DISTRIBUTION AND BREEDING BEHAVIOUR OF BRAHMINY KITE (*Haliastur indus)* ON PENANG ISLAND AND MATANG MANGROVE FOREST RESERVE, KUALA SEPETANG, PERAK

By

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ABSTRAK

Brahminy Kite (*Haliastur indus)* atau Helang Merah adalah haiwan yang dilindungi sepenuhnya di Semenanjung Malaysia. Merujuk kepada Jabatan Perlindungan Hidupan Liar dan Taman Negara 1992, populasi helang ini mulai berkurangan kerana kemusnahan habitatnya. Penyelidikan tentang taburan Helang Merah, kriteria pemilihan sarang, dan perlakuan, baik di kawasan terganggu (Pulau Pinang) mahupun kurang terganggu (Hutan Simpan Paya Bakau Matang, Kuala Sepetang, Perak) penting untuk dijalankan dalam memastikan usaha pemuliharaaan yang berkesan ke atas spesies ini terutama di Malaysia. Tinjauan dilakukan semasa musim mengawan, dan parameter mikrohabitat, seperti latitud, longitud, tinggi sarang, tinggi pokok, ketinggian pokok diatas permukaan air laut, dan ukur lilit pokok (GBH) di catat. Peta tata guna tanah dibuat guna mengenal pasti taburan sarang dengan menggunakan remote sensing (pemetaan jauh) dan Geographic Information System (GIS). Data makrohabitat, seperti jarak ke air, jarak ke jalan, dan jarak ke aktivi penduduk dikira dengan menggunakan GIS. Data mikrohabitat dan makrohabitat kemudian akan dievaluasi menggunakan ujian Mann-Whitney *U*-test dan Principal Component Analysis (PCA), sedangkan perilaku mengawan dicatat dengan tinjauan fokal. Di Pulau Pinang, sarang Helang Merah terletak di beberapa jenis habitat, seperti, bakau, kawasan pantai, dan berhampiran petempatan penduduk, sementara di Kuala Sepetang, Perak, semua sarang terletak di dalam kawasan bakau. Kriteria pemilihan sarang di Pulau Pinang berbeza antara satu sama lain walaupun ada sedikit kesamaan, jika dibandingkan dengan kriteria pemilihan sarang di Kuala Sepetang, Perak, yang mana semua sarang mempunyai kriteria yang sama. Ujian Mann-Whitney *U*-tests ke atas sarang-sarang burung di Pulau Pinang dan Kuala Sepetang, Perak, menunjukkan perbezaan corak yang signifikan ($p<0.05$). Ujian PCA ke atas habitat dan ciri-ciri sarang Helang Merah bergantung terhadap tiga pembolehubah utama, jarak ke air, jarak ke jalan, jarak ke aktivi penduduk, dan tiga pembolehubah sampingan, tinggi sarang, tinggi pokok, dan ketinggian pokok di atas permukaan air laut. Kajian ini menunjukan, kelakuan pembiakan sepasang helang merah di Pulau Pinang mempunyai persamaan dengan pasangan di negara lain seperti New South Wales, Australia dan di Tamil Nadu, India. Pasangan jantan dan betina helang merah berkongsi membina sarang, mengeram, dan menjaga sarang bersama-sama. Walau bagaimanapun, burung betina banyak menjalankan aktiviti mengeram dan memberi makan kepada anak-anak burung manakala burung jantan berfungsi menjaga sarang, mengusir pemangsa, dan menghantarkan makanan ke sarang.

ABSTRACT

Brahminy Kite (*Haliastur indus)* or Helang Merah is known as a totally protected bird in Peninsular Malaysia. Department of Wildlife and National Parks (1992) reported that their numbers are decreasing due to the destruction of their native habitat. For ensuring good management conservation of this species in Malaysia, the distribution, nest-site selection, and behaviors of Braminy Kite in both disturbed and less disturbed area should be studied. For this purposes nesting surveys were conducted in disturbed area (Penang Island) and in less disturbed area (Matang Mangrove Forest Reserve, Kuala Sepetang, Perak). The surveys were performed during the breeding season, and. the microhabitat parameters such as latitude, longitude, nest height, tree height, tree at elevation and Girth at Breast Height (GBH) were recorded. Land use map were made to identify the nesting distribution by using remote sensing and Geographic Information System (GIS). Macrohabitat data *i.e*, the distances of the nests to water, to road, and to built environment were calculated by using GIS. The microhabitats and macrohabitats data were then evaluated by using Mann-Whitney *U*-test and Principal Component Analysis (PCA), whilst the breeding behaviors were collected by using focal animal sampling. On Penang Island, Brahminy Kite nests were located in several land use activities, such as on mangroves, coastal area, and near human habitation, while in Kuala Sepetang, Perak the nests were located only in mangrove forest. PCA analysis showed that nests in Kuala Sepetang, Perak relatively have similar characteristics, whilst on Penang Island their characteristics were relatively different. Mann-Whitney *U*-test of the nests on Penang Island and Kuala Sepetang, Perak, was significantly different ($p<0.05$). PCA analysis also demonstrated that the nest site-selection of Brahminy Kite depended on three major variables, namely, distance to water, distance to main road, distance to built environment, and three minor variables *i.e.* tree height, nest height, and tree at elevation. Breeding behaviors of Brahminy Kite pairs on Penang Island were relatively similar to the kites that lived in New South Wales, Australia and Tamil Nadu, India. Both female and male shared efforts in building nest, incubation, and guard the nest. The female did most of the incubation and feeding activities, while the male did most of the caring of the nest and delivery preys.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

CHAPTER 1

INTRODUCTION

1.5 Background of Study

Much of the virgin forests in Malaysia have been cleared for agriculture, plantations, and industrial developments (Department of Wildlife and National Park, 1992). The changes and development has caused destruction of ecosystems and habitats, as well as global warming, which in turn have caused many species of plants and animals to be threatened with extinction (Reaka-Kudla *et al.*, 1996; Dolman, 2000).

Raptors have also decreased in number due to human disturbances, such as habitat loss, hunting, environmental pollution, and contaminants (U.S. Fisheries and Wildlife Service, 2002). Raptor population has been known to be a good indicator for detecting changes in the environment, climate, and land use as described by the work of Rodriguez-Estrella *et al.* (see Wichmann *et al.*, 2004, p.204). The number of raptors in Malaysia has decreased due to the opening and clearance of lowland forests for development (Department of Wildlife and National Parks, 1992). Deforestation, increase in urban development, and uncontrolled logging have caused many trees to be destroyed so that raptors have lost some of their nesting habitat. In addition, pesticides, garbage, oil spill, and water pollution could also affect their food chains (Department of Wildlife and National Parks, 1992), e.g, causing fishes and other preys to be killed or poisoned.

International Union for Conservation of Nature and Natural Resources (IUCN) listed Brahminy Kite (*Haliastur indus*) as a *least concern* species. *Least concern* species is defined as a species which has been evaluated against the criteria and found to be not qualified for critically endangered, endangered, vulnerable, or near threatened. Widespread and abundant species are also included in this *least concern* category (IUCN Red List, 2007). However, in Peninsular Malaysia, the Department of Wildlife and National Park has listed Brahminy Kite as a totally protected raptor under the Wildlife Protection Act 1972.

The abundance of Brahminy Kite is related to mangroves, which they depend for survival (Shahrul Anuar *et al.*, 2006). Therefore, any loss of these habitats could affect them negatively (Wells, 1999). Spalding *et al.* (see Ashton *et al.*, 1999, p.77) described in the period of 1980 until 1990, 12% of the mangrove forests in Malaysia have been lost. In the State of Penang 22,050 ha of mangrove forest has been lost during the year of 1959 to 1999 (Mangrove Working Group [UPEN and DANCED], 1999). Mangrove forest on Penang Island was left only about 370 ha in 2010 (Penang State Forestry Department [unpublish data], 2010) (Appendix B). In the year of 1999 to 2010, mangrove forest on this Island was lost about 10.19% from its total area. This implies that the raptor's function in the food chain, ecology, and breeding habitat has also been affected. Due to these reasons, Brahminy Kite is categorised as a totally protected species in Malaysia (Rahmah, pers. comm., 2010).

Raptors play an important role in the ecosystems because they are located on top of the food chains and control all the food chains below them (U.S. Fisheries and Wildlife Service, 2002). Some raptors, including Brahminy Kite, are also

valuable waste collectors because they feed on carrion (Few *et al.*, 1988). Raptors only hunt to feed their chicks or if they are hungry. Thus, there is a natural balance between the predators and the preys. The reduction in the number of the predators will cause an increase in the number of preys which will cause instability in the ecosystem.

The success of raptor breeding is affected by several aspects, such as, environmental differences between areas, habitat, and territories. A suitable habitat is important for all species including raptors. A species select its habitat based on the availability of food, water, and the safety of the nesting site. These factors are necessary for its survival (Cody, 1985). Therefore, study on a species' habitat characteristics is important and could be useful for developing habitat management and conservation plan (Ontiveros and Pleguezuelos, 2003). Hence, studies and observations of existing Brahminy Kite's nesting locations would be important to understand the environmental suitability and habitat prerequisite for Brahminy Kite nesting site. This data would be needed to find potential location for Brahminy Kite conservation. However, due to the widespread range of Brahminy Kite nesting locations, it would be difficult to collect the data.

Remote sensing and Geographic Information Systems (GIS) can be used to obtain and analyse data on Brahminy Kite's nesting distribution in Malaysia. GIS and remote sensing were used to predict the distribution of nesting site habitats of Eastern New Zealand falcon (*Falco novaeseelandiae*) in Otago (Mathieu *et al.*, 2006). Meanwhile, nest-site preferences of Elenora's falcon (*Falco eleonorae*) on a western Mediterranean Island were studied using GIS and Digital Terrain Models (DTM)

(Urios and Martinez-Abrain, 2006). Records of birds, vegetation characteristics, and habitat maps were analysed in order to build a GIS based-model of Serengeti grassland bird species (Gottschalk *et al.*, 2007). These tools are also useful for detecting conflicts between human activities and wildlife (Stoms and Estes, 1993). Many information, such as, vegetation, land use, and landscape structure can be extracted from satellite imagery (Haines-Young *et al*., 1993). These data can be used to analyse and to find the relationships between the kites breeding and nesting site locations with their habitats, such as vegetation and landscape structures in particular areas.

The distinctive habitat of Brahminy Kite is generally in tropical and subtropical coasts, such as mangroves, coral reefs, rocks, and so forth. In India, it can also be found on lakes, rivers, and swamps. In Peninsular Malaysia, Brahminy Kite is typically found in mangrove forest (Wells, 1999; Ferguson-Lees and Christie, 2001). In Australia and Tamil Nadu, India, Brahminy Kite is found near human environment (Sivakumar and Jayabalan, 2004; Lutter *et al.*, 2006). This shows that Brahminy Kite can be found in two different areas, first in places or forests which are far from the human environment (less disturbances; can be defined as relatively less disturbed environment), and secondly, it can also be found near to the human habitat (more disturbances; can be defined as disturbed environment). Therefore, it is interesting to study the difference of their nesting characteristics, selection, and behaviour in both different areas, in order to identify their nesting behaviour and preferences.

It is known that some mangrove forests in Malaysia are declining due to land conversion, such as on Penang Island, but some are in very good condition, such as, in Matang Mangrove Forest Reserve, Perak. Matang Mangrove forest has been known to be the best sustainable, managed mangrove forest in the world (Muda and Nik Mustafa, 2003). Its ecosystems remain natural without many disturbances. No distinctive habitats have been lost from the Matang Mangrove forest (Muda *et al.*, 2005). The forests provide permanent refuge to entire species, therefore, it has been placed as conservation forest and categorised as a totally protected forest. This would allow it to be defined as "less disturbed area". Less disturbed indicates that forest or the region is relatively free or very low human disturbances and relatively far from human territory. It is typified by high species richness and a plenty of stabilize epifauna which also makes complex of microhabitats available for other species (Talman *et al.*, 2004). Hence, Matang Mangrove Forest Reserve would be a good place for studying the Brahminy Kite's nesting distribution and characteristic in less disturbed area.

From 1959 to 1999, mangrove forests on Penang Island were declining (Mangrove Working Group [UPEN and DANCED], 1999) due to the higher rate of land reclamation for urban use. The loss of this forest could have led Brahminy Kite to lose their important nesting and breeding habitats. Therefore, the population of Brahminy Kite on Penang Island has been observed to decline (Kanda, pers. comm., 2008). Penang state is the second most urbanised state with urbanisation level growth at increase of 51% in 1970 to 79.5% in 2000 (Jafaar, 2004). Land cover classifications over Penang Island have also been studied by using SPOT data (Lim *et al.*, 2009). High urban population growth has caused land uses for housing and

other linked services to increase rapidly in Penang for the last four decades. Therefore forest on Penang Island can be defined as “disturbed area”. In this study, disturbed shall be defined as forest area, which is declined due to urban-use, or relatively close to the human territory, and all their activities; it is characterized by reduced of the structural diversity and heterogeneity of the habitat and supremacy by some species only (Talman *et al.*, 2004).

Brahminy Kite nesting and breeding behaviour has been studied in northern New South Wales by Lutter *et al.* (2006). Sivakumar and Jayabalan (2004) reported the Brahminy Kite nesting and parental feeding in Cauvery Delta Region, Tamil Nadu, India. There were also many publications which reported on nesting habitat, breeding, and macrohabitat selection of some other raptors (Bosakowski *et al.*, 1992; Berkelman and Fraser, 2002; Stout *et al.*, 2006; Kaneda *et al.*, 2007; Woodford *et al.*, 2008). However, in Malaysia, this study was conducted; studies and data on raptors, including Brahminy Kite have not been recorded scientifically. The status of Brahminy Kite is also equally poorly documented and understood. According to the Department of Wildlife and National Parks Malaysia, the population of Brahminy Kite in Malaysia has not been recorded systematically and completely (Appendix A). The individual recorded of Brahminy Kite from 1992 to 2002 in each state of Malaysia were poorly recorded, and many of them were labeled as “no record”. Thus, it is essential to study the ecology, behaviour, and distribution of Brahminy Kite in Malaysia to establish the baseline information.

In this study Brahminy Kite's nesting habitat and site-selection are compared between "disturbed" (i.e., Penang Island) and "less disturbed" (i.e., Matang Mangrove Forest Reserve, Kuala Sepetang, Perak). The data obtained are necessary for the study on conservation management of this raptor.

1.6 Rationale

At the time of this research, there was almost no detailed study on raptors (including Brahminy Kite) that has been conducted in Malaysia. Only a little information about its management and conservation was available. This has resulted in a large knowledge gap on its ecology, behaviour, and local distribution. Currently, the population of Brahminy Kite faces threats and decline due to habitat loss, due to deforestation and pollution (Department of Wildlife and National Parks, 1992). A preliminary study on Penang Island revealed that the Brahminy Kite population is decreasing due to the destruction of mangrove forest in many parts of the island (Kanda, pers. comm., 2008). It is generally known that mangrove forest is its natural habitat, although Brahminy Kite also lives on other areas, such as, on coastal, lakes, and so forth.

Many factors such as habitats, food resources, and human activities could influence the distribution of Brahminy Kite, however, it would be not possible to quantity all of those factors directly (Gough and Rushton, 2000). Therefore, for this study, remote sensing and GIS are used to identify the habitats, nesting characteristics, and distribution of Brahminy Kite. It is necessary to create a simplified representation of the species by identifying factors that are considered to

have the greatest influence on their distribution (Thompson *et al.*, 2004). Field observation on its behaviour is also carried out to complement the other aspects.

For the present study, GIS was used to locate the distribution, habitats, and nest site-locations of Brahminy Kite. SPOT 5 image was used to map Brahminy Kite's nesting distribution. Each land use was identified for locating the most suitable areas for its habitat. Statistical analyses using Principal Component Analysis (PCA) and Mann-Whitney *U*-test were performed to determine the preferred habitat variables of Brahminy Kite. All these information have to be obtained to determine the appropriate conservation strategies for Brahminy Kite in Malaysia.

In the future, the study could also facilitate a more accurate and advanced estimation of threat, and conservation status of Brahminy Kite. Spatial information studies like these could also be used to attract students, professionals, and also nature enthusiasts to selected areas that provide the most suitable observation places for Brahminy Kite in their natural environment without disturbing their natural habitat.

1.7 Objectives

The objectives of the study can be summarised as follows:

1. To establish the nest site-selection, criteria, and variables for Brahminy Kite's based on "disturbed" and "less disturbed" areas. For this purposes, the multivariate statistical analysis (PCA) and Mann-Whitney *U*-test were performed. Important variables that might influence the nesting selection and criteria were determined.

2. To determine the abundance, distribution, and characteristics of Brahminy Kite's nesting locations on "disturbed" and "less disturbed" areas. The field studies were performed at both locations on Penang Island (disturbed area) and Matang Mangrove Forest Reserve, Kuala Sepetang, Perak (less disturbed area). The macrohabitat analysis was carried out by using GIS.

3. To understand the behaviour of Brahminy Kite pairs during their breeding cycle.

1.8 Overview of the thesis

Chapter 1 describes the introduction, background, and objective of this present work.

Chapter 2 presents literature review. It consists of the appearance and distribution of Brahminy Kite (*Haliastur indus)*, breeding behaviour, diet, habitat, nest site-selection, and land use changes and their effects to the species.

Chapter 3 analyses and discusses the abundance, nesting distributions, and nest site-selection of Brahminy Kite in disturbed area (Penang Island). Field study was conducted to determine the macrohabitat characteristics, whilst land use mapping is evaluated using GIS. PCA and Mann-Whitney *U*-test statistical analysis are performed to evaluate variables of nesting preferences.

Chapter 4 analyses and discusses the abundance, nesting distributions, nest site-selection of Brahminy Kite in less disturbed area of Matang Mangrove Forest Reserve, Kuala Sepetang, Perak. Comparisons between two areas are made to demonstrate the effects of land use changes on its population.

Chapter 5 discusses the behaviour of Brahminy Kite during its breeding cycle. The field work was performed by observing four pairs of Brahminy Kite found at the campus of Universiti Sains Malaysia, Penang.

Chapter 6 presents the overview of the breeding process of Brahminy Kite. The most important factors which could influence the nesting selection and breeding processes of Brahminy Kite were described.

Chapter 7 presents the conclusions and recommendations of this study.

CHAPTER 2

LITERATURE REVIEW

2.1 The appearances and distributions of Brahminy Kite (*H. indus)*

Brahminy Kite (*H. indus)* is known as a raptor, a predatory bird that feeds on other animals. There are two kinds of raptors. The first one is the diurnal raptors (the Falconiformes), such as, hawks, falcons, and eagles. The other one is the nocturnal raptor (the Strigiformes), such as, owls (Ferguson-Lees and Christie, 2001; U.S. Fisheries and Wildlife Service, 2002). The Accipitridae family is the largest family of the Falconiformes. There are many species in this family, such as, accipiters, kites, hawks, buzzards, harriers, eagles, old world vultures, and sparrowhawks.

Brahminy Kite (*H. indus*) is one of the species in the Accipitridae family which is a largish-kite raptor (Ferguson-Lees and Christie, 2001). Brahminy Kite is also known as the Red or Rufous-backed/White headed Kite/Sea-/Fish Eagle and Whistling Eagle/Kite. In Malaysia, Brahminy Kite is a resident raptor; it does not migrate (Davison and Chew, 1995; Ferguson-Lees and Christie, 2001).

Brahminy Kite's features white and chestnut feathers (Plate 2.1), small head, short wing, tail and legs, as well as weak feet (it can only select certain preys; such as, fishes, insects, and small mammals). Female and male are similar; however the female is 3%-7% larger than the males. As juveniles, its colour is brown (Plate 2.2.). A juvenile develops into an intermediate immature stage in six months. It grows to a complete adult in 12-15 months (Ferguson-Lees and Christie, 2001). The appearance

of a Brahminy Kite's juvenile may be misidentified with some other species, such as, Black Kite, Square-tailed Kite, Whistling Kite, Pale-morph Little Eagle, juvenile Marsh Harriers, Pale-morph Black-breasted Kite, Common Buzzard, and Dark-morph Booted Eagle (Ferguson-Lees and Christie, 2001).

In general, Brahminy Kite's distribution site covers along Indo-Malayan, Australasian, and south-east Paleartic (32^{o}N to 32^{o}S). The raptor can be found in Pakistan (except Baluchistan and North West Frontier Province), South Himalaya through Peninsular India, Sri Lanka, Bangladesh, Burma, most coastal countries of south-east Asia, south-east China, south through Andamans (excluding Nicobars), the Philippines, Malaysia, Indonesia, Moluccas to New Guinea, Bismarck Archipelago, Solomons, Lousiades, as well as north-west, north, and east coastal of Australia (Ferguson-Lees and Christie, 2001) (Fig.2.1). In Peninsular Malaysia, it is distributed in Melaka, Johor, and south estuaries from Penang to Singapore, and in Kuala Lumpur (Wells, 1999). There are four subspecies of Brahminy Kite. *H. indus indus* is located in Indian region, Sri Lanka, Andamans, south-east Asia to China, and Thailand. *H. indus intermedius* is found in Malaysia, Philippines, and Indonesia. *H. indus intermedius* in Malaysia is usually about 44 to 52 cm long and weigh about 500-580 g (Ferguson-Lees and Christie, 2001; Department of Wildlife and National Park Malaysia, 2008). *H. indus girrenera* appears in the Moluccas and eastern Lesser Sundas from Timor through New Guinea, and Australia, while, *H. indus flavinostris* is seen in Solomon Islands (Ferguson-Lees and Christie, 2001).

Plate 2.1. An adult Brahminy Kite (Flickr, 2008)

Plate 2.2. A juvenile Brahminy Kite (Flickr, 2008)

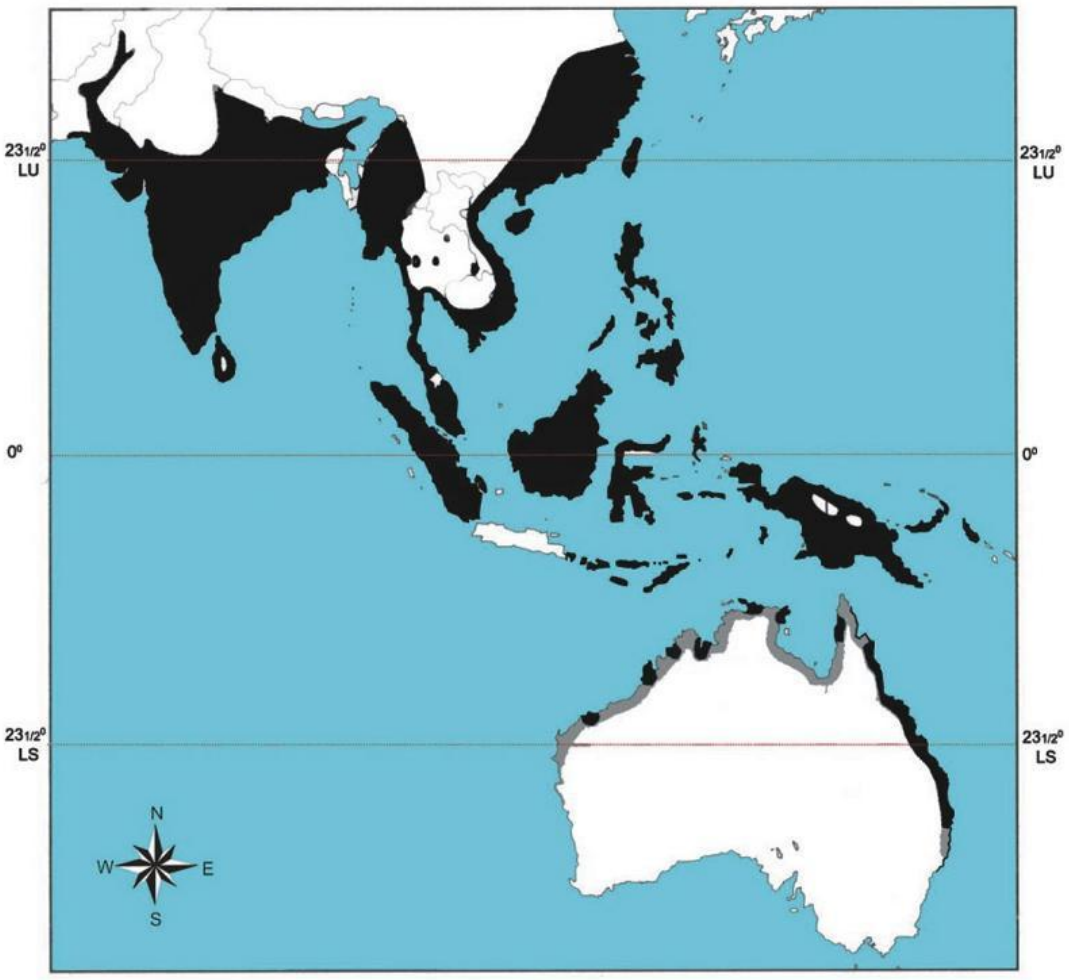

Fig 2.1. Distribution Map of Brahminy Kite in the World;
black: resident, grey: regular but not breed
(Ferguson-Lees and Christie, 2001)