

## Article

# Impact of Hydroelectric Dam Development and Resettlement on the Natural and Social Capital of Rural Livelihoods in Bo Hon Village in Central Vietnam

Hien Thanh Nguyen <sup>1</sup>, Ty Huu Pham <sup>2</sup> and Lisa Lobry de Bruyn <sup>3,\*</sup>

<sup>1</sup> Centre Rural Development in Central Vietnam, Hue 530000, Vietnam; hiennt@crdvietnam.org

<sup>2</sup> Department for the International Cooperation and Science-Technology, Hue University of Agriculture and Forestry, Hue 530000, Vietnam; phamhuuty@huaf.edu.vn

<sup>3</sup> School of Environmental and Rural Science, University of New England, Armidale, 2351 NSW, Australia

\* Correspondence: llobryde@une.edu.au; Tel.: +61-2-6773-3119

Received: 14 June 2017; Accepted: 7 August 2017; Published: 11 August 2017

**Abstract:** The study examined the natural and social capital of Bo Hon villagers in central Vietnam, before and after resettlement within Binh Thanh commune due to the building of Binh Dien Hydroelectric dam on the Huu Trach River. (1) Background: The two-fold aim was to develop solutions to the impacts of resettlement on natural and social capital, and strategies for timely intervention and new livelihoods after households were resettled. (2) Methods: Livelihood survey of all 46 households was conducted in 2010, and villagers were asked about 2004, before resettlement, and about 2009, when the occupants of Bo Hon village had been moved to a new location 15 km away from the original one. The research employed mixed-methods by using household surveys, focus group discussions, and key informant interviews. The impacts of displacement and resettlement on production activities and daily life of rural people were examined in the following areas: (i) land resource; (ii) access to common-pool natural resources; (iii) income structure; (iv) agriculturally based livelihoods; (v) material assets; (vi) customary practices; and (vii) social relationships. (3) Results: The most significant impact was on the type of production activities that could be conducted after resettlement and reduction in land area to grow profitable commodities such as Lồ Ô Bamboo. Specifically, land for growing rice and other crops were significantly affected with the land area substantially reduced or flooded. Also harvesting of common pool resources from the forest (NTFPs) were reduced such as honey and rattan, and only 25% of the villagers continued to fish in the river. (4) Conclusions: Strategies were put in place to reduce the level of disruption to the villagers' livelihoods, but some parts of the compensation package were short-lived or inequitably distributed (e.g., land), while infrastructure developments such as sealed roads have made the village far more accessible to Hue City some 25 km away.

**Keywords:** hydropower development; sustainable livelihoods; natural capital; social capital

## 1. Introduction

Hydroelectric dam development can bring many benefits such as: providing a clean energy source; using water for multiple industries; developing infrastructure; and improving social justice, but at the same time it also creates negative impacts on environment and society, especially for those people directly affected. By the late of 20th century, there were over 45,000 hydroelectric dams (those with the normal water rise level from 5 to 15 m height and water reserves for more than 3 million m<sup>3</sup>) built in over 140 countries, which has displaced about 40–80 million people [1]. Since 2004, the number of hydroelectric dams, and displaced people has increased rapidly.

In recent years, many hydroelectric power projects have been built in Vietnam such as Son La, Tuyen Quang, Hoa Binh, and Ban Ve hydroelectric plants. Most of the hydroelectric dam projects in Vietnam have been constructed in mountainous environments and in areas of high rural poverty, thus having a disproportionate effect on those people living in these isolated areas. With the construction of hydroelectric plants it first requires the establishment of water reservoirs and dams. With such activities, the establishment of water reservoirs and dams will cause direct impacts to people and landscape at the local area, by flooding land they previously occupied, causing them to be moved elsewhere.

In Vietnam, construction of a hydroelectric dam has significant benefits for the country by ensuring national energy security; it also contributes considerably to socio-economic development, and recent simulation studies indicate dam operation can decrease discharge during rainy season by 35% and increase release of water in dry season by 226% [2]. Concurrently, dam development for hydroelectric power also has negative effects on local environment (water quality and quantity), degradation or alteration of river flows, cultural and economic effects of people at the locality [3–5]. These type of short-term impacts along with long-term changes, especially to the type of rural livelihoods undertaken by displaced people, has only been investigated in a small number of local studies in central Vietnam [6,7]. Despite the growing reliance on hydropower in Vietnam there have not been many successful lessons established to ensure that affected people will be able to maintain a sustainable livelihood into the future.

According to statistics, the whole country has about 800 medium and small scale hydroelectric projects, which have capacity of 30 MW or less, and 335 of these have been implemented in central provinces of Vietnam. Thua Thien Hue province has been constructing 11 small and medium scale hydroelectric plants, of which Binh Dien hydroelectric dam on the Huu Trach River has been completed and was operational by the end of 2009 [8]. The majority of previous studies focus on the impacts of involuntary resettlement in relation to the five livelihood assets (natural, human, physical, financial, and social), but concentrate less on the natural and social capital of rural livelihoods in particular. Furthermore, many studies examined the current livelihood [9], but few studies examine future strategies for a sustainable livelihood.

In this study, 46 households who were directly affected by construction of Binh Dien hydropower plant and dam were interviewed. In addition, the study also applied a wide range of tools used in participatory rural appraisal with the aim of analyzing and identifying the most appropriate strategies to restore livelihoods of local people. The impacts of displacement and resettlement on production activities and daily life of rural people were examined in the following areas: (i) land resource; (ii) access to common natural resources; (iii) income structure; (iv) agriculturally based livelihoods; (v) material assets; (vi) customary practices; and (vii) social relationships. Through examination of the status of livelihood activities before and after resettlement, and assessment of relative advantage and disadvantage for each livelihood activity it is hoped the solutions for recovering and developing livelihood activities will be found.

## 2. Materials and Methods

### 2.1. Study Area Description

Binh Dien hydroelectric plant situated on the Huu Trach River, one of the three main tributaries of the Huong River in Thua Thien Hue province, central Vietnam. The Huu Trach River originates from A Luoi mountainous district, flows through Houng Tra District and then combines with the Ta Trach River at the confluence of Tuan to flow into the Huong River, and onto the coastal plain [2] (Figure 1). This river has a length of 70 km with a drainage basin of 691 km [10,11]. The Huong River plays an important role not only in terms of water resources but also for cultural, societal and landscape values in Hue city. The basin area of the Huong River is 2830 km<sup>2</sup>, accounting 56% of total area of Thua Thien Hue province. The largest proportion of land use in the district is comprised of forest land, making it appropriate for activities like forestry, industrial tree planting and animal husbandry. According to Smith et al., [12] in the neighboring Huong Thuy District is comprised of

14% agricultural land, 3% residential, 47% forestry (natural and planted forest), 7% special use (construction, transport and other facilities) and 29% unused land (located in mountainous area). At the Provincial level the relative proportion of land uses are: 12% agricultural production; 65% forestry; 6.4% special use; and 3.6% residential [13].



**Figure 1.** Location of Binh Dien hydroelectric plant in Huong Tra District, Thua Thien Hue province, in central Vietnam.

Binh Dien hydroelectric plant has a capacity of 181 million kWh a year and was invested by Binh Dien Hydropower Joint Stock, Ltd. (Hue, Vietnam), with the amount of \$5.3 million USD. The hydroelectric plant was designed to provide multiple functions including: producing electricity; controlling floods and droughts; and providing irrigation water for agriculture. The whole village of Bo Hon was resettled because the residential and farming land was expropriated for the construction of Binh Dien dam, and would be flooded. There were 618 hectares of land that was acquired for its reservoir, including 140 hectares of expropriated land for the construction of the Binh Dien hydroelectric plant [14].

The majority of people in Bo Hon village are of Katu ethnic origin, approximately 95% of people depend upon agriculture for their livelihood. At the time of displacement, 46 households were in the village. It is approximately 15 km from the centre of Binh Thanh commune and 40 km from Hue city. In August 2006, after receiving compensation from the Binh Dien Hydropower Joint Stock, Ltd., Bo Hon village moved to a new location in Binh Thanh commune, Huong Tra district, Thua Thien Hue province. The level of compensation was 35.8 million VND per household, and consisted of 0.3 ha of land, attached to a house and cash compensation for their losses [15]. The new settlement location is 2 km from Binh Thanh Commune headquarters, and connected to it by concrete road. There is a community meeting house, a primary school, and a kindergarten, in the new village location, and access to a secondary school and high school only 4 km away in Binh Dien commune [16].

## 2.2. Household Interviews and Focus Groups

The methodology applied in this study compares livelihoods of affected people before and after resettlement, and uses a modified livelihoods framework [17] explained fully in another study in adjacent district (Huong Thuy) by Nguyen et al. [6]. In 2010, all households in Bon Hon village were interviewed, and asked to recount current livelihood assets including: natural capital (e.g., land); material assets (e.g., mobile phone) and social capital (e.g., social relationships and customary practice), compared to their situation before resettlement in 2004. This method is based on affected households recalling conditions before displacement and after resettlement in a new location. The data from the two time periods were compared to detect positive and negative effects due to displacement and resettlement. This approach is a double recall method with the same households being interviewed and usually only a short time after resettlement, and has been used in studies on Son La hydropower development [18,19]. The limitations, however, are that some respondents might have difficulty recalling information dating a couple of years before, and other enterprises in newly settled villages have yet to establish an income e.g., acacia forestry.

This type of household survey was also used to develop a socio-economic development plan (SEDP) at commune and village level. The research tools included: status analysis, understanding advantages and disadvantages of resettlement, village history, paired comparison, selection and priority ranking for the recovery and development of agriculture and non-agriculture production activities by villagers. The method was applied to specific data on agricultural and non-agricultural production activities to supplement information from previous data collection. The research team research conducted in-depth interview with four knowledgeable households on agriculture production, three knowledgeable households on non-agriculture production and three households with knowledge on foundation and development history of Bo Hon village.

The first consultation meeting was on 25 November 2010, in Bo Hon village, with the participation of representative households for validation of the data from: secondary data collection, household survey, group discussion, and key informant interview. In these meetings additional ideas were raised and consensus was reached on solutions for the recovery and development plan with villagers. Additionally, participatory rural appraisal was used to negotiate between Binh Thanh People's committee (PC) and Forest Management Board of Huong River for areas where the forest land under board management was not used effectively or was not well managed. Such areas could be handed over to community or individual household for Lồ Ô (*Bambusa balcooa*) plantation, a plant belonging to bamboo family and is used widely in daily life of local people.

## 3. Results

### 3.1. Livelihood Assets: Land and Its Utilization

Farmers of Bo Hon village lost land for crop cultivation, including upland rice (Table 1). The crop land area of Bo Hon village before resettlement was 78.3 ha, which was reduced to 10 ha after resettlement (Table 1). As a result, the reduction of land for dryland crops and rice was an average loss of 1.5 ha per household. Bo Hon villagers had also lost 61 ha of Lồ Ô bamboo land, but in relocating the village in Binh Thanh commune, they were allocated 74 ha of land to grow acacia and with these lands received a land use right certificate.

Before resettlement, there were 41 households fishing regularly on the river, but when relocated to the new village location only 10 households continued fishing. Due to living further away from the river, and fewer people fishing the amount of fish caught was markedly reduced from 6430 kg to 653 kg (Table 2). A trend of decreasing access to common pool resources after resettlement has also occurred with non-timber forest products (NTFPs). Currently, harvesting of NTFPs is limited to three households harvesting rattan and five households collecting honey, compared with 27 households and 13 households before resettlement respectively were collecting these NTFPs (Table 2). Lồ Ô bamboo plantations were also lost due to the flooding of the land after hydroelectric dam construction (Table 2). In addition, the reduction in harvesting of common pool resources was due to

increased distance to travel to harvesting area compared with before resettlement, as the village is now located 15 km further down the river towards Hue City, and away from the forest area.

**Table 1.** Comparison of average land area (ha) in Bo Hon village used for various land use types by Bo Hon households before and after resettlement. Source: Binh Thanh People's Committee personal communication.

Land Use Types	Before Resettlement 2004 (ha)	After Resettlement 2009 (ha)	% Change	No of HHs 2004	No of HHs 2009
Rice land	26	3.2	−87	46	2
Annual dry crops	52	6.7	−87	46	46
Perennial trees	0.3	0	−100	8	2
Production forest	61 <sup>1</sup>	74 <sup>2</sup>	+21	40	5
Protected forest	33	0	−100	15	19
Aquaculture	0.08	0	−100	7	1
Non-agriculture land	10.6	3.2	−69		
Residential land	4.3	3.0	−30	46	46
Unused low land <sup>3</sup>	13	0	−100		
Unused high land <sup>3</sup>	417	0	−100		
Other	0	3.6	+100		
Total Land Area	618	94	−85		

<sup>1</sup> Lỗ ô Bamboo, <sup>2</sup> Acacia, <sup>3</sup> Unused land refers to land that as yet does not have an identified purpose, and may be low or high altitude.

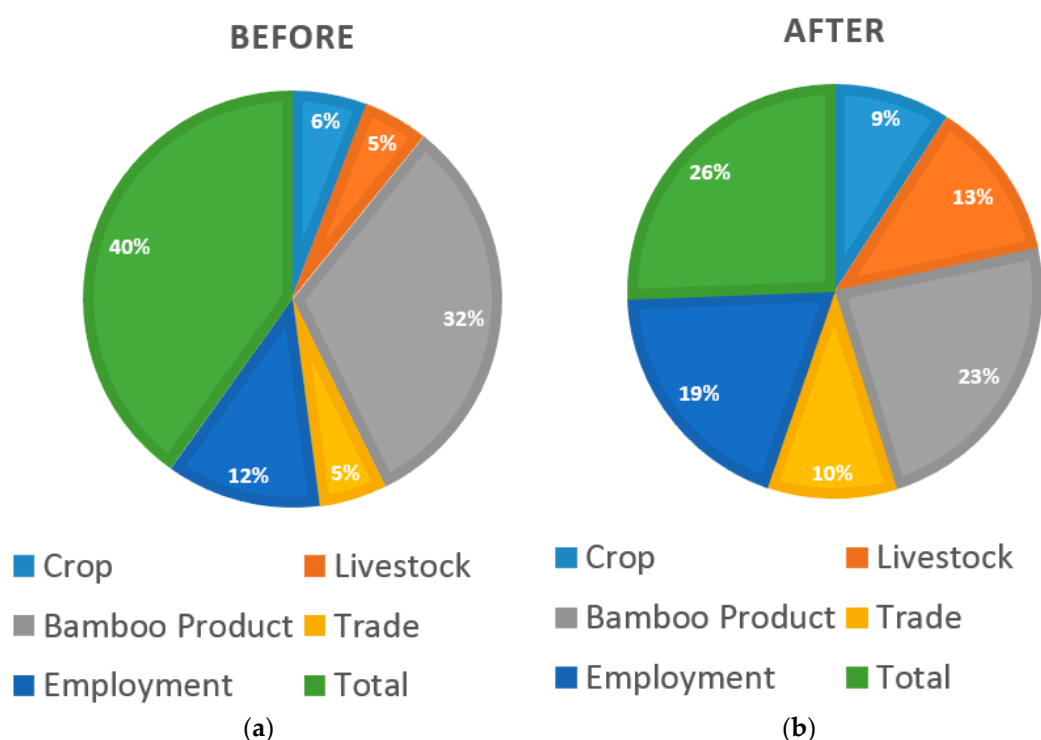
**Table 2.** Comparison of common pool resources used by Bo Hon households, before and after resettlement, recorded in household interviews in 2010 ( $n = 46$ ).

Common Pool Resources	Unit of Measurement	Before Resettlement 2004	After Resettlement 2009	% Change (−ve/+ve)
Fishing on the river	Household	41	10	−76
Production from fishing	tonnes/year	6.4	0.6	−91
Rattan harvesting	Household	27	3	−89
Production of rattan	tonnes/year	17.4	0.6	−97
Honey	Household	13	5	−62
Dot (type of grass)	Household	30	0	−100
Lỗ Ô Bamboo harvesting	Household	46	0	−100

The household surveys also examined over a year the income sources of Bo Hon households, and with resettlement where the main income sources were derived from (Figure 2). The loss of income from selling bamboo product had a significant impact on Bo Hon villagers with only two households earning any income after resettlement compared with 41 households before resettlement (Figure 2, Table 3). Nevertheless, for those few households who can still harvest bamboo, it is a significant source of income, at almost 92% of the average annual income (Figure 2, Table 3). The only area that recorded an increase in participation was employment, but despite the increase in participation, the income derived from this source was still lower than before resettlement (Table 3).

**Table 3.** Comparison of income sources for Bo Hon households, before and after resettlement, recorded in household interviews in 2010 ( $n = 46$ ). (1 USD = 22 117 VND, in 2016).

Income Source	Unit of Measurement	Before Resettlement 2004	After Resettlement 2009	% Change (−ve/+ve)
Cropping	(000 VND pa)	3160	1080	−65
	No of HHs	46	46	0
Livestock	(000 VND pa)	2728	1504	−45
	No of HHs	39	27	−31
Bamboo product (includes some NTFPs)	(000 VND pa)	17,396	2800	−84
	No of HHs	41	2	−95
Trade (non-farming)	(000 VND pa)	2850	1200	−58
	No of HHs	3	1	−66
Employment	(000 VND pa)	6530	2276	−65
	No of HHs	5	24	+380
Mean income per HH	(000 VND pa)	21,874	3050	−86



**Figure 2.** The distribution of income received from various enterprises in relation to average total income, as recorded in household interviews with Bo Hon Villagers in 2010 ( $n = 46$ ): (a) Before resettlement; (b) After resettlement.

The main source of employment is working in acacia production forests, which at time of the study had yet to produce their first harvest. After resettlement each household in Bo Hon village received 0.15 ha on average for cultivation, but to increase their land area they also used their residential land to make a home garden for growing produce. This area was used to plant six types of crops, however, cassava, lemongrass, and pineapple were the most commonly planted (Table 4).

**Table 4.** Types of crops grown and number of Bo Hon households participating, before and after resettlement, recorded in household interviews in 2010 ( $n = 46$ ). Households without access to land would use home garden.

Crop Type	Before Resettlement 2004		After Resettlement 2009	
	Number of Households	%	Number of Households	%
Cassava	46	100	46	100
Maize	46	100	0	0
Rice	46	100	2	4
Banana	46	100	41	89
Orange	46	100	0	0
Lemon	46	100	0	0
Lemongrass	3	6	42	91
Pineapple	46	100	46	100

In Bo Hon village, each household planted on average of 0.1 ha of a new variety of cassava (KM94). Planting lemongrass and pineapple were also of interest to farmers. Partly because of poor land quality and limited land availability the resettled households have focused on these crops. Before settlement, only three households planted lemongrass, but now due to good financial returns from lemongrass, it has been grown by most households (Table 4). The area planted to lemongrass and pineapple was on average 0.05 ha per household, so it does not require a large area of land.

Other fruit trees such as banana, lemon, and orange were still grown by farmers but the land area was reduced. Due to land shortage, rice and maize production did not continue in the new location. Currently, there remains only two households growing rice. In short, in comparison with before resettlement, the nature of cultivation has changed due to less land area available, and limiting the type of tree crops that can be grown.

Cassava, lemongrass, and pineapple were intercropped. Old varieties of cassava did not grow well in the new location due to poor soil quality, and the villagers had started growing a new variety, which was initiated by a former village leader, and shown to have better productivity, fetched a good price and was easy to sell [15]. To remedy the poor soil quality, many households have begun to use fertilizers to maintain productivity. Both manure and chemical fertilizers have been used by local farmers. However, they only used fertilizer for top dressing (additional fertilizer was applied after cassava plants were well-developed), rather than applying fertilizer to land before planting. Fertilizer was usually used one month after planting tree crops. Cassava was usually planted first, followed by lemongrass and then pineapple. People no longer cultivate through slash and burn techniques as before, and this practice will reduce water erosion risk.

Dealers come directly to each household to buy produce. Cassava and lemongrass were sold by the kilogram, while pineapple was sold by the number of fruit. The average price for cassava was 1000 VND/kg that was only sold as fresh cassava, which can be further processed into a higher value commodity. Lemongrass was purchased for 1000 VND/kg on average and pineapple was sold for 500 VND/fruit.

The main livestock raised, and the shifts in type of livestock are shown in Table 5. Overall, the participation in animal husbandry has fallen by 38%, and most notably in poultry: chickens and ducks (Table 5). Before resettlement, all pigs were free-ranging, but in resettled village location pigs were raised in enclosed conditions, fed with cassava and forest vegetables combined with commercial food. In the process of raising pigs before resettlement, farmers were not concerned about inoculation against disease, and would only call on commune veterinary staff for treatment after disease outbreaks occurred. Also, in the previous village location, pigs took 11–12 months to reach 40–50 kg, whereas in the new settlement, pig raising time had been more than halved, with a weight at maturity of 50–60 kg. In some cases, there were households whose pigs gained 70–75 kg in only in 3.5 months.

**Table 5.** Types of livestock husbandry, and average numbers per household raised in Bo Hon village, before and after resettlement, recorded in household interviews in 2010 ( $n = 46$ ).

Livestock Type	Before Resettlement (2004)			After Resettlement (2009)			
	Number of HHs	Average Numbers of Animals per HH	Std. Deviation	Number of HHs	Average Numbers of Animals Per HH	Std. Deviation	% Change in HHs
Pigs	39	14	12.4	27	7	4.4	−31
Chickens	41	28	22.0	23	17	13.9	−44
Ducks	16	17	4.5	10	10	2.3	−38
Cattle	10	4	4.9	7	3	3.6	−30
Buffaloes	13	5	11.2	9	3	8.0	−31
Total Average	24	14		15	8		−38

Before resettlement, Bo Hon people only raised local chicken varieties, these were allowed to roam freely, and over 8–10 months grew to 1–1.2 kg. After resettlement chicken varieties were mainly from commercial stock. Chickens were often purchased when they were 15–20 days old. Captive breeding of chickens were combined with free-range farming. Chickens were fed for 2.5–3 months to reach a weight of 1.8–2.0 kg per bird. In Bo Hon village people usually raised two clutches per year. While before resettlement only one clutch of local chicken variety would be raised per year. Ducks are allowed to roam freely and were fed on a mix of corn, banana, and old rice. Ducks were raised over a period of 3–4 months, and at maturity would weigh 1.5 to 2.0 kg. Each year, local farmers raised ducks twice a year, on nearby open water.

Cattle production is not a major livestock enterprise in Bo Hon village with 21% of households having cattle before resettlement, and 15% of households having cattle after resettlement (Table 5). In terms of cattle raising, some households own a small farm through forest encroachment and raised cattle there. For those who did not have their own small farm for grazing their cattle, they would take them to the protective forest under management by government, and left them to graze there, before herding them back to the village. The current method of cattle husbandry in Bo Hon village has not altered substantially from the practices used before displacement. Cattle were not vaccinated and their natural grass feed supplemented with commercial feed. In the new village location, the trading conditions were more convenient, with all agricultural products sold through dealers. The dealers would come to each household to purchase. Some small livestock such as chickens, ducks, and pigs were purchased by weight in kilograms. However, due to lack of technology to weigh cattle they were purchased based on estimated weight. The weight was estimated by the dealer through examining length and, height of cattle to calculate the weight of cattle before payment.

### 3.2. Rating of Livelihood Assets by Villagers

Bo Hon villagers together with research team derived four basic criteria for selecting livestock enterprise. The criteria were: appropriate land capability in terms of climate and land at the locality; small capital investment required; high profitability; and low technical input required. Using these four criteria, and by scoring each criteria from 1 to 10, with the higher the score the more important the criteria are in terms of selecting an enterprise the villagers rated livestock enterprises. At the meeting each participant would score independently, and the final score was averaged across the participants for every criteria. Local people were most inclined to raise chickens (7.5 points), followed closely by pigs (7 points), and ducks (6.8 points), while buffalo (6 points) and cattle (5.8 points) were not as favored by villagers. Pigs and chickens were two suitable livestock types to develop in the village. As for raising chickens, it was an activity that could be easily combined with the home garden (especially using local chicken varieties).

The ability to acquire more sows was not keeping pace with demand for raising pigs in the Bo Hon village. As a result, developing a sow breed that would limit disease outbreaks as well as promote out-scaling pig husbandry strategies. Other support that the villagers requested was building raised cages to ensure less chance of disease acquisition and meet appropriate living conditions. Other skills which would improve animal husbandry were techniques on vaccination and selection of breeds.

Cassava was an easily sold product, and dealers would sell fresh cassava for Binh Thanh or Phong Dien starch factory. Lemongrass and pineapple were often sold directly to retailers at market or to restaurants. Based on four criteria (profit, sustainability, ease of selling, and regular income), Bo Hon villagers selected lemongrass (8.2 points) as the first priority crop to develop, as it was viewed as more sustainable, profitable, and provided a regular income compared with pineapple (7.2 points) and cassava (6 points). Villagers considered the production of cassava was less sustainable due to poor land quality at new location, but the new variety used (KM94), had been shown to be more resilient to poorer quality soils and drought.

### 3.3. Material Assets

There were only two small boats in resettled village and a small boat was a valuable asset in harvesting Lỗ Ô bamboo, honey, and rattan by travelling up river into protected forest, but now due to being located further down river these production activities have not continued (Table 6).

Overall, the increase of material assets at Bo Hon village was not due to the development of a household economy compared with before resettlement, but because people used their compensation money for equipment purchase. Table 6 records an increase in material assets per household, compared with before resettlement. The villagers have a greater number of mobile phones and are increasingly mobile due to motorbike ownership, as well as the village is supported by infrastructure e.g., electricity, and road access to Hue City. The increase in material assets and infrastructure, such



as mobile phones, motorbikes and roads, also provides villagers with ways and means to gain employment, especially outside the village.

**Table 6.** Number of material assets in Bo Hon village, before and after resettlement, recorded in household interviews in 2010 ( $n = 46$ ).

Type of Asset	Number Before Resettlement	% of Households Before	Number After Resettlement	% of Households After
Mobile telephone	2	4	25	54
Television	8	17	34	74
Motorcycle	5	11	52	113
Electricity to home	3	7	46	100
Refrigerator	0	0	5	11
Small boat	11	24	2	4

### 3.4. Impacts of Displacement on Religion, Ceremonial Rituals, and Family Relationships

Religion is a critical aspect of mountainous ethnic minorities. After the upland rice is harvested, Bo Hon villagers often celebrated with the new rice ceremony. The ceremony is usually organized at two levels—community and household level. For the community level, the ceremony was held at the community house with the participation of all villagers who would contribute rice, pigs, chickens, and labor for the ceremonial event. However, after resettlement Bo Hon people had abandoned this ceremonial dinner because they were no longer undertaking paddy rice cultivation.

Hunting is also associated with a series of ceremonial rituals, showing the role of men, especially the village patriarch. Meat from the hunted animal is served to the whole community and divided among households in the village. Before resettlement, this ceremony was undertaken, but since the resettlement, due to economic difficulties as well as outside impacts, this ceremonial ritual is no longer performed. After resettlement the meat obtained from hunting was sold outside for financial gain.

Religious ceremonies also marked major stages of human development into adulthood. In particular, the main ones being: marriage and funeral ceremonies. Before resettlement, on these occasions and other big events in the village, community members often gathered together to show their solidarity and prayed to be blessed by spirits. However, after resettlement, these religious ceremonies were less communal, and only close relatives came to the ceremony and other people from the village did not attend.

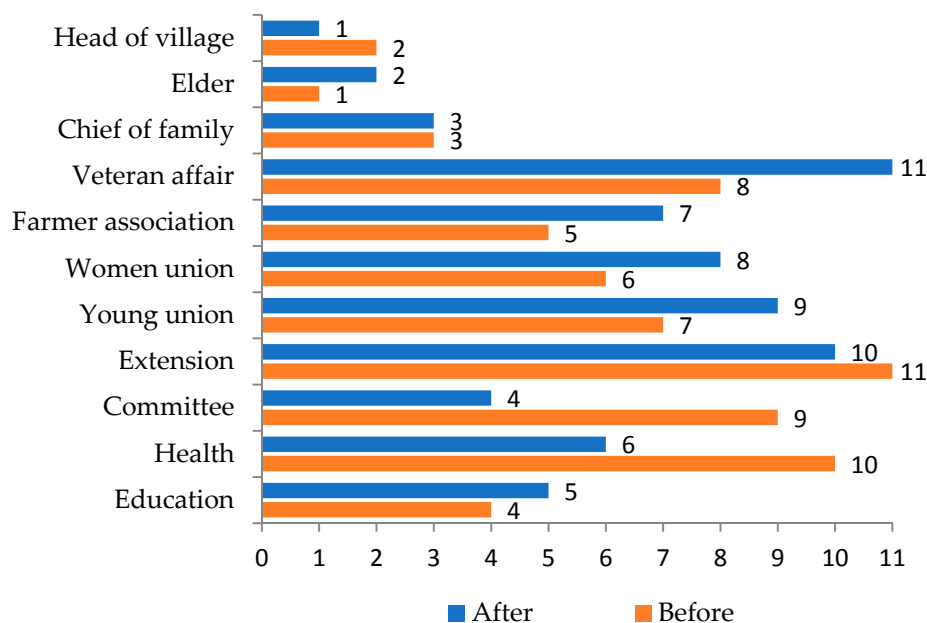
The religious activities and beliefs of Bo Hon villagers altered after resettlement, with 40% becoming Kinh from Ka Tu (an ethnic minority). This change was viewed as inevitable as influences from the outside world were becoming stronger. For instance some of the religious beliefs changed to those that were more likely to receive non-governmental agency support such as Buddhism or Christianity. However, it is also necessary to maintain the cultural rituals of Ka Tu people in Bo Hon village.

The villagers stated that bonding social capital (76%), sentimental relationship (61%), and labor relationship (72%) had deteriorated since resettlement. In terms of bonding social capital, before resettlement when a household did not have a breeding animal or seedlings other households were willing to lend without expecting anything in return. But since resettlement, this relationship has suffered. After resettlement many people faced difficulties in building an income, so more energy has been spent on developing income sources rather than maintaining bonding social capital within the village. People did not have enough land for production development, hence they did not mobilize cooperation in production as before (cultivating the soil, seeding, carrying rice, and so on) and labor sharing was greatly reduced.

### 3.5. Relationship Between Village Community and Other Organizations

The importance of the relationship between Bo Hon village community and other organizations was evaluated by villagers by asking them to rank an individual with a certain role, organization, or group from 1 to 11, with the higher the rank the greater the level of importance.

Prior to resettlement in Bo Hon village the village patriarch's or elder was considered the most important person in the community, with power and influence over villagers. However, after resettlement the elder's role was supplanted by the village head who became the most important person (Figure 3).



**Figure 3.** The importance of relationships between Bo Hon villagers and other individuals, organizations and groups before and after resettlement ( $n = 46$ ), 1 being the most important and 11 the least importance to villagers.

Before resettlement, Binh Thanh People's Committee (PC) was ranked ninth by villagers, because the community was relatively isolated from the outside world (Figure 3). However, the importance of Binh Thanh People's Committee improved to a rank of fourth when people were resettled to a new location (Figure 3). The importance of healthcare has also clearly changed since resettlement with easier access to Hue city. It was ranked tenth before resettlement and moved to sixth after resettlement (Figure 3).

In addition, other organizations such as: agriculture extension advice; youth union; and veteran affairs experienced changes in importance level, but these changes were not markedly different from before. In terms of livelihood support for villagers the low ranking of agricultural extension advice is a concern that should be addressed if agricultural practices need to be improved or altered.

## 4. Discussion

### 4.1. Livelihood Assets: Forestry and NTFPs

The natural capital of the area—soil—is already in a poor state [20]. The soil type of the region is Acric Ferralsols [2], which are characterized by a high amount of sesquioxides, which produce a net positive charge on clay-size particles. Instead of increasing the capacity to retain cations such as Ca, Mg, and K, the iron-oxides block the existing negative adsorption sites. In extreme cases, 100 g soil in the B horizon can only adsorb less than one milliequivalent of bases. These soils are usually high in clay content, but in Huong Basin they are dominated by sand-sized particles (54%) throughout the profile, and have been poorly managed or degraded in the past [2]. Often the soils have become degraded due to loss of natural forest by uncontrolled logging, timber extraction, and loss of vegetation during the Vietnam War. These soil types are considered difficult to reclaim and/or successfully farm as they are nutrient deficient in important elements, but also they have a high

capacity to fix phosphates and to adsorb Ca, as well as a higher risk of water erosion due to high intensity rainfall events [20].

For Bo Hon villagers, the loss of productive bamboo plantations and movement away from forest land has had a negative impact on income structure for households. Before resettlement, households had four major income sources including Lồ Ô Bamboo harvesting, animal husbandry, rattan and honey collection. They now have five income sources, of which two are new income sources: afforestation with acacia; and hired labor, but they have lost an extremely important income source which was Lồ Ô bamboo production, and only a few households engage in honey harvesting (Table 2). In a region further upland from where the village is located, in Nam Dong district, the role of NTFPs were shown to be a very important source of household income [21], but NTFPs can no longer provide a reliable income to the villagers of Bo Hon.

Being allocated 74 ha of forest land for acacia planting, Bo Hon villagers, could potentially make-up for the loss of income from Bamboo. With the support of the WB3 project, a project funded by World Bank in the third phase with the aim of poverty reduction and forest coverage enhancement, the village had 28 households planting 74 ha of acacia. To encourage farmers to plant acacia, the WB3 project supported lending capital for farmers. Each household was lent 10 to 15 million VND per ha for 7 years with interest rate as follow: 0.32% for the first and second year and 0.65% of interest rate for the third to seventh year. Apart from support via low interest loans, the project also supported local people to complete legal procedure to gain land use right certificates, and they were successfully granted to all the households participating.

Such industrial type plantations of acacia have been assessed in Indonesia and are perceived by landholders to provide less benefits due to their short rotation (5–7 years), and large land areas required [22]. In a nearby district of Hoang Thuy in villages resettled due to Ta Trach hydropower development there were similar developments, and in the villages studied there the role of forestry offered great income potential [6]. However, forest land allocation for displaced households is a long progress as it involves many legal procedures. Nevertheless, as reported by Ha [23] acacia forestry can generate a high profit for farmers because after 5 to 7 years, each hectare could yield 1000 to 2000 net USD (1 USD = 20,000 VND). This research also showed that people in Bo Hon village in Binh Thanh Commune, near Hue city experienced less land allocated for rice and cropping with increased allocation for acacia plantation. The average resettled household in Bo Hon village, Binh Thanh commune, by 2014 ( $n = 40$ ) had 1.65 ha allocated to forest land with an annual income of 7.9 million VND  $\pm$  12.4 million VND, which is consistent with the income data collected by Nguyen et al., [6,15] for acacia forestry in neighboring Huong Thuy District.

With the technical support from the WB3 project, farmers planted acacia under the supervision of the WB3 management board. At harvesting season, acacia would be sold to dealers and was based on the circumference of acacia trees to determine the type of market it would be sold to. For smaller trees, less than 50 cm in circumference, they would be wood chipped for paper production (Chan May economic zone, Phu Loc district). While, the acacia trees, that were greater than 50 cm in circumference, they would be sold to carpentry shops for domestic furniture manufacture. To improve the situation for growing acacia it was suggested by villagers in focus group discussion to: improve awareness of acacia seeds and encourage the development of acacia hybrid varieties; develop new forest areas; intercrop acacia with other crops such as chili, water melon, and cassava; and form a collective for those with smaller areas of acacia so they could pool resources and harvest acacia timber at the same time.

#### 4.2. Livelihood Assets: Implication for Livestock and Cropping Programs

Due to the expense of commercial food, most households currently utilize available household food in combination with commercial feed. Therefore, villagers identified a need to understand the techniques of processing and mixing up food in the most effective way for animal nutrition. The results obtained from this study concur with a study undertaken by Singer and Hoang [24] who found that in general animal husbandry amongst the displaced households was not thriving because of lack of appropriate land for foraging and insufficient animal shelter. Unlike the results from this

study, Bui and Schreinemachers [18], working in northern Vietnam, recorded an even greater decline in livestock units (by 53%) after resettlement in Son La province, which for those interviewed was explained by insufficient land for grazing of livestock or land to grow feed for livestock. A study in the central highlands of Vietnam [25] points to alternate possibilities for smallholder farmers to transform their cattle production from traditional, extensive grazing with low production values to a stall-fed system that achieves higher sales prices and reduces labor inputs. As cattle production is seemingly a low priority livestock system in Bo Hon village it may take some persuasion to consider adopting a new form of cattle husbandry.

To support local people in initiating a farmer-led sustainable cassava production system, such as cassava intercropping with acacia, or farming along the contour to avoid erosion, programs which are more participatory in nature are required. In other countries, farmer participatory programs have shown to be successful in achieving improved outcomes for smallholder farmers [26,27]. Promotion of harvesting tools for cassava to reduce labor costs was another priority of local villagers. Experimenting with new crops which have the capability of improving land quality and creating high economic efficiency (such as peanut) is an area worth developing. Intercropping cassava and peanut has been shown to improve profit margins, and was preferred by 67% of farmers in a nearby district of Phong Dien, Thua Thien Hue province [28]. The potential income from cassava has been shown in southern coastal provinces (Binh Dinh, Gia Lai) to produce an income of 10,960 thousand VND per ha [28]. In Bo Hon village, this would equate to 1096 thousand VND per household (based on 0.1 ha currently under cultivation), which if land area could be increased per household or cassava intercropped with acacia trees then an additional income source to households could be possible. Cassava maybe a suitable crop to develop in the region, due to its inherent drought tolerance, greater efficiency in use of nutrients, and tolerance of acidic soils, combined with new varieties that have increased value and can provide a higher income to farmers, especially those varieties that can be processed for starch, chips, and ethanol [27].

#### *4.3. Social Capital and Capacity-Building in Resettled Populations*

This study has shown the ability to sustain a viable household income has been compromised, and along with it much of the social fabric of the previous village location due to resettlement. The ability to maintain a suitable household income was shown to have not been possible, largely to the loss of bamboo income, and at the time acacia forestry had not adequately substituted for this loss. The average annual income was 3050 thousand Vietnamese Dong (VND) for resettled households without acacia forestry compared with 21,874 thousand Vietnamese Dong (VND) before resettlement. At the time shortly after resettlement the average annual household income was well below the poverty line of 6840 thousand VND income per capita of household [29]. However, by 2014 (some eight years after resettlement) acacia forestry was providing good returns, as well as employment opportunities, bringing the average annual income up to 10,950 thousand VND, and above the poverty line, but still considerably lower than before resettlement [15]. A study of Manwan Dam located on the upper Mekong River in southwestern China also recorded lower incomes of displaced households [5]. Other studies have shown the annual income may be higher in displaced communities, since they have been subsidized by government or can earn income from off-farm labor, but as these communities were largely rural, and the government programs had expired leaving little alternative sources of income [30]. According to Webber and McDonald [31], who examined livelihoods of people resettled from two different villages, Baigou and Dongpo, affected by construction of Xiaolangdi Dam on the Yellow river in China, the income of displaced households may be affected by the degree of dependence on agricultural production, and the availability of alternative sources of income. They remarked that Baigou villagers, whose income previously relied on agriculture, experienced an increased income from non-agricultural work as well as grain output because of better quality of the new land. While, similar to the situation described here, Dongpo villagers, who could not be compensated by non-agricultural work, and were more reliant on agriculture for household income, but because of smaller land area and poorer land quality allocated to them, experienced a decrease in income [31]. Other changes to the social dynamic of Bo Hon village

were harder to document, and one of the more important social changes was the decline in reciprocity between households to assist with labor or materials when they were in short supply. In work by Tilt and Gerkey [32], they have suggested inter-household exchange of financial resources and labor were key indicators of social capital. On that basis, the reduction in labor exchange between households experienced after resettlement in Bo Hon village would indicate a diminished social capital, even though levels of support were difficult to quantify.

## 5. Conclusions

Our findings had yet to show that Bo Hon village had recovered from resettlement, but a later study indicated that their income situation had improved [33]. After eight years, their income was much improved from the early years after displacement and many vulnerable households had escaped from poverty. Most households were less vulnerable to food insecurity and marginalization due to a significant improvement in income. However, this study showed that a major contributing factor for recovery of the village after resettlement, was its new location, which was closer and more accessible to infrastructure, education, health care, water and electricity, sanitation, and especially labor and agriculture product markets. Also, where the village was located there was a well-developed acacia forest plantation where jobs were available for displaced people. Therefore, wage labor income became the most important part of total income after resettlement. The demand for agricultural products from a nearby urban market (Hue city) also enabled villagers to cultivate cash crops to earn income. Ironically, the village's new location was also the reason for a loss of significant income from Bamboo plantation and NTFPs, as well as common pool resources such as fishing, a loss of social bonding capital, and ceremonial activities within the village.

Another important factor in assisting the recovery of displaced households was the strong support they received from local authorities who allowed them to reclaim unused uplands for acacia forestry soon after resettlement. In addition, the assistance of local and international non-governmental organizations (NGOs) enhanced their land security, financial, and technical capacity to invest in acacia forestry. As a result, they gained more forest land than before, and the resulting income became an important source of income. Thus, we can see that displaced households developed both land-based livelihoods and agricultural products and labor market-oriented livelihood model that secured and improved significantly, but by no means immediately, their livelihood outcomes after resettlement.

The ability to examine the study area in subsequent research and conduct a longitudinal study [15] provided greater insights into the resilience process of dam-induced displacement and resettlement, especially the impact on livelihoods. Without this initial study, conducted in 2010, there would be no baseline upon which to measure the changes in people's situation. The research reported here identified the major issues in resettlement and where support was required, and provided key measures that could be examined in follow-up studies. The metrics by which we measure people's situation, however, need to be broadened, especially social capital, and include a wider range of indicators [32]. This study would have benefited from a deeper inquiry into the level of labor exchange, and reciprocity between households, as well as quantifying the nature of biophysical limitations for agriculture, and the relationship between villagers and current agricultural extension support. One area that seems undeveloped, and unclear, is the strength of community support for agroforestry in the region, such as intercropping cassava with acacia trees.

Nevertheless, displaced households applied a mix of livelihood strategies after resettlement, including spending compensation money on food; restoration of agricultural livelihoods; crop diversification; land reclamation for acacia forestry; wage labor and migration for long-term adaptation or improved resilience. This case study also showed that displaced households have reasonable capacity to self-organize when livelihood opportunities are available, including: accessing more land; labor market access; good infrastructure and public services; access to urban areas; and good interaction with outsiders, even if at first there were few perceived benefits from resettlement due to hydropower development.

**Acknowledgments:** This study is an activity of a project namely “Enhance the ability to access and sustainable use forest resource and forest land for local people in the upland in Thua Thien Hue province”. This project was funded by ICCO (Interchurch Organization for Development Cooperation), a Non-governmental Organization from the Netherlands.

**Author Contributions:** Hien Thanh Nguyen and Ty Huu Pham conceived and designed the study; Hien Thanh Nguyen and Ty Huu Pham performed the household surveys and analysed the data; Hien Thanh Nguyen and Ty Huu Pham wrote the original unpublished report, and Lisa Lobry De Bruyn wrote the paper and re-analysed some of the original data with input from Hien Thanh Nguyen and Ty Huu Pham.

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

## References

1. World Bank. *Involuntary Resettlement Sources Book: Planning and Implementation in Development Projects*; The International Bank for Reconstruction and Development: Washington, DC, USA, 2004.
2. Le, T.; Al-Juaidi, F.; Sharif, H. Hydrologic simulations driven by satellite rainfall to study the hydroelectric development impacts on river flow. *Water* **2014**, *6*, 3631.
3. Cernea, M. The risks and reconstruction model for resettling displaced populations. *World Dev.* **1997**, *25*, 1569–1587.
4. Cernea, M. Compensation and benefit sharing: Why resettlement policies and practices must be reformed. *Water Sci. Eng.* **2008**, *1*, 89–120.
5. Tilt, B.; Braun, Y.; He, D. Social impacts of large dam projects: A comparison of international case studies and implications for best practice. *J. Environ. Manag.* **2009**, *90* (Suppl. 3), S249–S257.
6. Nguyen, H.T.; Lobry de Bruyn, L.; Koech, R. Impact of hydropower dam development on agriculturally based livelihoods of resettled communities: A case study of Duong Hoa commune in central Vietnam. *Int. J. Water Resour. Dev.* **2016**, *32*, 978–996.
7. Obour, P.B.; Owusu, K.; Agyeman, E.A.; Ahenkan, A.; Madrid, A.N. The impacts of dams on local livelihoods: A study of the Bui hydroelectric project in Ghana. *Int. J. Water Resour. Dev.* **2015**, *32*, 267–285.
8. Phuong, M. Thua Thien Hue Develop 11 Hydroelectric Small-Medium Scale. Retrieved. Available online: <http://icon.com.vn/vn-s83-99110-580/Thua-ThienHue-phat-trien-11-du-an-thuy-dien-vua-va-nho.aspx> (accessed on 9 August 2017). (In Vietnamese)
9. World Commission on Dams. *Dams and Development, a New Framework for Decision-Making*; Earthscan Publications Ltd.: London, UK, 2000.
10. Tran, P.; Marincioni, F.; Shaw, R. Catastrophic flood and forest cover change in the Huong river basin, central Viet Nam: A gap between common perceptions and facts. *J. Environ. Manag.* **2010**, *91*, 2186–2200.
11. Villegas, P. *Flood Modelling in Perfume River Basin, Hue Province, Vietnam*; International Institute for Geo-Information Science and Earth Observation: Enschede, The Netherlands, 2004.
12. Smith, W.; Williamson, I.; Burns, A.; Chung, T. The impact of land market processes on the poor rural Vietnam. *Surv. Rev.* **2007**, *39*, 3–20.
13. General Statistics Office (GSO). Structure of Used Land by Province (as of 1 January 2014). Available online: [http://www.gso.gov.vn/default\\_en.aspx?tabid=773](http://www.gso.gov.vn/default_en.aspx?tabid=773) (accessed on 9 August 2017).
14. Binh Dien Hydropower Joint Stock Company. Binh Dien Hydropower. 2001. Available online: <http://www.binhdienhjsc.vn/> (accessed on 10 August 2017).
15. Ty, P.H. *Dilemma of Hydropower Development in Vietnam: Between Dam-Induced Displacement and Sustainable Development*; Utrecht University: Utrecht, The Netherlands, 2014.
16. Binh Thanh Commune. *Report on Displacement and Resettlement in Binh Dien Hydropower Plant Construction*; Binh Thanh commune: Hue, Vietnam, 2008. (In Vietnamese)
17. Department for International Development (DFID). *Sustainable Livelihoods Guidance Sheets Framework Overview*; Department for International Development (DFID): London, UK, 2001.
18. Bui, T.; Schreinemachers, P. Resettling farm households in northwestern Vietnam: Livelihood change and adaptation. *Int. J. Water Resour. Dev.* **2011**, *27*, 769–785.
19. Bui, T.; Schreinemachers, P.; Berger, T. Hydropower development in Vietnam: Involuntary resettlement and factors enabling rehabilitation. *Land Use Policy* **2013**, *31*, 536–544.
20. Montanarella, L.; Pennock, D.J.; McKenzie, N.; Badraoui, M.; Chude, V.; Baptista, I.; Mamo, T.; Yemefack, M.; Singh Aulakh, M.; Yagi, K.; et al. World’s soils are under threat. *SOIL* **2016**, *2*, 79–82.

21. Huynh, H.; Lobry de Bruyn, L.; Prior, J.; Kristiansen, P. Community participation and harvesting of non-timber forest products in benefit-sharing pilot scheme in Bach Ma National Park, central Vietnam. *Trop. Conserv. Sci.* **2016**, *9*, 877–902.
22. Pirard, R.; Petit, H.; Baral, H. Local impacts of industrial tree plantations: An empirical analysis in Indonesia across plantation types. *Land Use Policy* **2017**, *60*, 242–253.
23. Ha, H.T. The Status and Planning for Acacia Development in Thua Thien Hue Province. Unpublished Work, 2013.
24. Singer, J.; Hoang, H. Participation in resettlement decision-making by dam-displaced villagers in central Vietnam. *Asia J. Glob. Stud.* **2014**, *6*, 16–29.
25. Stür, W.; Khanh, T.T.; Duncan, A. Transformation of smallholder beef cattle production in Vietnam. *Int. J. Agric. Sustain.* **2013**, *11*, 363–381.
26. Yuniwati, E.D.; Utomo, W.H.; Howeler, R.H. Farmers' based technology development for sustainable cassava production system. *Int. J. Agric. Res.* **2015**, *10*, 54–64.
27. Hershey, C.; Álvarez, E.; Tin, A.M.; Becerra, L.A.; Bellotti, A.; Ceballos, H.; Fahrney, K.; Howeler, R.; Lefroy, R.; Ospina, B.; et al. Eco-Efficient Interventions to Support Cassava's Multiple Roles in Improving the Lives of Smallholders. In *Eco-efficiency: From Vision to Reality*; Hershey, C., Neate, P., Eds.; CIAT: Palmira, DC, USA, 2016; pp. 1–26.
28. Hoang, K.; Nguyen, B.V.; Nguyen, P.; Hoang, L.; Tran, K.C.; Nguyen, H.T.; Ceballos, H.; Lefroy, R.; Fahrney, K.; Tin, A.M.; et al. *Current Situation of Cassava in Vietnam and the Breeding of Improved Cultivars*; CIAT: Hanoi, Vietnam, 2010; pp. 1–19.
29. General Statistics Office (GSO). General Poverty Rate by Residence and Region (as of 1 January 2014). Available online: [http://www.gso.gov.vn/default\\_en.aspx?tabid=773](http://www.gso.gov.vn/default_en.aspx?tabid=773) (accessed on 9 August 2017).
30. Galipeau, B.A.; Ingman, M.; Tilt, B. Dam-induced displacement and agricultural livelihoods in China's Mekong basin. *Hum. Ecol.* **2013**, *41*, 437–446.
31. Webber, M.; McDonald, B. Involuntary Displacement, Production and Income: Evidence from Xiaolangdi, PRC. *World Dev.* **2004**, *32*, 673–690.
32. Tilt, B.; Gerkey, D. Dams and population displacement on China's upper Mekong river: Implications for social capital and social-ecological resilience. *Glob. Environ. Chang.* **2016**, *36*, 153–162.
33. Ty, P.H.; Westen, A.C.; Zoomers, A. Compensation and resettlement policies after compulsory land acquisition for hydropower development in Vietnam: Policy and practice. *Land* **2013**, *2*, 678–704.



© 2017 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by/4.0/>).