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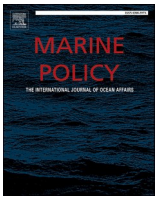

Mangrove ecosystem services: Contribution to the well-being of the coastal communities in Klang Islands

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ABSTRACT

Mangroves continue to be extensively replaced for alternative land uses despite global recognition of their value for ecosystem services. Limited effort has been directed into understanding how changes in mangrove ecosystems affect human well-being, especially in Asia. Using the inhabited Klang Islands, Selangor, Malaysia as a case study, this paper explores the relationships between mangrove ecosystem services and human well-being by adapting and modifying three existing conceptual frameworks. Semi-structured interviews with island residents were conducted to explore mangroves' contribution to human well-being. Analysis revealed that respondents recognised examples of regulating, cultural, and provisioning ecosystem services resulted from their interaction with mangroves. While all three ecosystem services contributed to both basic human needs and subjective well-being, provisioning and cultural services were reported to also contribute to economic needs and regulating services, more strongly to environmental needs. These findings contribute to more inclusive decision-making processes concerning development and conservation planning in the fast-urbanised Klang which would affect the overall well-being of the communities in general, largely the Malay, Chinese and Mah Meri communities, and the fishers specifically.

1. Introduction

Globally, mangroves are recognised for the benefits they provide to people ranging from the provision of food to the protection from storms as well as their significance to local culture, economic and social values [1]. Despite its importance, mangrove deforestation still takes place, although the rate of decline has reduced in recent years [2]. Between 2000 and 2012, 18.4% of global mangrove area was lost with more than 1000 km^2 recorded in Southeast Asia, the region with the mangrove greatest extent [3,4]. This loss was primarily found to be closely associated with urbanisation, aquaculture, rice and palm oil plantations, illegal harvesting and resource utilisation [2,6], with economic growth and development typically valued more highly than environmental benefits in the region of Southeast Asia [1] despite growing acknowledgement of the importance of the environment to human well-being, including psychological and physiological health [10–16]. Similar findings were reported in Malaysia [2,5–9].

To date, research efforts to understand the importance of nature have focused mainly on ecosystem services, with fewer studies focusing on cultural ecosystem services as compared to provisioning and regulating services [18]. This discrepancy is attributed to provisioning and regulating services being tangible, easily identified, and measurable compared to their cultural counterparts [19]. Meanwhile, lesser attention has been given to understand the impacts of ecosystem services to different dimensions of human well-being [13]. In fact, only a handful of studies explore both the material and nonmaterial contributions of ecosystem services in relation to well-being [20]. These include a study in Portugal [21] which demonstrated the acknowledgement of the full range of ecosystem services by a mountain community on the community's objective and subjective well-being, and another study [22] which revealed the impact of ecosystem services on diverse levels of well-being in Cyprus Island.

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Further studies are required, especially in less developed countries where the dependence of communities on natural resources is often greater [23] and an urgent need to support more effective resource management exists [10,24]. Such studies need to take a more holistic approach to assess ecosystems' contributions to well-being which covers not only both material and nonmaterial dimensions but also their links to objective and subjective human well-being [25]. Such an approach could provide an evidence-based assessment of mangroves for well-being, highlighting to decision-makers their value to coastal communities and the importance of nature as the core of sustainable development [17]. Understanding local uses and users of mangrove contribute to more effective management decisions by those responsible for mangrove management. Specifically, social preferences and communities' perception should be prioritised in management agenda [26] as local governments and businesses have different local sensitivities and cultural backgrounds [27].

Using mangrove ecosystems of the Klang Islands, Selangor, Malaysia as a case study, this paper aims to investigate the contribution of mangrove ecosystem services to coastal communities' objective and subjective well-being. A qualitative approach involving semi-structured interviews was employed to answer the following research questions; (i) What are ecosystem services provided by the mangroves of the Klang Islands? (ii) How do these ecosystem services contribute to the well-being of the coastal communities in the Klang Islands? (iii) What are the factors influencing the relationship between ecosystem services and well-being? and lastly, (iv) What are the effects of mangrove loss on this relationship?

This paper starts by elaborating the conceptual framework of the study then a description of the methods and the approach used in data collection and analysis. The subsequent sections present the results and discussions on the mangrove ecosystem services and these contributions to the community well-being as perceived by the research respondents. The paper closes with the way forward and conclusions of the study.

2. Conceptual framework

This study adapts the ecosystem services framework which was developed through The Economics of Ecosystem & Biodiversity (TEEB) project [28]. The proposed framework for this study is also augmented by the approach to cultural ecosystem services developed by [29], and human well-being framework introduced by [30] (see Table 1).

The TEEB framework is constructed based on the Cascade Model for Ecosystem Services [23]. According to TEEB, ecosystem services refer to both the direct and indirect contributions of ecosystems to human well-being [28]. The TEEB model highlights the cascade relationship between ecosystem functions, services, and well-being thus distinguishing it from the Millennium Ecosystem Assessment (MA) framework [31], where ecosystem services act as a bridge linking the ecosystem functions and human well-being. The model has also expanded the ecosystem services classification of the MA framework (of provisioning, regulating and cultural services) by including habitat services as a category which acknowledge the role of an ecosystem in providing living space for plants and animals.

In the TEEB framework, all services are assumed to result from ecosystem functions. While this linkage is justifiable for provisioning, regulating, and habitat services, this conceptualisation has been criticised in the context of cultural services [25]. There is a growing recognition that cultural services are relational, produced from people's interactions with ecosystems [19]. Meanwhile, [29] aimed to apply this dimension of appreciation by suggesting environmental spaces and cultural practices as two main elements of cultural ecosystem services. The environmental spaces refer to 'the geographical contexts of interaction between people and nature'. Cultural practices, on the other hand, are 'activities that relate people to each other and the natural world' which are broadly divided into four categories, i.e., (i) playing and exercising, (ii) creating and expressing, (iii) producing and caring, and (iv) gathering and consuming.

Table 1
Description of each subcategory of the study framework.

Key term	Source of Framework	Components	Subcomponents
Ecosystem services	TEEB, 2010	Provisioning services	Food, water, raw materials, medicinal resources, and ornamental resources
		Regulating services	Air quality regulation, climate regulation, moderation of extreme events, regulation of water flows, waste treatment, erosion prevention, maintenance of soil fertility, pollination, and biological control
Human well-being	Fish et. al, 2012	Cultural services	Environmental spaces and cultural practices (playing and exercising, creating and expressing, producing and caring, gathering and consuming)
	Summers et. al. 2012	Basic human needs	Food, shelter, building materials, physical health, security
		Economic needs	Income
		Environmental needs	Air quality regulation, climate regulation, erosion prevention, biological control, moderation of extreme event
		Subjective well-being	Mental health, social cohesion, value of importance of leisure, cultural requirement, aesthetics, calm & peaceful, sense of place, identity, happiness, affection/ respect towards nature

Each of these service categories are linked, in ecosystem service frameworks, to human well-being, in recognition of the contributions that they produced. This linkage between ecosystem services and well-being is typically poorly articulated. For example, the MA framework remains broad and excludes important aspects of well-being, i.e., physical, mental, and social well-being [32,33]. The Holistic Human Framework for Marine Policy [34], on the other hand, does not clarify in detail human basic needs such as shelter and education as well as environmental needs.

The Human wellbeing framework [30] addressed these shortcomings by explicitly outlining the material and nonmaterial components of well-being and providing detailed descriptions of its subcomponents. It also holistically covers both objective well-being i.e., basic needs, economic needs, environmental needs, and subjective well-being. The framework also includes physical health which is absent in the above two frameworks. This helps to frame the complex and diverse aspects of contributions of ecosystem services to the well-being [30]. Building on this, the diverse contributions of mangrove ecosystem services to well-being can be explored.

3. Methodology

3.1. The study area: The Klang Islands

The Klang Islands are located on the west coast of Selangor state and consist of seven islands in the Klang district jurisdiction (Fig. 1); Pulau Ketam [A], Pulau Tengah [B], Pulau Klang [C], Pulau Che Mat Zin [D], Pulau Selat Kering [E], Pulau Pintu Gedong [F], and Pulau Indah [G]. Except for Pulau Ketam [A] and Pulau Indah [G], the other five islands are uninhabited and are mangrove forest reserves [35]. While Pulau Ketam remains a predominantly mangrove island, Pulau Indah has undergone considerable economic development resulting in significant

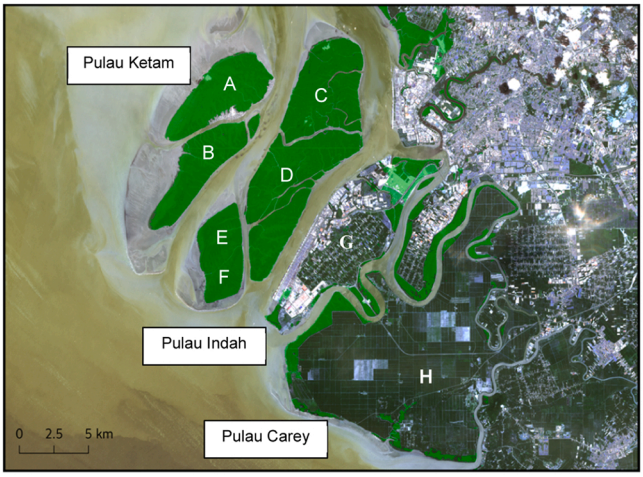

Fig. 1. Mangrove cover of the Klang Islands. A – Pulau Ketam, B – Pulau Tengah, C – Pulau Klang, D – Pulau Che Mat Zin, E - Pulau Selat Kering, F – Pulau Pintu Gedong, G – Pulau Indah, H – Pulau Carey [36].

mangrove loss since the 1990s [35]. To understand the impacts of mangrove ecosystems on human well-being, these two inhabited islands were chosen as case study sites, along with neighbouring Pulau Carey [H]. Pulau Carey demonstrates similar characteristics to Pulau Indah, insofar as it is inhabited with only fringing mangroves remaining.

Pulau Carey (H) is the largest in area among the three case study islands, covering approximately 161.87 km^2 [37] with primarily palm oil plantations left only small pockets of mangroves remaining (1514 ha) [35]. Apart from a small Malay community, the island is majorly populated by the Mah Meri people in villages. The Mah Meri is one of the tribes of Indigenous people in Malaysia whose lifestyle was traditionally linked to mangroves. They are traditional fishers who depend on fish from coastal areas, trapping crabs, and gathering bivalves. Today, like the Malays, many of the Mah Meri have joined the mainstream labour force working in oil palm plantations and private or government sectors in the mainland although fisheries remain as an important economic sector among the communities. The land conversion to palm oil plantation has left little room for natural resource cultivation among the local people [38].I.

Pulau Ketam (A) is the outermost of the Klang islands with a total area of 22.92 km^2. It is home to two settlements, Pulau Ketam and Sungai Lima, inhabited by a majority of Chinese ethnic groups and Mah Meri to a lesser extent. Only the Chinese community was a focus of the study in Pulau Ketam. The communities are dependent on both fisheries and tourism. Young people often migrate out of the island for better employment opportunities on the mainland, leaving the older population behind. Unlike Pulau Carey, Pulau Ketam is still mainly covered by mangroves (2248 ha). In fact, mangrove coverage has increased by 8.3% between 1988 and 2018, equivalent to approximately 172 ha [35].

Pulau Indah (G), the third study site, is the most developed island among all. The Selangor state appointed a government-linked company to improve the economic status of the island. Since then, the island has witnessed extensive residential and mixed-use development, which brought better infrastructure and accessibility to the island, including a highway bridge which now serves as the major access linking the island with the mainland. This transformation took place at the expense of mangrove existence where a total of 2216 ha of mangroves were removed since 1988. To date, only 934 ha remain [35]. Pulau Indah is inhabited by a majority of Malays with a small community of Mah Meri who are traditionally fisheries-dependent. Today, most of them find employment in the industrial sector, for example, at the international cargo shipping port (Westports Malaysia) or in light industry factories.

3.2. Methods

3.2.1. Study design, respondents, and data collection

Drawing upon the proposed conceptual framework, semi-structured interviews were conducted to explore the interactions between community members from the three islands with their mangrove environment. A set interview questionnaire containing 11 questions was developed to capture different aspects of ecosystem services as well as both objective and subjective dimensions of well-being. The questionnaire was divided into five sections covering (i) respondent background information and mangrove visitation; benefits of mangroves to (ii) objective and (iii) subjective well-being; (iv) the importance of mangroves to living well, and (v) respondent dependency on mangroves.

Both fishers and non-fishers were interviewed with prior consent given as per protocol approved by the University Malaya Research Ethics Committee (UMREC) and the University of Plymouth Research Ethics and Integrity Committee. Non-probability purposive sampling was used to identify the fisher respondents with the assistance of key informants, i.e., village heads and local government officers. Non-fisher respondents were identified through convenience sampling. The respondents were approached on the streets and at their houses for an interview during the day.

The interviews were conducted in Malay and Mandarin of which Mandarin interviews were conducted and assisted by an interpreter. The lengths of interviews varied between 15 min to more than one hour and were completed between May 2018 and May 2019. To facilitate communication, unfamiliar terms like ‘well-being’ and ‘ecosystem services’ were substituted for layperson terms such as ‘live well’ and ‘benefits/uses of mangroves’.

3.3. Data codification and analysis

A total of 23 interviews were transcribed and translated into English, supporting comprehension and analysis within an international team. A content analysis was conducted on the English transcripts using NVIVO 12 Qualitative Data Analysis Software. The transcripts were coded into themes based on a coding frame derived from the conceptual framework. The frequencies of the coded themes were recorded by number of people and number of references (derived from a reference in the interview texts that was coded to the predetermined themes, i.e., the subcomponents of the conceptual framework). Data were queried to reveal the factors influencing the relationship between ecosystem services and human well-being.

4. Results

The background profile of respondents in relation to locality, gender, age, occupation, education, ethnicity, and frequency of visits to mangrove areas is shown in Table 2. Most of the respondents are the older generation (40 years and above) of the communities, both male and female. Approximately half of the sample size are fishers. In terms of education, approximately a third had received some level of secondary education, while a quarter received only primary education. About forty percent, however, did not provide details of their education. The reason is due to the low rate of responsiveness, challenging time for the interview and others preferred to pass the question. In terms of ethnicity, nearly half of those interviewed were of Chinese ethnicity, followed by Orang Asli (30%) and Malay (22%). The majority (61%) of respondents no longer visited mangroves but all can see mangroves during their daily activities.

4.1. Mangroves ecosystem services in Klang Islands

Based on the interviews, all three categories of ecosystem services, i.e., provisioning, regulating, and cultural ecosystem services were recognised by the respondents. Of this, provisioning services received the

Table 2
The background profile of the respondents.

Background factor	Proportion (%)
LOCATION/ISLAND	47.8
Pulau Ketam	
Pulau Carey	34.8
Pulau Indah	17.4
GENDER	
Male	78.3
Female	21.7
AGE GROUP	
Not answered	21.7
18–19	21.7
20–29	4.3
30–39	8.7
40–49	21.7
50–59	26.1
60–69	4.3
70–79	8.7
OCCUPATION	
Fisher	47.8
Non-fisher	34.8
Ex-fisher	17.4
EDUCATION	
Not answered	39.1
Primary level	26.1
Secondary level	34.8
Tertiary level	0
FREQUENCY OF GOING TO MANGROVE	
Not answered	13
Often	17.4
Occasionally	21.7
Never	8.7
Not Anymore	39.1
ETHNICITY	
Malay	21.7
Chinese	47.8
Orang Asli	30.4

highest number of references: 115 comments by 22 respondents. Meanwhile, cultural services are referenced 53 times by 18 respondents, with 19 respondents commenting on regulating services 43 times.

Mangroves were recognised for providing food sources such as crab, prawn, snail, fish, mangrove apple, mangrove flower, and honey for the communities. Respondents also reported benefiting from mangroves for medicine, ornaments, and raw materials. In terms of regulating services, mangroves were appreciated for their role in erosion prevention, biological control, air quality regulation, moderation of extreme events such as natural disasters, and climate regulation. Cultural connections were also evident among respondents. Mangroves were used as places to play and exercise (although this was limited), inspiration for arts and crafts using materials from mangroves, and as a location to look after. Respondents valued mangroves as a meaningful environmental space that connected them with nature (Table 3).

4.2. Contribution of ecosystem services to well-being

By applying the adapted conceptual framework to the interview data, different types of contribution that ecosystem services have on various components of human well-being can be identified. Both provisioning services and cultural services are found to have contributed to basic human needs, economic needs, and subjective well-being. In contrast, regulating services influence basic human needs, environmental needs, and subjective well-being (Table 4).

The main contribution of provisioning services considered by respondents is basic human needs where 21 respondents mentioned harvesting food, fish, and shellfish from mangroves. One respondent also regarded mangroves as edible vegetation, including mangrove apples, mangrove flowers, and honey. Eighteen respondents revealed that some of these mangrove products are also a source of income. Barnacles are sold at 3.54 USD per kilogram, while snails are 2.36–2.84 USD per kilogram. The respondents considered these prices are higher as compared to the 1980s. Five respondents believed that mangrove products such as nipa fruit, mangrove lime, and *jemuju* fruit improve physical health. Mah Meri shaman uses mangrove lime to perform their healing ritual, while nipa and *jemuju* fruits are claimed to cure ailments such as coughs and hernias, and diseases like cancer.

Raw materials from the mangroves are also reported to have a role in cultural functions. Resources like mangrove trees and nipa leaf are important for arts and cultural practices in the Mah Meri communities. Mangrove wood is used by the Mah Meri for sculpture, making face masks and building *Rumah Moyang* (The House of Ancestors); nipa leaves are used for leaf origami and to make cultural wear (e.g., head gear and sash). These cultural elements are important, especially during their annual celebration of *Hari Moyang* (The Ancestors' Day). The local arts and crafts are a source of income for the communities. According to one respondent, wood sculptures, for example, can be sold from USD 72–723, depending upon the intricacy and aesthetics of the sculpture. The Malay community also uses mangrove wood to make sheaths for *keris* blades, a local artistic dagger. Sheath-making requires skill and expertise, according to one respondent, who offers the service at USD 19–24 per piece.

Table 3
Identified ecosystem services from the interviews.

Categories of Ecosystem Services	Subcategories	Description
Provisioning services	Food	Sources of protein such as crab, prawn, snail, barnacles, fish
		Edible vegetations such as mangrove apple, mangrove flower, and honey
	Medicinal resources	*Jemuju* fruit (*Acanthus sp.*)
		Nipa fruit (*Nypa frutican*)
		Mangrove lime
	Ornamental resources	Mangrove wood
	Raw materials	Mangrove wood
		Nipa leaf
Regulating services	Erosion prevention	Mangrove prevents from erosion to occur
	Biological control	Loss of mangrove makes the wild lose their habitat and being pushed to live in the human environment
	Air quality regulation	Mangrove contributes to a better quality of air
	Moderation of extreme events	Mangrove reduces the possibility of natural disaster to happen
	Climate regulation	Mangrove helps to regulate the temperature
Cultural services	Playing and exercising	Recreational activities such as boat sightseeing and exercise
	Creating and expressing	Leaf origami, Keris sheath, Wood sculpture
	Producing and caring	Take care of the mangroves
	Environmental space	Mangrove forest itself

Table 4
Contribution of ecosystem services to human well-being.

Ecosystem Services	Human well-being			
	Basic human needs	Economic needs	Environmental needs	Subjective well-being
Provisioning services	✓	✓		✓
Regulating services	✓		✓	✓
Cultural services	✓	✓		✓

Eighteen respondents relate regulating services with basic human needs. Ecosystem services, such as moderation of extreme events, erosion prevention, and biological control, are perceived as contributing to the security of coastal communities. Many respondents stated that mangroves help protect them from severe natural events, such as floods, strong wind, and wave currents. One respondent from Pulau Indah noted that the locals cannot depend on the seawalls as these alone cannot block the high tide and water current. The person added that the presence of mangroves near the walls supports a steadier wall position for flood prevention. Another respondent noted that the wind and waves are getting stronger closer to the land, which they attributed to a reduction of mangroves in their area.

In addition to the above, five respondents acknowledged mangroves for providing fresh air which have helped to improve their physical health. This claim also reflects the contribution of regulating services to environmental needs where mangroves provide clean air and a cooler environment (thermal comfort). Seven respondents stated that mangroves in their area act as a climate regulator, helping to reduce heat waves and cool the surrounding air. These respondents claimed that they are now experiencing higher temperatures due to a decrease in mangroves extent. The climate regulation role of mangroves was also highlighted, which led one respondent to state his affection (which is a subjective well-being component) for this habitat:

"If you know about the environment, mangroves must be very important to us. Generally, the oxygen content of our mangroves is very high, which is equivalent to the amount at the mountain. So, we can say that we love it." (Respondent, Pulau Ketam).

Although only nine respondents stated that they visit the mangroves, mangroves were still considered important locations for cultural purposes in Klang Islands. One respondent said that her exercise routine involved facing towards the mangroves as this made her feel relaxed, thus resulting in a better mental and physical health. Fishing near and boating within the mangroves with family members were other recreational activities reported by four respondents. At least two out of the four respondents did it, especially when relatives come to visit and with children. Other respondents (n = 5) describe how mangroves make them feel calm and at peace, evidencing that the environmental space (the mangroves) contributes to subjective well-being.

"It is quiet and peaceful inside there. I will feel better." (Respondent, Pulau Indah).

Mangroves are also considered to have contributed to subjective well-being through their role in the creation of identity among coastal communities. The way of life of local communities, especially the Mah Meri is strongly embedded within the coastal and mangrove environment. One Mah Meri respondent said he had tried to live in the uphill terrestrial forest area like other tribes of Orang Asli, but this was unsuccessful:

"Yes, we can live (without mangroves), but there is a but. The mangroves give us things. We, the Mah Meri, live in the coastal area, and we cannot separate ourselves from mangroves because it would be different if we lived on the hill. It is not our lifestyle. I have once travelled (to the hill to live there), my body hurts." (Respondent, Pulau Carey).

4.3. Factors that influence the relationship between ecosystem services and human well-being

In order to explore patterns in the data, responses were categorised according to respondent's demographic and geographic characteristics of ethnicity, location, age and occupation. All factors but educational level appears to have affected the perceptions of mangroves and their contributions to well-being. The details of the data patterns are described in Table 5.

Table 5
Factors that affect the contribution of ecosystem services to human well-being.

Factor	Description of data pattern
Ethnicity	Mah Meri respondents stated the use of non-fisheries food from mangrove.
Location	Respondents in Pulau Ketam mentioned about fresh air provided by mangroves.
Occupation	Fisher respondents reported on the mangrove role to protect them from strong winds and strong waves.
Age	Older respondents who aged 40 years old and above described about sense of place in relation to mangroves.

5. Discussions

5.1. Influential factors that determine the relationship between ecosystem services and human well-being

Among all the ethnic groups, Mah Meri respondents were more likely to mention services that were not raised by Malay and Chinese respondents, which includes the use of non-fishery foods and medicinal resources, similar to a study in Kenya [39] which revealed this factor. Each community identified a specific set of ecosystem services associated with the values in their unique customs. Instead of specific customs or behavioural values [38,40], the lifestyles of Mah Meri community in Klang Islands are fundamentally attached to mangroves compared to the Malays and Chinese, as Mah Meri literally means the people of the forest and they have been a tribe of fishers and coastal people since the time of their ancestors [38,41].

The location (i.e., islands) also influences the types of ecosystem services and their contribution to the well-being of the coastal communities. Only respondents in Pulau Ketam acknowledged fresh air as one of the mangrove contributions towards their health and well-being. This fresh environment may be due to the location of their island, which is situated further from the mainland as compared to Pulau Indah and Pulau Carey. Thus, the fresh air they consume and assume is coming from the mangroves might actually be the fresh breeze from the sea. Another study [39] also disclosed this finding where the location of the communities determines access to the services for the communities.

This study also observed that employment is a factor that influenced the communities in identifying the mangroves' role, i.e., protecting them from strong winds and strong waves which were mentioned by the fisher respondents. The non-fisher community, including vegetable sellers, farmers, housewives, electricians, teachers, and the village heads, did not mention this. Similarly, a study on Vietnamese mangroves revealed that fishers tend to better appreciate and value the mangrove ecosystem [42]. It is most probably the same reason for this study in which fishers observed these services due to the nature of their work, spending most of their time at sea and constantly experiencing the waves and the wind/breeze. The fishers take their routes from the coastal area, i.e., mangroves, towards the open sea. Artisanal fishers are more dependent on mangroves to moderate the risk in the sea than the trawlers since they use smaller boats [43].

Age is also a factor where only respondents aged 40 years and above pointed out about the sense of place connected to mangroves. It reminds them of their happy moments playing in the mangrove with their friends. This connectedness to nature is, however, not recognised by the younger generation, who are prone to screen and home entertainments. Many studies showed that connectedness to nature improves subjective well-being, emotional and cognitive regulations for both adults and kids [44–46]. This phenomenon was revealed in the case of Singaporeans who valued mangroves differently according to eras [32]. The cultural services that were observed during the 1980s tend to be intrapersonal, such as the sense of place and cultural heritage. However, in 2014, Singaporeans see mangroves within the scope of education and recreation, i.e., interpersonal values. The study indicates that the feeling of a sense of place may fade and eventually disappear over time as people

have lesser connections and experiences with mangroves. Another possible reason is the rise of physical economic development, which replaces the role of mangrove in people's life. Similarly, various economic development activities that took place in Klang Islands have transformed the natural landscape into the built environment, and mangrove coverage has reduced significantly in the process. Taking a retrospective review, the older generations in Klang Islands were in their teenage and youth phase when the port development started in the 1990s [47]. This also, to an extent, explains the lack of connectedness with mangroves as reflected by the younger generation since they grew up and were exposed to the relatively developed version of the Klang Islands.

These findings indicated the importance of taking demographic and geographical factors into consideration in decision making concerning mangroves management as well as economic development in Klang Islands. It is crucial to understand the socioeconomic and cultural preferences of the coastal communities for a more inclusive planning of which the conventional approach of 'one-size-fits-all' [39] may not be relevant.

5.2. *Effects of reduction of mangroves towards these ecosystem services' contributions to well-being*

Mangroves in the Klang Islands have gone through a high rate of decline in terms of its coverage and quality due to urbanisation and change of land use [47]. The reduction in mangrove coverage is remarkable in Pulau Indah and Pulau Carey because Pulau Ketam has been gazetted as Permanent Forest Reserve since 2009 [35]. The reduction of mangrove coverage in these islands has resulted in several significant impacts to the contribution of ecosystem services towards the coastal communities.

Many respondents expressed their concerns about reductions in fish and shellfish stocks both in the mangroves and surrounding sea areas. One respondent reported the negative impact on him where he is forced to buy food from the market instead of collecting it from the nearest mangrove. This also resulted in the increased market price for fish and shellfish. The Department of Fisheries Malaysia stated that even the price for low commercial value fish has already escalated because of excessive demand and decrease of high commercial value fish stocks at the same time [48]. Another respondent stated that he can no longer consume snails as the price is too high for him and at the same time, he cannot collect snails at the nearby mangrove due to a sharp decline in snails collected in recent years. This issue has also affected the individual income and employment within the fishing industry. One respondent admitted that he has quit his job as a fisher and become an electrician due to lack of fisheries harvest.

The National Agro-Food Policy (2011–2020) highlighted the importance of food security and sustainable utilisation of natural resources in ensuring the income maximisation[49]. It is necessary for the Department of Fisheries to adopt a holistic approach to address this issue rather than merely focusing on the formulation and enforcement of laws and regulations [48]. The department could apply an ecosystem approach to fisheries management by incorporating mangroves for mangroves being the nursery grounds for many important and subsistence species. The trade-offs between socioeconomic needs and ecological needs of the fisheries and mangroves must be adequately considered. Meanwhile, the department could also initiate mangrove replanting to protect the habitat of fisheries which would lead to directly secure fisheries resources as mentioned in the FAO Code of Conduct for Responsible Fisheries (CCRF) [50].

Securing *Nyireh (Xylocarpus sp.)* wood stocks has also become a challenge for one sculptor respondent in Pulau Carey due to reduced mangroves. The respondent stated that the sculptors need to source the wood from nearby islands since they can no longer find the specific wood in their immediate vicinity. The wood shortage has affected his income as the cost of sourcing raw materials has increased. More importantly, this issue has threatened the culture of the Mah Meri people who culturally depend on mangroves [51]. Mangroves are a part of Mah Meri's identity [40], as mentioned by a Mah Meri respondent. Since *Nyireh* wood is consistently in demand and harvested, the government agencies such as the Department of Orang Asli Development (JAKOA) and Department of Forestry could assist by conducting knowledge exchange sessions with the local communities to ensure the sustainability of mangroves for the benefits of both culture and income [40]. Continuous support and guidance from these agencies to the Mah Meri people is the key to success of *Nyireh* trees replanting initiatives as the trees usually take more than 10 years to mature [52]. In fact, The National Policy on Biological Diversity has clearly stated the necessity to develop policy and legal instruments to empower indigenous people and local communities as the custodians of biodiversity and among the suggestions include the setting up a community-based group to manage and facilitate the conservation plan of natural resources.

As mangroves decreased, respondents started to notice the negative impacts at the coast, notably erosion issues. This is not only a huge concern to the coastal communities, but also to the Sime Darby Plantation that manages oil palm plantations in Pulau Carey [37]. The state of erosion in Klang Islands has become critical and the continuous extensive shipping activities exacerbate the situation [35]. The conventional approach to curbing this problem is to build bunds- wall-like concrete structures along the coast, which were built in the 1970 s to protect the Sime Darby plantation from the erosion. However, this approach is extremely costly and it damages the coastal environment [37]. Instead, a natural based solution approach which has received rising recognition should be introduced to address this issue since mangroves have been well-known as a long term solution to coastal erosion [53]. A long-term commitment and cooperation of all key stakeholders ranging from the local government, coastal communities, to businesses such as port and plantation is required to ensure that the replanting and growing of mangroves is prioritised and monitored.

This study has also identified the importance of mangroves for the subjective well-being of coastal communities, a finding which is also shared by studies in Niger Delta Region and North-eastern Brazil [54,55]. Green spaces or natural spaces, which are very important for human physical and mental health and well-being [45,56] have been little discussed in the context of Southeast Asia including Malaysia. Only one study was found, with Kuala Lumpur being the case study [57] that focused on the influence of green spaces on park users to cope with stress relief and mindfulness besides improvement in physical health and well-being. Certainly, in the context of this study, mangroves need to be made accessible for the coastal communities and public. The importance of mangroves needs to be communicated to the public to strengthen the existing engagement and connectedness between people and mangroves, which will subsequently lead to increased sense of appreciation towards mangroves. Educational awareness activities are equally crucial to facilitate the interaction through highlighting the urgency of mangrove conservation efforts.

5.3. *Way forward*

Collaborative effort between government agencies (especially the state and local government where the decision-making for land use planning is held), communities and businesses should be strengthened to ensure the sustainability and conservation of mangroves in the Klang Islands [35]. Mangrove-relevant national policies including the recently revised National Forestry Policy, the National Policy on Biological Diversity and FAO CCRC must be considered by the state and local governments in its decision-making process where conservation plays a vital role to ensure long term sustainable development of the Klang Islands and its vicinity. The implementation of any development activity must include enhanced mangrove protection, with improved mangrove management. Certainly, the state of mangroves in the Klang Islands will worsen if there is no action taken to protect the remaining mangroves,

especially those which are not designated as Permanent Forest Reserves (i.e., Pulau Indah and Pulau Carey).

This joint work on conserving mangrove for economic and human development is urgently required for it contributing to the United Nation Sustainable Development Goals (SDGs). Sufficient and sustainable supplies of mangrove wood and fisheries would certainly respond positively to Goal 2 (Zero hunger), Goal 8 (Decent work and economic growth) and Goal 12 (Responsible consumption and production). The contribution of mangrove on the community's identity and subjective well-being are clearly outlined in Goal 3 (Good health and well-being) while the role of mangrove in providing natural based solutions is aligned with Goal 9 (Innovation and infrastructure) where sustainable, resource-use efficiency and environmentally sound industries are the highlights. Lastly, applying systemic thinking and solving by bringing multiple stakeholders to work together on mangrove conservation and sustainability supports Goal 17 (Partnerships for the Goals).

There is also a need to fully understand the diverse meanings of each of the ecosystem services as one ecosystem service may provide multiple services which are difficult to be categorised in a single category of ecosystem services. Wood and nipa leaf are good examples as both are instantly categorised under provisioning service since they are raw materials for various functions, including building house and furniture. However, these raw materials are also used for cultural purposes e.g., leaf origami, wood sculpture and *keris* sheath thus making them also technically correct to be classified as cultural services. Hence, one must understand the purpose of a service and then it will be easier in assessing the types of services.

6. Conclusions

At national level, this study supports the National Policy on Biological Diversity 2016–2025 that targets to mainstream the biodiversity conservation agenda into national development planning and sectoral policies and plans (Target 3, Action 3.1) and to include participation of indigenous and local communities in biodiversity protection (Target 15, Action 15.4).

At the local level, drawing on the perceptions of communities living on the Klang Islands, Malaysia, this study revealed the mangrove ecosystem services, i.e., provisioning, regulating, and cultural services, and how these services contribute to the communities' well-being. While provisioning and cultural services contribute to basic human needs, economic needs, and subjective well-being, regulating services help provide basic human needs, environmental needs, and subjective well-being. This study outcome clearly indicates that the intangible cultural ecosystem services have to be included in the decision-making process. Further study to identify methods of assessing and valuing cultural services at both local and state levels need to be carried out. Excluding cultural ecosystem services in the decision-making process would result in inadvertently capturing potential opportunities to enhance wellbeing and socioeconomic benefits to the communities [58]. Dissatisfaction and tensions among the stakeholders may arise especially among the community members who have established strong connections with the mangrove ecosystem [55,59]. Other suggested studies include trade-offs between ecosystem services and various stakeholders of mangroves in Klang Islands as well as the mechanisms for ecosystem services contributing to the well-being of communities as an attempt to empower or improve the flow of benefits of ecosystem services towards communities. It is also useful to explore the different priorities among the stakeholders and multiple interests of each stakeholder and how decisions are made according to these priorities or interests.

CRediT authorship contribution statement

Nur Fatin Nabilah Ruslan: Conceptualisation, Methodology, Investigation, Data curation, Analysis, Writing – original draft, editing, final draft. **Hong Ching Goh:** Supervision, Writing – review & editing. **Caroline Hattam:** Supervision, Writing – review & editing. **Andrew Edwards-Jones:** Software, Writing – review & editing. **Heng Hing Moh:** Supervision.

Conflict of Interest

The authors declare no conflict of interest. The funders had no role in the design of the study, in the collection, analyses, or interpretation of data, in the writing of the manuscript, or in the decision to publish the results.

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