



Capabilities Under Telecoupling: Human Well-Being Between Cash Crops and Protected Areas in North-Eastern Madagascar

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Global change processes are increasing their pace and reach, leading to telecoupled situations, where distant factors come to outpace local determinants of land use change. Often, these dynamics drive agricultural intensification processes, with as yet unclear implications for the well-being of human populations living in the areas affected. This study explores how two key telecoupling dynamics affect local well-being in the biodiversity hotspot of Madagascar. It focuses on forest frontier landscapes, which are undergoing processes of agricultural intensification as a consequence of distant factors. Concretely, we look at how the recent establishment of two, largely externally funded, terrestrial protected areas, Masoala National Park and Makira Natural Park, and the ongoing price boom for two export cash crops, vanilla and clove, have influenced the well-being of local populations in the country's north-east. We present data from eight focus group discussions conducted in four villages located on the periphery of the two protected areas. Drawing on the "capabilities approach," we identify the key components of the local understanding of well-being, lay out the interconnections between these components, and explore how the two telecoupling processes affect well-being dynamics. Our findings reveal that well-being components present bundle characteristics, where increases or decreases in one component lead to parallel increases, or decreases in a set of them. We further ascertain that telecoupling processes might lead to trade-offs between well-being components. These findings highlight the need for a holistic understanding of human well-being when planning protected areas, and when designing governance mechanisms to steer local landscapes under intense cash crop price fluctuations toward sustainable outcomes.

Keywords: human well-being, agricultural intensification, shifting cultivation, conservation, agricultural commodities trade, capabilities approach

INTRODUCTION: AGRICULTURAL INTENSIFICATION AND HUMAN WELL-BEING UNDER TELECOUPLING

Meeting increasing demands for food, fiber, feed, and other goods forecast in scenarios for future global human population and consumption habits requires rapid agricultural intensification over the next decades (Tscharntke et al., 2012). While research exploring the effects of agricultural intensification on social-ecological systems is becoming more common (Shaver et al., 2015; Jakovac et al., 2016), fewer studies have examined the impact of intensification on human well-being (see e.g., Gasparatos et al., 2011). A recent review found that the research that exists on this topic has evaluated the impacts of agricultural intensification on human well-being mostly in monetary terms (Rasmussen et al., 2018).

Moreover, the increasing extent and pace of the degradation of life-supporting ecosystems and biodiversity makes it imperative for agricultural intensification to occur in an environmentally sustainable manner (Tilman et al., 2011; Garnett et al., 2013). The paradigm striving to find a compromise between these two objectives has been labeled “sustainable agricultural intensification” and is currently being promoted as the pathway to address these challenges (Rockström et al., 2017; FAO, 2018). However, under economic and socio-political globalization, steering social-ecological systems toward sustainable outcomes is challenging, as local landscapes are increasingly subject to the influence of external factors, largely derived from clashing competition over land resources (Lambin and Meyfroidt, 2011; Niewöhner et al., 2016). These dynamics are leading to the emergence of *telecoupled* situations, where external factors outpace local determinants of land use change (Eakin et al., 2014; Friis and Nielsen, 2014), putting increasing strain on existing land governance structures (Oberlack et al., 2018).

Due to conflicting demands for land-based resources, forest frontier contexts in the tropics are representative of the challenges experienced in local landscapes in efforts to boost sustainable development and support human well-being. First, tropical forest landscapes benefit forest-edge populations in numerous ways. They provide the material basis needed to build people’s livelihoods, including the reserve of agricultural land that forests might mean for local communities, and a range of critical environmental processes such as water regulation or prevention of soil erosion—and they constitute the foundation of many local cultural practices (Lele, 2009; Sodhi et al., 2010).

Second, forests in the tropics and their soils are central to global climate change mitigation strategies through carbon sequestration (Houghton et al., 2015), while at the same time being globally critical for biodiversity conservation (Brown, 2014). In order to safeguard forest ecosystems, a key landscape planning tool is the establishment of protected areas (PAs) (Thomas and Gillingham, 2015; Melillo et al., 2016). Some scholars consider PAs as “telecoupled territories” in themselves, chiefly because of the large role played by international actors in their establishment and management, and the dependence of PAs on external financial flows (Boillat et al., 2018). The area of land under legal protection regimes has been increasing for

decades (Watson et al., 2014) and calls to vastly expand it are emerging (Dinerstein et al., 2019). However, the outcomes of PAs for actual conservation are still much debated (Spracklen et al., 2015), and evidence on the impact of PAs on human well-being is rather mixed (Pullin et al., 2013; Brockington and Wilkie, 2015; Naidoo et al., 2019). Situations with positive outcomes for both biodiversity conservation and human well-being are rare, with most cases facing trade-offs between socio-economic development and conservation (McShane et al., 2011), in many cases derived from the inherent restrictions in access to, and use of, forest land and products that PAs entail for local populations. And third, the tropics are a key region in the production of globally traded commodities and where much of the agricultural expansion foreseen in the next decades is expected to take place, likely onto forest land under a business-as-usual scenario (Laurance et al., 2014). While agricultural commodity trade may influence agricultural intensification through several pathways, it has also been widely regarded as one of the major telecoupling processes (Gasparri et al., 2016; Silva et al., 2017; Andriamihaja et al., 2019).

Madagascar illustrates the influence that telecoupling processes have on tropical forest landscapes and people’s well-being. While in 161st place of 189 countries in the Human Development Index (UNDP, 2018), and with 80% of its population relying on agriculture (World Bank, 2019), the Indian Ocean island state has long been considered one of the “hottest” biodiversity hotspots in the world (Myers et al., 2000). Most of Madagascar’s biodiversity is found in forest ecosystems across the island (Goodman and Benstead, 2005), with the greatest pressure on these habitats coming from the expansion of subsistence shifting cultivation, according to the available evidence (Waeber et al., 2015; Zaehring et al., 2015). This situation has underpinned decades-long efforts in development and conservation on Madagascar from the international donor community (Horning, 2008; Kull, 2014). While the effectiveness of these efforts in improving development conditions is still elusive, particularly among the rural poor, they are nonetheless greatly contributing to the ongoing expansion of PAs in Madagascar (Waeber et al., 2016). The total area covered by PAs has increased by more than 400% since 2003, with over 12% of the country nominally under protection today (Gardner et al., 2018). Many of these new PAs are largely designed, implemented, and managed by international conservation non-governmental organizations (NGOs). While PAs are showing some success in preventing forest loss in the country (Eklund et al., 2016), forest conservation mostly benefits the global community, with local populations incurring large costs (Neudert et al., 2016; Poudyal et al., 2018). In terms of a more comprehensive perspective on well-being, research revealed that community forest management, and strict conservation measures may have a similar magnitude of influence on local subjective well-being, although they may have different effects on individual well-being domains such as livelihood activities or health (Rasolofoson et al., 2018).

Madagascar is also a key producer of two of the world’s most sought-after agricultural commodities: vanilla (*Vanilla planifolia*) and clove (*Syzygium aromaticum*). Up to 80% of global vanilla

production comes from Madagascar, mostly from the north-east, and the country is the second-largest producer of clove, after Indonesia. These two cash crops are currently experiencing a price boom that has driven profound changes in the socio-economic dynamics of local populations (Osterhoudt, 2018; Zhu, 2018; Neimark et al., 2019; Tilghman, 2019). However, little work has focused on comprehensively understanding the impacts of this boom on the well-being of the affected populations.

Due to the prevailing importance of subsistence agriculture for a majority of Madagascar's rural population, and the untapped potential of commercial agriculture to promote human development, sustainable agricultural intensification has long been promoted in the country as the way to reconcile development and human well-being while preserving the environment (Messerli, 2006; Pollini, 2012).

OBJECTIVES OF THIS PAPER

Despite recognition of these dilemmas, to our knowledge no research has been done on the impact of commodity trade dynamics on local human well-being in forest frontier landscapes, let alone in a protected-area context. To address this gap, our overall goal is to explore how agricultural intensification processes driven by two telecoupling processes highly relevant to Madagascar, i.e., PA establishment and the export cash crop price boom, have in recent decades influenced the well-being of local populations in four forest frontier villages. We define agricultural intensification as the substitution of crops, with the objective of increasing the profitability of a given agricultural plot (Rasmussen et al., 2018). The main intensification pathway we focus on in this study is the conversion of shifting cultivation rice fields into permanent cultivation of cash crops. We understand well-being as the capacity of a person to satisfy the components they require to live a "good life" (Beauchamp et al., 2018). We explore these dynamics through the "capabilities approach," introduced in the following section. We disaggregate the overarching goal into three more concrete objectives.

- 1) Understanding how a "good life" is defined by people in our study villages, in terms of well-being components.
- 2) Exploring how the well-being components needed for a "good life" in our study villages relate to each other.
- 3) Investigating how PA establishment and export cash crop price booms have affected local well-being dynamics in our study villages, by looking at current satisfaction with well-being components and how this satisfaction has changed in recent decades.

CONCEPTUAL FRAMEWORK: THE CAPABILITIES APPROACH

The capabilities approach was first developed by economist Amartya Sen in the late 1970s, as a counterbalance to the prevailing—mostly monetary—approaches to measuring human welfare (Sen, 1979). The approach focuses on the freedoms individuals have to lead the lives they consider worth living,

an understanding which, at the time, represented a major shift from contemporary paradigms on assessing human welfare and development.

The central concept of the approach is that of *capabilities*, which are the freedoms a person has to pursue the life they value, understood as potential *beings* and *doings*. Through individual choice, capabilities are then materialized into achieved *functionings*, which are the actual *beings* and *doings* a person values. In this way, Sen's view of human development and well-being puts a strong emphasis on individual freedom of choice to decide what specific functionings a person decides to materialize out of a bunch of possible capabilities.

The capabilities approach was further developed by philosopher Martha Nussbaum (Nussbaum, 1992; Nussbaum and Sen, 1993), one of whose most prominent advancements was to advocate for a universal set of capabilities or "rights" any government should promote and protect in the form of a list of 10 central capabilities (Nussbaum, 2000, 2011a). The list includes the central capabilities of "Life," "Bodily health," "Bodily integrity," "Senses, imagination, and thought," "Emotions," "Practical reason," "Affiliation," "Other species," "Play," and "Control over one's environment" (see **Supplementary Material 1** for a detailed definition).

While Nussbaum's promotion of such a universal list was a major point of contention between the two academics and their respective understandings of the capabilities approach (Sen et al., 2003; Sen, 2004), both scholars came to agree that elaborating any such list should be rooted in a public deliberative process to select the capabilities relevant to any given context. Further, the list has attracted critics, chiefly because of the limitations of the universalist, normative stance it adopts to address the complexity and uniqueness of real-world problems (Menon, 2002; Olson and Sayer, 2009). However, as an analytical framework, such a list can provide an important theoretical and practical tool for assessing the well-being of individuals or groups of people (Alkire, 2002). Taking into account the context-specific nature of well-being, Nussbaum emphasizes that her list can always be further elaborated, leaving room for individual countries and their people to specify the 10 central capabilities differently (Nussbaum, 2007).

Over time, the capabilities approach was taken up by many other scholars (Holland, 2014; Robeyns, 2017), who have employed it to conceptualize sustainable development (Lessmann and Rauschmayer, 2013; Voget-Kleschin, 2013) or to explore the contribution of ecosystem services to human well-being (Polishchuk and Rauschmayer, 2012; Sangha et al., 2015). Some have suggested employing the capabilities concept as an end to environmental justice endeavors (Schlosberg, 2007; Martin, 2017); others have further theorized the initial focus of the capabilities approach on human well-being (Edwards et al., 2016). While we acknowledge and have to some extent derived inspiration from these advances, for this study we mostly use the capabilities approach heuristically, to explore how human well-being is understood in our study villages and how it is influenced by key telecoupling processes.

CASE STUDY VILLAGES

We conducted research in four villages located in two rural communes of Maroantsetra district in north-eastern Madagascar (see **Figure 1**). In this area, two parallel telecoupling processes—the establishment of internationally designed and funded PAs, and the price fluctuations of globally traded cash crops—connect local land use change processes to external dynamics such as international conservation agendas and global commodities trade.

North-eastern Madagascar hosts the largest tracts of humid rainforest on the island, making the region one of the most important for biodiversity in the country and a large carbon sink. In order to halt forest loss processes caused by the conversion of old-growth forest to shifting cultivation fields for rice production, two large PAs, Masoala, and Makira, were established in the region in recent decades. On the peninsula of Masoala, which already enjoyed reserve status for some decades in the mid-twentieth century, the current initiative for protecting the forests occurring there started in the late 1980s. At that time, the area was highlighted as a priority for conservation in Madagascar by the International Union for Conservation of Nature (IUCN) (Mittermeier et al., 1987), and designated as such in the first phase of the country's Environmental Action Plan (World Bank et al., 1988; Kull, 2014). In the early 1990s, an integrated conservation and development project (ICDP) was initiated in the area with support from the World Bank (Marcus, 2001). Following this, the international NGO Cooperative for Assistance and Relief Everywhere (CARE) was selected to lead a PA project in the area, in collaboration with the parastatal organization ANGAP and the Malagasy Ministry of Water and Forest (Kremen et al., 1999). CARE subcontracted the conservation design to the international NGO Wildlife Conservation Society (WCS). In 1997, Masoala was declared a National Park (NP) under IUCN category II, and has since been managed by Madagascar National Parks (MNP, formerly ANGAP). Masoala NP is currently funded largely by a range of international donors, including Zoo Zürich (Zoo Zürich, 2019), with WCS providing technical assistance (WCS, 2019).

The Makira Forest Project was initiated in the early 2000s by WCS and the Ministry of Water and Forest, supported by USAID, to develop carbon financing options for sustainable funding of conservation interventions in the area (Meyers, 2001). Makira received temporary protection status in 2005 and was eventually granted definitive protection as a Natural Park (IUCN category II) managed by WCS in 2012, with the first international sales of its REDD+ emission reduction credits taking place in 2013 (WCS, 2015). In 2014, the management rights of the forests in the buffer zone of Makira PA that fell within Beanana's village boundaries were transferred to local communities there.

In parallel to its global relevance for biodiversity conservation and climate change mitigation objectives, the north-eastern region is one of the country's main areas of production of vanilla and clove, commercial crops that were introduced in the nineteenth century (Brown, 2009; Danthu et al., 2014). These cash crops are mostly exported to the global market and are local farmers' main source of income. But the prices of vanilla and clove have fluctuated sharply: vanilla experienced

a short-lived boom in the mid-2000s and an ongoing boom that began in 2013; clove prices have been consistently high since 2006. Establishment of the two PAs was found to have two effects: on the one hand, it has led to a significant decrease in forest loss rates; on the other, combined with the cash crop price booms, it has encouraged agricultural intensification processes in our research villages in recent decades (Llopis et al., 2019).

Besides cash crop production for income generation, populations of all our four study villages depend nearly exclusively on other agricultural activities to meet their subsistence needs. Rice, the main subsistence food crop, is cultivated both on valley bottoms—where flat land, enough water, and infrastructure for irrigation are available—and on the hills surrounding the villages, under a rain-fed shifting cultivation system. Main complementary food crops include cassava, several pulses and fruits, and a range of wild crops collected as the shifting cultivation fields lie fallow.

While these overall characteristics are common to all four study villages, each of them can be located in a distinct position along the following gradient. At one extreme, we observe high reliance on shifting cultivation, a high degree of remoteness and thus low market accessibility, high proximity to PAs, low population density, and low degree of agricultural intensification at landscape level. This applies to the village of Beanana, in the periphery of the southern sector of Makira PA, and to a lesser extent to Fizonon, west of Masoala NP. At the other extreme, the research villages have a lower reliance on shifting cultivation, a lower remoteness and proximity to PAs, and higher market accessibility, population density, and degree of agricultural intensification. This applies particularly to Mahalevona, to the north of the district, but also to Morafeno, to the south (**Figure 1** and **Table 1**). However, some of these characteristics are closely interlinked in the same villages. For example, the villages closer to the PAs are also those with lower market accessibility and lower agricultural intensity at the landscape level, with potential for confounding among these factors. While we are thus unable to neatly distinguish between the different potential influences of each factor, we employ these characteristics to illustrate the complexity of aspects mediating human well-being and development in these landscapes.

METHODS

Following preliminary field visits in 2016, when we conducted key informant interviews with PA managers, local authorities, and farmers, fieldwork was completed between September and November 2017. During this period, we conducted eight focus group discussions (FGDs), two in each of our four study villages, with a group of men and a group of women, respectively. The methodology employed draws on previous experiences on conducting FGDs to explore local understandings of well-being (Abunge et al., 2013; Dawson and Martin, 2015) and is in line with approaches of subsequent work conducted on these issues (Beauchamp et al., 2018; Woodhouse and McCabe, 2018).

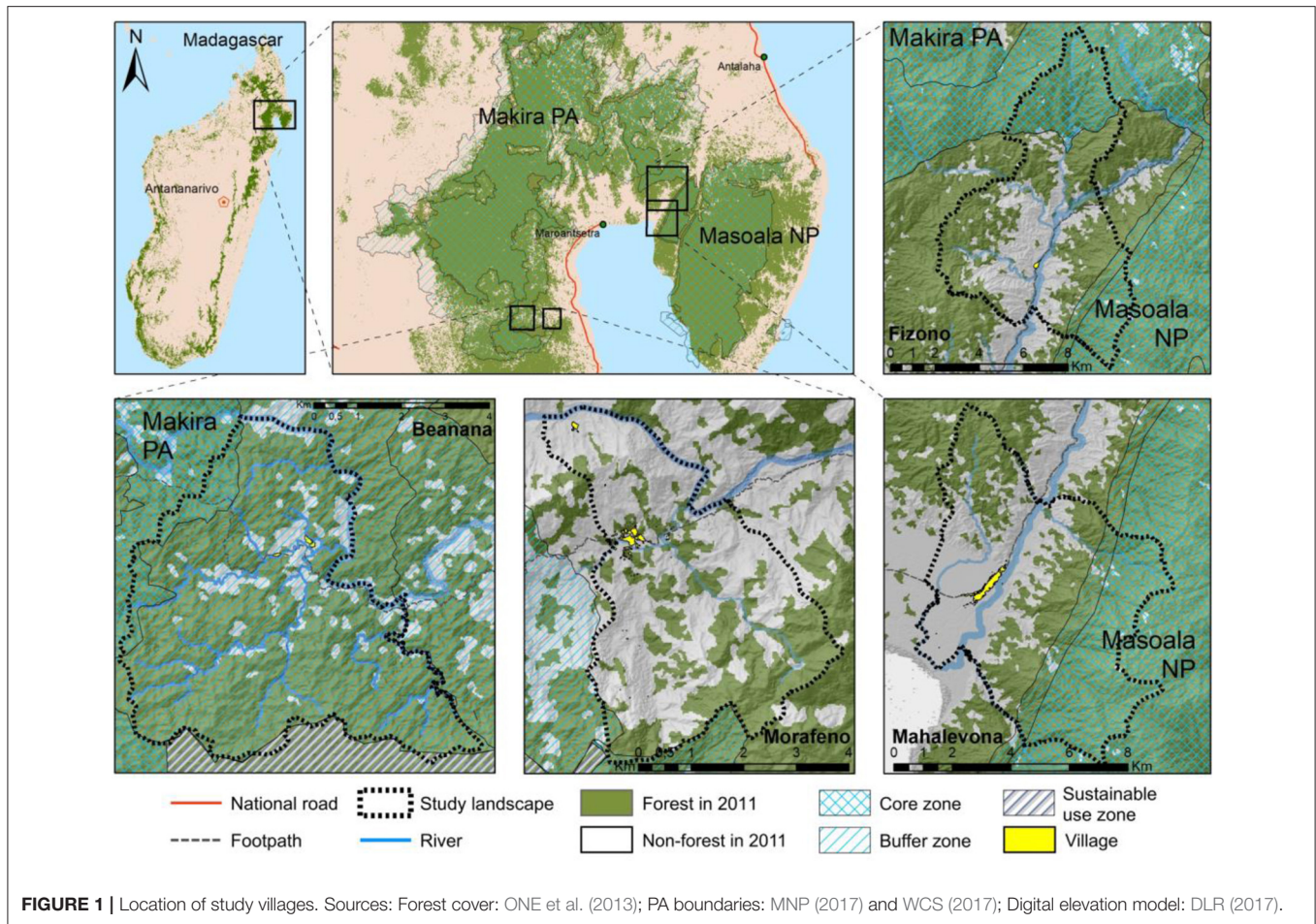


TABLE 1 | Characteristics of the study villages.

Commune	Village	Population (2015)	Population density Inh./km ²	PA establishment year	Shortest distance to PA's core zone (km)	Distance to district capital (h)	% area under PA's core / buffer zone	% area under shifting cultivation / intense land uses / forest
Mahalevona	Mahalevona	9,834	169	1997	3.4	3.5	28.6 / 7.9	11.1 / 46.4 / 36.9
	Fizono	3,851	50	1997	3.1	7	27.8 / 3.5	31.1 / 13.7 / 54
Morafeno	Morafeno	1,889	94	2012	3.9	6	0 / 1.4	40.9 / 41.5 / 13.6
	Beanana	721	19	2012	2.0	11	7 / 93	33.3 / 3.5 / 61.6

Distances are estimated from the center of the main built-up area in each village. PA, protected area.

Focus Group Discussions

The aim of our sampling strategy for FGD participants was to gather a representative age sample in each village. We asked local authorities to help us gather a minimum of six villagers for each FGD, including two young people (up to 39 years old), two middle-aged people (between 40 and 60), and two elders (over 60). To account for differences in socio-economic status within the local community, and given the problematic of asking authorities to gather individuals from “wealthy” or “poor” households, we limited ourselves to requesting participants that held no particularly privileged position in the local community, and from as wide a variety of socio-economic backgrounds as

possible. Given that the fieldwork period coincided with peak annual demand for labor in the agricultural calendar, on a few occasions we were not able to meet the requirements of age diversity or the minimum number of participants (Table 2).

The FGDs were conducted entirely in Malagasy language by a member of the research team, and translated simultaneously into French by a research assistant. To handle the power dynamics inherent to group discussions (Bloor et al., 2001), we strived to create a trustful atmosphere and moderated the discussion to enable all participants to feel comfortable enough to dare to speak out, reassuring them that all opinions were heard and taken into consideration. After each FGD, the research team debriefed

TABLE 2 | Focus group discussions' details.

Commune	Village	Focus group discussions women		Focus group discussions men	
		# participants (age range)	# WB components collected (discussed)	# participants (age range)	# WB components collected (discussed)
Mahalevona	Mahalevona	7 (21–74 years)	24 (5)	9 (48–74 years)	20 (7)
	Fizono	13 (20–80 years)	23 (5)	6 (25–43 years)	26 (6)
Morafeno	Morafeno	4 (37–54 years)	23 (7)	7 (33–65 years)	22 (8)
	Beanana	11 (25–61 years)	19 (7)	10 (34–74 years)	24 (6)

#, number. WB, well-being.

to clarify some aspects of the discussion and to digitalize the information collected on the flipcharts.

The FGDs proceeded as follows. We started with a short introduction of the research team and the participants, after which participants were asked for oral consent to record the discussion in audio. Then, we introduced the discussion topic, with one research team member playing the ukulele and singing a song. This input served both as an “ice breaker” to generate rapport with the participants, and also as an example of what could be needed to support one’s well-being, e.g., playing music. The discussion then followed seven steps.

First, we asked participants to provide examples of what is needed to have a “good life” (*tsara velontegna*) in the village—i.e., well-being components—which were compiled in a flipchart (**Figure 2**). However, we were aware that potential methodological limitations could arise when comprehensively trying to identify all components important for human well-being, using entirely open questions (Abunge et al., 2013). For this reason, once participants had mentioned all components they could think of as necessary to having a good life in the village, we used Nussbaum’s 10 central capabilities list as a heuristic to probe for further well-being components (see **Supplementary Material 1**). This involved using a series of probing questions to elicit from participants well-being components not listed so far in the discussion, prepared by drawing on recommendations on how to operationalize the capabilities approach (Anand et al., 2009).

Second, once all components considered necessary by participants to sustain a “good life” in the village were included in the list, we asked them to score the components by relevance. For this purpose, we gave each participant five stickers, asking them to place each sticker on one or more well-being component(s) of their choice. Thanks to this exercise, participants were able to determine the order of components to be discussed in the next step: those that ranked higher would be discussed first. Defining an order was necessary, as time constraints during the FGDs meant that on each occasion we could only discuss, in depth, between five and eight well-being components (**Table 2**).

Third, the FGD continued by asking participants why a certain well-being component is considered important for a good life in the village, or in other words, what value this component has for their well-being. Responses were written down on a flipchart prepared to this end, with columns for each of the questions asked (**Figure 2**). To obtain the core reason why a given component was considered important by

local participants, on several occasions we resorted to “iterative questioning” (Schleicher et al., 2017), by asking people the “why of the why” (Alkire, 2002; Finnis, 2011), until it was not possible to elicit further detailed explanation. Fourth, after working on this column, we asked participants to state what is needed to satisfy the respective well-being component. Fifth, participants were asked to discuss whether satisfying a given component was currently more, less, both more and less, or equally difficult compared with recent past decades. To capture the potential effect that the telecoupling processes we were interested in might have had on these change dynamics, we requested participants to imagine the situation in respect to their well-being some 20 years ago. To prevent biasing the exercise toward discussing exclusively the telecoupling processes we suspected of having a significant impact on villagers’ good life, i.e., cash crop booms and PA establishment, we avoided explicitly mentioning such processes.

Sixth, to fill in the last column in the flip chart, we asked participants to mention and explain why their satisfaction with certain well-being components might have changed. And seventh, we finished the FGD by giving participants three red and three green stickers, to be placed on the components considered, respectively, “most difficult to satisfy” and “most satisfied at the present time,” choosing from all components listed on the flip chart. To enable comparison of results from the three scoring exercises across all FGDs conducted, we processed the responses as recommended by Newing et al. (2011) for analyzing freelists. This allowed us to obtain what we label the frequency-weighted score of each well-being component, which can be calculated using the equations below.

$$\begin{aligned} \text{Score} &= \frac{\text{number of points obtained} \times 100}{\text{total points distributed in the FGD}} \\ \text{Average score across FGDs} &= \frac{\sum \text{scores across FGDs}}{\text{number of FGDs where a component was scored}} \\ \text{Frequency} &= \frac{\text{number of FGDs where a component was scored}}{8} \\ \text{Frequency weighted score} &= \text{Average score} \times \text{Frequency} \end{aligned}$$

We first calculated the score (percentage of points obtained by each component out of all stickers distributed in a given FGD for that scoring exercise) of each well-being component in each FGD, and subsequently averaged the score of each

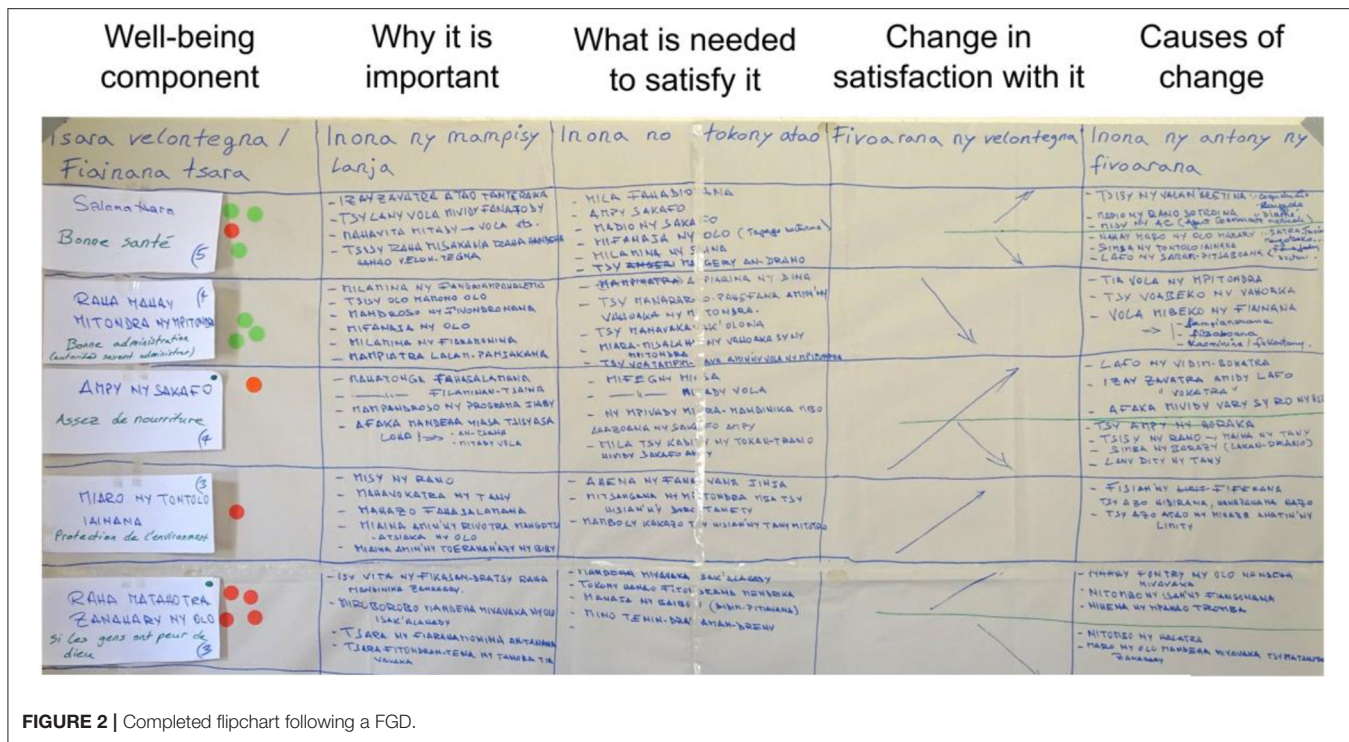


FIGURE 2 | Completed flipchart following a FGD.

component across FGDs. We then multiplied the average score of each component by its frequency across FGDs (number of FGDs where a component obtained at least one point, divided by the eight FGDs conducted), which results in the frequency-weighted score presented in Table 4 and the wedge size for each component in Figure 3 (see also Supplementary Material 2).

RESULTS

Good Life (Tsara Velontegna)

The FGDs yielded in total 72 distinct well-being components needed to have a good life (*tsara velontegna*) across all four study villages. In Figure 3 (see also Supplementary Material 2) we present the 28 components that obtained a frequency-weighted score (FWS) of at least 1 in the first scoring exercise conducted during the FGDs. Each component is aligned with the central capability they most relate to, following suggestions for developing indicators for such central capabilities (Anand et al., 2009).

Out of all well-being components considered in Figure 3, the most numerous (nine components) related to the central capability “Control over one’s environment.” These well-being components refer to the material foundations and the contextual conditions and institutions needed to actually make use of them, which in combination allow people to pursue their livelihood strategies. Second-most numerous (with four components) were aspects related to education, freedom of expression, and religion, which we attribute to the central capability of “Sense, imagination, and thought.” Only three well-being components related to the central capability of “Bodily health,” although when their respective scores are aggregated, this capability stands out as

the most relevant for participants, along with “Control over one’s environment” (Figure 3).

Three well-being components referred to social relations and were thus related to the central capability of “Affiliation”; equally, three components were linked to “Emotions,” which are aspects connecting individuals to things and people outside themselves. Two components were linked to “Practical reason,” encompassing aspects related to doing and achieving what one plans, and another two to “Bodily integrity,” which includes aspects related to reproductive freedom, freedom of movement, or being secure against violence. Only one well-being component referred, respectively, to the central capabilities of “Play” and “Other species.” Finally, “Life,” which refers to the central capability of having a life of normal length, was mentioned as a well-being component in one FGD as “having a long life,” but was not given a score and is therefore not included in Figure 3.

For the individual well-being components most relevant to participants, “good health” received the highest score across all FGDs (FWS 12.01), followed by “education” (FWS 8.52); both components were mentioned and scored in all FGDs (i.e., obtaining at least one sticker during the relevance scoring exercise). Next: the component of “having money” (FWS 6.78), on occasion expressed as having a stable source of income or earning money every day, and the component of having “enough food” (FWS 5.46); both components were mentioned in all FGDs but not scored in all of them. The next six well-being components are, in decreasing order: “having a house” (FWS 5.18), “having children” (FWS 4.46), “a good administration” (FWS 4.10) (mentioned in all FGDs), “planning one’s life” (FWS 3.61), “good relations in the couple” (FWS 3.13), and

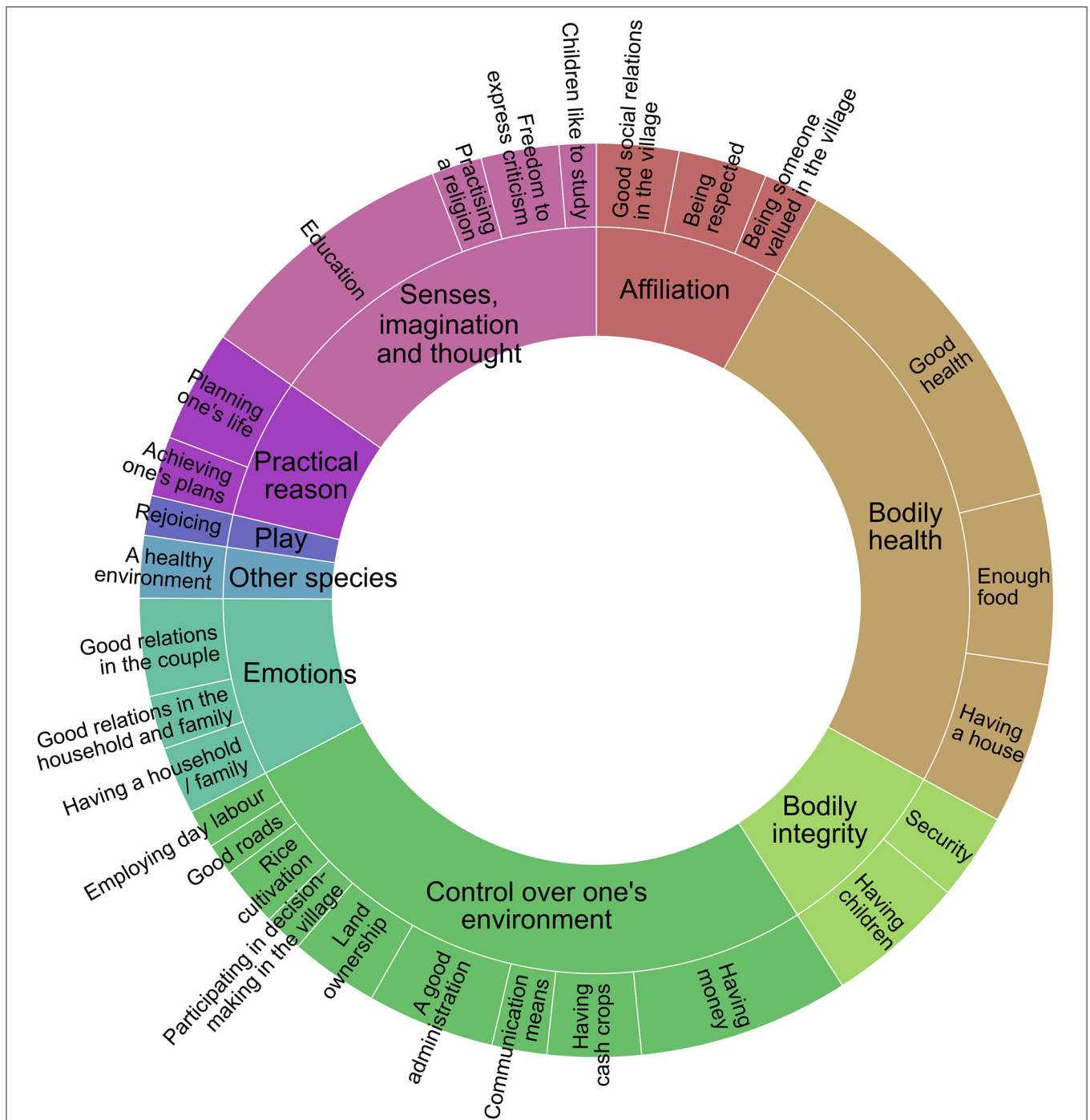


FIGURE 3 | Well-being components (outside circle) grouped by the central capability (inside circle) they most relate to. Wedge size of well-being components corresponds to frequency-weighted score obtained by the component across villages and genders. For reasons of space, only components with a minimum frequency-weighted score of 1 are displayed. See **Supplementary Material 2** for more details. Figure created with RAWGraphs (Mauri et al., 2017).

“having cash crops” (FWS 3.01). It is also worth mentioning that “a healthy environment” (FWS of 2.00), despite scoring relatively low, was also considered important to support local well-being in all FGDs. For all remaining scores, please see **Supplementary Material 2**.

Interrelations Between Well-Being Components

While we attributed well-being components to Nussbaum’s central capabilities in a rather unilinear manner, when probing more deeply into the reasons provided by participants to explain

why a given component is important for a good life in their village, the complexity of their interrelations becomes apparent (**Table 3**).

Having money was valued by its role in allowing people to meet the material needs of buying food or building a beautiful house. However, having money was also considered necessary for supporting children's education and planning one's life, but interestingly also because it supports the Affiliation-related well-being components of being, as participants put it, liked by everybody and respected in the village. Similarly, the well-being component of having a house was valued because it allows people to receive friends and be respected by others, while the most obvious use value of having a house, i.e., providing shelter, was not mentioned as a reason for its importance. Following this line, having good health was considered important in up to three FGDs because it allows people to engage in social activities, such as visiting friends or participating in celebrations in the village.

Conversely, having good social relations in the village was not directly valued for its positive impact on aspects of Affiliation. Rather, it was considered important because of its role in supporting the community in carrying out common tasks, such as building a health center or repairing a road, or at the individual level, because good social relations allowed people to help each other in agricultural tasks and other activities. Also highlighting the instrumental role of some components in supporting other, apparently unrelated, well-being aspects, education was considered important because it allows educated children to have the freedom to speak, or even to support their ability to choose a good partner. Further, education was deemed important because it might enable children, once they have finished their studies, to get a non-agricultural job, help with village development, or help the family.

The Impact of Telecoupling on Well-Being Components: Current Satisfaction and Change Trends

The results from the scoring exercise we conducted to elicit current satisfaction with well-being components (whether a given component is "difficult to satisfy" or "satisfied at the present time") were mixed (**Table 4**).

In many cases, at the aggregate level presented in **Table 4**, several components were scored both as "difficult to satisfy" but also as "satisfied at the present time", resulting in relatively comparable positions in the two respective lists. "Education," for example, was the component "most difficult to satisfy" while simultaneously the third-most "satisfied at present time". Similarly, "good health" was the fourth-most "difficult to satisfy" while at the same time "the most satisfied" well-being component.

Nonetheless, there are several other components with greater differences between the two lists. For example, "having money" scored across FGDs as the component that was second-most "difficult to satisfy," while it was not scored as "satisfied" in any FGD. Similarly, "having enough food," the sixth-most "difficult to satisfy," and "security," which scored as "difficult to satisfy" in four FGDs, did not score as satisfied in any FGD.

When discussing the change trends in the ability to satisfy given well-being components at the time of fieldwork compared with some two decades before, the effect of the two telecoupling processes we focus on in this study figured prominently in the reasons provided for such changes (**Table 5**).

The establishment of PAs in the respective villages was overwhelmingly considered by participants as the key reason why having a healthy environment has become easier to satisfy, a trend highlighted in up to five FGDs (**Table 6**). While this well-being component may at first sight relate to the central capability of "Other species," according to participants it also strongly relates with the ability of having good health. This is because a protected, healthy environment providing clean water and fresh air, and in general supporting hygiene, was considered necessary for good health (**Table 3**). Conversely, while the state of the natural environment did not show up among the reasons why having good health has become easier now, it was noted that the destruction of the environment was the reason for a higher incidence of diseases, and thus a decreasing satisfaction with having good health.

However, at the same time, participants in Fizonon and Beanana pointed to the creation of the PA as the main reason for some well-being components being more difficult to satisfy at the present time: this was chiefly related to the ban in the PA on expanding shifting cultivation into forest land. They said the ban made it more difficult to obtain enough food, carry out rice cultivation, and access agricultural land. These reasons were also given in another FGD to state that conservation interventions should be complemented with development support. Further, although in Mahalevona the existence of the PA was considered an overall positive influence, participants also mentioned that it involved limitations in extracting timber for construction and a ban on hunting wild animals.

Regarding the increase in cash crop prices, this factor was mentioned nine times as a reason for some well-being components being easier to satisfy at the present time. This was the case most obviously with having money, but also with getting enough food, having a house, planning one's life, and achieving one's plans. Further, although more indirectly, participants noted that the increased availability of money thanks to current cash crop prices is allowing people to invest, chiefly in commercial and trading activities, and thus to manage their money better. The increase in cash crop prices was also one of the reasons provided for the increase in the ability to rejoice, concretely because now people have more money and this allows them to participate in celebrations and ceremonies in the village.

However, the increase in the price for cash crops was also explicitly considered the main factor behind the negative change in the ability to satisfy certain well-being components. For example, the security situation in the villages had worsened, particularly due to more cash crop thefts, as highlighted in Beanana or Mahalevona, but also because it was felt that the sharp increase in cash crop prices had made people more materialistic and disloyal. Further, albeit indirectly, people also suggested that the increase in cash crop prices was behind the rise in living costs compared to the past. These dynamics in turn had a detrimental effect on social relations, as the increasing cost in welcoming

TABLE 3 | Central capabilities and well-being components: Examples provided during FGDs about their importance and what is needed to satisfy them.

Central capability	Well-being component	Why is the component important?	What is needed to satisfy the component
Bodily health	Good health	To work To achieve our plans To have social relations To not have worries or stress To have confidence in oneself To have good physical condition and strength To avoid spending money on medicines	Having enough and clean food Having rest Having respect between households Protecting the forest to have clean air Having respect for the environment and thus having good hygiene Having a health center Doing exercise/sports Having toilets
	Enough food	To progress and improve life To welcome visitors To be happy, without stress To have good physical condition/strength To have health To work and earn money	Having paddy fields Implementing the irrigation scheme Having agricultural tools Knowing how to manage the harvest throughout the year Searching for an agricultural technician Working and getting money to buy food
Bodily integrity	Security	To have peace To have no worries about working and getting money To have fewer/no thefts To have good social relations	Having mobile police Having an institution/organization ensuring security in the village during the vanilla harvest season Having confidence in community members Having a common law to respect Respecting the authorities Everybody having a cash crop plantation
	Having children	To continue the family line To be respected in the village To have help in the work we do To have successors when we are old To continue the traditions after we die (<i>retournement des morts</i>)	Having a wife/husband Having a family/household Visiting the doctor Preventing abortion
Senses, imagination, and thought	Education	To have a better life Educated children can go far in life Educated children can help in village development Educated children behave well Educated children find a job out of agriculture For children to know what life is about Educated children can choose a better partner For children to have freedom to speak	Mutual respect between parents and children Encourage children to attend school Making efforts to earn money Knowing how to manage our savings
Emotions	Having a household / family	To have love To have happiness To have mutual assistance	Working together, doing everything together (always being together) Exchanging ideas, not having arguments between husband and wife, and children Having good health
Practical reason	Planning one's life	To have a good production To make money with the cash crops To have an objective, a goal (every person must have an objective in life) To be satisfied To have morality To have good mood	Reflecting carefully Having money (it's easier to plan life when you have money) Having patience Having tools and materials Respecting the planning, the objective, persevering Having good will, being self-aware, not being lazy Prioritizing the objective
Affiliation	Good relations in the village	To have solidarity/help in the work To carry out common tasks (e.g., building a health center, or repairing the road) To not have conflicts with the decisions taken in the community (e.g., regarding development projects)	Having respect in the family Having respect in the community Helping and taking care of friends
Other species	A healthy environment	To have clean air To have a good environment/atmosphere in life To have water To have fertile land	Cleaning well (in the village) Planting flowers (in the village) Reducing shifting cultivation Authorities should stop bushfires

(Continued)

TABLE 3 | Continued

Central capability	Well-being component	Why is the component important?	What is needed to satisfy the component
Play	Rejoicing	To have a long life To not have heart diseases To nourish friendship To recognize the family	Celebrating ceremonies Celebrating weddings
Control over one's environment	Having money	To be liked by everybody To do whatever you want To progress in life To be respected in the village To buy food To buy whatever you want and have a good life To build a beautiful house	Working with major operators (for cash crop trade) Planting cash crops Having a farm or raising zebu Having secure and stable income Having a non-agricultural job
	Land ownership	To sell the land if we have economic problems To work the land To not spend money renting the land To bequest the land to the children, so they do not have problems in the future To build a house	Buying plots of land Inheriting the land Receiving land from relatives or friends Titling the land (for securing ownership)

TABLE 4 | "Difficult to satisfy" and "satisfied" well-being components mentioned in the FGDs across the four villages and both genders.

Difficult to satisfy at present time			Satisfied at present time		
Well-being component	# scored	Frequency-weighted score	Well-being component	# scored	Frequency-weighted score
Education	5	10.38	Good health	6	12.56
Having money	3	9.99	Having children	2	10.64
Good relations in the household and family	3	9.04	Education	6	9.65
Good health	5	8.45	A good administration	3	5.80
Having a house	3	7.09	Having cash crops	2	5.57
Enough food	4	5.62	Having a house	4	4.55
Having children	3	4.77	Being able to carry out everything one plans	1	3.37
Having free time	2	4.76	Having a household/family	3	3.05
Good social relations in the village	3	4.62	Earning money in the village	1	2.94
Good relations in the couple	2	4.17	Being respected	3	2.91
Rice cultivation	2	4.09	Riding the motorcycle	1	2.65
Security	5	3.94	Rejoicing	2	2.63
A good administration	2	3.16	Rice cultivation	1	2.27
To have a job (salaried)	1	2.78	Earning money every day	1	2.21
Being listened to	1	2.65	Increase in the number of exporters	1	2.08
Practicing a religion	1	2.38	Freedom of expression	1	2.08
Children like to study	1	1.89	Having livestock	1	1.89
Achieving one's plans	2	1.85	Price of products being high	1	1.79
Having a household/family	1	1.14	Planning one's life	2	1.67
Having fertile land	1	1.14	Having fertile land	1	1.52
Land ownership	2	1.11			

Only components with a frequency-weighted score of at least 1 (difficult to satisfy) and 1.5 (satisfied) are listed.

visitors or newcomers made it more difficult to do so. Also, and as mentioned in three FGDs, maintaining good health became more difficult because of the rising costs of seeing the doctor or of buying medicines. This inflationary trend was mentioned as the main reason for the decreasing ability to have money, for households not engaged in cash crop production. Further, in several FGDs participants mentioned the issue of people having more money as the cause for worsening social relations in the

village, because now one needs to pay people to get help, when in the past this help could be obtained based on principles of reciprocity and solidarity.

Additionally, the agricultural intensification process taking place in our study villages, with farmers converting their shifting cultivation fields into cash crop production, was mentioned as having a potentially negative effect on food security. This was specifically so in Fizonon and Beanana, the two villages

TABLE 5 | Examples of rationale provided during FGDs for the change in satisfaction with well-being components.

Central capability	Well-being component	Why it is more difficult to satisfy now	Why it is more satisfied now
Bodily health	Good health	There are more epidemics and diseases, because of the destruction of the environment Medicines and visiting the doctor are more expensive due to the increase in living costs There is less fruit available now due to the destruction of the environment There is not enough health personnel There is more malnutrition than before	There are more people selling medicines now There are more doctors now There is a new health center Now we drink water from the well-instead of from the river
	Enough food	Land has become less fertile now There is less water available for irrigation due to the lack of dams There is less rice available due to the growth of the population We have too many children Shifting cultivation fields have been converted into cash crop production, so there is less rice production Now we do not have access to the forest for getting new shifting cultivation fields	We can buy (more) food now because of the increase in the price for cash crops Now we can sell subsistence crops and buy food with the money we obtain
Bodily integrity	Security	We have more money now, and so money has become more important, and people more materialistic People have become lazy, they do not want to work nor study, so they steal People kill each other People have become disloyal due to the increase in price for the cash crops There are more thefts now	n/a
	Having children	Women and men are more aware of having fewer children Parents arrange marriages less than in the past There is less support from the extended family (to take care of the children)	n/a
Senses, imagination, and thought	Education	School fees are very expensive, and many parents cannot afford to send children to school Children are very undisciplined now	Parents have become aware of the importance of sending children to school and encourage them to study Children have become aware of the importance of education Now there are many teachers and many schools. We can choose from several
Emotions	Having a household / family	n/a	People create households younger now, meaning it is easier to do it Now, the new households are more respected
Practical reason	Planning one's life	n/a	More people are able to support children to go to university, because of the increase in cash crop prices We have now the possibility to improve the meal The antenna for the phone was installed recently, and now we can send money to other places through the phone. Also, we can order the tools from other places and get them here. We can also call other places (e.g., Antalaha) to get to know the price for the cash crops there Thanks to the radio antenna, we can send messages to other places (e.g., Maroantsetra), to spread information
Affiliation	Good relations in the village	There is less respect toward the <i>tangalamena</i> (i.e., traditional authority in the villages) People have become more selfish and materialistic: you have to pay if you need help from others People used to welcome visitors. Now, living costs have increased, so people do not welcome as much as before	n/a
Other species	A healthy environment	n/a	There is a protected area now People have become more aware of the need for a clean environment Bushfires have decreased

(Continued)

TABLE 5 | Continued

Central capability	Well-being component	Why it is more difficult to satisfy now	Why it is more satisfied now
Play	Rejoicing	n/a	We have more money now, so we can participate in ceremonies and parties We can ask people for money to participate in parties
Control over ones environment	Having money	Living costs have increased because of the price for cash crops. People not cultivating cash crops cannot afford them The price for subsistence crops is low, so you do not make money by selling them	The price for the cash crops has increased There are more people in the village investing (in trade and commerce), and more money circulating in the village We have increased our purchasing power We have learned how to manage money better
	Land ownership	There is a land shortage because of the growth in population People cannot obtain land because of the ban on clearing the forest Before, we could receive land from relatives, not anymore There are conflicts over land parcels now, a sign that it is more difficult to get land now	n/a

most reliant on shifting cultivation, where intensification was mentioned as one of the main causes for the decrease in the ability to obtain enough food and to cultivate rice, respectively.

The most salient changes in satisfaction without a direct relation to the two telecoupling processes were mentioned in relation to education and health. Education was on four occasions stated by participants to have become easier to satisfy now; twice it was mentioned as being more difficult to satisfy at the present time. Good health also showed mixed results: in three FGDs it was considered more satisfied at the present time, while in five FGDs it was deemed more difficult to satisfy.

Differences by Village

Results on what well-being components are important—as well as current satisfaction and change in satisfaction with these components—vary across and within FGDs, suggesting the existence of both intra- and inter-village differences. The approach chosen for the current study does not allow us to investigate more deeply the case of intra-village differences (e.g., by household characteristics). However, in the case of the inter-village differences, a few points can be noted.

While rice is the main subsistence crop in all our study villages, rice cultivation was explicitly stated as a well-being component only in the two FGDs conducted in Beanana, the village most reliant on shifting cultivation and with the least land devoted to cash crop production. In contrast, having cash crops was mentioned as necessary for a good life in most FGDs, with the notable exception of those conducted in Mahalevona, the village in which cash crop cultivation is most widespread and shifting cultivation least important. Also, the well-being component of having access to communication means, specifically referring to phone and radio coverage, was mentioned only by men in the FGDs conducted in Beanana and Fizonon, the most remote villages, and those whose mobile phone or internet coverage was barely existent at the time of research. There, participants particularly emphasized the role that the mobile network and new technologies play: these allowed them to obtain news through the

internet or send money by mobile phone, thus enabling them to order goods from distant towns or support children studying in faraway cities. Similarly, it was only in Beanana, by far the village most remote and difficult to access, where having good roads was mentioned as a component needed for local well-being.

Further, having money was overwhelmingly considered currently difficult to satisfy in the FGDs conducted in Morafeno and Beanana. However, in the case of Morafeno, the change in satisfaction was positive, while in Beanana it was negative. The main reasons provided for these differences was that in Morafeno, the cash crop price increase was perceived as a positive aspect for the majority of participants. However, in the case of Beanana, the main reason for a negative impact of this price increase was that it had pushed the price for most basic necessities and consumer goods upwards.

DISCUSSION

Human Well-Being Trade-Offs Under Telecoupling

The effects of the telecoupling processes we explore in this study in their relation to local well-being dynamics appear to have been both positive and negative. This suggests the existence of trade-offs both between well-being components at the individual level, and potentially, between villages and households, likely depending on their degree of reliance on cash crops and subsistence shifting cultivation.

Protected Areas and Links to Well-Being

The only positive impact of the PAs on local well-being that participants could identify was that of providing a healthy environment. Respondents in all four villages were unanimous on this point, emphasizing in particular the role of the forests in providing clean water and air. This is in line with findings from other contexts in Eastern Madagascar, where conservation interventions were considered by local populations to have had a positive impact on health (Rasolofoson et al., 2018). In

TABLE 6 | Change in satisfaction with well-being components.

Well-being component	Positive change	No change	Negative change
A healthy environment	5	-	-
Education	4	1	2
Having money	4	-	1
Good health	3	-	5
Achieving one's plans	3	-	1
Practicing a religion	3	-	1
Freedom of expression	3	-	-
Having cash crops	3	-	-
Enough food	2	-	5
Planning one's life	2	-	1
Having a house	2	-	1
Make your own decisions	2	-	-
Access to communication means	2	-	-
A good administration	1	1	2
Good social relations in the village	1	-	1
Having a household / family	1	1	-
Having livestock	1	-	-
Knowing how to manage your time	1	-	-
Rejoicing	1	-	-
Being respected	-	1	3
Security	-	-	3
Land ownership	-	-	3
Good relations in the household and family	-	-	2
Having children	-	-	2
Mutual assistance / solidarity	-	-	2
Good relations in the couple	-	-	2
Rice cultivation	-	-	2
Having free time	-	-	1
Participating in decision-making in the village	-	-	1
Having a long life	-	-	1

The numbers indicate in how many FGDs the level of change for each component was considered to have taken place.

another parallel, participants in our study related the increase in disease incidence to the destruction of the environment, which may link to findings from other PAs in Madagascar, suggesting the potential role of certain species, such as bats, in suppressing agricultural pests and disease transmitting insects (Kemp et al., 2019). More broadly, this aligns with studies from other parts of the world suggesting biodiversity conservation as a key factor for improving, or at least maintaining, health conditions, particularly to prevent transmission of diseases (Myers et al., 2013; Kilpatrick et al., 2017). While health outcomes of conservation interventions in developing countries remain an understudied aspect (McKinnon et al., 2016), some studies in the tropics have conversely tried to relate forest loss with impacts on health and well-being. In Kalimantan, Indonesia, for example, deforested areas were found to be associated with higher local temperatures, which in turn had negative effects on

both self-reported health and measured human heat strain (Wolff et al., 2018; Suter et al., 2019).

In regard to the negative impacts of PAs on well-being, the most relevant refers to the impact of the PA on people's ability to secure food, along with difficulties in accessing land, as reported in Fizonon and Beanana, villages where participants did not see any positive effect of the conservation scheme. In these villages, the closest to the respective PAs, populations rely more strongly on shifting cultivation for subsistence rice production and less on cash crop production, suggesting a lack of alternative non-forest-dependent livelihoods, and potentially a stronger impact of PA restrictions compared to Morafeno and Mahalevona. This was recently found for other conservation interventions in Eastern Madagascar (Rasolofoson et al., 2018), where it was also shown that a proportionally larger burden was borne by poorer populations due to restrictions in access to forest land (Poudyal et al., 2018). Restrictions imposed by the PAs might also have an impact on access to bushmeat for households relying on this source of protein, an issue brought up in one of the FGDs and also found in other African settings (Nguiffo, 2003). Restrictions in access to bushmeat might have important nutritional and economic implications also in the context of north-eastern Madagascar, and in our case in the villages of Beanana and Morafeno, as noted by other studies conducted in the area (Golden et al., 2011, 2014). Arguably related to these restrictions in access to forest land and products is the issue highlighted in one FGD, where participants related having the PA with a greater need for development support. While in our study, attitudes toward the PA were in general rather mixed across villages and within FGDs, both the perceived performance and scope of development interventions in connection to the conservation scheme were found to be positively related to local support for the PAs by other studies conducted in Masoala and Makira (Marcus, 2001; Ratsimbazafy et al., 2012). However, and as suggested in the case of Makira (Ratsimbazafy et al., 2012), negative views on the impacts of the PAs might be related to the degree of forest dependence of households, which may apply in our case to Fizonon and Beanana.

The latter point would align with other conservation contexts in the tropics, where negative attitudes toward PAs were found to be higher among poorer, landless populations living closer to conservation areas (Sarker and Røskoft, 2011). More generally, our findings also relate to other contexts where contradictory attitudes toward PAs were found within the same community, and even at the individual level. This was, for example, the case for shifting cultivation landscapes in Southeast Asia, where research highlighted a mix of institutional, ideational, and psychological explanations for the contrasting local views on PAs, while also suggesting an unequal distribution of benefits and burdens of conservation interventions across households as reasons for such contrasting attitudes (Martin et al., 2018).

Cash Crop Booms and Well-Being

In the case of the other telecoupling dynamic we explore in this study, cash crop prices, the increase in price—especially that of vanilla—appears to have had a mixed impact on local

populations' ability to satisfy valued well-being components. The price increase had a positive influence on those individuals engaged in cash crop production, which, through increased earnings, improved their ability to meet material needs and plan their life, while also increasing their social status. Further, some of the reasons put forward for the increase in satisfaction with having money, i.e., that people are investing in trade and commercial activities and that they have learned how to manage money better, might suggest the potential role of the current cash crop price in enabling households to diversify their livelihoods. The way money-related well-being components, and especially, what is needed to have money, was formulated in several FGDs, suggests that local populations might value such livelihood diversification because it provides them with a stable source of income, thus buffering them against seasonally uneven income availability. The positive impact of diversification, particularly involving high-return activities such as trade or other non-farm salaried jobs, on supporting well-being in a multidimensional manner, has been found recurrently by many other studies in the rural global South, from Nepal to Bangladesh or Ghana (Sultana et al., 2015; Gautam and Andersen, 2016; Sackey, 2018). However, as shown in the case of Nepal, entry barriers might prevent poorer households from engaging in activities such as trade, potentially resulting in increasing inequalities at the intra-community level (Gautam and Andersen, 2016), which could also be valid in our context.

Among the negative implications of the increase in cash crop prices, one of the most frequently mentioned was the increase in the cost of living. This was particularly noted in Beanana, where the majority do not cultivate vanilla and thus find it difficult to afford the current inflationary dynamic. While this inflation has so far been little covered by the scientific literature, the media has depicted its negative effects in other vanilla-producing regions in Madagascar (Lepidi, 2017). Related to this point, another way in which the increase in price for cash crops might influence the ability to satisfy valued well-being components is by its impact on the degree of monetarisation of the community. This was illustrated by participants as the current need to pay people if one needs help, in contrast to before, when people would help each other without the mediation of money, in turn affecting the level of solidarity in the village.

Finally, according to participants, the increase in cash crop prices had an important effect on the incidence of thefts and even murders, and in general on the level of security of the community, which was mentioned as a key well-being component in most FGDs. This increase of the level of insecurity in relation with the vanilla price spike has been widely reported for north-eastern Madagascar by different media (Kacungira, 2019; Steavenson, 2019). Further, the vanilla price boom was recently found to also entail an additional burden for households, as they have to allocate substantial labor to secure the cash crop production against thefts, for example in the Sava region of Madagascar (Neimark et al., 2019). This might also apply to our study villages, as participants were concerned about the security situation not only because of the material losses it might involve, but also because the prevailing context of insecurity might be a source of worry and stress, and an impediment to having good social

relations. More broadly, while the relation between insecurity and well-being in rural contexts remains a largely unexplored issue, a study from rural Colombia found a severe negative impact of perceived insecurity on the subjective well-being of local communities (Wills-Herrera et al., 2011), which might appear to be the case also in our study villages.

The trend toward agricultural intensification caused by the conversion of shifting cultivation fields into cash crop production highlighted in several FGDs and also described by other studies in the area (Llopis et al., 2019) appears to have had negative effects on a section of the population in our study villages. While participants did not mention any direct benefit from this agricultural intensification process, it was one of the key reasons cited for more difficulties in meeting food needs. This may in particular be the case for households relying more strongly on shifting cultivation and not yet engaged in cash crop production. On several occasions, participants noted that it was easier to buy food, thanks to the increase in cash crop prices, indicating that the effect of abandoning rice production on food security might be mitigated over time. Nonetheless, it takes several years after fields have been converted for both clove and vanilla to begin producing. For households that decide to convert their fields but without enough land to make up for the lack of rice production from the converted fields, the years between conversion and the start of production may constitute a substantial burden.

Finally, in regard to some of the apparent inconsistencies in satisfaction with some well-being components, one possible reason is that individuals may consider a certain component difficult to achieve (i.e., require a lot of effort to satisfy), while nonetheless being satisfied with it at the current moment. A second possible reason may be linked to the approach we chose for this study: diverging opinions within the same FGD were masked during the scoring exercise, as we aggregated the points obtained by each component. This could conceal a differential impact of economic dynamics, both by villages, and more crucially, by households. However, the approach we employ in this study does not permit us to draw conclusions about household differences, and further research should look at disaggregated well-being aspects by household, as recent studies have done elsewhere (Dawson and Martin, 2015).

The Bundled Nature of Well-Being Components

The reasons participants gave for considering the well-being components important were related to multiple capabilities at the same time, suggesting that well-being components are inherently bundled in character. In addition—and crucially—some components may contribute to the support of other components. The well-being component of having good health, for example, was appreciated by participants because it allowed them to pursue livelihood activities and also to avoid spending money on doctors and medicine, on the one hand. On the other, having good health was also key in enabling people to not have stress, to have confidence in themselves, or critically, to engage in social relations, particularly because they could both welcome visitors at home and physically visit friends and relatives. This

points to a broader positive impact of having good health on emotional and psychological well-being aspects, as has been found in developed and developing contexts alike (Chin, 2010; Aggraeni et al., 2018).

The case of education in our case is also illustrative of the bundled character of well-being components, because it was valued for its potential in allowing children to have a better life and to obtain a salaried job. This aspect was explored in south-western Madagascar, where better access to education appeared to allow people to access non-farm jobs, perceived as a better occupation than traditional agricultural activities (Neudert et al., 2015). Further, in a community forest management programme context in eastern Madagascar, it was found that having higher levels of education might translate into households enjoying more positive outcomes of the programme (Rasolofoson et al., 2017).

A remarkable aspect of the interconnection of well-being components is that an increase or decrease in a certain component might have an impact, either positive or negative, on an entire bundle of components. This can be a relevant insight when planning for external interventions which, while implemented at village level and thus benefiting the community at large, may have positive effects at the individual level in multiple ways. As stated by several studies, this might be the case of the extension of communication services, by for example installing a telecommunications antenna. This was found to be critical in supporting well-being in a variety of rural developing contexts (Foster and Handy, 2008; Thapa et al., 2012), particularly in the case of mobile phone coverage to facilitate connection with family and friends (Pearson et al., 2017). This appears in line with our results, as the extension of the mobile network was considered to have positive impacts on a wide range of well-being aspects, such as accessing news through the Internet or supporting children studying in other towns. More broadly, work on the sub-Saharan African region has highlighted the crucial role that expanding virtual mobility through access to mobile phones can have in the case of poorer households and their material well-being (Porter, 2012).

Using the Capabilities Approach to Explore Well-Being

Our exploration of human well-being through the capabilities approach has generated important lessons. As demonstrated in this study, using Nussbaum's central capabilities can constitute a solid basis for systematically eliciting a wide range of well-being aspects. Further, it can shed light on the interrelations between well-being components, and critically, provide clues as to how some capabilities might be needed to support others, as remarked also by Nussbaum (2011b).

Combining the central capabilities list with FGDs has demonstrated the usefulness of the list in eliciting a holistic understanding of well-being in a rapid and coherent manner. While this might be especially useful in the case of exploratory research, it can also serve as a preliminary step to deeper research. For example, the central capabilities list could be used as a basis for establishing indicators for quantitative surveys (Anand et al.,

2009), for elaborating categorizations of household taxonomies based on qualitative information (Roelen and Camfield, 2013), or to guide and complement quantitative data collection and analysis, in line with the Well-being in Developing Countries (WeD) approach (Gough and McGregor, 2007).

However, applying a universal capabilities list to real-world situations is not without challenges. In our case, this may be especially visible when translating some terms that in a Malagasy context might have overlapping or potentially conflictual meanings, such as "environment" (*tontolo'iainana*) and "land" (*tany*) (Osterhoudt, 2010). Being aware of such nuances may be particularly relevant, because, while it has been repeatedly acknowledged that the natural environment is critical in supporting human well-being (Duraiappah, 2004; Schleicher et al., 2017), the diverse ways in which natural environment-based capabilities are valued by different people are still barely understood. Our study thus contributes to recent efforts to better address the role of the environment in capability building (Holland, 2008), and particularly to understanding the diverse, often contradictory reasons why people might consider natural environment-based capabilities essential for their well-being. Taking into account such diverse views on the natural environment may be especially important in conservation interventions, which in many cases ultimately aim at changing human behavior toward nature. This might help anticipate, and plan for, some of the negative local impacts of conservation initiatives, while increasing the legitimacy and ethical groundedness of such interventions (Milner-Gulland et al., 2014).

CONCLUSION

This study used the capabilities approach to highlight the challenges that telecoupling poses to supporting and fostering human well-being in a context of agricultural intensification. First, we demonstrated the strengths of the capabilities approach, and concretely of Nussbaum's central capabilities idea, to help elicit the well-being components that are valued locally for a good life. Second, by exploring the interrelations between these well-being components, we have highlighted their bundled nature, where increases in one component might lead to increases in a whole set of them, and vice versa. This finding points to the potential positive multiplier effect that supporting one well-being component might have on many other components, as may be the case with e.g., access to education, to communication means, or to health services. And third, we have shown the trade-offs that telecoupling might entail for human well-being in a developing forest frontier context. While the PAs appeared to have had a significant positive effect in helping to secure a healthy environment for local communities, these very dynamics had severe detrimental effects on populations most reliant on forest land for their livelihoods. In terms of the ongoing surge in cash crop prices, while it allowed people engaged in commercial agriculture to better satisfy some material and status well-being components, this dynamic also had a negative impact on social relations, security, and inflation, the latter affecting more strongly

the households not engaged in cash crop production. Realizing that such trade-offs emerge as a consequence of factors exogenous to the local context, highlights the urgent need for a holistic, disaggregated understanding of human well-being dynamics under these telecoupling processes. This knowledge is needed, in particular, when designing conservation interventions that might have a much stronger impact on more disadvantaged populations, arguably those most reliant on forest land and not benefiting from the ongoing cash crop boom in the context we explored.

However, some of the limitations inherently involved in the approach we adopted for this study, such as the aggregation of participants by age and socio-economic status within the same FGDs, or the inherent power dynamics emerging in such types of exercises, should be addressed in future research. This and the apparent contradictions we found in this study, warrant further investigation into how telecoupling affects households according to their different socio-economic status and livelihood portfolio. In summary, while operationalizing the capabilities approach through extended FGDs in these forest frontier landscapes already yielded a wealth of deep, much-needed insights into local well-being dynamics, this step can also be the foundation for further research on differentiated well-being and sustainable development in a context of agricultural intensification.

DATA AVAILABILITY STATEMENT

The datasets generated for this study are available on request to the corresponding author.

ETHICS STATEMENT

Oral informed consent was obtained from all participants included in the study before the research was conducted.

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AUTHOR CONTRIBUTIONS

JL, CD, FS, PH, LP, PM, and JZ contributed to the conception and design of the study. JL, CD, PH, and JZ conducted fieldwork, analyzed the data, and interpreted the results. JL drafted a first version of the manuscript and elaborated the figures. JL, CD, FS, PH, LP, PM, and JZ commented on the manuscript, contributed to manuscript revision, read and approved the submitted version.

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SUPPLEMENTARY MATERIAL

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

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