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Measurement of Carbon Dioxide Emissions for Eco-tourism in Malaysia

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Abstract: Tourism sector is one of the main sources of carbon emission. The transportation used in tourism is the major contributor when considering all the factors in the tourism industry for energy consumption and carbon emission. Malaysia emphasizes ecotourism for tourism development. There are 42 recreational forest areas situated in East Coast Economic Region (ECER) of Malaysia. The aim of this study was to measure the carbon emissions from Sekayu recreational forest in Terengganu by tourists. The study highlights the considerable issues and policies of carbon emissions in the forest by ecotourism activities. The study considers only the carbon emissions from transportation sector. Local tourists' vehicles have been used to measure carbon emissions. The study shows that carbon emissions from buses and motorcycles are lower than those of small car (compact-size) and big car (family size). The study suggests that some initiatives can be taken for low carbon emissions in this ecotourism destination. Those are low-carbon technologies, sustainable tourism, low-carbon tourism consumption, paid carbon taxes, government and tour operator initiatives, institutional facilities development and tourism friendly traffic system. The ecotourism destinations, government, tour-operators and tourists are trying to reduce carbon emissions by improving and changing their transportations usage and other service systems. Finally, Malaysian government should develop linkage with international organizations for developing low-carbon ecotourism in ECER.

Key words: Carbon emission, ecotourism, ECER, Sekayu recreational forest, transportation

INTRODUCTION

The increasing of CO_2 in the environment occurs significant climate changes in the world (Mahlman, 1997). The use of energy resources is the main cause for CO_2 emissions (Scholes and Noble, 2001). Many countries in the world emphasize carbon emissions from various sectors of their economies. They are adopting various programs for minimum carbon emissions from their economic development activities. Researchers in environmental issues have emphasized quantitative measurement of carbon emissions in tourism industry. Kuo and Chen (2009) explored Life Cycle Assessment (LCA) to measure carbon emissions of tourism in transportation, accommodation and recreation activities. They showed the transportation sector consumes the largest CO_2 emissions (67%) followed by accommodation 17% and recreation activities 16%. Peeters and Dubois (2010) found that tourists are responsible for 4.4% of global CO_2 emissions and emissions are increasing at an average rate of 3.2% per year up to 2035.

Sustainable fuel and hydrogen production have been become more and more attractive because of the energy crisis and the increase of environmental issues. The hydrogen concentration in the product gas was increased by more than 19% due to higher thermodynamic efficiency for the integrated gasification process compared to the conventional gasification (Inayat *et al*., 2010). Biomass has been the potential solution to the problem due to the energy crisis and because it may be converted into hydrogen and other gases (Ahmad *et al*., 2011). For power systems, air temperature changes are closely related to peak loads, due to the air conditioning equipment. During the summer, 30% of power consumption has been accounted from the power consumption of air conditioning equipment for electric power loads (Yu *et al*., 2011).

According to the World Trade Organization, tourism is the biggest industry in the world now (WTO, 2007). 11.5% of global Gross Domestic Product (GDP) is depending on tourism and this sector creates employment for 200 million people. This employment is 11% of the

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world's total workforce (WTO, 2004). Tourism sector is one of the main sources of carbon emission. This industry can develop the economy of a country. But at the same time, energy consumption and carbon emission also associated with the industry (Chen and Chiou-Wei, 2009). For energy consumption and carbon emission, the transportation used in tourism industry has been the major contributor. Transportation, shopping, food, entertainment and other services for tourists can increase carbon emissions in an area (Liu *et al*., 2011). Becken *et al*. (2003) proposed that transportation sector is contributing 65-73% of the total energy consumption in the world. Most of international tourists are visiting tourism destinations by civil aviation. In a report of Intergovernmental Panel on Climate Change (IPCC) estimated that aviation accounts for 2-3% of the world's total use of fossil fuels, with more than 80% consumed by civil aviation (Penner *et al*., 1999).

Ecotourism is one of the boosting and potential tourism segmentation in the world today. Many developed and developing countries build up their economic advancement by using the tourism segmentation (Bhuiyan *et al*., 2011a). Malaysia has captured the 16th position in terms of tourism receipt which is 2% of global market share in 2008. This industry has employed 1.7 million people or approximately 16% of total employment of the country in 2008 (Malaysia Unit Perancang Ekonomi, 2007). Malaysia emphasizes ecotourism for tourism development in the wide country. The country has formulated separate plan for sustainable ecotourism development in the country. "The Ministry of Culture, Arts and Tourism has formulated The Malaysian National Ecotourism Plan". The plan was drafted in 1995 and was accepted by the government in 1996. This plan ensures conservation of Malaysia's natural and cultural heritage with the proper ecotourism development (Bhuiyan *et al*., 2011b).

The East Coast Economic Region (ECER) consists of three states in Malaysia-Kelantan, Terengganu, Pahang and District of Mersing in Johor. The economic region established under an Act of Parliament. There are 42 recreational forest areas situated in this region. These recreational forests are suitable and potential for ecotourism development in the region. Sekayu is the largest recreational forest in Terengganu. The forest gets famous for tourists due to its natural beauties and recreational facilities (Bhuiyan *et al*., 2011c). The aim of this study was to measure the carbon dioxide emissions from Sekayu recreational forest by tourists through ecotourism activities. The study also highlighted the considerable issues and policies of carbon emissions in this recreational forest to develop ecotourism.

MATERIALS AND METHODS

Data attainment: The study is empirical in nature. Both primary and secondary data have been used in the study. The secondary data have been collected from the study site office, document analysis and published materials on ECER. The primary data have been collected through the questionnaire survey from the local tourists who visit the Sekayu. The survey was conducting during the last week of January 2011. A total of 110 respondents were selected to collect the primary data for the study.

Sekayu recreational forest: Sekayu Recreational Forest is situated in Terengganu state of Malaysia (Fig. 1). It is the largest recreational forest in this state. The forest site has been selected for data collection in the study. It was established in 1974 and officially launched in 1985. It is located within Hulu Terengganu forest reserve at Kuala Berang of Terengganu. The total area of the recreational forest is 30 hectares (Bhuiyan *et al*., 2011c).

Carbon emissions in Malaysia: Carbon emissions have been increasing in Malaysia year by year. In 1970, carbon emissions in Malaysia were 1.34 metric tons per capita. The emissions reached in 7.57 metric tons per capita on 2008. Average carbon emissions in the world were 4.03 and 4.80 in 1970 and 2008, respectively. The scenario shows that carbon emissions are higher in Malaysia than world average emissions. On the other hand, the annual growth rate of carbon emissions in Malaysia was 4.2 and 4.3% in the period 1970-80 and 2000-08, respectively. In this period, annual growth rate in the world was 0.9 and 2.1%, respectively. Statistics reveal that annual growth rate of carbon emissions is also higher in Malaysia rather than world perspective (Table 1).

Methods: The study only considers carbon emissions from transportation sector. Local tourists' vehicles have been used to measure carbon emissions. The vehicles are divided into four portions-motorcycle, small car (compact-size), big car (family size) and bus according to respondents' feedback. The following formula has used to measure the carbon emission in the study:

$$CO_2E = \sum_{m}^{n} FC \times CO_2co$$

Again:

$$FC = \frac{TD}{DL}$$

Fig. 1: Map of Sekayu Recreational Forest (Waterfall), Terengganu

Table 1: Carbon emissions and annual growth rate in Malaysia and World

	Carbon emissions (metric tons per capita)					Annual growth (%)			
	1970	1980	1990	2000	2008	1970-1980	1980-1990	1990-2000	2000-2008
Malaysia	1.34	2.02	3.11	5.41	7.57	4.2	4.4	5.7	4.3
East Asia and pacific	0.87	1.34	1.93	2.33	4.27	4.4	3.7	1.9	7.9
Upper middle income	1.93	2.82	3.55	3.55	5.32	3.9	2.3	0.0	5.2
High Income	11.24	12.20	11.82	12.28	11.94	0.8	-0.3	0.4	-0.3
World	4.03	4.40	4.28	4.07	4.80	0.9	-0.3	-0.5	2.1

World Bank Database (2012)

Where:

CO_2E = CO_2 emission
FC = Total fuel consumption
CO_2co = CO_2 co-efficient
TD = Total distance
DL = Distance per liter
n = Type of vehicle
m = Type of fuel consumption

Here, total distance is calculated by the distance between tourist's home state capital and Sekayu. Distance per liter means movements of vehicles per liter of fuel. The CO_2 co-efficient per liter of petrol and diesel are 2.3 and 2.7 kg, respectively (Global Warming, 2012).

Table 2 represents the distance between respondents' home state capital and Sekayu. The distance is largest between Johor and Sekayu and lowest from Terengganu to Sekayu. Table 3 shows the fuel consumption of vehicles used by respondents. Motorcycle, small car and big car use petrol as fuel with bus using diesel. Motorcycle, small car and big car are moving a distance of 30, 15 and 10 km with 1 L of petrol. On the other hand, bus is moving a distance of 8 km with 1 L of diesel.

Table 2: Distance between respondents' home state capital and Sekayu

State	Sekayu recreational forest (km)
Terengganu	39
Pahang	176
Kelantan	205
Selangor	435
Melaka	450
Kedah	497
Johor	535

Google maps

Table 3: Fuel consumption by vehicles

Vehicle type	Fuel use	Consumption (L^{-1})
Motorcycle	Petrol	30[e]
Compact-size car	Petrol	15
Family-size car	Petrol	10
Bus	Diesel	8[e]

Autoworld (2005), e: Estimated by authors

RESULTS

Table 4 highlights the domestic tourists' arrival in Sekayu Recreational Forest. The total domestic tourists' arrivals were 134,337 and 203,947 in 2006 and 2010, respectively. The annual growth rate of tourists was 7.1% in 2010.

Table 5 reveals the respondents' demographic profile. Most of the respondents (81.8%) are of Malay ethnicity

Table 4: Domestic tourist arrival in Sekayu recreational forest

Year	Total tourists	Annual average growth rate (% year)
2006	134,337	-
2007	181,000	34.7
2008	181,275	0.2
2009	190,465	5.1
2010	203,947	7.1

FDPM (2011)

Table 5: Respondents' demographic profile

Variable	Item	Frequency	Percentage
Ethnicity	Malay	90	81.80
	Chinese	18	16.40
	Indian	2	1.80
Occupation	Student	66	60.00
	Job	27	24.50
	Business	17	15.50
Sex	Male	50	45.50
	Female	60	54.50
Marital status	Single	78	70.90
	Married	32	29.10

while 16.4% are Chinese and 1.8% Indian. In terms of occupation, 60% respondents are students. On the other hand, 24.5% are job holder and 15.5% businessmen. In terms of gender, the distribution of sample is 45.5% male and 54.5% female. Seventy-one percent of the total respondents are single whereas 29% are married.

Table 6 shows the use of transportations by respondents according to their home state. Most of respondents from Terengganu (28%) used motorcycle in their visit period while 13.64% is used compact-size car and family size car. Maximum number of respondents (5.45%) from Pahang and Kelantan is used family size car and bus respectively. Respondents from Selangor used family size car (4.55%), bus (4.55%) and compact-size car (0.9%). Most of respondents from Melaka and Kedah used compact-size car (2.73%) and bus (4.55%) respectively. Same portion of respondents (2.73%) is used compact-size car and family size car from Johor.

Figure 2 highlights vehicles used by respondents according to their income level. Motorcycle and bus used by respondents who are in below USD 165 income level. Larger number of compact-size car (16.36%) used by below USD 165 income level respondents. 13.64% and 10.91 of respondents used family size car under USD 166-665 and USD 666-1332 income level, respectively. Again, motorcycle (28.18%) and bus (14.55%) are used by respondents being students. Compact-size car is used by the respondents from students (17.27%), job holder (6.36%) and businessman (1.82%). Family size car used by job holder (18.18%) and businessmen (13.64%) among respondents (Fig. 3).

Table 7 highlights total carbon emissions by respondents' vehicles. Larger amounts of emission come from family size car (2279.45 kg). On the other hand, lowest emissions come from motorcycle (185.38 kg).

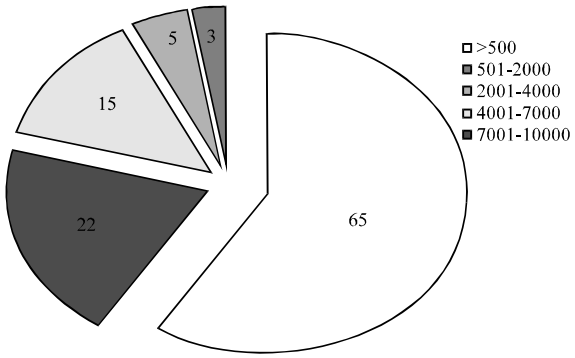

Fig. 2: Use of vehicles by respondents according to their income level

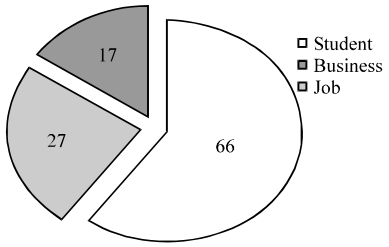

Fig. 3: Vehicles used by respondents according to their occupation

Carbon emissions from bus and compact-size car are 767.48 and 1452 kg, respectively. According to state, respondents from Selangor (1060.68 kg) are emitting highest carbon emissions and lowest emitting from Kelantan (326.98 kg).

An independent-sample t-test is conducted to compare the carbon emissions conditions of transportations use by respondents. There is a significant difference in carbon emissions between motorcycle ($M = 5.98$, $SD = 0.000$) and compact car ($M = 51.87$, $SD = 50.544$), conditions; $t(27) = -4.805$, $p = 0.000$. Again, significant difference also shows between family car ($M = 65.13$, $SD = 57.92$) and bus ($M = 248.49$, $SD = 89.73$) conditions; $t(20.92) = -7.492$, $p = 0.000$. There are significant differences present between motorcycle and family car (conditions; $df = 34$, $t = -6.041$, $p = 0.000$), motorcycle and bus (conditions; $df = 15$, $t = -10.81$, $p = 0.000$), compact car and bus (conditions; $df = 20.56$, $t = -8.064$, $p = 0.000$). Only, compact car and family car shows no significant difference in carbon emissions (conditions; $df = 61$, $t = -0.954$, $p = 0.344$). Carbon emissions from motorcycles are lower than other vehicles. The emissions from compact-size car and family size car are nearly same. The buses are carrying more passengers than other vehicles. So, average emissions from bus are lower than car. From above analysis motorcycle and bus

Table 6: Use of transportations by respondents according to their home state

	Transportation use by respondents									
	Motorcycle		Compact size		Family size		Bus		Total	
State of respondents	No.	%	No.	%	No.	%	No.	%	No.	%
Terengganu	31	28.18	15	13.64	15	13.64			61	55.45
Pahang			2	1.82	6	5.45			8	7.27
Kelantan					3	2.73	6	5.45	9	8.18
Selangor			1	0.90	5	4.55	5	4.55	11	10.00
Melaka			3	2.73	2	1.82			5	4.55
Kedah			4	3.64	1	0.90	5	4.55	10	9.09
Johor			3	2.73	3	2.73			6	5.45
Total	31	28.18	28	25.45	35	31.82	16	14.55	110	

Table 7: CO_2 emission by respondents' vehicles

	CO_2 emission by different type of transportation (CO_2 kg^{-1})				
State of respondents	Motorcycle*	Compact size*	Family size*	Bus*	CO_2 emission (CO_2 kg^{-1})
Terengganu	185.38	134.55	179.40	0.00	499.33
Pahang	0.00	80.96	323.84	0.00	404.80
Kelantan	0.00	0.00	188.60	830.25	1018.85
Selangor	0.00	100.05	667.00	1468.13	2235.18
Melaka	0.00	310.50	276.00	0.00	586.50
Kedah	0.00	457.24	152.41	1677.38	2287.03
Johor	0.00	369.15	492.20	0.00	861.35
Total	185.38	1452.45	2279.45	3975.75	7893.03
Per person emissions	5.98	51.87	65.13	248.48	71.75

*Here we assume that every tourists use one types' single unit vehicle

are convenience for tourists in terms of carbon-emissions. The study shows per tourists emissions in Sekayu is 71.75 CO_2 kg^{-1} which is higher than per capita emissions in Malaysia. In 2008, per capita carbon-emissions was calculated in Malaysia about 7.57 metric tons (20.74 kg^{-1} per day).

DISCUSSION

Sekayu recreational forest is one of the more famous and suitable ecotourism destinations for local visitors as well as foreign tourists. Every year domestic tourists' arrival is increasing in this forest area. The recreational forest is attracting the tourists by its unspoiled and environment friendly situations. Among domestic tourists, students are visiting this forest for educational purposes. On the other hand, professionals are visiting for recreation and site seeing facilities. Liu *et al.* (2011) have shown that transportation is the major factor for carbon emissions in their study. They emphasize low carbon emissions from transportations. Kuo and Chen (2009) mentioned that about 67% of total energy in tourism sector is used for transportation. According to the findings of their research, transportation sector is the major contributor for carbon emissions in tourism industry. They recommended that carbon emissions may become an important tool for measuring tourism sustainability in the future. Most of student tourists are using motorcycle as transport to visit the destination. Moreover, the professionals are using compact-size car and family size car during their visit period according to their income levels. Again, some students and low income tourists are using bus as their transport that comes from very far distance.

Environmental pollution and sustainability are the concerning issues for ecotourism development in some areas. The main focus of ecotourism is minimum negative impact and long term sustainability. Many ecotourism destinations in the world become hazardous and polluted due to environmental degradations. High carbon emissions can be of the unsustainable and polluted situations for ecotourism development in the Sekayu recreational forest. Cai and Wang (2010) give priority to low-carbon tourism. This tourism is a new way for ensuring sustainable development of an area. Peeters *et al.* (2006) have employed carbon emissions to identify the sustainability of the tourism destinations. Many countries have taken steps for preventing carbon emissions from tourism destinations. China, one of the big tourism developed country in the world has formulated agenda and regulations for low carbon emissions from their tourism industry (Huang and Deng, 2011). The following steps can be adopted for the low carbon emissions in Sekayu as well as sustainable tourism development.

Low carbon technologies: Carbon emissions should be reduced by low-carbon technologies. In Sekayu, low-carbon technologies should be applied to the tourism facilities and services.

Sustainable tourism: Maintain sustainability is the main concerning point for any ecotourism destination. Low-carbon emission is prerequisite for sustainable ecotourism development in Sekayu. This destination can ensure sustainability by minimum carbon emissions from all tourism related activities.

Low carbon tourism consumption: In Sekayu, carbon offset program can introduce to visitors for low carbon consumption. The forest authority can be introduced tree plantation program for tourists which reduce carbon emissions from visitors.

Paid carbon taxes: The local authority can apply tax payment program for carbon. Tourism destinations should be paid for the carbon consumption by tourism activities.

Institutional facilities development: Government, tour-operators, local communities and tourists are working together to reduce carbon emissions in Sekayu. The local government should plan mechanisms for low-carbon emissions tourism and other involved parties can implement the plan effectively.

Government initiatives: Government has a vital role for low-carbon emissions in ecotourism destinations. Tang *et al*. (2011) emphasize the inclusion of low-carbon tourism into national five-year development plan. In this connection, Malaysian government takes special agenda in five-year development plan to reduce carbon emissions from the tourism destinations. Government can formulate laws and regulations, allocate fund for low-carbon ecotourism development and ensure other facilities in this regard.

Tour operators: Tour-operators can operate low-carbon tourism and develop low carbon vehicles for tourists. They can encourage tourists to use buses and other big vehicles instead of personal vehicles.

Tourism friendly traffic system: Tourism friendly traffic system can reduce carbon emissions in Sekayu recreational forest area. Low-carbon advocate buses, electric cars, bicycles and other free-carbon transportation mode can operate to reduce carbon emissions. Alternative fuels, mainly bio-fuel, are helpful for saving energy and reducing carbon emission.

CONCLUSION

Carbon emission is one of the concerning matter for ecotourism destinations in the world now. The ecotourism destinations and related parties are trying to reduce carbon emission by improving their transportations and other service systems. Tour-operators can make tourists aware of regarding carbon emissions and environment friendly travel. Tourists are the main contributors for low-carbon ecotourism development. They can give priority to bicycle, bus, railway and other low-carbon transportations to reduce emission. Tourists are promoting low-carbon ecotourism development by changing their transportation use. Government should develop low carbon appraisal system for ecotourism development, encouraging tourism transport and energy conservation and support tourism organizations for low-carbon ecotourism development. The campaign and advertisement to promote low-carbon ecotourism are helping for carbon emission in this sector. Finally, Malaysian government should develop linkage with international agencies and organizations for developing low carbon ecotourism in ECER and reducing carbon emission from ecotourism destination.

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