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**PRESERVING MALAYSIAN INDIGENOUS AND LOCAL  
COMMUNITIES' ASTRONOMICAL KNOWLEDGE  
THROUGH ASTROTURISM TO MAINTAIN ITS  
CULTURAL SECURITY**

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**Abstract:**

The Malays in northern Peninsular Malaysia, the *Orang Asli*, Dayak-Iban and Kadazan-Dusun in East Malaysia possess their own astronomical knowledge to predict suitable seasons for paddy planting and navigation. This knowledge may soon be extinct because the indigenous and local communities almost no longer practise their astronomical knowledge because modern machinery permits paddy planting twice per year and also on account of restrictions by Islam and Christianity. Astrotourism could revive such practice by promoting cultural astronomy. This study's main objective is to investigate the extent that astrotourism can play a part in preserving the astronomical knowledge of Malaysia's indigenous and local communities that contributes to their cultural security. This is a qualitative study that refers to documents of the United Nations Educational, Scientific and Cultural Organisation (UNESCO), the United Nations World Tourism Organisation (UNWTO), the 1977 Bangui Agreement on the Creation of an African Intellectual Property Organisation, Malaysia's National Heritage Act 2005 and the Cook Islands Traditional Knowledge Act 2013. Secondary resources were also consulted for an overview of the astronomical knowledge possessed by the mentioned Malaysian indigenous and local communities. Textual and content analysis were used to analyse primary and secondary resources where appropriate as this is socio-legal research. The results of this study show that promoting astrotourism together with the astronomical knowledge of these indigenous and local communities is still in its infancy and very few tour packages promote such initiatives. The results also show Malaysia lacks a *sui generis* law specifically to protect traditional knowledge that encompasses astronomical knowledge making possible for the exploitation of this knowledge for commercialisation.

The implication is for the younger generation among these indigenous and local communities to learn the astronomical knowledge from the custodians to become tour guides to disseminate this information through astrotourism so that the legacy lives on. Malaysia also needs to draft a *sui generis* law specifically protecting traditional knowledge that covers astronomical knowledge or amend its intangible cultural heritage aspect in its National Heritage Act 2005 to include astronomical knowledge and navigation skills.

**Keywords:**

Astrotourism, Cultural Security, Astronomical Knowledge, *Orang Asli*, Dayak-Iban, Kadazan-Dusun, *piama*.

**Introduction**

The indigenous people of Sarawak known as the Dayak-Iban, as well as the Kadazan-Dusun in Sabah in East Malaysia have been known to refer to certain stars located in the night sky as a guide to pinpoint seasons for agriculture production. Likewise, the case of Malay farmers in Kedah and fisherman on the East Coast of the Peninsular Malaysia who rely on the cosmos of the night sky throughout the year not only to indicate suitable timing for agricultural production but to identify when the sea is calm or the monsoon season emerges barring them from the seas (Abdul-Hamid, 2015; Dr Singa, 2013; Jaafar & Khairuddin, 2017; “Petua generasi”, 2014). The Malays, constituting a majority in Malaysia, do not qualify as indigenous people of the land but their origins are scattered throughout various islands of Indonesia such as Sumatera, Java, Sulawesi and other neighbouring states throughout Southeast Asia. Culture as understood in this study is defined as the “distinctive spiritual, intellectual, emotional and material features that characterise a society or social group [to include] the arts and letters as well as human modes of life, value systems, creativity, knowledge systems, traditions and beliefs” (Association of Southeast Asian Nations [ASEAN], 2000). Traditional knowledge should be understood to mean the “knowledge, innovations and practice of indigenous and local communities” (United Nations Education, Scientific and Cultural Organisation [UNESCO], 2025).

UNESCO indicates that traditional knowledge has developed progressively over generations relying on a community’s experience, tested over centuries of use, adopted to local culture and use, and transmitted orally to encompass stories, songs, folklore, cultural values, beliefs, rituals, community laws, local language and agricultural practices (UNESCO, 2025). According to the Food and Agriculture Organisation of the United Nations (FAO), traditional knowledge need not be confined to tribal groups or original inhabitants of an area but relates to all communities that possess local knowledge (FAO, 2004). This study focuses on astronomical knowledge, a subset of traditional knowledge possessed by Malay farmers and fisherman, the Dayak-Ibans in Sarawak, as well as the Kadazan-Dusun in Sabah of East Malaysia. These ethnic groups were specifically chosen because there is a need to create a balance among indigenous groups equally in both Peninsular and East Malaysia since Malaysia is a multicultural society and their astronomical knowledge has the potential to help boost astrotourism. Astronomical knowledge will be understood as “the understanding and interpretation of celestial phenomena, including the movement of stars, planets and other celestial bodies” (Fiveable, 2025).

Malay farmers and fisherman in Malaysia possessing astronomical knowledge concerning stars are categorised as local communities as only some constitute the indigenous people of the land. The Convention on Biological Diversity Secretariat (CBD Secretariat, 2006, p.2) has made a distinction concerning who are indigenous people and local communities by indicating “[s]ome local communities may include peoples of indigenous descent”. This implies that local communities may cover other groupings of individuals and not necessarily be confined to indigenous people although the latter could still be categorised under this term. The CBD Secretariat (2006, p.2) had stated that “[l]ong term established rice and fish farmers in Asia may represent another type of local community”. Notably too, Article 8 (j) of the Convention on Biological Diversity (CBD, 1992) also uses the term “indigenous and local communities” showing a difference concerning which parties can fall appropriately under which groupings. For the purpose of this study, farmers and fisherman fall under the grouping of local communities.

To date, there has not been a single agreed definition of indigenous people but a reference has been made to the International Labour Organisation’s (ILO’s) Convention on Indigenous and Tribal People [thereafter C169] that elaborates the characteristics constituting indigenous people. For someone to be categorised as indigenous, they need to be descended from a population which had inhabited a geographical region before a colonial power ever conquered their land or before the colonizer ever formed the present state boundaries (United Nations High Commissioner for Refugees [UNHCR], 2025). Moreover, indigenous people must demonstrate a historical connection with pre-invasion or pre-colonial societies, such as the occupation of ancestral lands, ancestry, language or cultural beliefs or practices (UNHCR, 2025). These indigenous people also do not constitute the dominant majority in the socioeconomic and political spheres in their country (UNHCR, 2025). The right to practise customary law, protect their traditional knowledge, intellectual property and cultural heritage are also some of the features of indigenous people (UNHCR, 2025). If someone can match all the characteristics described, then they are likely to be classified as indigenous people.

In highlighting the need to preserve astronomical knowledge, of uttermost importance is the concept on cultural security. In this context, Hassan and Al-Zaabi (2025, p.26) have defined cultural security as “the protection and preservation of the dynamic, interconnected system of symbols, beliefs, values, behaviours and practices that shape a group’s identity and worldview in the face of internal challenges and external pressures”. Naupa (2023, p.2) defines the scope of cultural security to encompass “tangible and intangible cultural heritage [...] traditional knowledge, social protection and cultural resilience and adaptations.” Naupa (2023, p.4) also asserts that cultural security is vital because it “frames the range of threats facing our cultural systems and guides policy responses”. In defining the parameters of intangible cultural heritage, Hassan and Al-Zaabi (2025, p.26) have indicated that these refer to “the practices, representations, expressions, knowledge skills – as well as instruments, objects, artefacts and cultural spaces associated therewith- that communities, groups and, in some cases, individuals recognise as part of their cultural heritage”. This indicates that cultural security must be prioritised, especially when it comes to the astronomical knowledge possessed by farmers, fisherman and indigenous people that may be under threat because light pollution obliterates the sighting of stars, and also because of modernisation and the adoption of new technology allowing old practices decay but which should be rejuvenated for future generations.

The preservation of valuable astronomical knowledge possessed by farmers, fishermen, and indigenous people can be spurred through the adoption of cultural tourism. The United Nations Tourism General Assembly (2025) has defined cultural tourism to mean “a type of tourism activity in which the visitor’s essential motivation is to learn, discover, experience and consume the tangible and intangible cultural attractions/ products in a tourism destination”. Guided tours through museums showcasing the farmers or fisherman’s astronomical knowledge through display boards, videos or other forms of audiovisuals could educate the public and spur their interest to find out more about this valuable knowledge that may be on the brink of extinction. However, the better option is to involve tourist in a hands-on activity at an astronomical site of interest such as a dark sky area retreat in a remote place where a demonstrator can show how, on certain times of the night, it is possible to locate relevant stars indicating suitable seasons for agriculture. The idea is to spur the younger generation’s interest and make them learn about this astronomical knowledge to preserve it so that it is imparted to future generations. The World Committee on Tourism Ethics had indicated that tourism can offer a “powerful incentive for preserving and enhancing intangible cultural heritage, as the revenue it generates can be channelled back into initiatives to aid its long-term survival” (World Committee on Tourism Ethics, 2019, p.1). Furthermore, the World Committee on Tourism Ethics (2019, p.2) also reiterates that “[i]f managed responsibly and sustainably, indigenous tourism spurs cultural interaction and revival, bolsters employment, alleviates poverty, curbs rural flight migration, [and] empowers local communities [...]”.

One way to maintain the continuity and preservation of indigenous people and local communities' astronomical knowledge is to merge both cultural tourism together with astrotourism. In this study, astrotourism is defined as “tourism using unpolluted night skies as a natural resource for astronomical, cultural and environmental activities” (Fayos-Solà & Marin, 2009, p. 5). According to Loredana et al. (2001, p. 268), astrotourism can overlap with educational tourism, which also encroaches into the realm of historical cultural tourism that seeks to emphasise “the importance of the history and traditions of a place and the impact on the culture and identity of the respective people [as well as] the natural landscapes and its needs”. Loredana et al. (2001, p. 267) have identified certain places of interest that tourists can visit to realise the activity of astrotourism such as educational astronomical centres, astrotourism centres, astronomical institutes and laboratories, space museums, astronomical museums, astronomical observatories, planetariums and archeo-astronomical sites. As a subset of astrotourism, terrestrial space tourism involves trips to see a meteorite, observe eclipses or even to see the stars and constellations under dark skies in very remote areas. Thus, astrotourism need not necessarily focus on the scientific explanation of stars merely, but it can also incorporate indigenous people and local communities’ stories and their knowledge of science and nature as an alternative cultural explanation behind the existence of stars and other celestial bodies, something which can be very invigorating.

In other parts of the world, certain countries have seen the viability of astrotourism to showcase and promote their indigenous people’s astronomical knowledge to maintain its continuity and preserve it from going into extinction. South Africa has been at the forefront in integrating its indigenous people’s knowledge of astronomy into responsible astrotourism as tours can be taken at Karoo and Carnarvon whereby at the latter location there are huge optical telescopes attracting researchers and tourists (Department of Science, Technology and Innovation, 2024). In Namibia, efforts are also underway to promote astrotourism with one which merges indigenous storytelling about the skies, stars and constellations, and their myths to employ local

indigenous people and uplift their income and strata (Aula & Dalglish, 2023). In Peru, the cultural tourism initiative has also blended modern science astronomy together with the Quechua's traditional astronomical knowledge at Machu Picchu (Machupicchu Gateway, 2025). In Australia, a similar initiative is being spurred by the Djaara-led Sky Country tour in partnership with the Dja Dja Wurrung Clans Aboriginal Corporation, as well as non-Aboriginal cultural astronomers to blend indigenous astronomical knowledge together with dark sky tours allowing observing stars and constellations through telescopes (Rooney & Douglas, 2025).

While these countries are planning to conduct their astrotourism initiatives which incorporate a segment of introducing indigenous people's astronomical knowledge to tourism, not much is known as to whether Malaysia has embarked on the same path. This study asserts that astrotourism which incorporates Malaysian indigenous people and local communities' astronomical knowledge can seek to preserve or revive an endangered culture to ensure its survival for future generations as a form of cultural security. Ethnic groups in Malaysia must be permitted to practise their own culture freely without being threatened by any external or internal threats or this will endanger their cultural security. Thus, indigenous and local communities' preservation of astronomical knowledge as asserted in this study hinges on the promotion of astrotourism to disseminate this knowledge which, in turn, maintains the cultural security of these ethnic groups as depicted in Figure 1 below.



**Figure 1 :Preservation of Indigenous and Local Communities Astronomical Knowledge in Malaysia Hinges on Astrotourism Promotion to Ensure Cultural Security**

Against this background, the main objective of this study is to investigate the extent that astrotourism can play a role in preserving the astronomical knowledge of Malaysian indigenous and local communities from extinction so as to realise their cultural security. Further elaboration on this study will be organised according to a literature review, methodology and a section focusing on the United Nations World Tourism Organisation (UNWTO) and UNESCO initiatives which promote tourism as a means to maintain cultural heritage. This will be followed by an elaboration about Malaysia's indigenous people and local communities' astronomical knowledge practices both in East and West Malaysia, as well as intellectual property rights (IPR) issues that arise from the promotion of indigenous and local communities' astronomical knowledge, and an examination of tours promoted by Tourism Malaysia and other entities to detect if indigenous astronomical practices form an integral part of astrotourism.

### **Literature Review**

Astrotourism is not solely a scientific endeavour but an activity that can overlap with other tourism niches such as heritage tourism (Loredana et al., 2001). Astrotourism can assist in preserving indigenous and local communities' astronomical knowledge from extinction through the dissemination of information to a widespread audience, making this a sustainable activity (Páskova et al., 2021). This is provided that any astrotourism package being offered to tourists incorporates a programme which introduces indigenous and local communities'



astronomical knowledge as a component of cultural astronomy to impart knowledge to various segments of society and to spark their interest so that this valuable information can be saved for future generations.

Astrotourism can be beneficial to indigenous people and local communities provided they are directly involved in giving their inputs and managing most of the activities themselves which is known as communal based tourism (CBT) (Nisa, 2024, p.8). Nisa (2024, p.15) and Seal et al. (2024) have highlighted that tourism can bring job opportunities to the locals who are directly involved in its management, such as storytellers who disseminate folklore and ancillary workers in the sectors of transport, hospitality, leisure and local businesses. This in turn can increase the indigenous people and local communities' income, living standards, and spur small and medium enterprise starters as well as reducing poverty (Nisa, 2024, p.15; Seal et al., 2024, p.125). Besides these, Nisa (2024, p.23) highlights that CBT encourages intercultural exchange between the tourists, indigenous people and local communities because they will be exposed to local culture and customs as this is being publicised. At the same time, Nisa (2024) has stressed that CBT can lead to incubation business programmes for local entrepreneurs and equip them with basic business skills.

In Gorontalo, for instance, storytellers in this area portray their folklore as imaginative tales to tourists weaving in god and goddesses, historical heroes and great warriors (Seal et al., 2024). This is very relevant in promoting indigenous and local communities' astronomical knowledge as a lot of their understanding of the stars and constellations in the night sky is interwoven with stories, legends and myths that incorporate gods and goddesses, heroes and warriors. Although this may be dismissed as unscientific, this provides an alternative cultural explanation as the elaboration on stars and other celestial bodies within indigenous and local communities can contribute to cultural studies. Most importantly, Seal et al. (2024, p.125) view storytelling or folklore dissemination as good content creation for movies that can showcase and sustain a cultural heritage of a region and contribute towards cultural preservation in digital form. Nakata et al. (2015, p.105) have highlighted that a collection of indigenous astronomical knowledge can be preserved by forming a database which keeps photographs, documents, videos and webpages of their related activities. Indeed, not only is indigenous and local communities' storytelling crucial to disseminate their astronomical knowledge, but creating documentary films, music and presenting it to tourists in an auditorium, publishing story books and pamphlets and selling them to tourists can be regarded as a transmission of knowledge and also promotes preservation efforts. This is crucial to the discussion of this study as any astrotourism activity which promotes Malaysian indigenous and local communities' astronomical knowledge will be more effective if their storytelling or folklore can be supplemented by animated films, the creation of websites, playing music, and the sales of stories or coffee table books. While this may be an attractive suggestion, Seal et al. (2024, p.128) have cautioned, however, that this may be marred by financial difficulties on the part of indigenous and local communities needing a financial boost from government agencies to realise this endeavour. In turn, any royalty generated through films, music, the sale of story or coffee table books should be channelled directly to the indigenous and local communities to be used for any future projects or their villager's wellbeing. Seal et al. (2024, p.128) also recommend that the showcasing of storytelling or folklore can be best promoted during cultural fairs or religious festivals. This may be relevant to the Dayak-Ibans in Sarawak as well as the Kadazan-Dusun in Sabah located at Borneo Island of East Malaysia who can showcase their storytelling of stars and celestial bodies during the Gawai and Kaamatan festival.

While astrotourism may benefit indigenous and local communities, there are also some drawbacks. Nisa (2024, p.14) has cautioned that tourism activities can cause any cultural practices to be too commercialised leading to losing its original identity to suit the tourists' tastes, becoming modified and no longer remaining authentic. This may lead to cultural degradation. The same applies to traditional knowledge to encompass astronomical knowledge that may be misused. In China, for instance, the Rmi people of Qiang national have adopted their local ritual of offering to the mountain deity to be more attractive to the tourists' tastes in the form of a *zhuan shan hui* (Yang & Zeng, 2025). However, this modified *zhuan shan hui* is claimed by other tribal groups to be no longer authentic, and they feel threatened. The original cultural practice of placing offerings to the mountain deity is called *Hsugdu* (Yang & Zeng, 2025). Thus, other tribal groups feel that the practice of *zhuan shan hui* threatens their cultural identity and the ownership of their own culture, which may have a negative impact on their cultural security. Therefore, Nisa (2024) has the right to be concerned that cultural practices can be eroded in the course of promoting tourism, as the case of the Rmi people in China has shown. On the other hand, if tourism activities are carefully managed as in the case of promoting glutinous rice growth with cultural activities at Ban Phu in Mukdahan Province, the Khao Mao Wan Community Enterprise, Ban Phon in Nakhon Phanom, and the Noi Chomsi Enterprise in Sakon Nakhon in Thailand, it can help to maintain the cultural security of the said community (Sattaka, 2019).

As a solution to prevent cultural practices from being modified from their original form, Nisa (2024) has suggested the utilisation of heritage protection laws. Nevertheless, this study is of the view that heritage laws have their limitations as they are more useful for the preservation, conservation, documenting and keeping records of a cultural practice. Heritage laws have setbacks, namely they cannot provide adequate punishment to wrongdoers who seek to reproduce indigenous and local communities' astronomical knowledge recordings in bulk, for instance, in the form of films or figures on calendars, t-shirts or pencil boxes. This is clearly exploitation of indigenous and local communities' astronomical knowledge as there is no attribution to the original holders nor remuneration or royalty given to them. An examination of Malaysia's Section 2 (1) of its National Heritage Act 2005 shows it covers expressions, notes, audible lyrics, songs and oral tradition as some form of intangible cultural heritage (Zaky & Azmi, 2017, p. 62). Indigenous and local communities' word of mouth transmission of astronomical knowledge from one generation to another might qualify as oral tradition that is not defined under the National Heritage Act 2005. If indigenous people relate stars and other celestial bodies as a form of storytelling that incorporates characters such as gods, goddesses, heroes and warriors as a form of legend this would qualify as traditional cultural expressions (TCE) but the said law just refers to it as expressions. Even indigenous songs and lyrics that incorporate their own names for stars and celestial bodies also fall under TCE. However, the term "expression" is not defined in this law nor in any guideline, making it vague for application.

This study's criticism of Malaysia's National Heritage Act 2005 is that it fails to incorporate the term knowledge of science and skills of indigenous and local communities, which renders astronomical knowledge as having no form of protection under this law. Neither does Section 2 (1) of Malaysia's National Heritage Act 2005 address the "navigation skills and techniques" nor "metallurgical skills" of indigenous and local communities because the Malay fishermen's decision to go to sea and direction for navigation depends on the stars, with such valuable astronomical knowledge becoming extinct. Even the Malays, Dayak-Ibans, *Orang Asli*, and

Kadazan-Dusun's reliance on the stars as their astronomical knowledge to determine suitable planting times and seasons to harvest paddy or when the fruiting season will occur can find no protection under Malaysia's National Heritage Act 2005 because of the short-sightedness of its drafters in omitting this valuable aspect of traditional knowledge. Therefore, this study's task is to identify any role model country that has a better foresight and a unique *sui generis* law of their own that can protect the traditional knowledge of their indigenous and local communities to include that of astronomical knowledge. This is because the traditional knowledge of indigenous and local communities normally cannot find adequate protection under IPR laws because the knowledge is communally owned with no time limit, thereby needing its own unique law, called a *sui generis* system.

At the international level, international organisations such as UNESCO and the UNWTO have supported sustainable astrotourism (Escario-Sierra et al., 2022). Not only have these organisations advocated to protect the night sky from light pollution, which can prevent indigenous and local communities from detecting the stars to practise their astronomical knowledge but they also provide valuable guidance and declaration documents that help to promote and manage astrotourism sustainably for all related parties, which will be elaborated in another section in this study.

In the African region, South Africa has been at the forefront in promoting astrotourism that not only explains the science of stars and celestial bodies but blends indigenous astronomical knowledge together for dissemination (Viviers, 2025; Wyk-Jacobs, 2018). Wyk-Jacobs (2018) has asserted that the indigenous community in South Africa should be trained with basic astronomy and the handling of telescopes to be effective tourist guides who can offer stargazing lessons accompanied against the background of indigenous storytelling, which can generate income for them. Wyk-Jacobs (2018) highlights the need for indigenous communities to be more aware about the potential of astrotourism which can provide them job opportunities as tour guides but, to do so, they will have to undergo capacity building training. Since then, South Africa's promotion of astrotourism has surged forward as training has been provided to allow people to become qualified cultural tour guides specialising in dark sky tours that promote stargazing and the indigenous storytelling in the area of Carnarvon, and which was sponsored by the South African Radio Astronomy Observatory (SARAO). This has been integral to SARAO's Carnarvon Science Exploratorium project since the incorporation of local lore and stories about the stars and celestial bodies sets it apart from other tour operations (Viviers, 2025).

Likewise, the case of Kenya whereby its astrotourism tours not only blend modern science of stargazing but utilises the astronomical knowledge of its indigenous communities such as the Maasai, Samburu, Borana, Kalenjin and Kikuyu for dissemination of knowledge to sustain the cultural heritage (Nganga, 2025). Similarly to South Africa, Kenya provides its tour guides with professional astronomical training and how to use high grade telescopes (Nganga, 2025). If Malaysia were to embark on a similar capacity, professional training to utilise telescopes among indigenous and local communities, and courteously telling folklore must be undertaken by its government agencies and to provide certification as a trusted guide.

In Ethiopia, the Borena community have depended on oral astronomical knowledge to construct their own lunar calendar as a form of time keeping relevant for agricultural seasons and ritual practices (Goshu & Ridwan, 2024). However, modernisation and the lack of



documentation have reduced intergenerational transmission of astronomical knowledge from the older to younger generation, threatening to make this useful knowledge to obsolescent (Goshu & Ridwan, 2024). Some suggested ways to preserve the precious astronomical knowledge include incorporating astronomical knowledge of the indigenous community in Ethiopia into the education curriculum as well as promoting this knowledge to outsiders through cultural tourism and astrotourism (Goshu & Ridwan, 2024).

Elsewhere in Almaguin and Jasper in Canada, astrotourism promotion is not only concentrated on science and stargazing but also blends indigenous storytelling of the stars and constellations to impart valuable knowledge to tourists (Banack & Hvenegaard, 2025; Travel and Tour World [TTW], 2025).

In the Andean, potato planting time has been guided by the heliacal rising of the *Pleiades* stars while the constellation of the Milky Way indicates seasonal weather patterns that can help to predict drought, excessive rainfall or early frost conditions that affects agriculture (Machupicchu Gateway, 2025). Today, the Quechua communities in the Sacred Valley still practise their astronomical knowledge for agricultural timing and ceremonial scheduling by depending on the "altomisayuq", traditional sky watcher knowledgeable about stellar positions, seasonal changes and weather predictions passed down orally from one generation to another which was central to the Machu Picchu sites (Machupicchu Gateway, 2025). As a means of preserving this traditional knowledge, the Peru education programmes have blended indigenous astronomical knowledge alongside modern science education while cultural tourism has also included indigenous cultural astronomy in appreciating the Inca civilization and to support the Quechua communities (Machupicchu Gateway, 2025).

At the Murchison region, East Kimberly and the South West of Western Australia, efforts to disseminate indigenous astronomical knowledge have resulted with community short courses, occasional public presentations by knowledgeable elders, and other public events being organised to spread this knowledge (Goldsmith, 2014, p.255). This has been considered as a form of informed education beyond the Australian curriculum and has evolved into eco-cultural tourism ventures (Goldsmith, 2014).

In Nicaragua, cultural tourism seeks to organise community gatherings involving the elders who possess oral astronomical knowledge and are willing to share information about the stars in connection to the building of astrolabes to the interested younger generation (Mexicohistorico.com, 2015). In the past, the astrolabe had assisted with navigation and other initiatives of cultural tourism have included organising cultural festivals to promote the astrolabe, interactive sessions whereby students can build the astrolabe, museums and cultural centres showcasing the astrolabes, and the organising of guided tours to historical sites where astrolabes were used with narrating storytelling by indigenous navigators (Mexicohistorico.com, 2015). Other efforts to impart the knowledge on stars and the astrolabe include incorporating astronomy, the navigation and historical significance of astrolabes in the curriculum development in Nicaragua (Mexicohistorico.com, 2015).

In another example to preserve Micronesian astronomical knowledge for navigation, Goodenough and Thomas (1987) have emphasised the usage of the boathouse as a place for young navigators to learn from their elders the name of stars, the movement of waves and the environment at sea to prepare them as exemplary navigators proficient in the orientation and

leadership of their crew. Moreover, chants and songs are being used as a means to remember elaborate lists of astronomical knowledge among the Micronesians (Goodenough & Thomas, 1987). This is a hands-on experience that can be incorporated to promote the Malay astronomical knowledge in Malaysia concerning navigation which stands endangered in the era of modernisation and the adoption of new navigation technologies. A better way to promote this hands-on experience of Malay astronomical knowledge would be through cultural and astrotourism, which will be explored in this present study.

Discussions on astrotourism in Malaysia today have largely focused on promoting Islamic astronomy to the public by encouraging them to visit various observatories located among the different states in the country and gaining knowledge from an Islamic perspective (Ahmad et al., 2022; Muttaqin et al., 2024; Safiai et al., 2020). While it is acknowledged that Islamic astronomy is synonymous with the dominant Malays constituting a majority in the country, lesser attention has been given towards promoting the Malay's own astronomical knowledge connected with determining agricultural timing for paddy planting or the fruiting season nor the navigation skills in referring to the stars as an attractive package for astrotourism. Previously, Sahabat Langit Utara (SALUT), a club of immature astronomers largely based in Northern Peninsula Malaysia, have tried to promote dark sky gazing together with briefings and presentations about the Malay understanding of stars and its utilisation in agriculture and navigation (Abdul-Majid, 2025). However, it is unknown if such briefings and presentations come from a representative from the learned Malay group themselves who are more well-versed in explaining the astronomical phenomenon of stars meant to determine the suitable agricultural seasons than a third party who may impart inaccurate information.

Within East Malaysia itself, extensive scholarly literature focusing on indigenous people's astronomical knowledge connected with the right timing to embark on various agricultural processes, such as the clearing of land for planting dry and wet paddy and when to welcome harvesting time among the Ibans, Bidayuh, and Dayaks in Sarawak, as well as the Kadazan-Dusun in Sabah of East Malaysia, have received considerable attention (Ammarell, 2008; Gislen & Eade, 2019; Kadazan-Dusun Cultural Association, 2024; Sait et al., 2018; Tugang et al., 2022). There is a tendency for Malaysian scholars to present the names of different stars associated with the various processes of paddy planting in East Malaysia in the original Malay language (Sait et al., 2018; Tugang et al., 2022), whereas Western scholars retain the original names of the stars in English such as *Pleiades*, *Orion* and *Sirus*. The subtle differences indicate that Western terms of the stars tend to predominate brushing aside the local names of these stars.

A study by Azam et al. (2024) focused on the potential of astrotourism developing at Kampung Kapit in Sarawak among its indigenous communities, according to which (p. 1071), the guided night tours and stargazing activities have been conducted by the knowledgeable locals themselves, incorporating the indigenous astronomical knowledge with regard to constellations, planets and other celestial bodies. Nevertheless, nothing has been mentioned as to whether these locals have been professionally trained as certified guides. Indeed, there is a potential to promote the *Orang Asli's* astronomical knowledge of the stars and other celestial bodies as an attractive astrotourism activity that involves these indigenous people themselves rather than a third party. This is provided that the *Orang Asli* who themselves still practise the sighting of stars and other celestial bodies that can guide them in their agricultural practices. A hands-on briefing by the *Orang Asli* of this astronomical knowledge would certainly enlighten

the tourists, provide job opportunities for them as guides, and increase their strata and income. This is an under-explored area that could very well unleash its potential for the *Orang Asli*.

Based on the elaboration made in the literature review, there is clearly a research gap to identify if astrotourism packages offered in East and West Malaysia have truly included cultural astronomy among the indigenous and local communities as this helps to preserve their cultural heritage and disseminate valuable knowledge so that it would not die a natural death. This presents an opportunity for this study to fill this void. Moreover, there is also another void to be investigated, namely whether Malaysia's heritage and IPR laws are geared towards protecting indigenous and local communities' astronomical knowledge from being exploited by opportunists in the course of astrotourism. All of these arising issues will be dealt with in the results and discussion sections of this article.

### Methodology

This is socio-legal research qualitative study since it combines legal materials and utilises the social sciences mode of analysis such as a document, textual and content analysis.

This study refers to primary sources of documents issued by the UNWTO and UNESCO or jointly issued by both such as the soft law document called the Muscat Declaration on Tourism and Culture: Fostering Sustainable Development of 2017 [thereafter Muscat Declaration], the 2018 Istanbul Declaration on Tourism and Culture: For the Benefit of All [thereafter Istanbul Declaration], the UNWTO's Recommendations on Sustainable Development of Indigenous Tourism (2019) document and its Study on Tourism and Indigenous Cultural Heritage (UNWTO, 2012).

Among UNESCO's World Heritage Sustainable Tourism Online Toolkit series referred to by this study are Guide 4: Engaging Local Communities and Businesses (UNESCO, 2023a), Guide 7: Adding Value through Products, Experiences and Services (UNESCO, 2023b) and Pakistan's filing list to UNESCO concerning Nomination File No. 0138/ for Inscription in 2018 on the List of Intangible Cultural Heritage in the Need of Urgent Safeguarding that nominates the astronomical knowledge practices among the Kalasha community for preservation as they stand in danger of becoming extinct. This is to provide an overview regarding the UNWTO's and UNESCO's best practices and recommendations for promoting cultural tourism.

Documents such as the 1977 Bangui Agreement on the Creation of an African Intellectual Property Organisation [thereafter Bangui Agreement 1977], the Cook Islands Traditional Knowledge Act 2013, Malaysia's National Heritage Act 2005, and South Africa's Protection, Promotion, Development and Management of Indigenous Knowledge Act 2019, Science and Innovation were also referred to.

Tourism Malaysia's Star Gazing Packages 2026, relevant Facebook and Instagram social media websites advertising relevant training, talks and tours were also addressed to examine if there were any tourism packages that highlighted Malaysian indigenous people and local communities' cultural astronomical practices in both East and West Malaysia. This signified there could be a form of promotion to disseminate indigenous and local communities' astronomical knowledge. However, it is acknowledged there are limitations in capturing data from the Facebook and Instagram social media websites as the search terms used may not necessarily capture all relevant sites that advertise astrotourism tours together with cultural

astronomy. There may be other private initiatives of astrotourism not necessarily advertised on social media websites which were not captured by this study and remain hidden. Thus, the scope of detecting astrotourism tours in this study merely covers a search of internet and social media websites while discounting any private initiatives absent from websites and social media. Therefore, it is acknowledged there are limitations to this study in making an overarching generalisation that there could be few astrotourism initiatives which have incorporated the cultural astronomy aspect of indigenous and local communities. Analysis from the astrotourism tours and packages found on Facebook and Instagram social media is presented as a table.

A document and textual analysis of relevant articles was conducted for the soft law documents such as the Muscat and Istanbul Declarations, the Bangui Agreement 1977 and domestic statutes of relevant countries such as the Cook Islands Traditional Knowledge Act 2013, Malaysia's National Heritage Act 2005, and South Africa's Protection, Promotion, Development and Management of Indigenous Knowledge Act 2019, Science and Innovation. This is to obtain the ordinary meaning from the relevant articles of these soft law documents, international agreement and domestic countries statutes through interpretivism.

Reference materials from newspapers, book chapters, books, journals, conference paper, magazines, thesis and relevant internet websites were also consulted to provide elaboration within the section of the literature review and an overview about the northern Malays and the *Orang Asli* in Peninsular Malaysia, the Dayak-Iban and Kadazan-Dusun in East Malaysia with regard to their forms of astronomical knowledge of stars and other celestial bodies.

Moreover, this study also visited relevant blogs that contain knowledge of the different stars and their names based on the Malay, *Orang Asli*, Dayak-Iban and Kadazan-Dusun culture to know the suitable agriculture and fishing seasons. These blogs are a form of knowledge sharing from Malaysian individuals who possess knowledge on the stars' function among the different indigenous and local communities, and are intended to be imparted to future generations so that such information will not be forgotten.

A content analysis was conducted with regard to the secondary resources and to locate emerging themes that would be presented in this study as relevant sub-titles.

### **Results of the Study and Discussion**

The results and discussion of this study are presented as follows. First, the study highlights international initiatives led by the UNWTO and UNESCO, which provide guidance and good practices for countries to emulate in their domestic tourism sectors. This is followed by a discussion of the astronomical knowledge possessed by various indigenous and local communities in both East and West Malaysia, demonstrating that the country's indigenous communities are also rich in astronomical knowledge that deserves greater recognition, particularly for its potential contribution to astrotourism. Subsequently, there is also a section that analyses various tours, talks, and training programs organised in Malaysia to assess the extent to which the astronomical knowledge of indigenous and local communities previously highlighted is incorporated to promote astrotourism.

***The United Nations World Tourism Organisation (UNWTO) and the United Nations Educational, Scientific and Cultural Organisation's (UNESCO's) Efforts to Promote Cultural Tourism among Indigenous and Local Communities***

An appraisal of UNWTO and UNESCO documents in this section serves to highlight the emerging international law in the area of tourism, which provides guidance concerning best practices for tourism activities among countries to emulate domestically. Emerging soft law documents issued by the UNWTO and UNESCO in promoting cultural and rural tourism emphasise the fair treatment of indigenous and local communities. In the Muscat Declaration (UNWTO & UNESCO, 2017), it has been emphasised that any rural tourism endeavour must ensure "the engagement of local communities in managing tourism at heritage sites in sustainable, responsible and inclusive manner and meeting the aspirations of communities on safeguarding and transmitting their tangible and intangible cultural heritage and values". This means that if the tour operator intends to utilise any indigenous communities' astronomical knowledge to promote astrotourism, they will have to directly engage with the indigenous people themselves and not resort to a third party. According to the World Committee on Tourism Ethics (2019, p.14), there is a need to "[w]ork side by side with indigenous community leaders in order to avoid the promotion of non-authentic cultural performances [...] or an inaccurate interpretation of indigenous culture". By permitting third party tour guides to orally explain indigenous or local communities' astronomical knowledge, there is a chance they may misconstrue a particular practice and convey wrong information to tourists. For this reason, indigenous and local communities need to be direct communicators of their astronomical knowledge.

In turning indigenous and local communities into effective tour guides, some form of training, possessing the necessary skills and having business acumen must be provided to these groups. In realising this the Muscat Declaration (UNWTO & UNESCO, 2017) has stressed for governments to ensure "the necessary financing for preserving cultural heritage sites and safeguarding intangible cultural heritage through investments [...]". Since indigenous and local communities will function to disseminate their astronomical knowledge while enabling them to contribute towards astrotourism, this would mean that government agencies must allocate financial assistance to enable them to be trained as proper tour guides with certification. In achieving this goal, the World Committee in Tourism Ethics (2019, p.15) stresses to "[t]ransfer knowledge and skills on tourism guiding to community members so that they feel more empowered to be guides themselves". The World Committee in Tourism Ethics also stresses to:-

*Engage young people from the community in guided tours in order to enable their own cultural learning, motivate them to become tour guides themselves and facilitate mentoring or future entrepreneurs* (World Committee in Tourism Ethics, 2019, p.17).

By training young indigenous people as tour guides proficient in their astronomical knowledge at a fast rate, they will not only earn a salary and increase their standard of living but assist the Malaysian authorities, for instance, in preserving this endangered knowledge through oral transmission to others.

As trained tour guides, indigenous people and local communities must be able to relate the emergence of stars and other celestial bodies with their folklore to attract tourists' attention. In this regard, UNESCO has stressed that:-



*There is growing evidence that storytelling comes to life beyond museums and interpretation panels. People in the host community are crucial to this process. Research has shown that tourists spend less than 10% of their time in museums or galleries [...]. If you want to become excellent at storytelling and interpretation, we need to take stories of the site and the community into those places [...] (UNWTO, 2012, p.5).*

The above shows that tourists are likely to retain much more information in their mind if oral transmission of astronomical knowledge is transmitted to them and, furthermore, through interesting folklore. Display boards documenting fishermen's astronomical knowledge at the Tanjong Balau museum in Johor, Malaysia, may be a good endeavour but it is not so effective in capturing the attention span of tourists and for them to retain this information. Thus, hands-on activities such as local fishermen explaining the meaning of stars to tourists on a guided tour boat at night would be more meaningful and memorable to them.

Moreover, the Istanbul Declaration (UNESCO & UNWTO, 2018) asserts the usage of information communications technology (ICT) "to safeguard, archive, preserve, manage and promote cultural heritage, while bringing competitive advantage to destinations and fostering social inclusion". While different forms of ICT can be used to document indigenous folklore or songs through CD-ROM's or thumb drives, for instance, there must be attribution made to these indigenous and local communities who possess this knowledge. The UNWTO (2012) has stressed to "protect the IPR of communities with regard to [Intangible Cultural Heritage] (ICH) products used in souvenirs and other items (such as traditional music CD's) [...]". For example, indigenous and local communities' astronomical knowledge of the different seasons for agriculture or navigation may be used to produce unique calendars sold as souvenirs to tourists to be commercialised by exploiters. In this regard, the World Committee on Tourism Ethics within the UNWTO (2019, p.10) stresses "to develop indigenous tourism products, services and experiences in a way that tourism related benefits revert to as many individuals of the indigenous communities as possible [...]". Therefore, any calendar produced using the astronomical knowledge of indigenous and local communities or CD ROM documenting their songs and lyrics which are being commercialised and sold must acknowledge their communal ownership. Moreover, these indigenous and local communities must be paid appropriate royalties out of their songs and lyrics being sold as well as their calendars. Failure to do so would mean the exploitation of their astronomical knowledge.

In the event that any IPR dispute arises between indigenous people, the local communities, and the exploiters, there should be a recourse to settle the dispute. In this context, the World Committee on Tourism Ethics (2019, p.16) recommends to "[d]iscuss and agree on consultation and grievance remedial processes and tourism partners". This should be the course taken to settle any arising IPR issues affecting indigenous and local communities.

Much can be learnt from Pakistan's example in documenting and preserving the Kalasha community's endangered astronomical knowledge that is already going into extinction. In 2018, Pakistan informed UNESCO of its own efforts to protect the Kalasha communities' Suri Jagek, the observing of the sun, moon and stars to determine appropriate seasons for social events, animal husbandry and agriculture (UNESCO, 2017). Observatories were located in Kalasha valleys such as Mumuret, Biri and Rukmu. One effort of preserving the astronomical knowledge of the Kalasha involves the community's own youth visiting observatories for practical lessons among the elders so that this knowledge will not become obsolete (UNESCO,

2017, p.8). Other efforts include utilising traditional bearers of astronomical knowledge such as Qazis, village elders and storytellers to narrate stories to their youths through oral transmission (UNESCO, 2017, p.9). In sparking the interest of youths and small children to be interested in the Kalasha's astronomical knowledge, animated, graphic representations of Kalasha stories, oral traditions, songs and proverbs were recorded and produced to be disseminated and preserved (UNESCO, 2017, p.9). Through all of these efforts, Pakistan has ensured that the elders possessing the astronomical knowledge of the Kalasha community would be consulted directly and without reliance on third parties who could distort the valuable knowledge.

Most importantly, Pakistan ensured that its primary, secondary and middle schools curriculum incorporated information about the Kalasha culture and aspects of the Suri Jagek (UNESCO, 2017, p.9). Teachers were trained to develop the necessary curriculum structure and students were to undergo practical lessons pertaining to the Suri Jagek that would be led by Qazis, village elders, farmers and shepherds (UNESCO, 2017, p.10).

Malaysia can learn much from Pakistan's example. In order for Malaysia to produce educated guides proficient in astronomical knowledge, maritime or agriculture degrees being offered by universities or colleges should offer a specific course on the astronomical knowledge of the various ethnic groups in the country. There is a need to consult indigenous and local communities possessing this astronomical knowledge directly to develop the curriculum and include practical training. There is no point in consulting third parties who may relate distorted astronomical knowledge which is no longer authentic. The idea is to produce graduates who are knowledgeable about the astronomical knowledge of ethnic groups as their specialisation to make a living as certified tour guides once they have graduated. This way, Malaysia may have a pool of resources to promote astrotourism that specialises in the cultural astronomy aspect.

Based on the elaboration in this section, the UNWTO and UNESCO documents that serve as guidance have indicated the course of action that countries should implement domestically to ensure the well-being of indigenous and local communities involved in astrotourism. These may include actions to ensure that indigenous and local communities are directly engaged in promoting their cultural astronomy, undergo appropriate training as tour guides, are not exploited when employed, and their astronomical knowledge should be preserved through IPR and heritage laws rather than being abused for exploitation.

Subsequent sections in this study will then elaborate on some of Malaysia's indigenous and local communities' possession of astronomical knowledge presented in the form of tables and a diagram, as proof that this country is also a contributor to worldwide indigenous and local communities' cultural astronomy. Subsequent sections of elaboration will also show some of the actions already taken or to rectify them to better ensure the preservation of indigenous and local communities' astronomical knowledge from going into extinction.

### ***Preserving Malay Fishermen's Astronomical Knowledge in the East Coast of Peninsular Malaysia***

In this section, the astronomical knowledge possessed among the fishermen on the East Coast of Peninsular Malaysia and the current preservation efforts of this knowledge will be elaborated. The Tanjong Balau museum situated in Johor of Peninsular Malaysia, is certainly

one of its kind in preserving Malay fishermen's astronomical knowledge on a display board readable to the Malaysian public. Table 1 below summarises the Malay fishermen's astronomical knowledge of different stars indicating the different seasons when the sea is calm to fish or when the sea is choppy signifying the monsoon season. This astronomical knowledge of the stars is still in practice among Malay fishermen of Kelantan and Terengganu in the East Coast of Peninsular Malaysia although the number of practitioners may be dwindling over time as most of them are ageing. The implication from discovering that Malay fishermen on the East Coast of Peninsular Malaysia still possess valuable astronomical knowledge that guides their navigation at sea and is an indicator concerning the type of fish being caught shows the need for the relevant Malaysian authorities to act and preserve this valuable knowledge on the brink of extinction. Therefore, there is a need to pass on this knowledge to the younger generation so that this legacy lives on and will not die a natural death.

While the Tanjung Balau Museum has done an awesome job in documenting the East Coast fishermen's astronomical knowledge in Peninsular Malaysia, it is unlikely that short attention spans mean any tourist who has read the display board will retain much of this information in their memory. A hands-on experience would be much more memorable to tourists if they are involved themselves in trying to locate the stars from the boat. For example, together with knowledgeable elderly fishermen, boat tours are organised at night. This is in line with the UNWTO's recommendation for a hands-on experience among tourists to experience cultural tourism and learn about other races' culture and a useful way to disseminate knowledge that supports sustainable development. The state and federal governments of Peninsular Malaysia should solicit elderly knowledgeable fishermen who have still retained their astronomical knowledge to train younger fishermen who can function as tour guides on the boat and provide them with approved certification. As for the elderly fishermen who are trainers in disseminating astronomical knowledge, they should be paid remuneration for their efforts. Another implication from knowing that Malay fishermen still possess this valuable knowledge is that disseminating this knowledge of the stars could take place among Malaysian universities and colleges that offer maritime courses with the practical experience on a boat at sea to detect stars at night to obtain certification as a tour guide. These are indeed some of the efforts that can be undertaken to preserve the East Coast Malay fishermen's' astronomical knowledge of Peninsular Malaysia and save it from extinction through the merger of astrotourism and culture.

**Table 1: Stars Indicating Suitable Times for Fishing, the Type of Fish Caught and the Monsoon Seasons**

| Star Name                                                                | Functions and Characteristics                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                      |
|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| The <i>Tika</i> Star<br>The <i>Pleiades</i>                              | <ul style="list-style-type: none"> <li>• Comprises of seven stars arranged in a row.</li> <li>• Rises alternatively with the <i>belatek</i> star in certain months, but disappears in June.</li> <li>• Rises around 3.00 a.m. and is linked with the habits of the fish, specifically the "tamban" fish that wait together at an artificially made "unjang-unjang", comprising of coconut leaves and branches from the tamarind tree, which are subsequently lowered into the sea with something to pull them down to attract the fish.</li> </ul> |
| <i>Belatek</i> Star<br>Orion's Belt, or the Three Kings or Three Sisters | <ul style="list-style-type: none"> <li>• Comprises of three stars in the shape of a triangle.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                           |

| Star Name           | Functions and Characteristics                                                                                                                                                                                                                                                                                                                                                                   |
|---------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|                     | <ul style="list-style-type: none"> <li>Will rise one month after the <i>tika</i> star, utilised as a guide by fishermen to go back to land and to determine the Muslim <i>qibla</i>.</li> <li>The ascent of this star shows strong winds will occur without rain. The star ascends from around December to May.</li> <li>There will be fierce winds, signifying a rough, choppy sea.</li> </ul> |
| <i>Tukoh</i> Star   | <ul style="list-style-type: none"> <li>Comprises of seven stars arranged in a necklace.</li> <li>Normally seen in November and appears from the east.</li> <li>Brings heavy rains and strong winds for a long duration.</li> </ul>                                                                                                                                                              |
| <i>Kelambu</i> Star | <ul style="list-style-type: none"> <li>Comprises of four stars in the shape of a square.</li> <li>Emerges in December.</li> <li>Brings continuous wild winds and heavy rains to cause floods along the East Coast of Peninsular Malaysia.</li> </ul>                                                                                                                                            |

Sources: Abdullah (2017); Dr Singa (2013); Teh (2021)

### ***Malay Paddy Farmers and Fishermen's Astronomical Knowledge Conservation in Northern Peninsular Malaysia***

This section seeks to highlight the northern Malays astronomical knowledge in Peninsular Malaysia which has guided paddy planting, the fruiting and fishing seasons traditionally. Paddy planting in Kedah, a state in northern Peninsular Malaysia, can trace its roots perhaps to the 15th or 16th century or even much earlier than that (Hill, 1977). The river valleys in Kedah were cleared and planted with paddy to be exported to traders from afar and later to the sultanate of Malacca (Ibrahim, 1991). Until the 16th century, Kedah was an exporter of paddy within the Nusantara region having the same status as Java (Ibrahim, 1991). This would not have been possible unless Kedah already had a long history of paddy planting to be a supplier to foreign traders within Southeast Asia. Wet paddy cultivation flourished in Kedah in the early 18th century at the Kedah plains when Penang took over as the central port for trade (Ibrahim, 1991).

The development of paddy planting in Kedah had spurred the local community to observe when the rain, drought, and flood seasons occur to gauge the right time when to plough land, sow rice seeds, transfer paddy stocks to a permanent bed and to harvest the paddy seedlings. Through their observation, the Malay community in Kedah constructed their own calendar called the *piama bendang*. *Piama* literally means seasons and can be broken down into a shorter span of time for a duration of 30 days in a month (Ibrahim, 1991, p.62). This *piama bendang* calendar was being practised until the early 1970s in Kedah (Ibrahim, 1991). When modern machinery was introduced and paddy could be cultivated twice a year, Malay paddy farmers forgone their reference to the *piama bendang*.

Malay farmers in Kedah in the 1970s divided the seasons into two, namely the raining season known as the west season because the wind blows from the sea to the land to bring rain, and the drought season known as the east season because the wind moves from the east of Peninsular Malaysia (Ibrahim, 1991). In constructing the *piama bendang*, the Malay farmers in Kedah had also observed changes to plants, wind direction, rain, humidity, animal habits and most importantly the *bintang ketika* [ketika star], also known as the *Pleiades*. The different

times when the star appears during dusk, night and dawn has its significance as it indicates the different processes to be undertaken to plant wet paddy. The *piama bendang* is also an indicator when certain plants would flower, trees would bear fruit, certain fish would travel from the paddy fields to the river, certain species of birds would sing, when the sea is calm or choppy for fishermen in northern Peninsular Malaysia to go to sea or refrain from doing so. Figure 2 provides a summary of the 12 months of the *piama bendang* with the Malays having specific names for each month and the duration of time accorded for each month. Table 2 also lists certain criteria to be observed for each specific month as an indicator to Malay paddy farmers and fishermen in northern Peninsular Malaysia concerning the form of activity to be undertaken based on guidance of this calendar.

Based on the *piama bendang*, the Malay paddy farmers would start to repair the paddy beds in April when it rains heavily to ensure that the beds are flooded with water (Ibrahim, 1991, p. 62). This is followed by ploughing the land and creating a site for growing the budding paddy stocks which will go on until July (Ibrahim, 1991, p. 62). The paddy seedlings will then be thrown at the site to grow budding paddy stalks. The paddy seedlings take about 44 days to grow into mature paddy stalks ready to be transferred into a permanent site until it is ready to bear fruit and be harvested (Ibrahim, 1991, p. 62). The transfer of these paddy stalks to a permanent site until they are fully matured takes place around August and ends in September (Ibrahim, 1991). Depending on whether light or heavy paddy is planted, it could take five to eight months before the paddy is ripe for harvesting, which can start at the end of December up to February in the following year (Ibrahim, 1991). This whole cycle of paddy planting takes one year to complete when paddy is planted traditionally in Kedah without the usage of machinery.

Figure 2 shows a wheel cycle of the *piama bendang* showing the seasons of drought, flood, spring (flowering season), and the fruit season. The suitability of planting a paddy type will depend on the brightness or dimness of the *bintang ketika* [ketika star]. The recognition that the Malays of northern Peninsular Malaysia historically developed their own calendar—detailing seasons for paddy cultivation, fruiting, and fishing—demonstrates a sophisticated community whose ecological knowledge warrants systematic preservation and dissemination by the relevant Malaysian authorities to prevent its disappearance. A further implication is the need to safeguard this calendar, which is derived from indigenous seasonal knowledge, from commercial exploitation without proper attribution to the originating community. For example, the calendar could easily be reproduced and sold for profit without acknowledging its rightful custodians. This underscores the necessity of examining whether existing IPR laws in Malaysia can adequately protect communal knowledge or whether alternative protective mechanisms are required. Table 3 indicates the type of paddy to be planted depending on the characteristics of the *bintang ketika*.



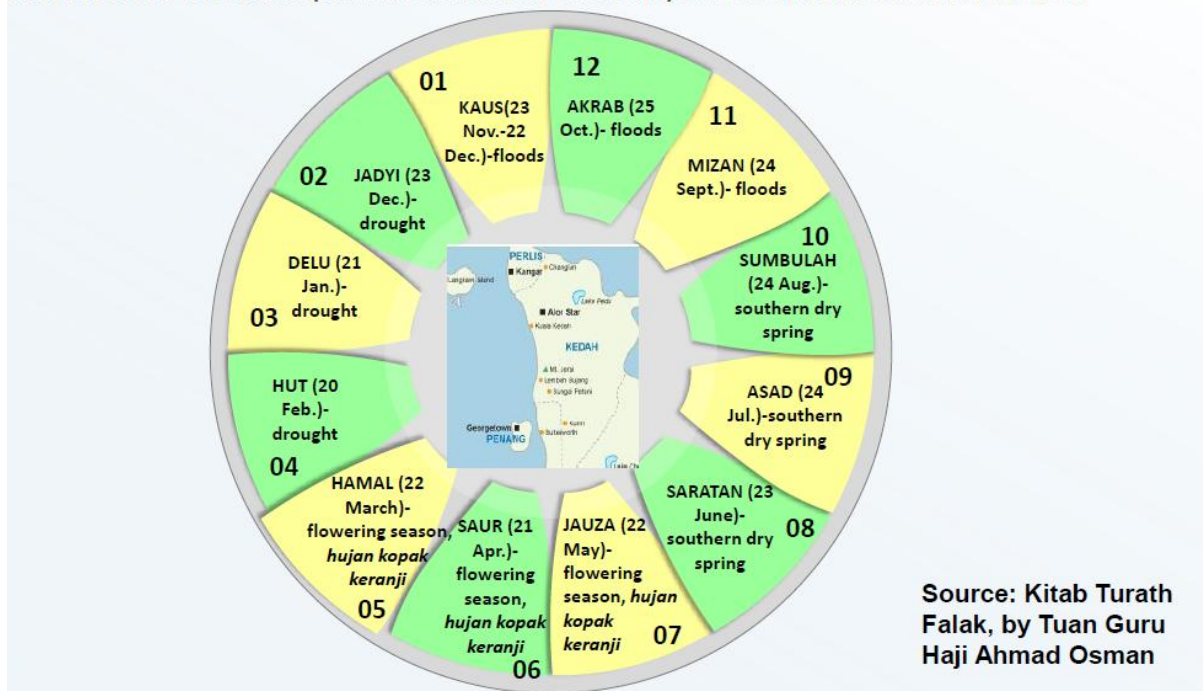
12 MONTHS OF THE *PIAMA* (TRADITIONAL MALAY CALENDAR) IN NORTHERN PENINSULAR MALAYSIA

Figure 2: The Twelve Months within the *Piama* (Calendar) that Guides Agriculture, Fishing and the Fruiting Seasons in Northern Peninsular Malaysia

Table 2: Northern Malay's *Piama* in Guiding Them for Agriculture, Fishing and the Fruiting Seasons in Peninsular Malaysia

| Month | <i>Piama bendang</i> month | Approx. Gregorian dates | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |
|-------|----------------------------|-------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1     | Kaus (Sa)                  | Nov 23 – Dec 22         | <ul style="list-style-type: none"> <li>Large <i>gelenggang</i> tree blooms.</li> <li>The <i>kendong</i> fruit will ripen and the birds will eat it.</li> <li>The fish in the fields chase each other to the river because the paddy fields are dry for the upcoming drought.</li> <li>Paddy cannot be planted during this month and if it is planted, there will be no seedlings, but if there are seedlings, it will not be full.</li> <li>The <i>bintang ketika/ puyuh</i> (<i>Pleiades</i>), a group of seven stars will blink throughout the night because it rises at dusk from the east and sets at dawn in the west. At midnight, the <i>bintang ketika</i> is at its zenith, in the middle of one's head. The seven stars are arranged in a group whereby some stars are visibly clear and others unclear, so that some people say in a poem 'the seven stars are left with six [...]'</li> </ul> |
| 2     | Jadyi                      | Dec 23 – Jan 21         | <ul style="list-style-type: none"> <li>Floodwaters recede; fish and <i>tuntung</i> [river terrapin] return to paddy fields.</li> <li>Turtles are starting to lay eggs on the beach.</li> <li>The paddy stalks have produced seedlings that can be made into rings or <i>emping</i> [pancakes].</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 |

| Month | <i>Piama bendang</i><br>month | Approx.<br>Gregorian dates | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               |
|-------|-------------------------------|----------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       |                               |                            | <ul style="list-style-type: none"> <li>• People who plant light paddy called "Ridin Keling" can now start harvesting.</li> <li>• The season for birds to mate in the gaps of paddy stalks such as the <i>sintar</i>, <i>ruak-ruak</i> and chickens.</li> <li>• Fishermen also lower their traps because fishes such as the mackerel and sea bass are actively moving around.</li> <li>• The <i>janggus</i> fruit blooms and the <i>putat</i> sprouts.</li> <li>• At 10 pm, the <i>bintang ketika/ puyuh</i> (<i>Pleiades</i>) is right at the top of the head.</li> </ul>                                                                                                                              |
| 3     | Delu                          | Jan 22 – Feb 20            | <ul style="list-style-type: none"> <li>• <i>Macang</i> tree flowers.</li> <li>• East wind begins.</li> <li>• Harvestable paddy grains.</li> <li>• Bamboo shoots grow low in the bamboo groves.</li> <li>• Heavy paddy starts to ripen for harvest.</li> <li>• The fruits of the kin and <i>cenerai</i> will be ripe.</li> <li>• Other trees such as the <i>dedap</i> tree, <i>cengkering</i>, <i>kacang gula</i> and <i>keriang lada</i> will flower in this month.</li> <li>• At the end of this month, fruits such as mango, <i>bacang</i>, <i>rambai</i>, <i>pupur</i> begin to flower.</li> <li>• The <i>bintang ketika</i> (<i>Pleiades</i>) will be upright and twinkling around 8pm.</li> </ul> |
| 4     | Hut                           | Feb 21 – Mar 21            | <ul style="list-style-type: none"> <li>• Trees such as durian, mangosteen and langsung will produce flowers.</li> <li>• At this time, people also start fishing in the paddy fields using <i>serkap</i> [a trap] because the paddy has been harvested.</li> <li>• The east wind starts to blow wildly and can blow fishing boats miles out to sea.</li> <li>• On the shore, the water is calm but in the middle of the sea there are big waves.</li> </ul>                                                                                                                                                                                                                                             |
| 5     | Hamal                         | Mar 22 – Apr 21            | <ul style="list-style-type: none"> <li>• No visible shadow at noon; sun overhead.</li> <li>• Ideal seed sowing time begins.</li> <li>• On the 15th day of this month, the midday sun will be directly overhead and the shadows will disappear momentarily before the time of Zuhor. At this time, the <i>janggus</i> tree will begin to bear fruit.</li> <li>• The first <i>sena</i> flowers are a sign that rain will fall soon. At this time, the villagers will go into the forest to find wood to make <i>tenggala</i> and tools to go down to the fields. The fishermen in the <i>kuala</i> [mouth of the river] are also preparing to lift the splint.</li> </ul>                                |
| 6     | Saur / Thaur                  | Apr 22 – May 22            | <ul style="list-style-type: none"> <li>• <i>Keranji</i> flower petals fall like rain.</li> <li>• The <i>ketika/ puyuh</i> star (<i>Pleiades</i>) is no longer visible at night.</li> <li>• Prawns and baby sea bass will rise along the Sanglang coast to Tanjung Dawai and this will continue until the Sa month.</li> <li>• The <i>kapar keranji</i> rain, which is the name for the rain that begins to fall after the summer, will arrive</li> </ul>                                                                                                                                                                                                                                               |

| Month | <i>Piama bendang</i><br>month | Approx.<br>Gregorian dates | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|-------|-------------------------------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       |                               |                            | with thunder, closing the cracks in the ground and refreshing the trees.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                |
|       |                               |                            | <ul style="list-style-type: none"> <li>• The <i>nipah</i> [palm] tree will begin to bloom.</li> <li>• When the rain is heavy enough and the <i>sena</i> tree blooms for the third time, the paddy farmers will begin to plough the paddy fields.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             |
| 7     | Jauza                         | May 23 – June 22           | <ul style="list-style-type: none"> <li>• Prepare planting beds and sow light paddy seeds.</li> <li>• Although it is the rainy season, the heat is very intense. The sea level has started to rise and the strong west wind brings storms every five or six days. During this month, clouds begin to roll on the horizon, indicating that the sea will be visited by storms. Storms usually come at high tide or low tide and the sea waves begin to swell.</li> </ul>                                                                                                                                                                                                                                                                                                                                   |
| 8     | Saratan                       | June 23 – July 23          | <ul style="list-style-type: none"> <li>• <i>Bintang ketika</i> [ketika star] is visible at dawn.</li> <li>• Sow heavier paddy varieties so that the seedlings will have time to ripen in the dry season.</li> <li>• People in the hilly areas are busy digging holes in the paddy fields to plant hill paddy.</li> <li>• The <i>nipah</i> [palm] fruit is also ripe and this is the time when people start making <i>nira</i> syrup.</li> <li>• At the end of this month, the rain will stop and the short dry season called <i>selatan anak keli</i> or <i>anak puyu</i> [south fingerling catfish or puyu fingerling fish] will arrive.</li> <li>• Storms at sea and southeast thunder are often heard and the waves at sea are getting bigger due to strong winds blowing from the south.</li> </ul> |
| 9     | Asad                          | July 24 – Aug 23           | <ul style="list-style-type: none"> <li>• Suitable for planting medium/heavy paddy seeds.</li> <li>• Women planting paddy using a tool called <i>kuku kambing</i> [goat's claws].</li> <li>• As long as the stars have not yet set at dawn, paddy can be planted. After exceeding this time, the paddy will be affected by diseases and may not produce fruit.</li> <li>• Durian fruits also start to fall from trees in Kedah.</li> <li>• If it rains during this month, it will only be a drizzle.</li> <li>• At the end of this month, the wind will move north and the waves at sea will become stronger.</li> </ul>                                                                                                                                                                                 |
| 10    | Sumbulah                      | Aug 24 – Sep 23            | <ul style="list-style-type: none"> <li>• No noon shadow.</li> <li>• West monsoon fully entrenched.</li> <li>• On the 15th day of this month, the sun is at the top of the head crossing to the north like the fifth month.</li> <li>• The <i>bintang ketika</i> [ketika star] is clearly visible at dawn. At the end of this month, the <i>balai</i> bird calls from the top of the trees to welcome the 11th month.</li> <li>• It is still possible to plant paddy late into the season, but it is better to plant light paddy, which is the one that ripens quickly.</li> </ul>                                                                                                                                                                                                                       |
| 11    | Mizan                         | Sep 24 – Oct 23            | <ul style="list-style-type: none"> <li>• <i>Balai</i> birds are still singing signalling that the west season is still ongoing.</li> </ul>                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                              |

| Month | <i>Piama bendang</i><br>month | Approx.<br>Gregorian dates | Criteria                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    |
|-------|-------------------------------|----------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|       |                               |                            | <ul style="list-style-type: none"> <li>Light paddy is only to be planted at the beginning of this month and no later or it will not produce bountiful harvests. Existing planted paddy should be in its prime.</li> <li>There are storms at sea and on land there will be floods if the rain meets the tide.</li> <li>Land fish such as <i>puyu</i>, catfish, <i>haruan</i>, <i>sepat benua</i>, and <i>selat</i> move from the paddy fields to the rivers with the floodwaters.</li> </ul> |
| 12    | Akrab                         | Oct 24 – Nov 23            | <ul style="list-style-type: none"> <li>Sound of <i>ruak-ruak</i> birds heard.</li> <li>Marks the end of <i>piama</i> and planting paddy period.</li> <li>Heavy rains are occurring in Kedah and flooding is likely in the next few weeks. The storm at sea has subsided and the people of <i>kuala</i> [mouth of the river] are starting to prepare to go to sea.</li> </ul>                                                                                                                |

Sources: Abdul-Hamid (2010); Arbanji (2014); Illani (2019)

**Table 3: The Type of Paddy Planted Depending on the Brightness or Dimness of *Bintang Ketika***

| Observation of <i>Bintang Ketika</i>                                                                                                                                                                                                                     |                                                                                                                               |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------|
| Characteristic of the Star                                                                                                                                                                                                                               | Type of Paddy                                                                                                                 |
| <ul style="list-style-type: none"> <li>Dim at the top but shines brightly at its tail.</li> <li>Can withstand heavy rainfall.</li> <li>Star cluster is light or luminous at the top but dim at its tail.</li> <li>Can withstand drier season.</li> </ul> | <ul style="list-style-type: none"> <li>Red paddy (heavy/ weighty paddy)</li> <li>White paddy</li> <li>Yellow paddy</li> </ul> |

Sources: Abdul-Hamid (2015, p. 181); Jaafar and Khairuddin (2017)

### ***Knowledge of the Stars among the Orang Asli Semelai in Pahang, Peninsular Malaysia***

Like the northern Malays in Peninsular Malaysia, one sub-group of the *Orang Asli*, the *Semelai*, also possess valuable astronomical knowledge with the potential to be incorporated into an astrotourism package. A study conducted among the *Orang Asli* at Kampung Lubuk Perah located in the upstream of Bera river in Pahang indicated that they referred to a few stars called the *bintang keran cong*, *bintang jekat* and *bintang peyh*, located in the middle of the sky before the sun rises as a sign or *periantan penungguyan* that will take place within a duration of two to three months before the paddy is matured enough to be harvested (Jaafar & Khairuddin, 2017). Below is a table that summarises the names of stars given by the *Orang Asli Semelai* and its equivalent counterpart understood in Western terms. The *Orang Asli Semelai* once planted *padi huma* (hill paddy) but with economic modernisation they have devoted themselves to some more lucrative economic activities which meant the death knell to the astronomical knowledge they possess (Jaafar & Khairuddin, 2017). The researchers who conducted the study on the *Semelai's* at Tasik Bera in Pahang indicated the elders they had interviewed were the very few people of their generation who still possess knowledge of the relevant stars whereas the younger generation are devoid of this knowledge (Jaafar & Khairuddin, 2017). This being the case, there is a need for the *Semelai* elders to pass down the astronomical knowledge to their younger generation. As an incentive, the younger generation of *Semelai's* could be trained as certified tour guides knowledgeable about the stars by the elders provided the *Orang Asli* Department in collaboration with Tourism Malaysia providing financial

assistance to this ethnic group to make dark sky tourism in their village a reality. Through training to manage modern telescopes together with their cultural knowledge of stars, will this be an attractive package to attract local and foreign tourists to visit the village for astrotourism. In turn, the poor *Semelai* can generate income and uplift their livelihood.

**Table 4: *Semelai*'s Terminology of Stars**

| No. | <i>Semelai</i> 's Terminology of Stars         | Western Equivalent Terminology                                                             |
|-----|------------------------------------------------|--------------------------------------------------------------------------------------------|
| 1   | <i>Bintang keran cong</i>                      | Unknown                                                                                    |
| 2   | <i>Bintang peyh</i> (meaning <i>belantik</i> ) | The three stars in the same row with the <i>Orion</i> constellation                        |
| 3   | <i>Bintang jekat</i> (meaning animal jaws)     | Identifiable based on the arrangement of stars that form a "V" in the Taurus constellation |

Source: Jaafar and Khairuddin (2017)

Another issue which has led to the declining astronomical knowledge among the *Semelai* include their conversion to Islam as it is feared that their beliefs in the stars is a mere myth and could be against Islamic teachings (Jaafar & Khairuddin, 2017).

### ***The Dayak-Iban Interpretation of Stars in Sarawak***

While the discussion so far has focused on the astronomical knowledge of indigenous and local communities in Peninsular Malaysia, this section shifts the focus to the Dayak-Ibans in Sarawak in East Malaysia, who have traditionally relied on the stars to determine the appropriate season for land clearing and paddy planting. Table 5 depicts the processes of paddy planting based on the movement of various stars and the months these activities take place.

**Table 5: Dayak-Iban's Terminology of Stars for Guidance in Agriculture**

| No. | Type of star                                             | Western equivalent | Gregorian month   | Activity                                                                                                                                                                                                                                                                                                                                                                                                                                            |
|-----|----------------------------------------------------------|--------------------|-------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | <i>Bintang banyak/<br/>Bintang tujuh</i>                 | <i>Pleiades</i>    | May<br><br>July   | <ul style="list-style-type: none"> <li>• Appeasement of spirits in the forests.</li> <li>• Commencement of land selection and land clearing called <i>manggul</i>.</li> <li>• Star is located right in the middle of the sky.</li> <li>• During the full moon, this star will be in the middle of the sky without moving for a week to signify paddy planted during this time will be fertile and bear lots of fruit which will be full.</li> </ul> |
| 2   | <i>Bintang Tiga/<br/>Bintang belantik</i>                | <i>Orion</i>       | August/September  | <ul style="list-style-type: none"> <li>• The season for sowing the paddy seeds known as <i>nugal</i>.</li> </ul>                                                                                                                                                                                                                                                                                                                                    |
| 3   | <i>Bintang tangkung/<br/>peredah/<br/>Bintang ngayap</i> | <i>Sirius</i>      | Around 19 October | <ul style="list-style-type: none"> <li>• The end of the planting season.</li> <li>• Paddy grown after <i>Sirius</i> has passed its zenith will not be fertile and be immature.</li> </ul>                                                                                                                                                                                                                                                           |

Sources: Barau (2021); Kendawang et al. (2005); Tugang et al. (2022).



While the Dayak-Ibans generally still refer to the stars to guide them when to commence paddy planting, a study at Lubok Antu indicated that merely the older generation still possess the knowledge of these stars and that this knowledge was gradually disappearing among the younger generation (Kendawang et al., 2005).

The Dayak-Ibans also have a legendary story about the *bintang banyak* (Pleiades) consisting of seven stars who are sisters (Sampurai, 2015). The youngest of the seven sisters, named *Bunsu Bintang Banyak*, was married to a wanderer named Jenggelai and they had a son called Selamunda (Sampurai, 2015). Jelenggai and his son were told by *Bunsu Bintang Banyak* never to look and open a jar in their home as they live up above in the heavens in the sky. One day though, out of curiosity Jelenggai opened this jar and to his surprise he saw thousands of men on earth planting paddy (Sampurai, 2015). When his wife came home, she looked at Jelenggai's uneasy face and realised he had opened the sacred jar as he confessed his wrongdoing. From then on, Jelenggai and his son had to move back to earth. His wife reminded him whenever he sees the seven stars of the *bintang banyak*, Jelenggai and his people on earth should immediately commerce to clear land and plant paddy when these stars are right in the middle of the sky (Sampurai, 2015).

Another legendary story with regard to the emergence of *bintang banyak* concerns forbidden love between two lovers, namely Dayang Laing, who came out of a golden rock known as *Tengkulas Batu Mas* and became the spouse of Bunsu Ribut (Sampurai, 2021). Both the forbidden lovers soon became husband and wife and they had seven beautiful daughters (Sampurai, 2021). As their union was unapproved by god, these seven daughters were taken away from them and cast into the night sky to be known as *bintang banyak* among the Dayak-Iban community (Sampurai, 2021).

Apart from legendary stories about the stars, the Dayak-Ibans have created songs with lyrics about *bintang banyak*. One such song is entitled *Kumang Bintang Tujuh* readily downloadable from YouTube which tells a story of one of the seven princess from their star who came down for a bath at Wang Julian waterfall in Borneo but lost her dress and was unable to return to the *Pleiades* (Merang, 2023).

While these stories narrated by the Dayak-Ibans may be dismissed as a myth, their value lies in signifying the cultural identity of the Dayak-Ibans who are closely associated with nature. Possessing and practising astronomical knowledge shows how civilised an ethnic group is. The loss of such knowledge would mean a decay of the ethnic group as they do not know their history nor identity. The Dayak-Ibans can promote their various remote places where they live as an area for astrotourism. Imagine having a native Dayak-Iban narrating the legendary stories about *bintang banyak* to tourists, which can be enlightening and informative. An added touch could be the sales of attractive storybooks to children based on the legendary stories told. Thumb drives containing Dayak-Iban songs about the *bintang banyak* could also be sold as tourist souvenirs. This way, knowledge is disseminated and the legacy lives on. However, Dayak-Iban storytellers must be paid fairly for their efforts and not exploited. These can certainly generate income for the Dayak-Iban community if the astrotourism package is planned carefully but most importantly channelled back for their own utilisation.

A word of caution is needed though with the commercialisation of the Dayak-Iban songs or their legendary folktales sold as storybooks to promote astrotourism. This involves IPR's and

ownership. By right, the astronomical knowledge of uniquely naming the stars in the Dayak-Iban language is communally owned but Malaysia does not have a traditional knowledge law *per se* that would protect this. Moreover, created Dayak-Iban songs, their lyrics and the production of storybooks on their folklore should be IPR protected and they should be paid royalties for these. This is in line with the UNWTO's caution that while cultural tourism combined with astrotourism can be promoted among indigenous people, it is also crucial to implement IPR laws that can safeguard their rights.

### ***Observation of the Stars and the Moon among Indigenous People in Sabah to Guide Cultural Activities***

Having previously discussed the astronomical knowledge of the Dayak-Ibans in guiding their farming practices, this section focuses on the Kadazan-Dusun community in Tambunan, Sabah, who have similarly relied on the sighting of stars to guide the entire process of planting either hill or wet paddy. Table 6 shows the Kadazan-Dusun's given name for the stars and their Western equivalent, as well as the activities carried out leading to paddy planting.

**Table 6: Kadazan-Dusun Terminology of Stars and Calendar for Guidance in Agriculture**

| No. | Kadazan-Dusun Star Name                  | Western equivalent | Dates                  | Activities                                                                                           |
|-----|------------------------------------------|--------------------|------------------------|------------------------------------------------------------------------------------------------------|
| 1   | <i>Walatik</i> is low in the eastern sky | Aries              | June                   | • Clearing of the jungle to begin planting hill paddy.                                               |
| 2   | <i>Muru-puru</i> is seen overhead        | Orion              | 20 August              | • Appropriate time for planting and transplanting paddy.                                             |
| 3   | <i>Ro-oh</i> stars is seen overhead      | Unknown            | 15 September           | -                                                                                                    |
| 4   | <i>Walatik</i> stars is seen overhead    | Aries              | 10 October             | • The shining edge of the <i>walatik</i> indicates the direction where hill paddy should be planted. |
| 5   | <i>Walatik</i> is low in the western sky | Aries              | April (following year) | • Time for harvesting paddy.                                                                         |
| 6   | -                                        | -                  | May (following year)   | • Resting time and Kaamatan festival.                                                                |

Sources: Low and Pugh-Kitingan (2015); Kadazan-Dusun Cultural Association (2024)

The Kimaragang ethnic who speak Dusunik and live around the Kota Marudu and Pitas areas normally refer to the different phases of the moon for their cultivation process. The Kimaragangs also have their own terminologies for the different phases of the cultivation process as indicated in Table 7 below.

**Table 7: The Cultivation Activities Undertaken by the Kimaragang's Based on their Momiwulan Calendar System***Momiwulan System*

| <i>Kimaragan's<br/>Term for<br/>Cultivation<br/>Activity</i> | <i>Activity</i>                                           | <i>Duration</i> | <i>Gregorian<br/>Calendar</i> |
|--------------------------------------------------------------|-----------------------------------------------------------|-----------------|-------------------------------|
| <i>Rumilik</i>                                               | Clearing of land and cutting process.                     | 1 month         | July                          |
| <i>Managad</i>                                               | Cutting down large trees around the cultivation area.     | 1 month         | August                        |
| <i>Monotud</i>                                               | Burning the felled trees and shrubs surrounding the area. | 1 month         | September                     |
| <i>Mangosok</i>                                              | Planting rice seeds.                                      | 1-2<br>months   | October-<br>December          |
| <i>Gompus</i>                                                | Rainy season.                                             | -               | December                      |
| <i>Monguguni</i>                                             | -                                                         | 1 month         | January                       |
| <i>Mongomot</i>                                              | Harvesting paddy.                                         | 2-3<br>months   | February-April                |
| <i>Minginakan</i>                                            | Thanksgiving celebration.                                 | 1 month         | May                           |
| <i>Mamasa do<br/>rami</i>                                    | Rainy season.                                             | 1-2<br>months   | June                          |

Source: Pangayan et al. (2018)

The compilation of the above table about the Kimaragangs astronomical knowledge is one that had been passed down by the elders orally as most of the younger generation are unaware about it (Pangayan et al., 2018).

Another factor which contributes to the declining practice of astronomical knowledge among the indigenous people in Sabah can be attributed to their embrace of Christianity (Low & Pugh-Kitingan, 2015). Referring to stars to guide agricultural practices can then be regarded as nonsensical. Till today Islamic practice in Malaysia still refers to the sighting of the crescent moon to predict when the month of Ramadan starts for the Muslims to fast, the start of Syawal to mark Eid al-Fitr or when the Muslim pilgrims would go for their Hajj in Mecca, Saudi Arabia in conjunction with Eid al-Adha.

Then again, Malaysia is a multicultural society with so many ethnic groups and respect for other beliefs without making judgement of right or wrong should be upheld. Scholarly literature in Malaysia has a tendency to showcase Islamic astronomy as a good potential for astrotourism that ignores the promotion of other ethnic groups' astronomical knowledge, as highlighted in this study. Moreover, there is also a prejudice to dismiss other ethnic groups' folklore beliefs even though they may be a myth. This is because some individuals in Malaysian society tend to use Islamic beliefs as a yardstick to judge other ethnic groups' folklore as being nonsense and forbidden. This should not be the case as Malaysians should have religious tolerance towards other ethnic groups beliefs regardless whether it makes sense or not as this, is after all, a particular group's cultural identity. One such case occurred in Sabah whereby the sighting of the eclipse reflected a folklore of a particular ethnic group which believed that the dragon was eating the sun ("Hundreds witness", 2016). Someone from an Islamic background dismissed this as being against Islamic principles to make a judgement on another ethnic group's beliefs. Thus, religious tolerance should be promoted to respect all ethnic groups beliefs regardless as to whether it is sensible or not.

### ***The Need to Review Existing Laws in Malaysia to Protect Astronomical Knowledge as a Heritage and a Need for a Sui Generis Law Protecting Traditional Knowledge***

Previously, it was briefly highlighted that, in the course of promoting astrotourism together with the cultural astronomical knowledge of indigenous and local communities, there is a chance that this valuable knowledge could be exploited without proper attribution to the parties who are its custodians. Published folklore relating to the astronomical knowledge of the Dayak-Ibans should have copyright and they should be paid royalties. Similarly too the song and lyrics depicting legendary heroes and heroines, princes and princesses of the Dayak-Ibans associated with the formation of stars and other celestial bodies should have a copyright. The problem with IPR is that it gives ownership of the copyright to individuals and not to the communities who are guardians of this astronomical knowledge. Furthermore, IPR provides protection for a certain duration of time whereas astronomical knowledge is communally owned since time immemorial and transverses from generation to generation without any time limit whatsoever.

An examination of Malaysia's National Heritage Act 2005 is needed to inquire whether indigenous and local communities' astronomical knowledge can find protection from being exploited under this law. Section 2(1) of Malaysia's National Heritage Act 2005 in its definition of intangible cultural heritage seems to cover "any form of expressions, [...] audible lyrics, songs, and oral traditions" but does not explicitly mention "astronomical knowledge" nor "scientific knowledge" that could protect this valuable information. However, the Iban song about the *bintang banyak* (*Pleides*) and its lyrics could find protection under Section 2(1) of the National Heritage Act 2005. A critical appraisal of the term "natural heritage" under Section 2(1) of Malaysia's National Heritage Act 2005 also is silent and excludes "astronomical knowledge". This is indeed a short-sightedness of the drafters of this law that now leaves "astronomical knowledge" vulnerable to be exploited.

Much can be learnt from Article 68 (1) of the amended Bangui Agreement 1977 in Africa as it refers to folklore to cover any "literary [...] religious, scientific, technological and other traditions [...] created by communities and handed down from generation to generation". If it is assumed that the elderly among indigenous and local communities have already passed down their astronomical knowledge to the younger generation through narration as though it were a story, then the knowledge on stars and celestial bodies can find protection under this article. Additionally, Article 68(2) of this Bangui Agreement 1977 has indicated that scientific knowledge and works, theoretical and practical attainments in the fields of natural science and astronomy, technical knowledge and productions, and agricultural techniques can be protected under this agreement. Indeed, astronomical knowledge can be protected under Article 68(2) of the Bangui Agreement 1977 as discussed.

Another example to emulate is the Cook Islands Traditional Knowledge Act 2013. This is a *sui generis* law which is one of its kind being created to protect communally owned traditional knowledge which cannot find protection under IPR laws. Section 4(1)(a) of its Traditional Knowledge Act 2013 defines this knowledge as one manifested in "tangible and intangible form [...] or was intended by its creator to be transmitted from generation to generation and must originate from a traditional community". Section 4(1)(b)(i) of the Traditional Knowledge Act 2013 explains that knowledge can be manifested as legends, songs or story (or other oral narrative) in the Cook Islands Maori or Pukapukan language. This way, any song that incorporates lyrics depicting the astronomical knowledge on the indigenous and local communities of Cook Islands or orally transmitted information about the stars passed on by the

elderly as a narrative of stories can be protected under this law. Section 4(1)(b)(xiii) of the Traditional Knowledge Act 2013 also protects traditional astronomical knowledge of practice. This being the case, any fishermen's astronomical knowledge about the stars to guide them in sailing can find protection under this law.

As for the case of South Africa, its indigenous people's astronomical knowledge can be protected under the Protection, Promotion, Development and Management of Indigenous Knowledge Act 2019, Science and Innovation. Astronomical knowledge practitioners can register valuable information they possess under this law from being exploited by third parties. The South African law is noticeably very specific in protecting indigenous communities but in the case of the Cook Islands, reference to traditional knowledge in a broad sense permits local communities knowledge apart from those of indigenous people to be protected on this island.

It is crucial that heritage laws or a *sui generis* system of law to protect traditional knowledge, including that of astronomical knowledge, be created because any opportunist might exploit this valuable information for commercialisation. Imagine someone creating a calendar out of the *piama bendang* in Kedah as discussed previously and selling the calendars as souvenirs to tourists in the course of promoting astrotourism. Another creative person may also choose to design t-shirts with the unique names given for each month of the *piama bendang* in Kedah and sell them for profit. However, these exploiters may not acknowledge the custodians who have held this knowledge all this while as a form of attribution and neither are royalties paid to those who communally retain this knowledge. This is the reason that Malaysia needs to amend its National Heritage Act 2005 to incorporate protection for astronomical knowledge, specifically, and navigation skills and techniques, and provide appropriate punishment to those exploiting this knowledge for commercialisation. It is also high time for Malaysia to have its own *sui generis* traditional knowledge law as this knowledge comes in all forms of manifestations with astronomical knowledge as one of them to be communally protected as ethnic groups in Malaysia possess this information, as discussed previously. As pinpointed by the UNWTO, having IPR or heritage laws in place to protect indigenous knowledge is vital to protect vulnerable indigenous people from being exploited.

### ***Malaysia's Tourism Packages, Talks and Training to Promote Cultural Astronomy***

In previous sections, this study has shown some examples of ethnic groups in Malaysia who are culturally rich in their own astronomical knowledge. While this may be the case, this section seeks to investigate the extent that tourism packages in Malaysia seek to incorporate these indigenous and local communities' astronomical knowledge as a way to diffuse precious information and prevent it going into extinction and to create awareness about its importance. On the other hand, ordinary talks could be prevalent in Malaysia in promoting the cultural astronomy of these indigenous and local communities organised by impromptu astronomy clubs or among associations in local universities. Table 8 below presents the results of the search conducted on social media such as Facebook and Instagram, the Tourism Malaysia and other websites which show tourism packages, ordinary talks and training, that have promoted indigenous and local communities' astronomical knowledge within the subject matter of cultural astronomy.



**Table 8: Tourism Packages, Training and Talks Incorporating Cultural Astronomy**

| No. | Dates                                             | Place                                                                                                    | Organisers                                                                                                                                                                                                            | Tourism Package | Talks | Training | Activity                                                                                                                                                                                                                                             |
|-----|---------------------------------------------------|----------------------------------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------|-------|----------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1   | 18-21 Dec. 2021                                   | Online at: <a href="http://bit.ly/astronomi_dan_budaya_2021">http://bit.ly/astronomi dan budaya 2021</a> | University Sultan Zainal Abidin Astronomy Club <sup>2</sup>                                                                                                                                                           | X               | √     | X        | A course on cultural astronomy exposing participants to the navigational methods using stars prevalent among Malays in the Nusantara.                                                                                                                |
| 2   | 11-12 Dec. 2021                                   | Online at <a href="http://bit.ly/astronomidanbudaya2021">http://bit.ly/astronomidanbudaya2021</a>        | University Sultan Zainal Abidin Astronomy Club <sup>4</sup>                                                                                                                                                           | X               | √     | X        | A programme on enlightening about the Kadazandusun's reliance on their almanac/calendar than depends on the movement of the sun and crescent moon to predict weather conditions whether suitable for agricultural activities.                        |
| 3   | - 8 July 2021<br>- 15 July 2021<br>- 22 July 2021 | Online                                                                                                   | <ul style="list-style-type: none"> <li>Astronomy and Information Sources Section, Mufti Department, Negeri Sembilan Government.</li> <li>Sahabat Langit Utara (SALUT), immature astronomy club<sup>1</sup></li> </ul> | X               | √     | X        | <ul style="list-style-type: none"> <li>A talk on the cluster of stars within the Malay Archipelago.</li> <li>Folklore on the sky theme talk.</li> <li>Astronomy and the <i>Orang Asli</i> talk.</li> </ul>                                           |
| 4   | Starting 25 June 2023 for 7 weeks                 | Langkawi island, Kedah                                                                                   | <ul style="list-style-type: none"> <li>Tourism Malaysia</li> <li>Langkawi Development Authority (LADA)</li> <li>National Corridor Economic Region Implementation Authority (NCIA)<sup>5</sup></li> </ul>              | X               | X     | √        | <ul style="list-style-type: none"> <li>Training for tour guides in Peninsular Malaysia regarding how they can benefit from astronomy to promote astrotourism.</li> <li>One of the training issues includes skylore and cultural heritage.</li> </ul> |
| 5   | 29-30 June 2024                                   | Bukit Jawa, World Heritage Site, Lenggong, Perak                                                         | <ul style="list-style-type: none"> <li>SALUT</li> <li>Tanjak Adventure Tour<sup>8</sup></li> </ul>                                                                                                                    | √               | X     | X        | Include sharing of legendary stories on a meteor which hit Lenggong 1.83 million years ago.                                                                                                                                                          |
| 6   | 2-4 Aug 2024                                      | Sungai Pin Conservation Area, Malaysia                                                                   | <ul style="list-style-type: none"> <li>Conservebyu by Sawit Kinabalu<sup>6</sup></li> <li>Dark Sky Malaysia</li> </ul>                                                                                                | X               | X     | √        | <ul style="list-style-type: none"> <li>A promotion of astrotourism in Sabah.</li> <li>The training included how celestial objects can be utilised in folklore as part of an item to promote dark sky tourism.</li> </ul>                             |
| 7   | 29 Nov 2024                                       | Paddy Museum, Gunung                                                                                     | <ul style="list-style-type: none"> <li>SALUT<sup>7</sup></li> </ul>                                                                                                                                                   | √               | X     | X        | In conjunction with the camping activities                                                                                                                                                                                                           |

| No. | Dates           | Place                                       | Organisers                                                                                              | Tourism Package | Talks | Training | Activity                                                                                                                                                                                                                                                                                                                                               |
|-----|-----------------|---------------------------------------------|---------------------------------------------------------------------------------------------------------|-----------------|-------|----------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
|     |                 | Keriang, Alor Setar, Kedah                  | <ul style="list-style-type: none"> <li>Paddy Museum, Kedah</li> </ul>                                   |                 |       |          | organised, a briefing was held concerning how the Kedahan Malays in the past relied on the <i>Pleiades</i> , a cluster of seven stars, to guide the seasons for paddy planting which related with cultural astronomy, thus the <i>bintang tujuh, tinggal enam</i> [seven stars, six left] refers to the visible and non-visible <i>Pleiades</i> stars. |
| 8   | 9 May 2025      | Archaeological Museum, Lembah Bujang, Kedah | <ul style="list-style-type: none"> <li>SALUT<sup>3</sup></li> <li>Museum Department Malaysia</li> </ul> | √               | X     | X        | An event called <i>Menyingkap Peta Bintang dan Khazanah Buruj Melayu</i> [Unveiling the Star Map and Treasures of the Malay Constellations] was held to provide an understanding concerning the Malays' interpretation of constellations.                                                                                                              |
| 9   | Throughout 2026 | Sungai Pin Conservation Area, Sabah         | Tourism Malaysia <sup>9</sup>                                                                           | √               | X     | X        | <ul style="list-style-type: none"> <li>A tourism package called Astrowild at SPnCA<sup>2</sup>, a blend of astronomy and wilderness in Sabah.</li> <li>Includes an event on the local indigenous folklore in interpreting stars, the moon and constellations in line with cultural astronomy.</li> </ul>                                               |

Sources: Bahagian Falak dan Sumber Maklumat (2021)<sup>1</sup>; Dark Sky Malaysia (2021)<sup>2</sup>; Jaafar (2025)<sup>3</sup>; Kelab Astronomi UniSZA (2024)<sup>4</sup>; Office of Astronomy for Development (2023)<sup>5</sup>; Rehman (2024)<sup>6</sup>; SALUT (2024)<sup>7</sup>; Tanjak Adventure Tour (2024)<sup>8</sup>; Tourism Malaysia (2025)<sup>9</sup>

Based on Table 8 it is noticeable that only a few astrotourism tours taking place in both East and West Malaysia have included the cultural astronomy aspect of indigenous and local communities as an event in their programme. Camping tours organised especially by SALUT in May, 2025, at the Archaeological Museum in Kedah, in Lenggong, Perak in June, 2024, at the Paddy Museum, Kedah on 29 November, 2024, and a tourism package promoted by Tourism Malaysia throughout 2026 in Sabah are just a few examples showing how cultural astronomy has started to take root. This shows that the realisation to include cultural astronomy as part of an item among astrotourism tours in Malaysia is still at its beginning. The implication from this is that any existing astronomical knowledge being held by indigenous and local communities could be further degraded since the oral dissemination of this knowledge is slow to pass on through astrotourism.

One weakness of the astrotourism tours currently being promoted in Malaysia is their failure to showcase the astronomical knowledge of Malay fishermen on the East Coast of Peninsular Malaysia, as highlighted in an earlier section. These tours have so far focused on dark, secluded locations on land, rather than offering night-time boat tours at sea where fishermen could impart their knowledge of stars used for navigation and fishing. As discussed in the literature review, Goodenough and Thomas (1987) noted the use of the boathouse as a space to train young navigators in identifying stars for navigation. Building on their ideas, this study proposes that astrotourism could be enhanced through boat journeys navigated by Malay fishermen on the East Coast, who could narrate and impart their knowledge of the stars that guide navigation as well as the types of fish associated with different conditions. Based on Table 8, the University of Sultan Zainal Abidin in Terengganu organised a talk in 2021 on navigational methods that rely on stars among the Malays in the Nusantara region. Moving beyond such talks, this study argues for incorporating these star-based navigational traditions into an appealing sea-based astrotourism package that would offer tourists a distinctly different experience.

Consecutive efforts have also been undertaken by Tourism Malaysia, LADA, and the NCIA to provide training for tour guides in Peninsular Malaysia on the use of cultural astronomy to promote astrotourism, as shown in Table 8. This aligns with the recommendation of the World Committee in Tourism Ethics (2019, p. 17), which emphasises the importance of training—particularly for young people—to prepare them as tour guides and support their entrepreneurial activities in the tourism sector. However, this study is critical of the initiative, as it argues that such training should also be extended to tour guides in Sabah and Sarawak to avoid discriminatory practices. There is significant potential in these two states to draw upon the astronomical knowledge of various indigenous groups to further enhance astrotourism.

Astrotourism camping tours organised by SALUT, especially with regard to the astronomical knowledge of the Malays concerning paddy planting and the navigation of stars, as well as that of the *Orang Asli* to guide their agricultural processes, is being presented by a postgraduate rather than a representative from an indigenous or local community itself. This indicates that a third party is the one disseminating the astronomical knowledge which could be misconstrued as it is not authentic and not coming from the indigenous or local communities themselves as first-hand knowledge. Referring back to the recommendation of the World Committee in Tourism Ethics (2019), as discussed in an earlier section, the committee asserts that the dissemination of astronomical knowledge should be carried out by representatives of the relevant indigenous or local communities to maintain the authenticity of the information and prevent misinterpretation.

In Sabah, one of the astrotourism packages promoted by Tourism Malaysia incorporates a cultural astronomy component in which indigenous folklore is presented. However, it remains unclear whether this cultural astronomy and folklore element will be delivered directly by members of the indigenous communities themselves or delegated to a third party. Tourism Malaysia's initiative to promote astrotourism in Sabah through the inclusion of indigenous astronomical knowledge is noteworthy, as this aspect has received limited attention in Borneo. As highlighted earlier in the literature review, Azam et al. (2024) identified Kampung Kapit in Sarawak as a promising location for astrotourism that could showcase the region's indigenous astronomical knowledge. The promotion of the astrotourism package at the Sungai Pin Conservation Area in Sabah draws further attention to East Malaysia, where indigenous

cultural astronomy has historically received scant governmental support, aligning with the concerns raised by Azam et al. (2024). Nevertheless, challenges may arise in identifying reliable indigenous practitioners who possess and continue to apply this knowledge. As discussed in an earlier section, the widespread adoption of Islam and Christianity among the *Orang Asli* and the Kadazandusun in Sabah has contributed to a decline in such practices. Consequently, society may view reliance on traditional astronomical knowledge as outdated or irrelevant. Additionally, the introduction of modern agricultural machinery, particularly in paddy cultivation, has further diminished the use of this longstanding practice.

It is stressed in this study that the continued legacy of practising astronomical knowledge dissemination has to be done orally and through a hand-on experience if it is to survive any threats from its demise. Astrotourism can be regarded as a means to disseminate that astronomical knowledge as a continuity from the past to live on by involving direct participation from indigenous people and local communities as first-hand informants functioning as paid tour guides. By providing regular salary to indigenous people to function as tour guides, they can disseminate this precious knowledge. It has to be remembered that the cultural security of ethnic groups all depends on the continuity of them practising their cultural practices, which includes their astronomical knowledge. If this knowledge is erased, it would mean that their cultural security will be eroded over time. While documenting these indigenous and local communities' astronomical knowledge through books and journal articles functions to suit academic researchers in preserving this information, the truth is that this knowledge will only survive through oral dissemination and practical hands-on experiences. Knowledge preserved in books and journals will merely remain for posterity and largely unused, accessible only to those specifically interested in the subject rather than being widely disseminated. Therefore, there must be training organised by relevant Malaysian departments to train indigenous and local communities still possessing this astronomical knowledge to be effective tour guides so that they can contribute towards astrotourism. Malaysia appears to be at an early stage in promoting the astronomical knowledge of its indigenous and local communities, especially when compared to more proactive countries such as Kenya, South Africa, Nicaragua, Australia, Canada, Ethiopia, and Peru, which have extensive experience in promoting cultural astronomy among their indigenous populations, as highlighted in the literature review (Banack & Hvenegaard, 2025; Goldsmith, 2014; Goshu & Ridwan, 2024; Machupicchu Gateway, 2025; Mexicohistorico.com, 2015; Viviers, 2025; Wyk-Jacobs, 2018).

Notably, this study deliberately omits emphasis on astrotourism initiatives that aim to promote Islamic *falaq* practices at observatories throughout Malaysia, as previously discussed by several scholars (Ahmad et al., 2022; Muttaqin et al., 2024; Safiai et al., 2020), because this aspect has already received considerable publicity and is not reflected in Table 8. This study purposely chose to focus on the less discussed astronomical knowledge practices among other ethnic groups in Malaysia besides those of Islamic beliefs because this study views their potential to be developed and publicised to contribute towards astrotourism. Malaysia being a diversified society, the promotion of disseminating astronomical knowledge must not be monopolised by Islamic *falaq* practices but should include those of other ethnic groups to promote equality and should be heeded by relevant Malaysian government agencies. This study views other ethnic groups' astronomical knowledge practices as a potential to contribute towards astrotourism and to uplift the indigenous people's economic strata since most of them live in poverty. This being the case, it is time to promote all ethnic groups' astronomical

knowledge equally through astrotourism as diversity symbolises unity among the different cultures.

It should be noted though that the astrotourism initiatives listed in Table 8 is by no means exhaustive since there could be other hidden initiatives not captured by search terms on the internet or there could be other private initiatives that are not listed on the internet or social media at all. Thus, this study acknowledges the limitation in making a generalisation that few astrotourism initiatives in Malaysia have incorporated the cultural astronomy aspect as there could be hidden efforts that are unknown.

## Conclusion

This study set out with the main objective to investigate the extent to which astrotourism can play a role in preserving the astronomical knowledge of Malaysian indigenous people and local communities from extinction to realise their cultural security. Based on the analysis, it can be concluded that astrotourism has a small role to play so far in preserving the astronomical knowledge possessed among Malay paddy farmers and fishermen because only a few camping astrotourism tours organised by SALUT have paid attention to incorporate talks about cultural astronomy not only among Malays but also the *Orang Asli*. In Sabah, only one astrotourism tour package under Tourism Malaysia has sought to incorporate the cultural astronomy aspect of its indigenous communities. This shows that the incorporation to promote indigenous and local communities' astronomical knowledge as part of the itinerary for astrotourism is at an infancy stage in Malaysia and is slow to pick up. Malaysia could face a setback in promoting its indigenous and local communities' astronomical knowledge to tourists because this precious information is almost going into extinction, especially among the *Orang Asli* in Peninsular Malaysia who have embraced Islam and the Kadazandusun in Sabah, East Malaysia who have converted to Christianity. The continuity in practising this astronomical knowledge based on prediction could be regarded as pagan beliefs and against the religion they embrace. Moreover, the introduction of modern machinery in paddy farming has also led to the demise in practising this astronomical knowledge among the northern Malays.

The implication from these findings is that, if they still retain the astronomical knowledge, elderly people within indigenous and local communities must be willing to pass down this information orally to their younger generation and provide practical training to them to revive this dying culture so that they could become proficient tour guides well-versed in cultural astronomy. This needs to be done fastidiously before the few remaining older generations who are custodians of this knowledge pass away. By this time, it will be too late as the astronomical knowledge once possessed by these indigenous and local communities will be totally lost. While documenting this precious knowledge in books and journals may be feasible for preservation, the continuity of this practice will be more effective through oral transmission and hands-on practices. In such a manner, this will lead to the cultural security of the different indigenous and local communities' wellbeing since they will be able to continue practising their astronomical knowledge for future prosperity.

This study has also highlighted the need to amend Malaysia's National Heritage Act 2005 to include the preservation of astronomical knowledge by adding clauses that recognise "scientific and technological traditions" created by communities and passed down through generations, as outlined in the Bangui Agreement 1997 in Africa. Alternatively, Malaysia could refer to the Cook Islands Traditional Knowledge Act 2013, discussed earlier, which explicitly protects



traditional astronomical knowledge. Notably, current IPR laws may be unsuitable for safeguarding the astronomical knowledge of indigenous and local communities, as these frameworks prioritise individual innovation. Under existing IPR laws, communally owned knowledge is not acknowledged, thereby necessitating a *sui generis* system through the introduction of a new Traditional Knowledge Act in Malaysia. This carries legal and policy implications for relevant ministries, such as the Ministry of Tourism, Arts and Culture—which may consider amending the National Heritage Act 2005—as well as the Ministry of Domestic Trade and Costs of Living, which oversees IPR laws and could initiate a comprehensive Traditional Knowledge Act that includes the protection of astronomical knowledge.

For future research, there is a need to conduct studies that monitor the progress of tourism companies in Malaysia to determine whether more of them will offer astrotourism tours featuring programmes that showcase the direct participation of indigenous and local communities and their astronomical knowledge, rather than relying on third parties. Future research may also examine the courses and curricula offered by Malaysian colleges and universities to assess whether any institutions have made sustained efforts to introduce subjects related to cultural astronomy. Such subjects should not be limited to science students but should adopt a multidisciplinary approach that includes the social sciences as well.

Additionally, further studies are needed to review the traditional knowledge laws of other countries as potential models for Malaysia if it intends to draft a new traditional knowledge law to protect the astronomical knowledge of indigenous and local communities, beyond the example of the Cook Islands previously discussed. This would provide Malaysia with a range of options should the country decide to develop such legislation. This study also highlights the limited but growing literature on international law pertaining to tourism, primarily in the form of non-binding soft law documents, which, although previously receiving little attention, provide guidance to countries in managing tourism and contribute to the corpus of knowledge.

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