sustainability

MDPI

Article

The Effects of Road Access on Income Generation. Evidence from An Integrated Conservation and Development Project in Cameroon

Ina-Kathrin Spey [1,*], Denis Kupsch [1,*], Kadiri Serge Bobo [2], Matthias Waltert [1] and Stefan Schwarze [3]

1 Department of Conservation Biology/Workgroup on Endangered Species, Georg-August Universität Göttingen; Bürgerstrasse 50, 37073 Göttingen, Germany; mwalter@uni-goettingen.de
2 Department of Forestry, University of Dschang, P.O. Box: 222 Dschang, Cameroon; bobokadiris@yahoo.com
3 Institute of Rural Studies, Johann Heinrich von Thünen Institute, 38116 Braunschweig, Germany; stefan.schwarze@thuenen.de
* Correspondence: inakathrin.spey@gmail.com (I.-K.S.); dkupsch@gwdg.de (D.K.)

Received: 19 May 2019; Accepted: 14 June 2019; Published: 18 June 2019

Abstract: Many integrated conservation and development projects use road construction to induce a shift in income activities, since road access can reduce both poverty and environmental degradation. There is, however, little empirical evidence on the effects of road access on income patterns. We contribute to existing literature by analyzing the effects of road access on income activity choice in Korup National Park, Cameroon using a difference-in-difference approach. Road access led to a rise in total household income by 38% due to higher household participation in self-employment and wage labor. We neither found an effect on income from crop farming nor on participation in hunting activities. The effects of road access can be diverse and unforeseeable. Road construction in protected areas should thus be carefully considered and planned and only be implemented when other options are not feasible.

Keywords: rural road; income; hunting; difference-in-difference; impact evaluation; poverty

1. Introduction

In accordance with the Sustainable Development Goals of the United Nations, the need for infrastructure in developing regions and its positive effect on poverty reduction has been widely accepted [1–3]. Among others, roads enable access to public services and institutions, providing connection and simplifying transport [4]. In the past, studies have focused on highlighting these positive effects of road access on poverty alleviation and livelihoods by reducing travel time and costs, as well as creating job opportunities and establishing better access to local markets, which in turn increase agricultural production and household income [1–3,5–8]. Additionally, local communities profit from employment during construction and better access to public services, like hospitals and schools [4].

In Western Africa, where commercial bushmeat hunting remains one of the main conservation challenges [9], road access is also suggested to induce a shift in primary occupation from hunting to farming [10]. Indeed, others found hunting effort to be a negative function of farming effort and likely to decline if agricultural production increases [11,12]. In West Africa, many integrated conservation and development projects (ICDP), which aim to promote conservation in a way that reduces poverty and use poverty reduction as a tool to enhance conservation [13], failed to substitute poaching as a very lucrative income source with alternatives, such as cash-crop farming or livestock keeping [14,15]. Improving road access may serve as a key instrument in ICDPs, since it fosters agricultural production

and in turn combats both poverty and wildlife decline. However, information on the effects of road access on income activity patterns as well as the effectiveness of ICDPs in general remains limited [15].

Here, we present a case study from Southwest Cameroon, where the construction of unpaved motorbike roads in the context of an ICDP has been used to facilitate the marketing of crops such as cocoa, plantain, and cassava and, therefore, promote crop farming and reduce hunting [14,16]. Acknowledging that there are many other adverse effects of roads on biodiversity, such as deforestation [17], fragmentation [18], genetic degradation [19], and wildlife collisions [20], we want to focus this study on the impact of road access on income patterns of rural communities, which indirectly affect biodiversity.

Taking the case of an ICDP in Southwest Cameroon, we aim to identify the causal effects of road access on income activities. We hypothesized that total household income will increase in response to road access due to higher crop sales and new job opportunities. In consequence, we expected a negative impact of road access on income from hunting. We further enrich these quantitative findings by the perceptions of rural households concerning the effects of improved road access on village life.

2. Materials and Methods

2.1. Study Area

Korup National Park (KNP), located in the Southwest Region of Cameroon (4°53′ N to 5°27′ N and 8°43′ E to 9°15′ E), is part of the largest continuous forest block in West Africa, the Cross-Sanaga-Bioko coastal forests. Its 1260 km^2 range is dominated by an intact and diverse lowland rainforest and offsets of the Cameroonian mountain line [21]. KNP is part of the Gulf of Guinea Biodiversity Hotspot, harboring a rich fish, insect, bird, and herpetofaunal species pool [22]. The Korup region is also home of more than 160 mammal species, many of which are endangered due to commercial hunting, such as the African forest elephant, Elliot's chimpanzee, and the Mainland drill. There are five isolated villages located within the park (Figure 1), which are part of an ICDP, aiming, amongst others, to reduce hunting pressure using a variety of incentives and agreements. Out of these, one incentive entailed first-time road access for the park villages Erat and Esukutan (in March 2015 and April 2015, respectively). The new motorbike roads are dirt roads constructed along former foot tracks with small-sized culverts for drainage, preventing the passage of cars. The motorbike roads allow transport of heavy cargo, while they reduce travelling time to the nearest regional markets from four to two hours for Mundemba and three to one hour for Babi ([23], Figure 1).

Ikenge village, which is situated within the same natural environment as the road villages, providing similar conditions for crop farming, hunting, and collecting forest products, served as a control site for this study. As it can only be reached by foot, spending at least three hours to get to the next neighboring village, we considered Ikenge as not affected by the road. The other two remaining villages in the park were excluded from the study because of their small size.

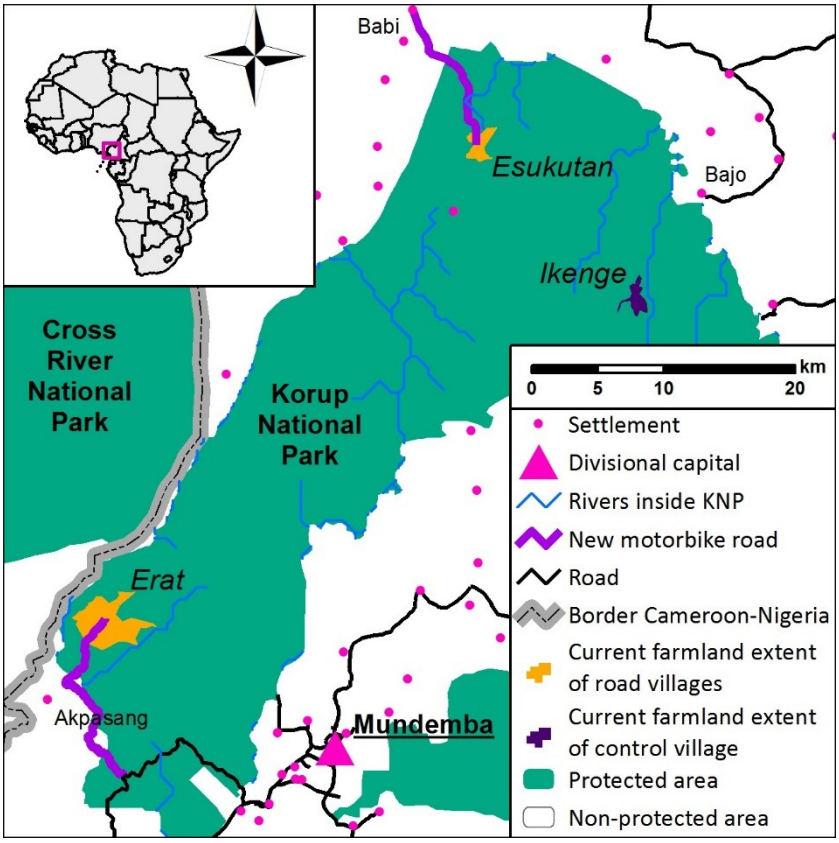

Figure 1. Study area in Korup National Park, Cameroon with the road villages (Erat and Esukutan) and control village (Ikenge) and their farmland extent in 2016, as well as the new motorbike roads (thick purple lines) connecting to the road network.

2.2. Data Collection

We conducted structured interviews on quantitative household data in Erat, Esukutan, and Ikenge prior to (March and April 2015) and post-road construction (April and May 2016). Though the members of the survey team changed from 2015 to 2016, the local assistant and translator, the sampling protocol, and the questionnaire sheet remained the same. In 2016 only, we used a box questionnaire, open as well as with questions with item-specific response options in road villages to support and describe quantitative survey results. We organized box questionnaires to ascertain that the household selection for interviews was representative, as direct questions on sensitive topics, such as illegal activities (i.e., poaching), are likely to result in biased data [24–26]. All inhabitants were invited to fill out a short anonymous questionnaire. Sheets were thrown into a cardboard box. Questionnaires were filled out prior to the actual interviews and generated 95 completed sheets in Erat and 92 in Esukutan. Similar income source distributions between face to face interviews and box questionnaires were found ($X^2 = 20$, df = 16, p value = 0.2202; Table A1).

In both years, sample households were drawn randomly based on census lists received from local authorities. Since income-generating activities of men and women differed in the study region and contribution to household income was not equal, the household head and his/her spouse were interviewed separately, and data pooled subsequently [23,27,28]. All interviews were conducted face to face with only the respondent, interviewer, and translator present.

Each interview consisted of three sections and lasted between one and a half to two hours. Section one covered household demographics. Section two encompassed the main part of the survey. Here, we collected data about household income by requesting detailed information on inputs, outputs, and prices for different income sources as well as expenditures for the last 12 months. Income and

expenses were recorded in local currency (CFA Franc CFAF). The third section of the survey only addressed households in road villages after road construction. It consisted of open-ended questions as well as questions with item-specific response options [29], regarding attitudes towards the new road, farming, and poaching.

All interview sheets were reviewed during the survey and households revisited if data were unclear, inaccurate or incomplete. We revised or eliminated interview sheets when either the sum of all income data exceeded 150% of total expenses and vice versa, or the interviewee did obviously withhold information, such as income from poaching activities. Accordingly, data from 30 households in 2015 (n_{road} = 20, $n_{control}$ = 10) and from 68 households in 2016 (n_{road} = 51, $n_{control}$ = 17) with similar household demographics (Table A2) was analyzed.

2.3. Data analysis

We considered income as the sum of cash income plus the market value of produced but self-consumed goods, minus all expenditures for inputs such as pesticides and hired labor. Labor provided by household members was hereby not considered [30]. We distinguished between six major income sources (Table 1). Income from self-employment and wage labor (SEW) was combined because engagement was often short-dated or undefined and could not be allocated to one or the other category (e.g., irregular paid work on farm, employed teacher with irregular payment). Changes in income between the survey years were tested in the road villages and control village, respectively, using Mann–Whitney U tests (MWU). For the econometric analyses, total income, crop income, NTFP income (income from nontimber forest products), and income from fishing were log transformed due to non-normal distributions [31,32]. SEW income, hunting income, and income from livestock were zero inflated and therefore transformed to binary variables (0,1). Statistical analysis was carried out in R version 3.3.2 [33].

Table 1. Description of income sources.

Income Source	Description	Potential Inputs
Crop income	Net income from cash and food crops	Seeds, seedlings, chemicals, processing, transport, and hired labor
Nontimber forest product (NTFP) income	Net income from plant material collected in the forest excluding values for wooden goods such as timber, firewood etc.	Baskets and bags for collection
Hunting income	Net income from hunting and trapping including revenues from bushmeat, skins, bones, and feathers	Gun, dog, cartridges, wire
self-employment and wage labor (SEW) income	Net income from wage labor (e.g., teacher) and from self-employment other than own farm work (e.g., shop owner, motorbike driver)	Porter, transport, goods
Fishing income	Net income from freshwater catch using fishing baskets, crossing net, crossing hook, hooking or flying hook	Nets, hooks, lines
Livestock income	Net income from farm animals and their products such as eggs	Animals purchased, material, feed
Total income	Net total household income calculated as the sum of crop, NTFP, hunting, SEW, fishing and livestock income	Sum of all inputs

We tested the effect of road access on total income and income composition using the difference-in-difference (DD) approach. It measures an impact by comparing a treatment and control group with respect to heterogeneity and changes over time. DD allows unobserved heterogeneity but assumes that this is time-invariant. By collecting data of a control and treatment group, before and

after the treatment, this heterogeneity can be differenced out [34]. The underlying estimation equation for the outcome variable is [35]:

$$Y^j_{it} = \alpha + \alpha d_t + \alpha^1 d^j + \beta d^j{}_t + \varepsilon^j{}_{it}, \quad (1)$$

where Y^j_{it} is the outcome variable for household i, d_t is a dummy variable for time (d_t = 1 for 2016 and zero for 2015), d^j is a dummy variable for treatment status (d^j = 1 for all households living in villages with road access and zero otherwise), and $d^j{}_t$ is an interaction term between time and treatment. The coefficient β captures the effect of the treatment on the outcome for the treatment group, while α^1 controls for the difference within the control group before and after the treatment. ε^j is a vector of time-variant variables, which might have an impact on the outcome variable as well.

Applying DD estimation, the effect of road connection was tested on total income and all six major income sources (Table 1). As mentioned above, DD controls for time-invariant unobserved heterogeneity, i.e., that other covariates do not change across the years. If those variables, however, vary over time, they need to be controlled for in the regression model to get the net effect of improved road access on the outcome. We hence extended the regression model by including other covariates that may affect the outcome. The selection of covariates was based on a previous study [7]. Multicollinearity was identified using Spearman rank tests and the generalized variance inflation factors (GVIF; [36]). GVIF was used because there were categorical and dummy variables in the model. We defined moderate correlations at GVIF > 5 and strong correlations at GVIF > 10 and ρ > 0.7 (rhô, a measure of correlation strength [36–39]). Since the interaction term of treated and time constitutes the heart of a DD analysis, it was kept despite a moderate GVIF value [34]. Model selection was based on selective stepwise backward regressions, impact of road connection (that is, the respective *p*-value) and ranked adjusted R square values [34]. Covariates of the final models can be found in Table 2.

Table 2. Covariates used in difference-in-difference (DD) analysis, HH: Household, NTFP: Nontimber forest products, SEW: Self-employment and wage labor.

	Income Sources						
Covariates	**Total Income**	**Crop**	**NTFP**	**Fishing**	**Livestock**	**SEW**	**Hunting**
Age of HH head	X	X	X		X	X	
HH head born in village	X	X		X			X
HH head is female	X	X	X	X			X
HH head is married	X	X	X	X			
Nr. of children in HH	X		X	X	X		
Nr. of adult men in HH	X		X		X		X
Nr. of elders in HH				X	X	X	X
Nr. of adult females in HH				X	X		
Hunting carried out in HH	X						

Furthermore, we tested the effect of road access on total income of different wealth groups. Therefore, we divided the dataset into two income categories (I = 'below median total income' and II = 'above median total income') using the median of total income as the threshold value and repeated DD estimations.

Following the idea of the qualitative content analysis in [40], responses from open-ended and focus group questions were first paraphrased, then generalized, and finally reduced to their central statements. All data on behavior change and attitude towards the road were analyzed using frequency analysis.

3. Results

3.1. Descriptive Analysis of Household Incomes

The main income source in road villages was crop farming, followed by hunting, collection of NTFP, fishing, SEW, and livestock keeping (Figure 2) before the road opening. With road access, income from crop farming (MWU, U = 321, $p = 0.015$) and SEW was significantly higher (MWU, U = 351, $p = 0.038$); the latter was even higher than income from fishing. In the control village, hunting income was the main income source in 2015 but significantly dropped in 2016 (MWU, U = 136, $p = 0.001$). Further, income from livestock breeding (MWU, U = 140, $p = 0.005$) significantly decreased. Even though SEW increased significantly (MWU, U = 118, $p = 0.094$) total income decreased significantly (MWU, U = 124, $p = 0.052$).

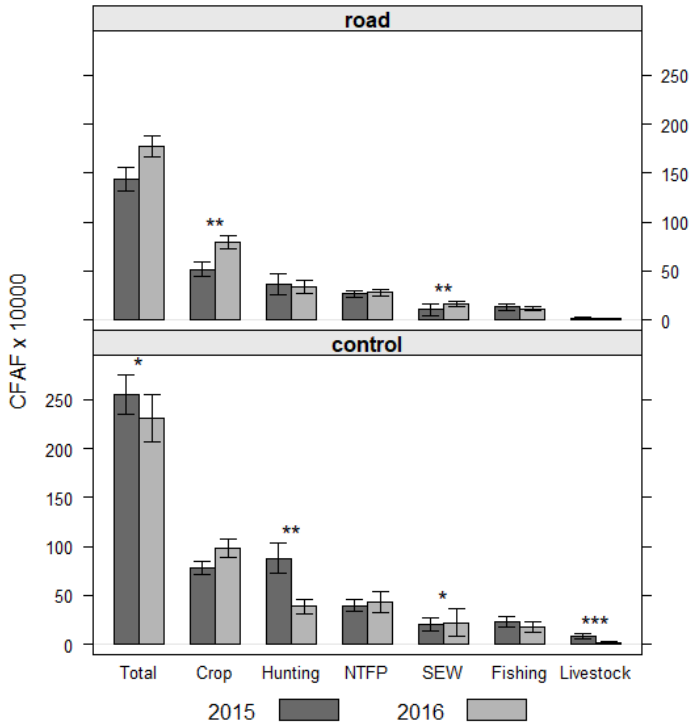

Figure 2. Income (CFAF × 10,000) before (2015) and after (2016) road access in road and control villages. NTFP: Nontimber forest products, SEW: Self-employment and wage labor. Significant Mann–Whitney U test results are presented as *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

3.2. Impact Analysis of Road Access on Household Incomes

The results of the DD models indicate that road connectivity led to an increase in total income by 38% (Table 3). When looking at the different income sources, we found that road access had a positive effect on the participation of households in self-employment and wage labor, which increased by 63% (Table 4). All other income activities were not affected (Tables 3 and 4). Road connectivity lead to a significant increase in total income of 'above median income' households by 33% but had no significant impact on the income of 'below median income' households (Table 3).

Table 3. Impact of road access on logarithmized incomes. HH: Household, DD: Difference-in-difference, NTFP: Nontimber forest products, SEW: Self-employment and wage labor. Standard error (Std. error) given in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

	Control Village (1000 CFAF)			Road Villages (1000 CFAF)			DD Results
	2015	2016	Diff	2015	2016	Diff	
Crop income (Std. error)	781 (66)	982 (94)	201	514 (71)	794 (64)	280	0.222 (0.365)
NTFP income (Std. error)	396 (60)	435 (105)	38	264 (39)	280 (36)	16	−0.652 (1.187)
Fishing income (Std. error)	228 (54)	173 (50)	−55	131 (31)	115 (22)	−16	0.481 (1.600)
Tot. income all HH (Std. error)	2552 (196)	2307 (231)	−245	1437 (119)	1774 (109)	336	0.381 ** (0.178)
Tot. income below median HH (Std. error)	835 (–)	1610 (119)	774	1147 (90)	1258 (86)	111	−0.224 (0.401)
Tot. income above median HH (Std. error)	2743 (89)	2597 (297)	−145	2116 (88)	2454 (164)	338	0.330 ** (0.141)

Table 4. Impact of road access on participation in self-employment and wage labor (SEW), hunting, and livestock keeping. Standard error (Std. error) given in parentheses. *, **, and *** indicate significance at 10%, 5%, and 1% levels, respectively.

	Control Village [%]			Road Villages [%]			DD [1] Results (%)
	2015	2016	Diff	2015	2016	Diff	
SEW participation (Std. error)	100 (0)	59 (12.3)	−41	50 (11.5)	75 (6.2)	25	63.4 *** (21.0)
Hunting participation (Std. error)	80 (13.3)	82 (9.5)	−2	80 (9.2)	75 (6.2)	−15	−12.5 (17.5)
Livestock participation (Std. error)	100 (0)	82 (9.5)	−18	80 (9.2)	57 (7.0)	−23	24.7 (22.5)

[1] DD: Difference-in-difference.

3.3. Perception of Road Impacts

In addition to the quantitative results concerning the income effects of improved road access presented above, we also asked the respondents in the road villages about their perceptions regarding the influence of improved road access. According to them, the road had positive effects on vending outside (48%) and inside the village (59%), of which the latter could be attributed particularly to an increased number of customers. The number of visitors (85%) and vendors (75%) also increased in the village. Bushmeat sales, on the other hand, decreased (37%) or stayed the same (34%) following road construction. Most respondents stated that their crop sales stayed the same (55%), yet some also reported an increase (31%). Respondents agreed that transport costs were higher after road opening (69%). It appears that hunting quantity was reduced (73%) mainly due to fear of consequences (34%) and alternative income sources (24%). According to respondents, road access led to an increase in agricultural production (55%), which could be attributed to simplified sales (21%) and less hunting (11%). Most respondents stated that income was positively affected (47%) largely due to improved sales (28%), while respondents who reported that income had been affected negatively (29%) explained this with reduced hunting effort (35%; Table 5).

Table 5. Perceptions of respondents regarding road effects in road villages.

	Decreasing (n/%)	Same (n/%)	Increasing (n/%)	No Response (n/%)
Sales				
Sale in the village	7 (7)	24 (24)	60 (59)	10 (10)
Sale outside the village	2 (4)	15 (30)	24 (48)	9 (18)
Bushmeat sale	37 (37)	34 (34)	8 (8)	22 (22)
Crop sale	12 (12)	56 (55)	31 (31)	2 (2)
Transport costs	19 (19)	9 (9)	70 (69)	3 (3)
Income generation				
Hunting quantity	74 (73)	19 (19)	5 (5)	3 (3)
Fear of consequences	25 (34)			
Alternative income sources	18 (24)			
Other	3 (4)			
No response	28 (38)			

Table 5. *Cont.*

	Decreasing (n/%)	Same (n/%)	Increasing (n/%)	No Response (n/%)
Agricultural production	11 (11)	32 (32)	56 (55)	2 (2)
Simplified sales			12 (21)	
Less/no hunting			6 (11)	
Farmland increase (not because of the road)			4 (7)	
No response			34 (61)	
Total income	29 (29)	22 (22)	47 (47)	3 (3)
Less/no hunting	10 (35)			
Expensive transport	2 (7)			
Economics (exchange rate, bad price for cocoa)	2 (7)			
No response	15 (52)		27 (57)	
Improved sales			13 (28)	
Employment at road construction site			4 (9)	
More ambition			3 (6)	
Arrival frequency in the village				
Visitors	7 (7)	6 (6)	86 (85)	2 (2)
Vendors	8 (8)	14 (14)	76 (75)	3 (3)

Nearly half of the respondents (45%, Figure 3) perceived behavioral changes in the villages, including less conflicts and violence, lifestyle improvement, decreased alcohol consumption, tidiness of the village, and more civilized behavior. About 15% of the respondents mentioned that the village had developed and that traveling and transportation had increased. Personally, most respondents intended to improve their income situation (45%), mainly with business (57%) and crop farming (24%). Hunting to improve income was mentioned by just 2% of the respondents. Other intended personal changes included improving the housing situation (16%) and a lifestyle change (16%). Respondents described the latter as investing more into education, dressing differently, and becoming a 'town person'.

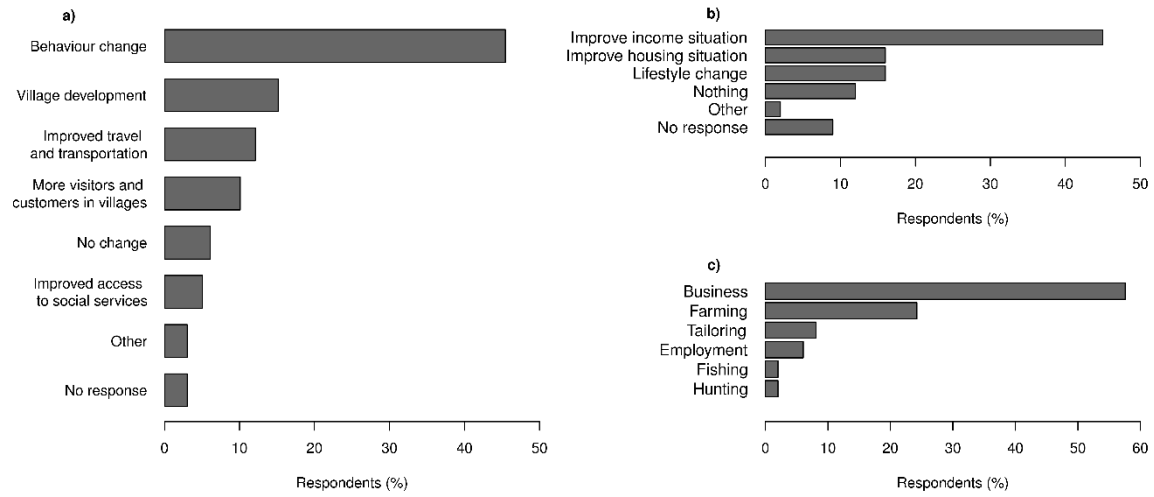

Figure 3. Opinions and strategies of respondents in road villages towards (**a**) changes in the village since road connection (n = 102), (**b**) intended personal changes (n = 102), and (**c**) intended income-generating activities (n = 49), presented in percentages.

4. Discussion

In this study, we examined the effects of road access on the income structure of rural households and their perceptions concerning the effects on village life. Our results support the finding that

livelihood of local people in KNP largely depends on crop farming, followed by hunting and income from NTFPs [41,42]. Moreover, we found that total household income increased due to improved road access, which is in line with previous studies [1–4]. However, 'below median income' households did not profit from road access. This could be due to lack of capital in combination with high transportation costs [43], preventing people from reacting on structural changes (i.e., road access) with an investment in their farms or opening of a business as well as gaining market access [44]. Even for nonbusiness travels, most households are now confronted with transportation costs, which were previously only paid when hiring porters. This is mainly because hiring a bike has become the modern way to travel, and people feel reluctant to walk.

We further found that the increase in total income can be attributed to a higher participation in household self-employment and wage labor. Our qualitative results suggest that the enhanced business activities are strongly related to a higher turnover rate in the village. Road access seems to establish new self-employment opportunities such as small shops. Traders, who buy products in neighboring Nigeria or nearby towns, are now using cheap transport to their villages, which creates higher profit margins. Furthermore, men with access to motorbikes offer transportation and delivery services. Women sell meals to visitors and vendors in the village. Many villagers declared their intentions to continue and extend such business activities. The qualitative results further suggest that wage employment has not improved. Overall, these findings show that the road not only opened new opportunities for villagers but also for people outside of KNP, which, on the downside, suggests growing human presence and activity in the protected area.

Crop income did not change in response to road access. This is not surprising, since the main cash crops in the area are tree crops, which need at least three years to reach maturity [45]. It seems to be beyond debate that road access can increase farming activities by enhancing access to fertilizers, speeding up transport of perishable products, and increasing transport capacities and better market access [6,46,47]. Respondents confirmed that road access stimulated their farming activities to increase agricultural outputs and explained this trend with simplified sales. This is in line with findings of an earlier study in neighboring villages, which found a link between increased income and simplified product marketing and noted increased quantities of NTFP and agricultural products in response to primary road access [16]. However, successful development of farming as an alternative income source to hunting will fail if wildlife-induced crop destruction re-increases hunting activities [12,48]. Additional measures should thus include projects on mitigation of crop-raiding and human wildlife conflicts.

We also found that participation in hunting was not affected by road access. A reason for this result could be that giving up a major income source will only be manageable if alternative activities can yield similar income [48]. Many respondents mentioned that people who have mainly relied on hunting struggle to take up alternative activities due to a lack of necessary skills, tools, and capital. By ameliorating the income situation of only 'above median income' households, road access unfortunately seems to not reach this group. However, many respondents intended to decrease hunting output and effort as well as bushmeat sales, while only one respondent aimed at pursuing this activity, all of which point towards less hunting activities in the future. According to interview responses, this trend seems to primarily rely on enhanced law enforcement rather than alternative income sources. Apparently, the enhanced accessibility of eco guards reinforces the fear of legal consequences and thereby stalls hunting activities.

Nevertheless, in accordance with findings from Tanzania, our results suggest that reduced hunting efforts relate to an increase in agricultural production [12]. Moreover, several studies suggest a similar link to increased income from labor and self-employment [44,49]. An increased participation in self-employment activities within road villages may thus lead to reduced hunting in KNP [50], which itself could be a consequence from time famine [44]. Fishing provides the main source of protein in Southern Cameroon, while bushmeat hunting serves primarily to generate income [42]. A decrease in hunting activities should thus not create a strong need for protein replacement, so fishing activities

and livestock rearing are unlikely to be enhanced for this reason. Fishing, however, has the potential to become a lucrative business, as the fish can be caught and prepared in the village and sold for profit in town, while strenuous livestock production in the village cannot compete with mass-produced town meat. However, the short time span between road opening and data collection requires considering the results of this study as short-term effects, leaving the door open for consequences in the long-term.

Respondents' perceptions of changes in the village were primarily a reduction of conflicts and violence attributed to easier access of gendarmerie. Communities also reported a change in visitor fluctuation associated with a different presentation of the village and its inhabitants, including less alcohol consumption. Indeed, the road seems to provide possibilities for new and permanent constructions by facilitating transportation of large and heavy construction materials (such as cement). Respondents explained that access to hospitals stays limited, as transportation with motorbikes on dirt roads remains challenging for elderly and badly injured community members. Hence, many respondents suggested the construction of health centers inside the villages. Overall, road access appears to not only impact income distribution but also lifestyle and behavior of the forest communities and provides a stepping stone for village development.

5. Conclusions

Conflicts between local communities and national park management objectives often arise where villages are set within national park boundaries. This demands for solutions such as resettlements, compensations, alternative livelihood strategies or changed management approaches [51]. In order to reduce negative anthropogenic effects on wildlife in the park, indigenous people in Korup National Park were successfully encouraged to leave the park through various measures, such as incentives, the implementation of new conservation policies or resettlements [52,53]. However, experiences from resettling Ikondo Kondo I village, which was formerly situated inside Korup National Park, have shown that successful resettlements are difficult to realize since they require very careful planning and need to meet many prerequisites [54]. Our results suggest that road access for villages in formerly remote areas, for which resettlement is not feasible, can lead to desired short-term shifts in income patterns in the framework of an ICDP. Connectivity provides new opportunities regarding income generation and village development and changes village life as well as individual behavior, especially for households with above median incomes. In KNP, road construction was the outcome of a long process included in a set of incentives to halt hunting activities (e.g., paid involvement in park activities, monetary incentives at community level, support of road maintenance), where a resettlement was not an option [21,55]. Still, potential long-term consequences of road access, such as vehicle collisions [20], fragmentation effects [18], increased pressure on wildlife, and open markets for species that were previously not hunted [56], also need to be taken into account in the decision-making process. Hence, we support other findings [57] that using road access as an incentive in biodiversity rich areas should be carefully considered and planned and only be implemented when other options (such as resettlements) are not feasible. We therefore conclude that road access can only approach sustainability of the desired effects if it (1) can meet the target group (below medium households, relying on hunting); (2) is embedded in a framework of good communication, support, education, alternative income sources, and incentives and (3) if possible adverse effects on wildlife are considered.

Author Contributions: Conceptualization, I.-K.S., D.K., M.W. and S.S.; methodology, D.K., I.-K.S. and S.S.; validation, K.S.B., I.-K.S., D.K., M.W. and S.S.; formal analysis, I.-K.S. and S.S.; investigation, I.-K.S.; resources, D.K. and K.S.B.; data curation, I.-K.S. and D.K.; writing—original draft preparation, I.-K.S.; writing—review and editing, I.-K.S., D.K., M.W., K.S.B. and S.S.; supervision, M.W. and S.S.; funding acquisition, D.K. and M.W.; project administration, D.K. and I.-K.S.; visualization, I.-K.S. and D.K. The authorship order of the article follows the 'sequence-determines-credit' approach [58].

Funding: Fieldwork was financially supported by the Programme for the Sustainable Management of Natural Resources, South-West Region (PSMNR-SWR), Buea, Cameroon. D.K. was financially supported by the Heinrich-Böll Foundation (scholarship P103707). The funders had no role in the design of the study; in the

collection, analyses, or interpretation of data; in the writing of the manuscript, or in the decision to publish the results.

Acknowledgments: Our appreciation goes to Luisa Knobloch as well as all field assistants and members of the Korup Rainforest Conservation Society (KRCS) for their support during fieldwork.

Conflicts of Interest: The authors declare no conflict of interest.

Appendix A

Table A1. Box questionnaire (n = 187) and face to face interview results (n = 143) in road villages (2016) regarding percentage of respondents conducting a certain income-generating activity in Korup National Park, Cameroon.

	Number (n) and Percentage (%) of Respondents Active in:				
	Crop Farming	**Fishing**	**Hunting**	**NTFP** [1]	**SEW** [2]
Box	185 (99)	113 (60)	64 (60)	147 (79)	73 (39)
Face to face	92 (93)	71 (77)	42 (72)	76 (60)	59 (42)

[1] Collection of nontimber forest products, [2] self-employment and wage labor.

Table A2. Demographic data of respondents (household (HH) head and spouse) in road villages and the control village in Korup National Park, Cameroon.

	Road Villages		**Control Village**	
	2015	**2016**	**2015**	**2016**
Sampled HH	14.4%	44.6%	27.8%	52.8%
Mean HH size	5	5.6	5.5	5.9
Ethnic groups	Korup (50%), Bakoko (45%), Ejagham (5%)	Korup (49%), Bakoko (51%)	Bakoko (100%)	Bakoko (100%)
Only Primary school education	47.4%	60%	80%	81%
Only Secondary school education	13.2%	21%	0%	11%
Higher education	0%	4%	0%	3%
Engagement in at least one income-generating activity	100%	100%	100%	100%
No. plots/HH	2.1	1.8	2.0	3.0
Mean farm size/HH	na	13.2 m^2	na	20.1 m^2
Age HH head male <30	27.7%	19.6%	44.4%	23.5%
Age HH head male 30 to 50	27.7%	60.8%	44.4%	58.8%
Age HH head male >50	44.4%	21.6%	11.1%	17.6%

References

1. Gibson, J.; Rozelle, S. *Poverty and Access to Infrastructure in Papua New Guinea*; Working Paper; Department of Agriculture and Resource Economics, University of California: Davis, CA, USA, 2002; p. 2.
2. Warr, P. How Road Improvement Reduces Poverty: The Case of Laos. *Agric. Econ.* **2008**, *39*, 269–279. [CrossRef]
3. Warr, P. Roads and poverty in rural Laos: An Econometric Analysis. *Pac. Econ. Rev.* **2010**, *15*, 152–169. [CrossRef]
4. Hine, J.; Abedin, M.; Stevens, R.; Airey, T.; Anderson, T. *Does the Extension of the Rural Road Network Have a Positive Impact on Poverty Reduction and Resilience for the Rural Areas Served? If so How, and if Not Why Not?* EPPI-Centre, Social Science Research Unit, Institute of Education, University of London: London, UK, 2014.
5. Gockowski, J.; Dury, S. The Economics of Cocoa-Fruit Agroforests in Southern Cameroon. *Multi-Strata Agrofor. Syst. Perenn. Crops* **1999**, 239–241. [CrossRef]
6. Porter, G. Transport Services and their Impact on Poverty and Growth in Rural Sub-Saharan Africa: A Review of Recent Research and Future Research Needs. *Transp. Rev.* **2014**, *34*, 25–45. [CrossRef]
7. Charlery, L.C.; Qaim, M.; Smith-Hall, C. Impact of Infrastructure on Rural Household Income and Inequality in Nepal. *J. Dev. Eff.* **2016**, *8*, 266–286. [CrossRef]

8. Charlery, L.C.; Nielsen, M.R.; Meilby, H.; Smith-Hall, C. Effects of New Roads on Environmental Resource Use in the Central Himalaya. *Sustainability* **2016**, *8*, 363. [CrossRef]
9. Lindsey, P.; Balme, G.; Becker, M.; Begg, C.; Bento, C.; Bocchino, C.; Dickman, A.; Diggle, R.; Eves, H.; Henschel, P.; et al. *Illegal Hunting & The Bushmeat Trade in Savanna Africa: Drivers, Impacts & Solutions to Address the Problem*; Wildlife Conservation Society Report; Panthera/Zoological Society of London: New York, NY, USA, 2012.
10. Willcox, A.S.; Nambu, D.M. Wildlife Hunting Practices and Bushmeat Dynamics of the Banyangi and Mbo People of Southwestern Cameroon. *Biol. Conserv.* **2007**, *134*, 251–261. [CrossRef]
11. Shively, G.E. Poverty, Technology, and Wildlife Hunting in Palawan. *Environ. Conserv.* **1997**, *24*, 57–63. [CrossRef]
12. Johannesen, A.B. Wildlife Conservation Policies and Incentives to Hunt: An Empirical Analysis of Illegal Hunting in Western Serengeti, Tanzania. *Environ. Dev. Econ.* **2004**, *10*, 271–292. [CrossRef]
13. Roe, D.; Elliott, J. Pro-poor Conservation: The Elusive Win-Win for Conservation and Poverty Reduction. *Policy Matters* **2006**, *14*, 53–63.
14. Amadi, R.M. Harmony and conflict between NTFP use and conservation in Korup National Park. *Rural Dev. For. Netw.* **1993**, *15*, 16–23.
15. Wicander, S.; Coad, L. *Learning Our Lessons: A Review of Alternative Livelihood Projects in Central Africa*; ECI: Oxford, UK; IUCN: Gland, Switzerland; University of Oxford: Oxford, UK, 2014.
16. Nana, T.; Cheumani, C.; Grandjean, L. *Impact Assessment and Management of Motorbike Roads Inside National Parks and Around (Buffer Zone) in the South West Region of Cameroon*; Eco Consult for GIZ-Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH: Bonn, Germany, 2014.
17. Barber, C.P.; Cochrane, M.A.; Souza, C.M.; Laurance, W.F. Roads, Deforestation, and the Mitigating Effect of Protected Areas in the Amazon. *Biol. Conserv.* **2014**, *177*, 203–209. [CrossRef]
18. Newman, M.E.; McLaren, K.P.; Wilson, B.S. Assessing Deforestation and Fragmentation in a Tropical Moist Forest over 68 Years; The Impact of Roads and Legal Protection in the Cockpit Country, Jamaica. *For. Ecol. Manag.* **2014**, *315*, 138–152. [CrossRef]
19. Forman, R.T.T.; Alexander, L.E. Roads and their Major Ecological Effects. *Annu. Rev. Ecol. Syst.* **1998**, *29*, 207–231. [CrossRef]
20. Bruinderink, G.W.T.A.G.; Hazebroek, E. Ungulate Traffic Collisions in Europe. *Conserv. Biol.* **1996**, *10*, 1059–1067. [CrossRef]
21. Ministry of Forestry and Wildlife. *The Management Plan for Korup National Park and its Peripheral Zone 2017–2021*; Ministry of Forestry and Wildlife: Buea, Cameroun, 2017.
22. Oates, J.F.; Bergl, R.A.; Linder, J.M. Africa's Gulf of Guinea Forests: Biodiversity Patterns and Conservation Priorities. In *Advances in Applied Biodiversity Science*; Conservation International: Washington, DC, USA, 2004.
23. Oben, D.; Zachary, I.; Edward, E. *Korup National Park-Agro-Socio-Ecological Assessment Report for Esukutan*; Ministry of Forestry and Wildlife: Buea, Cameroun, 2013.
24. Tourangeau, R.; Yan, T. Sensitive Questions in Surveys. *Psychol. Bull.* **2007**, *133*, 859. [CrossRef] [PubMed]
25. Tsuchiya, T.; Hirai, Y.; Shigeru, O. A Study of the Properties of the Item Count Technique. *Public Opin. Q.* **2007**, *71*, 253–272. [CrossRef]
26. Nuno, A.; St John, F.A.V. How to ask sensitive questions in conservation: A review of specialized questioning techniques. *Biol. Conserv.* **2015**, *189*, 5–15. [CrossRef]
27. Serges, M.D.; Zachary, I. *Korup National Park-Agro-Socio-Ecological Assessment Report for Erat*; Ministry of Forestry and Wildlife: Buea, Cameroun, 2013.
28. Oben, D.; Zachary, I.; Sumbede, S. *Korup National Park-Agro-Socio-Ecological Assessment Report for Ikenge Village*; Ministry of Forestry and Wildlife: Buea, Cameroun, 2014.
29. Saris, W.; Revilla, M.; Krosnick, J.A.; Shaeffer, E.M. Comparing Questions with Agree/Disagree Response Options to Questions with Item-Specific Response Options. *Surv. Res. Methods* **2010**, *4*, 61–79.
30. Angelsen, A.; Lund, J.F. Designing the Household Questionnaire. In *Measuring Livelihoods and Environmental Dependence: Methods for Research and Fieldwork*; Larsen, H.O., Lund, J.F., Smith-Hall, C., Wunder, S., Eds.; CIFOR: Bogor, Indonesia, 2011; pp. 112–114.
31. Mincer, J. Investment in Human Capital and Personal Income Distribution. *J. Political Econ.* **1958**, *66*, 281–302. [CrossRef]

32. Mandelbrot, B.; Hudson, R.L. *The Misbehavior of Markets: A Fractal View of Risk, Ruin and Reward*; Basic Books: New York, NY, USA, 2005; pp. 155–167.
33. R Core Team. *R: A Language and Environment for Statistical Computing*; R Foundation for Statistical Computing: Vienna, Austria, 2015.
34. Khandker, S.; Koolwal, G.B.; Samad, H. *Handbook on Impact Evaluation: Quantitative Methods and Practices*; World Bank Publications: Washington, DC, USA, 2010.
35. Meyer, B.D. Natural Quasi-Experiments in Economics. *J. Bus. Econ. Stat.* **1995**, *13*, 151–161.
36. Fox, J.; Monette, G. Generalized Collinearity Diagnostics. *J. Am. Stat. Assoc.* **1992**, *87*, 178–183. [CrossRef]
37. O'brien, R.M. A Caution Regarding Rules of Thumb for Variance Inflation Factors. *Qual. Quant.* **2007**, *41*, 673–690. [CrossRef]
38. Hair, J.F.; Black, W.C.; Babin, B.J.; Anderson, R.E. *Multivariate Data Analysis*, 7th ed.; Pearson Education: Upper Saddle River, NJ, USA, 2014; p. 200.
39. Dormann, C.F.; Elith, J.; Bacher, S.; Buchmann, C.; Carl, G.; Carré, G.; Marquéz, J.R.G.; Gruber, B.; Lafourcade, B.; Leitão, P.J.; et al. Collinearity: A Review of Methods to Deal with it and a Simulation Study Evaluating their Performance. *Ecography* **2013**, *36*, 27–46. [CrossRef]
40. Mayring, P. Qualitative Inhaltsanalyse. In *Handbuch qualitative Forschung: Grundlagen, Konzepte, Methoden und Anwendungen*; Flick, U., Kardoff, E.v., Keupp, H., Rosenstiel, L.v., Wolff, S., Eds.; Beltz- Psychologie Verl. Union: München, Germany, 1991; pp. 209–213.
41. Mbile, P.; Vabi, M.; Meboka, M.; Okon, D.; Arrey-Mbo, J.; Nkongho, F.; Ebong, E. Linking Management and Livelihood in Environmental Conservation: Case of the Korup National Park Cameroon. *J. Environ. Manag.* **2005**, *76*, 1–13. [CrossRef] [PubMed]
42. Wright, J.H.; Priston, N.E.C. Hunting and Trapping in Lebialem Division, Cameroon: Bushmeat Harvesting Practices and Human Reliance. *Endanger. Species Res.* **2010**, *11*, 1–12. [CrossRef]
43. Hettige, H. *When do Rural Roads Benefit the Poor and How? An In-Depth Analysis Based on Case Studies*; Asian Development Bank: Hettige, Phillipines, 2006; pp. 30–51.
44. Vasco, C.; Sirén, A. Correlates of Wildlife Hunting in Indigenous Communities in the Pastaza Province, Ecuadorian Amazonia. *Anim. Conserv.* **2016**, *19*, 422–429. [CrossRef]
45. Nalley, L.L.; Dixon, B.L.; Popp, J.S. An Optimal Phased Replanting Approach for Cocoa Trees with Application to Ghana. *Agric. Econ.* **2014**, *45*, 291–302.
46. Laurance, W.F.; Balmford, A. A Global Map for Road Building. *Nature* **2013**, *495*, 308–309. [CrossRef] [PubMed]
47. Weng, L.; Klintuni Boedhihartono, A.; Dirks, P.; Dixon, J.; Lubis, M.I.; Sayer, J.A. Mineral Industries, Growth Corridors and Agricultural Development in Africa. *Glob. Food Secur.* **2013**, *2*, 195–202. [CrossRef]
48. Barrett, C.B.; Arcese, P. Wildlife Harvest in Integrated Conservation and Development Projects: Linking Harvest to Household Demand, Agricultural Production, and Environmental Shocks in the Serengeti. *Land Econ.* **1998**, *74*, 449–465. [CrossRef]
49. Kümpel, N.F.; Milner-Gulland, E.J.; Cowlishaw, G.; Rowcliffe, J.M. Incentives for Hunting: The Role of Bushmeat in the Household Economy in Rural Equatorial Guinea. *Hum. Ecol.* **2010**, *38*, 251–264. [CrossRef]
50. Knobloch, L. Gender, Livelihoods, and Employment in Industrial Oil Palm Plantations in Southwest Cameroon. Master's Thesis, Georg-August-Universität, Göttingen, Germany, 2016.
51. Dudley, N. (Ed.) *Guidelines for Applying Protected Area Management Categories*; IUCN: Gland, Switzerland, 2008; pp. 16–17.
52. Tiani, A.M.; Diaw, M.C. Does resettlement contribute to conservation? The case of the Ikundu-kundu, Korup National Park, Cameroon. *Policy Matters* **2006**, *14*, 113–127.
53. Siewe, S.; Vadjunec, J.; Caniglia, B. The politics of land use in the Korup National Park. *Land* **2017**, *6*, 7. [CrossRef]
54. Schmidt-Soltau, K. Conservation-related Resettlement in Central Africa: Environmental and Social Risks. *Dev. Chang.* **2003**, *34*, 525–551. [CrossRef]
55. Linder, J.M. The impact of hunting on primates in Korup National Park, Cameroon: Implications for Primate Conservation. Ph.D. Thesis, The City University of New York, New York, NY, USA, 2008.
56. Schmitt, K.M.; Kramer, D.B. Road Development and Market Access on Nicaragua's Atlantic coast: Implications for Household Fishing and Farming Practices. *Environ. Conserv.* **2010**, *36*, 289–300. [CrossRef]

57. Caro, T.; Dobson, A.; Marshall, A.J.; Peres, C.A. Compromise Solutions between Conservation and Road Building in the Tropics. *Curr. Biol.* **2014**, *24*, 722–725. [CrossRef]
58. Tscharntke, T.; Hochberg, M.E.; Rand, T.A.; Resh, V.H.; Krauss, J. Author Sequence and Credit for Contributions in Multiauthored Publications. *PLoS Biol.* **2007**, *5*, e18. [CrossRef]