	0.056	0.002
Agricultural assets	0.120***	0.028	0.000
Electricity access	0.149**	0.060	0.013
Distance to the forest			
<30min	−0.128	0.181	0.479
30–60min	0.064	0.162	0.693
$SCap_1$	0.181**	0.091	0.048
$SCap_2$	0.126*	0.076	0.097
$SCap_3$	0.076	0.072	0.293
$SCap_5$	0.087	0.075	0.248
$SCap_6$	−0.079	0.079	0.321
$SCap_7$	0.137*	0.073	0.064
$SCap_8$	0.054	0.065	0.413
$SCap_9$	−0.012	0.072	0.865
$Value_1$	0.119	0.074	0.110
$Value_2$	−0.082	0.083	0.328
$Value_3$	−0.165*	0.089	0.067
$Value_4$	−0.001	0.075	0.985
$PsyCap_1$	−0.097	0.078	0.216
$PsyCap_2$	−0.033	0.074	0.653
$PsyCap_3$	0.028	0.074	0.706
$PsyCap_4$	−0.055	0.084	0.516
Constant	−0.402	0.380	0.292
Number of observations	226		
F (32, 193)	17.94		
R-squared	0.294		
Prob > *F*	0.000		
Mean VIF	4.29		

Note: ***, ** and * refer to significance at 1 percent, 5 percent and 10 percent, respectively.
Source: Household Survey Data (2018).

and legitimise such projects, which would attract and encourage people from hierarchical backgrounds to participate.

PCA findings on social capital showed that household heads turn to family and friends for financial assistance. Household heads indicated experiencing food shortages and turning to social groups for help. However, they were reluctant to ask for financial support from these groups, despite having contributed financially or otherwise. Public life was meaningful, as evidenced by active participation in local and national elections. Even so, there is unhappiness with service delivery in the community, and many household heads have indicated they do not like living in their communities. These factors could prevent cooperation and a sense of shared responsibility and ownership for the project. Therefore, relevant stakeholders can connect social groups to the project by assigning specific and clear roles in the reforestation project.

Regression estimates indicate that NTFP dependence increases with the presence of more adults, a better agricultural endowment, access to electricity, social capital related to strong personal social networks, positive perceptions about the community, and active civic engagement. The significance of the number of adult equivalents suggests that policy should ensure that larger households diversify their livelihood strategies by starting food gardens, and that the PES scheme include skills development training. This will enable these households to acquire marketable skills and secure employment, therefore decreasing the pressure on the forested area. Regarding agricultural assets, policies should support households in cultivating economically viable NTFP crop species in home gardening and linking them to markets.

Furthermore, the significance of electricity indicates that households need to be supported in transitioning away from firewood and incorporating electricity connectivity with alternative energy sources for cooking. Households need to be encouraged to join and form rotating savings clubs (i.e., stokvels), as these will serve as reliable sources of funds in times of emergency. Nevertheless, household endowment, fatalistic, and egalitarian worldviews negate NTFP dependence. This suggests that policy should support households with fewer assets to reduce their NTFP dependence through market-relevant technical skills training. Additionally, to encourage household heads with fatalistic attitudes to participate, project managers can use and refer to successful participants in the reforestation project to demonstrate the outcomes of consistent effort. This will build their agency, increase participation, and lower dependence on NTFPs.

The study was limited in that the NTFP dependence index relies on self-reported behavioural data, and that data on income or imputed value were not included, which could introduce recall bias where household respondents may over- or under-report. It can affect accuracy, misrepresent the economic significance of NTFPs, and limit the generalisability of the study relative to research using income as a measure. Therefore, future research should consider including behavioural indicators of NTFP dependence, along with income or imputed value, to provide a broader measure of NTFP dependence. Furthermore, the long-term livelihood impacts of the reforestation project should be addressed A longitudinal study would be necessary to determine whether the project has decreased NTFP dependence in established forested areas while improving community livelihoods. Moreover, future studies must assess community involvement and perceptions through time. Such a study could provide valuable insights into engagement, attitudes, and trust, offering project stakeholders feedback on the project and the opportunity to refine approaches for a more positive societal impact. Additionally, future studies can assess NTFP dependence by comparing rural and peri-urban areas. Due to rapid urbanisation, it is becoming important to understand the spread of NTFP dependence in the country. This could provide insights into the effects of location and access to infrastructure, changing socioeconomics, and the relevance of psychological capital and cultural worldviews.

For peri-urban people dependent on various NTFPs for their livelihood wellbeing, limiting the harvesting of NTFPs to address environmental management concerns comes at a cost to their livelihoods. Therefore, ecological restoration and PES become important in safeguarding and improving livelihoods while reducing dependence on NTFPs through payments for this loss. The findings that cultural worldview and social capital factors explain NTFP dependence indicate a need also to adopt a behavioural approach that focuses on the sociocultural aspects of ecological restoration and PES programmes in peri-urban communities. Including these factors in PES programmes will ensure that incentives align with community values and existing social networks, which will encourage participation in sustainably using, restoring, and better managing forest resources that peri-urban people live near, thereby increasing the effectiveness of such programmes.

Ethics statement

The study involving human participants was reviewed and fully approved by the University of KwaZulu-Natal, Humanities and Social Sciences Research Ethics Committee (reference number: HSS/0614/018D), South Africa.

Respondents gave their written consent to participate in this study.

Funding

We gratefully acknowledge the funding, data collection support, and guidance of the Environmental Planning and Climate Change Protection

Department in the eThekwini Municipality through the "Buffelsdraai Landfill Site Community Reforestation Project" in South Africa.

CRediT authorship contribution statement

Karabo Donald Munonde: Writing – original draft, Methodology, Formal analysis, Data curation, Conceptualization. **Edilegnaw Wale Zegeye:** Writing – review & editing, Supervision, Formal analysis.

Declaration of competing interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests:

Karabo Donald Munonde reports administrative support was provided by eThekwini Municipality, Environmental Planning and Climate Change Protection Department. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

The authors are grateful to the Environmental Planning and Climate Change Protection Department in the eThekwini Municipality, Durban, for their support and guidance in data collection, which enabled the completion of this work on the Buffelsdraai Landfill Site Community Reforestation Project in South Africa.

Data availability

Data will be made available on request.

References

Agrawal, A., Gibson, C.C., 1999. Enchantment and disenchantment: the role of community in natural resource conservation. World Dev. 27 (4), 629–649. https://doi.org/10.1016/S0305-750X(98)00161-2.

Angelsen, A., Wunder, S., 2003. Exploring the forest-poverty link. CIFOR Occas. Pap. 40, 1–20.

Arnold, J.E., 2001. For. people: 25 years community for.

Babulo, B., Muys, B., Nega, F., Tollens, E., Nyssen, J., Deckers, J., Mathijs, E., 2009. The economic contribution of forest resource use to rural livelihoods in tigray, northern ethiopia. For. Policy Econ. 11 (2), 109–117. https://doi.org/10.1016/j.forpol.2008.10.007.

Bandura, A., 1997. Self-Efficacy: The Exercise of Control. Macmillan.

Barnes-Mauthe, M., Oleson, K.L.L., Brander, L.M., Zafindrasilivonona, B., Oliver, T.A., van Beukering, P., 2015. Social capital as an ecosystem service: evidence from a locally managed marine area. In: Ecosystem Services, 16, pp. 283–293. https://doi.org/10.1016/j.ecoser.2014.10.009.

Beattie, G., 2009. Optimism bias and climate change. Psychology. 29, 1–12.

Belcher, B., Ruíz-Pérez, M., Achdiawan, R., 2005. Global patterns and trends in the use and management of commercial ntfps: implications for livelihoods and conservation. World Dev. 33 (9), 1435–1452. https://doi.org/10.1016/j.worlddev.2004.10.007.

Belcher, B.M., Vantomme, P., 2003. What isn't an ntfp? Int. For. Rev. 5 (2), 161–168.

Beyene, A.D., 2011. Forest dependency, property rights and local level institutions: Empirical evidence from ethiopia.

Buxton, M., 2022. Chapter 3 - connecting peri-urban theory with policy: implications for practice. In: Pereira, P., Gomes, E., Rocha, J. (Eds.), Mapping and Forecasting Land Use. Elsevier, pp. 55–94. https://doi.org/10.1016/B978-0-323-90947-1.00005-3.

Byron, N., Arnold, M., 1999. What futures for the people of the tropical forests? World Dev. 27 (5), 789–805. https://doi.org/10.1016/S0305-750X(99)00025-X.

Cavendish, W., 2000. Empirical regularities in the poverty-environment relationship of rural households: evidence from zimbabwe. World Dev. 28 (11), 1979–2003. https://doi.org/10.1016/S0305-750X(00)00066-8.

Chan, K.M., Guerry, A.D., Balvanera, P., Klain, S., Satterfield, T., Basurto, X., Bostrom, A., Chuenpagdee, R., Gould, R., Halpern, B.S., 2012a. Where are cultural and social in ecosystem services? A framework for constructive engagement. Bioscience 62 (8), 744–756. https://doi.org/10.1525/bio.2012.62.8.7.

Chan, K.M., Satterfield, T., Goldstein, J., 2012b. Rethinking ecosystem services to better address and navigate cultural values. Ecol. Econ. 74, 8–18. https://doi.org/10.1016/j.ecolecon.2011.11.011.

Chazdon, R.L., 2008. Beyond deforestation: restoring forests and ecosystem services on degraded lands. Science 320 (5882), 1458–1460. https://doi.org/10.1126/science.1155365.

Chipfupa, U., Wale, E., 2018. Farmer typology formulation accounting for psychological capital: implications for on-farm entrepreneurial development. Dev Pr. 28 (5), 600–614. https://doi.org/10.1080/09614524.2018.1467377.

Cocks, M.L., Wiersum, K.F., 2003. The significance of plant diversity to rural households in eastern cape province of south africa. For. Trees Livelihoods 13 (1), 39–58. https://doi.org/10.1080/14728028.2003.9752443.

Douwes E., Buthelezi N., Winn R., Alli F., Mavundla K., Zungu B., Muirhead K. (2017). *Seeing the wood for the trees: Forest restoration at the buffelsdraai regional landfill site, durban, south africa.*

Douwes, E., Roy, K., Deiderichs-Mander, N., Mavundla, K., Roberts, D., 2015. The Buffelsdrai Landfill Site Community Reforestation Project: Leading the Way in Community Ecosystem-Based Adaptation to Climate Change. eThekwini Municipality, Durban, South Africa.

Dovie, D.B., Shackleton, C.M., Witkowski, T., 2002. Direct-use values of woodland resources consumed and traded in a south african village. Int. J. Sustain. Dev. World Ecol. 9 (3), 269–283. https://doi.org/10.1080/13504500209470122.

Dunteman, G.H., 1989. Principal Component Analysis. Sage Publications.

Engel, S., Pagiola, S., Wunder, S., 2008. Designing payments for environmental services in theory and practice: an overview of the issues. Ecol. Econ. 65 (4), 663–674. https://doi.org/10.1016/j.ecolecon.2008.03.011.

Essa, J.A., Nieuwoudt, W.L., 2003. Socio-economic dimensions of small-scale agriculture: a principal component analysis. Dev. South. Afr. 20 (1), 67–73. https://doi.org/10.1080/0376835032000065462.

Fabricius, C., Collins, S., 2007. Community-based natural resource management: governing the commons. Water. Policy. 9 (S2), 83–97. https://doi.org/10.2166/wp.2007.132.

Fisher, M., 2004. Household welfare and forest dependence in southern malawi. Env. Dev Econ 9 (2), 135–154. https://doi.org/10.1017/S1355770X03001219.

Garekae, H., Thakadu, O.T., Lepetu, J., 2017. Socio-economic factors influencing household forest dependency in chobe enclave, botswana. Ecol. Process. 6, 1–10. https://doi.org/10.1186/s13717-017-0107-3.

Glenday, J., 2007. Carbon storage and sequestration analysis for the ethekwini environmental services management plan open space system.

Guild, J., Shackleton, C., 2018. Informal urban fuelwood markets in south africa in the context of socio-economic change. Energy Policy 117, 136–141. https://doi.org/10.1016/j.enpol.2018.03.023.

Gujarati, D.N., 2009. Basic Econometrics. Tata McGraw-Hill Education.

Handavu, F., Chirwa, P.W.C., Syampungani, S., 2019. Socio-economic factors influencing land-use and land-cover changes in the miombo woodlands of the copperbelt province in zambia. For. Policy Econ. 100, 75–94. https://doi.org/10.1016/j.forpol.2018.10.010.

Heubach, K., Wittig, R., Nuppenau, E.-A., Hahn, K., 2011. The economic importance of non-timber forest products (ntfps) for livelihood maintenance of rural west african communities: a case study from northern benin. Ecol. Econ. 70 (11), 1991–2001. https://doi.org/10.1016/j.ecolecon.2011.05.015.

Hoogstra-Klein, M.A., Permadi, D.B., Yasmi, Y., 2012. The value of cultural theory for participatory processes in natural resource management. For. Policy Econ. 20, 99–106. https://doi.org/10.1016/j.forpol.2011.12.001.

Illukpitiya, P., Yanagida, J.F., 2008. Role of income diversification in protecting natural forests: evidence from rural households in forest margins of sri lanka. Agrofor. Syst. 74 (1), 51–62. https://doi.org/10.1007/s10457-008-9153-2.

Jolliffe, I.T., Cadima, J., 2016. Principal component analysis: a review and recent developments. Philos. Trans. R. Soc. A: Math. Phys. Eng. Sci. 374 (2065), 20150202. https://doi.org/10.1098/rsta.2015.0202.

Kamanga, P., Vedeld, P., Sjaastad, E., 2009. Forest incomes and rural livelihoods in chiradzulu district, malawi. Ecol. Econ. 68 (3), 613–624. https://doi.org/10.1016/j.ecolecon.2008.08.018.

Kaoma, H., Shackleton, C.M., 2015. The direct-use value of urban tree non-timber forest products to household income in poorer suburbs in south african towns. For. Policy Econ. 61, 104–112. https://doi.org/10.1016/j.forpol.2015.08.005.

Keshavarz, M., Maleksaeidi, H., Karami, E., 2017. Livelihood vulnerability to drought: a case of rural iran. Int. J. Disaster Risk Reduct. 21, 223–230. https://doi.org/10.1016/j.ijdrr.2016.12.012.

Knowles, T., Theron, l-J, 2010. Buffelsdraai landfill site community reforestation project: community, climate, and biodiversity standard project design document. Environmental planning and climate protection department and wildlife conservation trust. The Cirrus Group: A Climate Change and Natural Resource Practice. eThekwini Municipality, Durban, pp. 1–75.

Knowles T., Theron l-J (2014). *Buffelsdraai landfill site community reforestation project* (Community, Climate and Biodiversity Standard Project Design Document, Issue.

Krantz, L., 2001. The sustainable livelihood approach to poverty reduction. Swed. Int. Dev. Coop. Agency 2, 42–98.

Leßmeister, A., Heubach, K., Lykke, A.M., Thiombiano, A., Wittig, R., Hahn, K., 2018. The contribution of non-timber forest products (ntfps) to rural household revenues in two villages in south-eastern burkina faso. Agrofor. Syst. 92 (1), 139–155. https://doi.org/10.1007/s10457-016-0021-1.

Lewis, M., 2010. Durban's Municpal Climate Protection Programme. eThekwini Municipality, Durban, South Africa.

Li, C., Wang, C.-P., Liu, S.-T., Weng, l-H, 2010. Forest value orientations and importance of forest recreation services. J. Env., Manage 91 (11), 2342–2348. https://doi.org/10.1016/j.jenvman.2010.06.020.

Luthans, F., Avey, J.B., Avolio, B.J., Norman, S.M., Combs, G.M., 2006. Psychological capital development: toward a micro-intervention. J. Organ. Behav. 27 (3), 387–393. https://doi.org/10.1002/job.373.

Luthans, F., Avolio, B.J., Avey, J.B., Norman, S.M., 2007. Positive psychological capital: measurement and relationship with performance and satisfaction. Pers. Psychol. 60 (3), 541–572. https://doi.org/10.1111/j.1744-6570.2007.00083.x.

Luthans, F., Luthans, K.W., Luthans, B.C., 2004. Positive psychological capital: beyond human and social capital. Bus. Horiz. 47 (1), 45–50. https://doi.org/10.1016/j.bushor.2003.11.007.

Luthans, F., Youssef, C.M., 2004. Human, social, and now positive psychological capital management: investing in people for competitive advantage. Organ. Dyn. 33 (2), 143–160. https://doi.org/10.1016/j.orgdyn.2004.01.003.

Macfarlane, D., Harvey, J., Hamer, M., 2011. Biodiversity assessment of the buffelsdraai landfil site community reforestation project. Report No. EP 08-01 Wildlands Conservation Trust. eThekwini Municipality, DurbanSouth Africa.

Macfarlane, D., Teixeira-Leite, A., Mafela, B., Harvey, J., Hamer, M., Conway, C., 2015. *Buffelsdraai landfill site community reforestation programme* (EP143-01). Buffelsdraai Reforestation Programme: Biodiversity Monitoring Report 2015. Issue.

Mamo, G., Sjaastad, E., Vedeld, P., 2007. Economic dependence on forest resources: a case from dendi district, ethiopia. For. Policy Econ. 9 (8), 916–927. https://doi.org/10.1016/j.forpol.2006.08.001.

Mancebo, E., 2011. Final report to wildlands conservation trust: social assessment of the buffelsdraai landfil site community reforestation project. Gt. Cap.

Masozera, M.K., Alavalapati, J.R., 2004. Forest dependency and its implications for protected areas management: a case study from the nyungwe forest reserve, rwanda. Scand. J. For. Res. 19 (S4), 85–92. https://doi.org/10.1080/14004080410034164.

Masten, A.S., 2001. Ordinary magic: resilience processes in development. Am. Psychol. 56 (3), 227. https://doi.org/10.1037//0003-066x.56.3.227.

Mbiba, M., Collinson, M., Hunter, L., Twine, W., 2019. Social capital is subordinate to natural capital in buffering rural livelihoods from negative shocks: insights from rural south africa. J. Rural. Stud. 65, 12–21. https://doi.org/10.1016/j.jrurstud.2018.12.012.

Mohammad Abdullah, A.N., Stacey, N., Garnett, S.T., Myers, B., 2016. Economic dependence on mangrove forest resources for livelihoods in the sundarbans, bangladesh. For. Policy Econ. 64, 15–24. https://doi.org/10.1016/j.forpol.2015.12.009.

Morse, S., McNamara, N., 2013. Sustainable Livelihood approach: A critique of Theory and Practice. Springer Science & Business Media.

Muradian, R., Corbera, E., Pascual, U., Kosoy, N., May, P.H., 2010. Reconciling theory and practice: an alternative conceptual framework for understanding payments for environmental services. Ecol. Econ. 69 (6), 1202–1208. https://doi.org/10.1016/j.ecolecon.2009.11.006.

Nerfa, L., Rhemtulla, J.M., Zerriffi, H., 2020. Forest dependence is more than forest income: development of a new index of forest product collection and livelihood resources. World Dev. 125, 104689. https://doi.org/10.1016/j.worlddev.2019.104689.

Newton, P., Miller, D.C., Byenkya, M.A.A., Agrawal, A., 2016. Who are forest-dependent people? A taxo nomy to aid livelihood and land use decision-making in forested regions. Land. Use Policy. 57, 388–395. https://doi.org/10.1016/j.landusepol.2016.05.032.

Pandey, A.K., Tripathi, Y., Kumar, A., 2016. Non timber forest products (ntfps) for sustained livelihood: challenges and strategies. Res. J. For. 10 (1), 1–7. https://doi.org/10.3923/rjf.2016.

Persha, L., Agrawal, A., Chhatre, A., 2011. Social and ecological synergy: local rulemaking, forest livelihoods, and biodiversity conservation. Science 331 (6024), 1606–1608. https://doi.org/10.1126/science.1199343.

Plummer, R., FitzGibbon, J., 2006. People matter: the importance of social capital in the co-management of natural resources. Nat. Resour. Forum.

Pretty, J., Ward, H., 2001. Social capital and the environment. World Dev. 29 (2), 209–227. https://doi.org/10.1016/S0305-750X(00)00098-X.

Ragie, F.H., Olivier, D.W., Hunter, L.M., Erasmus, B.F., Vogel, C., Collinson, M., Twine, W., 2020. A portfolio perspective of rural livelihoods in bushbuckridge, south africa. S. Afr, J. Sci 116 (9–10), 1–8. https://doi.org/10.17159/sajs.2020/7522.

Scoones I. (1998). *Sustainable rural livelihoods: a framework for analysis* (IDS Working paper 72, Issue.

Shackleton, C., Shackleton, S., 2004. The importance of non-timber forest products in rural livelihood security and as safety nets: a review of evidence from south africa. S. Afr, J. Sci 100 (11–12), 658–664.

Shackleton, S., Shackleton, C., Shanley, P., 2011. Building a holistic picture: an integrative analysis of current and future prospects for non-timber forest products in a changing world. In: Shackleton, C., Shackleton, S., Shanley, P. (Eds.), Non-timber Forest Products in the Global Context. Springer, Berlin Heidelberg, pp. 255–280. https://doi.org/10.1007/978-3-642-17983-9_12.

Shackleton, C.M., 2004. Assessment of the Livelihoods Importance of Forestry, Forests and Forest Products in South Africa. Rhodes University, Grahamstown.

Shackleton, C.M., 2015. Non-timber forest products in livelihoods. *Ecological sustainability for non-timber forest products*. Routledge.

Shackleton, C.M., Pandey, A.K., 2014. Positioning non-timber forest products on the development agenda. For. Policy Econ. 38, 1–7. https://doi.org/10.1016/j.forpol.2013.07.004.

Shackleton, C.M., Shackleton, S.E., 2006. Household wealth status and natural resource use in the kat river valley, south africa. Ecol. Econ. 57 (2), 306–317. https://doi.org/10.1016/j.ecolecon.2005.04.011.

Shackleton, C.M., Shackleton, S.E., Buiten, E., Bird, N., 2007. The importance of dry woodlands and forests in rural livelihoods and poverty alleviation in south africa. For. Policy Econ. 9 (5), 558–577. https://doi.org/10.1016/j.forpol.2006.03.004.

Sharaunga, S., Mudhara, M., Wale, E., 2013. Values rural households in kwazulu-natal hold towards forests and their participation in community-based forest management. Agrekon 52 (4), 113–147. https://doi.org/10.1080/03031853.2013.847039.

Shen, J., Zhang, Y., Zhou, W., Song, Z., Duan, W., 2022. Dynamics and determinants of household's non-timber forest products collection in the giant panda nature reserves of china. For. Policy Econ. 137, 102705. https://doi.org/10.1016/j.forpol.2022.102705.

Small, l-A, 2007. The sustainable rural livelihoods approach: a critical review. Can. J. Dev. Stud. 28 (1), 27–38. https://doi.org/10.1080/02255189.2007.9669186.

Snyder, C.R., 2002. Target article: hope theory: rainbows in the mind. Psychol. Inq. 13 (4), 249–275. https://doi.org/10.1207/S15327965PLI1304_01.

Suleiman, M.S., Wasonga, V.O., Mbau, J.S., Suleiman, A., Elhadi, Y.A., 2017. Non-timber forest products and their contribution to households income around falgore game reserve in kano, nigeria. Ecol. Process. 6 (1), 23. https://doi.org/10.1186/s13717-017-0090-8.

Tanner, A.M., Johnston, A.L., 2017. The impact of rural electric access on deforestation rates. World Dev. 94, 174–185. https://doi.org/10.1016/j.worlddev.2016.12.046.

Ticktin, T., 2004. The ecological implications of harvesting non-timber forest products. J. Appl. Ecol. 41 (1), 11–21. https://doi.org/10.1111/j.1365-2664.2004.00859.x.

Timko, J., Waeber, P., Kozak, R., 2010. The socio-economic contribution of non-timber forest products to rural livelihoods in sub-saharan africa: knowledge gaps and new directions. Int. For. Rev. 12 (3), 284–294. https://doi.org/10.1505/ifor.12.3.284.

Tugume P., Buyinza M., Namaalwa J., Kakudidi E.K., Mucunguzi P., Kalema J., Kamatenesi M. (2017). Socio-economic predictors of dependence on non-timber forest products: lessons from mabira central forest reserve communities.

Twine, W., Moshe, D., Netshiluvhi, T., Siphugu, V., 2003. Consumption and direct-use values of savanna bio-resources used by rural households in mametja, a semi-arid area of limpopo province, south africa. S. Afr, J. Sci 99 (9), 467–473.

Viljoen S. (2010). Buffelsdraai landfil site community reforestation project: phase 1 report.

Wagstaff, A., O'Donnell, O., Van Doorslaer, E., Lindelow, M., 2007. Analyzing Health Equity Using Household Survey Data: A Guide to Techniques and Their Implementation. World Bank Publications.

Wale, E., Nkoana, M.A., Mkuna, E., 2022. Determinants of rural household livelihood dependence on non-timber forest products: a case study from inanda community, kwazulu-natal, south africa. Front. For. Glob. Change 5, 788815. https://doi.org/10.3389/ffgc.2022.788815.

Whitley A. (2012). *Buffelsdraai landfill site community reforestation project: phase 3 report.*

Whitley A. (2014). *Buffelsdraai landfil site community reforestation project: phase 5 annual report 2013/2014.*

Wunder S. (2005). *Payments for environmental services: some nuts and bolts.*

Wunder, S., 2008. Payments for environmental services and the poor: concepts and preliminary evidence. Env. Dev Econ 13 (3), 279–297. https://doi.org/10.1017/S1355770X08004282.

Yeomans, K.A., Golder, P.A., 1982. The guttman-kaiser criterion as a predictor of the number of common factors. J. R. Stat. Soc., D (Stat.) 31 (3), 221–229. https://doi.org/10.2307/2987988.