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Economic valuation from direct use of melaleuca forest at U Minh Ha National Park, Vietnam

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Abstract:

This paper investigates the direct use values of melaleuca forests at U Minh Ha National Park. The market price method (MPM) was utilised to estimate the economic value. A semi-structured questionnaire comprising multiple-choice and open-ended questions was administered to 360 families in 2022 to collect data on the various forest products available locally, the quantity of these products collected, as well as their corresponding prices and costs. The results revealed that the total net benefits that the local people derived from the entire melaleuca ecosystem were US$ 73,022,184 per year, or an average worth of US$ 1,723 per person per year. Most of the local annual income was derived from construction pole harvesting (US$ 57,092,223), followed by wood for fishing boats (US$ 5,792,757) and fish (US$ 6,226,995). The melaleuca ecosystem was significant, contributing an average of 75% to the total annual per capita income for the local people. However, the U Minh Ha melaleuca ecosystems are threatened and predicted to disappear in 118 years if the current extraction rate of wood products (2,204 kg/person/year) remains uncontrolled. This suggests an urgent need for an integrated management plan that incorporates melaleuca preservation, as well as the commercial and local use interests in this area.

Keywords: **forest economic valuation, forest livelihood, melaleuca forests, peatland.**

Classification number: **2.1**

1. Introduction

U Minh Ha National Park is one of the three core zones of the Ca Mau Biosphere Reserve, which was recognised by UNESCO as a global biosphere reserve. The melaleuca forest in this area once covered 90,000 hectares of land [1]. Due to forest fires, population resettlement programmes, and the creation of new economic development zones by the government, this forest has gradually shrunk to a mere 50,000 hectares. Today, the national park encompasses only 7,639 hectares in total, with the remaining land being utilised for production forests [1]. However, a variety of plants, animals, and other organisms still survive in the tropical and subtropical environment along the saline coasts in the melaleuca forest in this area. This rich and diverse melaleuca ecosystem provides both direct and indirect values to the ecosystem. Indirect values include environmental functions such as coastline protection, maintaining water cycles, climate regulation, wave mitigation, absorption and breakdown of pollutants, and ecological functions like breeding grounds for aquatic species, biological diversity, and recreational values of natural resources. The direct values encompass nature's products that are consumed directly, or passed through a market, such as fish, shrimp, timber, honey, and construction materials.

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Due to its vital economic role, the melaleuca forest of U Minh Ha is currently under enormous pressure from the growing human demands placed upon it. Population expansion and prosperity translate into increased conversion of natural ecosystems for agricultural, industrial, or residential uses. Additionally, there is a high demand for ecosystem services such as freshwater, fibre, and soil fertility, along with increased pressure on the capacity of natural ecosystems to assimilate waste, and mitigate air and water pollution.

To protect the forest, the U Minh Ha National Park management board has approved the management planning for melaleuca protected areas until 2025, in which the ecosystems and aquatic species are protected in coherence with the livelihood improvement of local communities living in this peatland [1]. However, the conflict between developing the economy and protecting the environment at U Minh Ha is still on the rise. Conserving melaleuca ecosystems and the goods and services they provide involves foregoing certain uses of these ecosystems and the benefits that would have been derived. For instance, the failure to convert melaleuca ecosystems for other uses, such as aquaculture, preserves certain valuable services that the ecosystem may provide more effectively than fish farming, but it also prevents the local people from enjoying the benefits that fish production can offer [2]. To assess the consequences of different courses of action, it is essential to understand how valuable the melaleuca ecosystem is, and how that value is affected by various forms of management. Accordingly, understanding the ecosystem's values is crucial for responding to human demands appropriately.

This paper measures the economic evaluation of U Minh Ha ecosystems. Economic valuation offers a means to compare the diverse benefits and costs associated with natural ecosystems by quantifying and expressing them in monetary units. The results would assist forest users and policymakers in mutually promoting local livelihood and melaleuca protection, so as to optimise the management strategies for the U Minh Ha region.

2. Calculation method

A forest's ecosystem goods and services can be categorised according to how they are used, such as direct use value, indirect use value, option value, and non-use value [3]. However, this study concerns mostly the direct economic values of the forest, whose prices can be observed in the marketplace, and provides direct cash income for the local people. The direct use products and services are monetised to help demonstrate why their survival is important to the local income [4].

Using the following formula explained by A. Malik, et al. (2015) [4], direct use value was estimated by calculating the net income generated by local communities in terms of products extracted directly from the ecosystem, *Direct use value = Gross revenue - Total cost* = $\sum P_i Q_i - C_i$, where P_i: prices of product i; Q_i: amount of product i being collected; C_i: total costs involved in the collection of product i.

In the aforementioned formula, the gross revenue was estimated by calculating the total quantity of all products collected on a monthly basis and then multiplied by the market prices of each. Market prices for all products will be used in the valuation of the ecosystem as there is no data on proportions of products sold in markets to subsistence food. It is assumed that market prices are fixed and not distorted in the short run. Selling some products to tourists, which normally fetches higher prices, was not considered. In the case of unpriced commodities, such as those local people obtained through illegal means, a comparable market value is utilised for valuation purposes.

Total costs include the cost of time spent reaching the forest, harvesting products, and the cost of tools such as axes or knives. Transport costs to commercial centres are not taken into account, as the majority of respondents indicated they sold their products through intermediaries who come and collect them directly from local areas.

Subsequently, the calculation of the annual per capita net benefits is based on the direct use value allocated to each individual. The estimation of total annual net benefits, in turn, involves the multiplication of annual per capita net benefits by the proportion of the population that relies on the forest for subsistence.

3. Data collection

3.1. Study site

U Minh Ha National Park is located in two districts, Tran Van Thoi and U Minh. This park has a total forest area of 7,639 hectares, of which 3,600 hectares are strictly protected and the remaining area is a restoration zone [1]. Additionally, the buffer zone surrounding U Minh Ha National Park encompasses an area of 25,000 hectares of the U Minh forest-fishery, which is renowned for its diverse array of fauna and flora. Notable species include melaleuca, eleocharis, reed, monkey, squirrel, lizard, python, snake, turtle, amphibian, and birds, among others [5]. The acreage of forested land accounted for about 90% of the total area of U Minh Ha National Park (Table 1). However, the area of natural forest has remained in only two communes, Tran Khoi and Khanh An, with an amount of 1,100.6 ha and 753.6 ha, respectively.

Table 1. Description of U Minh Ha National Park.

Categories	Total area	Tran Van Thoi district		U Minh district	
		Tran Hoi commune	*Khanh Binh Tay Bac commune*	*Khanh An commune*	*Khanh Lam commune*
Forested area (ha)	7,639.3	2,694.0	1,037.7	3,340.1	567.5
Natural Forest (ha)	1,854.2	1,100.6	0	753.6	0
Plantation forest (ha)	5,785.1	1,593.4	1,037.7	2,586.5	567.5
Population (person)	60,669	15,069	15,198	16,712	13,690

Source: U Minh Ha National Park, 2018 [1].

The total population of these districts is 60,669 people, with a population density of about 136 people/km^2 [5]. Throughout history, forest resources have served as the primary means of livelihood for a significant proportion of the local population. A preliminary survey conducted recently indicates that approximately 65% of the community relies on the ecosystem for their subsistence.

3.2. Interview design

The sample for this study was chosen based on the characteristics of the households, including their distance from the forests (<10 km) and their reliance on the ecosystem for survival. The strategy was to represent the population of U Minh Ha in terms of the factors thought to have a strong influence on the household economic value. Such factors include the household's income and its perception of odours from the ecosystem. According to our survey, the average household income in the region is 191 $/month (calculated at the exchange rate of US$/VND 23.184) with a standard deviation of US$176. Using a 95% confidence interval and a 10% sampling error, our analysts figured that a sample of 323 homes would be required. The necessary sample size was calculated based on the amount of tolerable error in the sample estimate of mean income, using a standard statistical formula that acknowledges only type I error [6].

$$N = \frac{\partial}{e} Z_{\alpha/2} = \left(\frac{176}{19.1} \times 1.96\right)^2 = 322$$

where *N*: desired sample size; *z*: the 95% confidence interval statistic (1.96) at significance level α = 5%, two-sided test; ∂: standard deviation of income (US$ 176); *e*: acceptable error (US$ 19.1) in the sample estimate of the population (i.e., a 10% error).

To improve the power of the estimation, this research surveys 360 households (1,219 people) instead (Table 2). The survey was undertaken in all 4 communes in the U Minh Ha area (Khanh Binh Tay Bac commune, Tran Hoi commune, Khanh An commune, and Khanh Lam commune) from April 2022 to July 2022. In each commune, 90 households were chosen from various locations of the ecosystem and at various distances to the forests, to provide a representative sample for utilisation of the entire ecosystem. A semi-structured questionnaire with multiple-choice and some open-ended questions was used, in which questions aimed at providing information regarding various uses of the ecosystem,

Table 2. Description of sampled villages surrounding the melaleuca ecosystems at U Minh Ha based on a survey in 2022.

Name of commune	Distance to forest (km)	Average travel time to reach forest by motorbike (min)	Population of 360 sampled households (person)	Total population in 2015 (person)	% population relying on forest for subsistence
Tran Hoi	6	33	395	15,069	67
Khanh Binh Tay Bac	3	20	188	15,198	48
Khanh An	3	17	201	16,712	75
Khanh Lam	8	42	435	13,690	91
Total			1,219	60,669	70.3

Source: Author's calculations.

Table 3. Weight estimation procedure for products collected from U Minh Ha melaleuca ecosystems based on a survey in 2022.

Parameter	Unit	Estimated weight (kg)	Method of estimation
Firewood	Bundle	5	A scale was used to weigh 3 bundles, and an average weight taken
Construction poles	Pole	10	A scale was used to weigh 3 poles, and an average weight taken
Fishing boats	Bundle	30	A scale was used to weigh 3 bundles, and an average weight taken
Charcoal	Bag	90	One bag of charcoal was weighed using a scale. Assuming all charcoal is packed in the same size bag
Honey	Litter	1.44	Means of metric conversion. Assuming a honey density of 1.44 g/ml [7]
Fish	Kg	Kg	Quoted by respondents
Crabs	Kg	Kg	Quoted by respondents
Prawns	Kg	Kg	Quoted by respondents

Source: Author's calculation.

size of each household, amount of products collected, frequency of harvesting, and lifespan of tools used in harvesting, etc. The main output of the survey is summarised in Table 2.

3.3. Data of the products

After collecting data from the interviews for the quantification of various local uses, the number of products collected was converted to one unit (kilograms) for statistical purposes. Table 3 illustrates the procedures undertaken.

Assuming an average of 30 days in a month, the total amount of products collected on a monthly basis for each household was calculated by multiplying the amount of product collected per visit to the forest by the frequency of harvest in a month, and then divided by the number of persons within a household to determine the monthly per capita quantity of forest resources used. Subsequently, the annual per capita extraction rate and the annual extraction rate per commune were calculated by extrapolation.

3.4. Data on the price

For all products, the market price, investigated directly from the market, was used to determine gross income generated, assuming the prices are fixed and not distorted in the short run (Table 4).

Table 4. Extraction costs incurred by harvesting melaleuca products at U Minh Ha based on our survey in 2022.

Product	Market price (US$)	Extraction costs (or cost of tools used in extraction)			
		Harvesting tools	*Average price of harvesting tools (US$)*	*Average life span of harvesting tools (days)*	*Average time spent harvesting (hours)*
Firewood (US$/ton)	3.783	Working knife	19.410	1,800	2
		Axe	28.037	2,520	
		Rope (US$/5 m)	1.294	180	
Construction poles (US$/ton)	2156.660	Working knife	19.410	1,800	2
		Axe	28.037	2,520	
		Saw	176.846	720	
		Chisel	8.195	1,440	
		Hammer	24.155	1,800	
Wood for fishing boats (US$/ton)	1940.993	Working knife	19.410	1,800	2
		Small knife	6.039	720	
Charcoal (US$/ton)	388.198	Working knife	19.410	1,800	3
		Axe	28.037	2,520	
		Lighter	0.216	1	
		Spade	6.901	1,080	
		kiln	647	1,825	
Honey (US$/kg)	35.944	Helmet	3.882	1,800	4
		Smoker	6.039	180	
		Bucket	2.157	1,080	
		Gloves	3.451	720	
Fish (US$/kg)	2.588	Net	21.567	1,080	3
		Canoe (hiring fee US$/day)	25.880	1	
		Floater (hiring fee US$/day)	0.004	1	
Crabs (US$/kg)	15.528	Traps	3.451	150	2
		Bait ($/500 g)	0.431	1	
		Basket	1.725	180	
		Hand net	21.567	180	
Prawns (US$/kg)	5.047	Canoe (hiring fee US$/day)	25.880	1	3
		Basket	1.725	180	
		Hand net	21.567	180	
		Floater (hiring fee US$/day)	0.004	1	

Source: Author's calculation. Note: charcoal production cycle (e.g., wood collection, loading of the kiln, burning and cooling) takes 5 to 10 days according to charcoal producers assessed during the household survey. Assuming that wood is collected during the burning/cooling period, a production cycle of 3 hours was used in the analysis, which is only when the charcoal producer visits the kiln during the burning and cooling phase.

3.5. Data on the cost

The total cost includes the following: (i) The cost of time spent reaching the forest, calculated by multiplying the average time used for reaching the forest (in hours) by the hourly minimum wage rate, and then by the number of trips made per month, where the minimum hourly wage rates are 0.92 US$/hour. The average time used for reaching the forest and the number of trips per month is derived from the interview (Table 5); (ii) The cost of time for harvesting products is derived similarly to the cost of time spent reaching the forest; (iii) The cost of harvesting tools used in extraction was expressed on a daily basis, where the price was divided by the lifespan (in days) of the item (Table 4).

3.6. Data for evaluation of impacts of local direct uses on the ecosystems

Survey questions were also aimed at revealing information on the current threats to the melaleuca ecosystem, and the views of the respondents on the causes of the threats.

4. Results

4.1. Volume of local direct uses

The result reveals that the villagers rely heavily on the ecosystem for their livelihoods. The firewood and construction poles were most utilised with average annual per capita extraction rates of 1,082 and 625 kg respectively (Table 6). Wood for making fishing boats and charcoal were also major uses despite having a lower extraction rate. This reflects a notably high demand for wood from this region. Within this forested region, our further investigation reveals that there are two distinct categories of loggers. The first group comprises individuals from external regions who venture into the area with the intention of procuring valuable logs for commercial purposes. Locals usually report that illegal logging activities are carried out by organised groups, often with the

Table 5. Cost of time spent reaching the forest, hourly minimum wage rate, average time to reach the forest, and number of trips made per month, based on a survey in 2022.

Name of communes	Distance to forest (km)	Average time to reach forest (min)	Hourly minimum wage rate (US$/hour)	Number of trips per month
Tran Hoi	6	33	0.92	3
Khanh Binh Tay Bac	3	20	0.92	2
Khanh An	3	17	0.92	4
Khanh Lam	8	42	0.92	2

Source: Author's calculation.

Table 6. Summary of annual per capita extraction rates for various melaleuca products collected at U Minh Ha in 2022, calculations are based on a sample population of 1,219 persons.

Name of communes	Wood products (kg)				Fishes (kg)			Honey (kg)
	Firewood	*Charcoal*	*Fishing boat*	*Construction poles*	*Fish*	*Crabs*	*Prawns*	
Tran Hoi	356	121	53	15	45	8	2	0.6
Khanh Binh Tay Bac	64	76	55	22	70	6	2	0.5
Khanh An	237	103	91	8	79	8	3	0.7
Khanh Lam	971	59	19	18	167	4	6	0.6
Average annual/capita extraction (kg)	317	91	44	41	82	6	4	1

Source: Author's calculation.

cooperation of some corrupt government officials. The second group consists of local inhabitants who require timber for building fishing boats or as a source of fuel. In the past, deforestation was primarily carried out through the use of axes and machetes, resulting in a relatively low annual loss of forest cover. However, the utilisation of chainsaws today has enabled unlawful loggers to deforest a significant expanse of land within days.

Other forest products such as fish, crab, and prawn play a minor role in terms of quantity of local direct use. Fish extraction records an annual per capita extraction rate of 49 kg per person per year, while prawn and crab contribute only 8 and 2 kg. In recent years, the wetland areas have experienced a notable decline in fish population, primarily attributed to the contamination of agricultural fertilisers and pesticides, as well as the employment of destructive fishing techniques such as the use of small fishing nets and electric shock fishing. Furthermore, the phenomenon of climate change has been observed to result in severe drought conditions downstream, thereby creating an unfavourable environment for the proliferation of fish populations, ultimately leading to a decline in catch.

Another frequent food source harvested from forests is honey, which has been used for many generations in U Minh Ha. Honey has an average annual per capita extraction of about 1.9 kg. Because U Minh Ha National Park is located in Ca Mau Biosphere Reserve, thousands of households in this region have been trained to harvest honey sustainably. However, this activity has been blamed for many bushfire incidents in the region, and many large bushfires have caused multiple direct impacts on the well-being of affected communities and on the survival of species.

Among four communities, Khanh An exhibited the highest annual per capita extraction rate for wood products (3,331 kg). These wood products encompassed firewood, charcoal, fishing boats, and construction poles, with firewood accounting for the largest proportion at 1,671 kg. Khanh An has a high annual per capita extraction rate for firewood because of its high population consumption (16,712 persons) and its favourable proximity to the nearest local market. However, charcoal production was extracted in Khanh An at much lower rates due to its capital-intensive establishment and long production process which pose challenges for market entry. Tran Hoi records the second highest annual per capita extraction of firewood. This could be attributed to its large population living near the forest. Surprisingly, a low annual per capita extraction rate of fish at Tran Hoi is observed (35 kg/person/year), and this is attributed to the unproductive traditional ways of fishing effort. Khanh Binh Tay Bac and Khanh Lam have a similar pattern of extraction rates, with firewood having the largest harvested rate, followed by construction poles, charcoal, and fish. Fishing boats, crabs, and prawns contribute the least to the extraction proportion in Khanh Binh Tay Bac and Khanh Lam.

4.2. Local direct use value

Using the direct market price method, our research found that the total annual net benefit derived from the melaleuca ecosystems by the four communities was US$ 73,022,184 (Table 7). Most of the annual income came from construction poles, contributing US$ 57,092,223 per year (Table 8). Fishing boats provided only one-tenth of that of construction poles (US$ 5,792,757 annually), while firewood contributed the least (US$ 125,000 annually). It is worth noting that fish, crabs, and prawns give lower income, but they are expanding rapidly in this region because they fetch higher prices in the market compared to other products. Their expansion causes high pressure on forest land reservation and the ecosystem.

On average, the local people earn US$ 1,723 per person per year from the melaleuca ecosystem, in which construction poles contribute the highest annual income of US$ 1,347 per person; and fishing

boats and fish contribute US$ 137 and US$ 100 per person per year respectively (Table 7).

Among four communities, Khanh An gains the highest income, in which construction poles contributed the highest proportion (2,058 US$/person/year). Khanh Lam, Khanh Binh Tay Bac, and Tran Hoi have a similar pattern of the source of income. Firewood has nearly a two-fold higher extraction rate than that of construction poles, but its net benefits remain quite low. It is noted that various capacity-building programmes have been carried out by the government to assist local people at U Minh Ha to harvest forest products sustainably, yet their livelihood depends heavily on the forest, forcing them to over-harvest the forest for instant money.

Our calculation reveals that a person who depends entirely on the ecosystem for livelihood would earn US$ 1,723 per year. Considering an average per capita monthly income of US$ 191 earned by most local people, an individual would earn US$ 2,292 per year. Income accrued from the melaleuca ecosystem is therefore important to the community as it contributes an average of 75% of the total annual per capita income.

A sensitivity analysis was undertaken to test whether net income from the ecosystem varied when time changed. The result showed that the melaleuca ecosystem values decreased heavily when time increased. According to the General Statistics Office of Vietnam (1999) [8], the population of four communes in the U Minh Ha area (Khanh Binh Tay Bac, Tran Hoi, Khanh An, and Khanh Lam) is approximately 60,669, of which about 29.7% live in neighbouring towns [9], leaving an estimated 42,650 persons who depend on the melaleuca ecosystem for their livelihood. This study revealed that the average

Table 7. Summary of annual per capita net benefits derived from various melaleuca products collected at U Minh Ha melaleuca ecosystem, results are based on a sample population of 1,219 persons from a survey in 2022.

Name of communes	Wood products (US$)				Fishes (US$)			Honey (US$)	Total annual capita net benefit (US$)	Total annual net benefit (US$)
	Firewood	*Charcoal*	*Fishing boat*	*Construction poles*	*Fish*	*Crabs*	*Prawns*			
Tran Hoi	4	21	130	1,281	63	29	13	70	1,613	16,282,603
Khanh Binh Tay Bac	1	8	81	821	85	30	9	35	1,070	7,802,268
Khanh An	5	35	174	2,058	157	60	28	125	2,643	33,127,491
Khanh Lam	1	27	162	1,228	97	14	3	35	1,566	19,513,295
Average annual/capita net benefit	3	23	137	1,347	100	33	13	66	1,723	73,022,184

Source: Author's calculation.

Table 8. Summary of total net values of melaleuca products at U Minh Ha melaleuca ecosystem, results are based on a sample population of 1,219 persons from a survey in 2022.

Name of commune	Wood (US$)				Fish/shellfish (US$)			Honey (US$)
	Firewood	*Charcoal*	*Fishing boat*	*Construction poles*	*Fish*	*Crabs*	*Prawns*	
Tran Hoi	45,119	213,359	1,317,057	12,937,389	637,653	292,331	129,646	710,049
Khanh Binh Tay Bac	6,713	60,701	590,090	5,987,677	618,372	217,824	63,460	257,431
Khanh An	65,812	443,564	2,176,248	25,798,491	1,965,338	758,128	356,669	1,563,240
Khanh Lam	14,419	341,898	2,014,895	15,294,831	1,208,808	170,132	37,098	431,216
Total net value	125,000	977,848	5,792,757	57,092,223	4,256,919	1,408,773	561,303	2,807,360

Source: Author's calculation.

per capita per annum extraction of wood in the area is about 2,204 kg. As a result, the annual use of wood in the simulation for U Minh Ha becomes 94,001,277 kg. The typical forest density of mature melaleuca is about 6,100 trees/ha [10], while an average melaleuca tree weighs 97 kg according to S.V. Briggs (1977) [11]. For 7,639.3 ha of melaleuca forests, U Minh Ha is currently estimated to harbour 4,520,173,810 kg of wood. Assuming an average production rate for melaleuca vegetation of 3.2 megagram/ha/year [12], and if the extraction rate of wood products remains the same (2,204 kg/person/year) without immediate control measures, all of U Minh Ha melaleuca forest will be depleted in about 118 years.

These community members are aware of the values and threats to the ecosystem [13]. Many have confirmed a reduction in fish catches over the years. This result is consistent with the finding by I.C. Campbell (2012) [14], who discovered that fish species and biodiversity in this region have decreased rapidly over the last few decades. The problem of over-extraction of forest resources may persist, given that the increasing population is exerting more pressure on forest wood products in terms of firewood consumption, which forms the main energy source for household use in nearly all rural homes [15]. The lack of employment opportunities for the youth also contributes to the problem, as most villagers, the majority of whom are young people, have been harvesting products for immediate financial gain for many years.

Ironically, many local people are concerned about losing income generated from the ecosystem once the forest is depleted, yet under the current management of the ecosystem, wood products such as firewood, charcoal, construction poles, and fishing boats are poached by local residents for sale [15]. Given the difficulties in limiting access to the melaleuca ecosystem, it is unlikely that poaching wood products can be prevented [16]. Furthermore, in many instances, illegal logging activities are often carried out by highly organised groups, often facilitated by state officials, who also employ local individuals to undertake risky tasks. In remote areas, forest guards lack the necessary resources, including human, equipment, and financial, to effectively confront these illegal loggers. The illegal exploitation, coupled with land clearance for short-term profitable crops [15], has resulted in the modification of natural capital and the inefficient utilisation of natural resources. Considering the significant value of the ecosystem to the community, it is essential that an integrated management plan be developed to facilitate the coexistence of melaleuca forest conservation and the local livelihoods in the region, thereby ensuring mutual benefit.

5. Conclusions

This research provides insight into the economic evaluation of U Minh Ha ecosystems in order to assist forest users and policymakers in exploiting forests optimally and sustainably. The results reveal that firewood was the least valuable, contributing US$ 178,929 annually but having the highest extraction rate of 1,082 kg/person/year. Most of the annual income came from the harvesting of construction poles, contributing US$ 57,092,223 per year. Fishing boats provided US$ 5,792,757 annually, while fish and honey earned annual incomes of US$ 6,226,995 and US$ 2,807,360, respectively. The total net benefits derived from the entire melaleuca ecosystem were estimated at US$ 73,022,184 per annum or an average value of US$ 1,723 per person per year. The income obtained from the melaleuca ecosystem contributes 75% to the total annual per capita income. With a population of whom 70.3% depend on the ecosystem for their livelihood, all of U Minh Ha melaleuca forests will be lost in about 118 years if the forest extraction rate is not controlled. This high depletion rate suggests an urgent need for an integrated management plan to mitigate the conflict between preservation and local uses in this ecosystem.

COMPETING INTERESTS

The author declares that there is no conflict of interest regarding the publication of this article.

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