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Caves and karst of SW Sarawak, Malaysia – an overview

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Dedication

Dr Gerald (Wilf) Edward Wilford, OBE,
1928–2019.

David William Gill,
1941–2024.

Abstract: The caves, if not the exposed outcrops, of spectacular tropical karst, in the Bau–Serian area of western Sarawak have largely been incidental to studies published on the area during the past four decades. This Report collates and updates known information on the history, caves, karst, biodiversity, conservation, protection, threats, tourism potential and references, as compiled by the authors over this period.

Despite almost two centuries of increasing knowledge of the area by outside authorities, the karst of SW Sarawak is not well-known. Mapping of most known caves is rudimentary, and it is likely that the known caves constitute only a small proportion of the those that exist. Unless cave exploration and the speleological sciences become established pursuits and accepted foci of study in Sarawak, with dedicated research projects, it seems that quarrying will remain as a serious threat and continue to destroy caves of historical, economic, and environmental importance.

Keywords: Biology; Borneo; conservation; description; geology; history; tropical; limestone; lists; location; protection; threats; tourism.

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Toponymy: (*See also **[Note 1]**, below*). The names given to the exposed areas of karst outcrop are taken predominantly from Wilford (1964), and from geological and topographical maps. Where, in a few cases, the identity of a small karst area is not known to the authors, the name of the nearest village, or that of the closest major named karst is used. It is important to note that local names might differ, slightly or completely, from those that appear on maps or in publications: a situation to which multilingualism, misunderstanding, mishearing, and orthographic changes have all contributed. Gunung (Gunong in older orthography) means mountain; Bukit means hill, but Batu, stone (and milestone), is also used for small hills: the Bidayuh name for hill is Dorod (or Dered). Sungei is a river or stream; Kampong (Kampung) a village. The Malay word for cave is Gua (derived from Sanscrit, gúhā); Lubang (Lobang), meaning a hole, opening, or gap, is also used. The Bidayuh word for cave, Tang (and dialectic cognates like Tahang, Ta'ang, perhaps from Tang in Hakka, or Dòng in Mandarin Chinese), may identify only a specific entrance, the whole of a single or multi-entrance cave, or individual parts of a cave (typically by ownership (for birds' nest rights), but perhaps also by character (the stream cave; the upper cave;...)). Further, the Bidayuh have a name for many peaks: a single mountain can therefore have multiple names, besides those bestowed by outside officials and mapmakers. Generally, the names of the outcrops and caves are derived from the local community but beware: the Bidayuh word Raya, meaning Big, often crops up.

[Note 1] *The indigenous, largely rural, population within the Sarawak River basin, the Bidayuh (referred to as Land Dayak until the creation of Malaysia in 1963) are identified by regional dialects, which are not always mutually comprehensible. There are also substantial numbers of Chinese, and some Malays, in Bau town and other small townships.*

Introduction

The primary objective of this Report is to promote conservation of the caves and exposed outcrops of karstic rock in the Bau–Serian area. Achievement of this objective requires the collation of known data to justify Total Protection, rather than watching as the outcrops are removed progressively, for use as roadstone and in cement manufacture.

The Bau–Serian District of West Sarawak is a tropical area of outstanding natural beauty, with numerous spectacular karst towers and peak clusters. Arguably these correspond to the *fenglin* and *fengcong* of modern geomorphological terminology adopted from China (Waltham, 2008) but, nevertheless, this Report retains the use of the more-descriptive English terms.

Whereas most of the area is drained by the western and southern branches of the Sarawak River, its southeastern part lies within the Sadong River catchment. Despite it attracting significant early interest (Laverty, 2025), little has been published concerning recent studies of the area's caves, karst, and biodiversity. Most published geological reports pre-date 2000, with the emphasis then on mineral deposits, principally gold. Among the few reports published during the past 30 years, most relate to archaeology and biodiversity. The groundbreaking work of the late Dr G E Wilford, mainly from 1949–1965 (Gill *et al*., 2023), contributed substantially to the present knowledge of the caves and karst of the area (Wilford, 1955, 1962, 1963, 1964; Wilford and Kho, 1965; Wilford and Wall, 1965). Wilford's 1964 publication, which has inevitably been considered as the "bible" of Sarawak speleology, provided the catalyst for the eventual exploration of the Gunung Mulu caves (Mulu Caves Project, from 1978).

Prior to the Mulu'80 Expedition, during a four-man reconnaissance visit, a few caves south of Bau and at Jambusan were explored and mapped (Crabtree and Friedrich, 1982), and Phil Chapman made a collection of cave fauna, details of which are being published (Chapman, 2025). The Oxford University Cave Club (OUCC) explored and mapped caves between miles 14 and 20 of the Penrissen Road (which now extends beyond Semadang as the Jalan Puncak Borneo (Borneo Heights Road), as well as recording some caves near Temurang (Laverty, 1983). Additional explorations have taken place during the past decades, but the work was neither well-coordinated nor well-documented ***[Note 2]***. Uncoordinated activities, in some cases recorded online or in undated sketches, continue alongside more-serious interest in karst, as summarized, for example, by Drawhorn (2022). However, interest in the sporting and touristic potential of caves has grown significantly, with *Kuching Caving* – a guided-caving business that was run by Handfield-Jones with Bidayuh partners and staff from November 2007 until the Covid-19 pandemic of 2020 –being a prominent example.

Location

The town of Bau (Fig.1) lies within the Kuching Division, approximately 26km straight-line distance southwest of the capital city of Sarawak, Kuching, with the travel distance being about 32km on good, paved road. Serian town lies some 57km along the Pan-Borneo Highway (Asian Highway Route AH150) from Kuching. The karst area centres approximately on UTM coordinates 49N: 426601m E: 137566m N,

Bau is the capital of Bau District, with an area of 884.4km^2 and a population of 52,643 (2020 census). Outside the town, most people are Bidayuh (known as Land Dayak before independence within Malaysia) who were based on the hills above their farms and forests. Small numbers of Malays lived along the rivers, while Chinese from Sambas (to the SW) crossed the watershed and began settling early in the 1800s, making Bau their gold-mining centre by the 1850s.

[Note 2] *David William Gill, Rambli Ahmad of Sarawak Forestry Corporation (SFC), David Clucas, and Jos Burgers conducted some partial cave surveys in 2007, 2010 and 2011. This work on the Joara, Skunyit, Trans-Borneo Highway, Trumat, Chupak, Temurang caves is recorded in the British Caving Association (BCA) Cave Registry Data Archive (Clucas, 2015). Between 2007 and now, James Handfield-Jones has collated much information about the Bau–Serian caves, as well as locating and GPS-fixing the sites of many new caves and surveying 14 of them (Handfield-Jones, 2021); much of the unreferenced information in this publication derives from personal communications with him.*

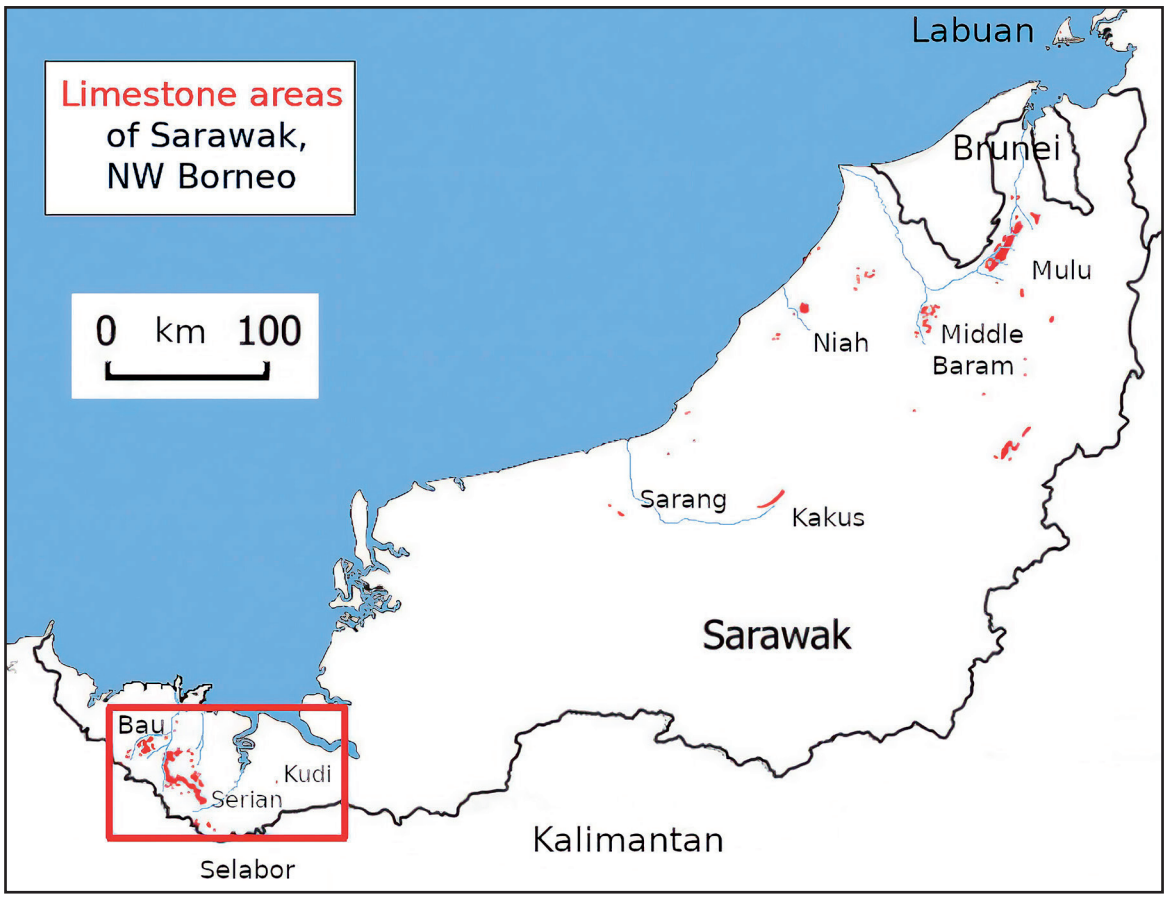

Figure 1:
Location of the Bau–Serian karst area in SW Sarawak.
[After Marzuki et al., *2021.]*

The area remains agricultural, but also supplies limestone for road making and cement manufacture. Serian grew up as the administrative centre for Sadong, bordering the region where Bidayuh settlement gave way to that of the Iban (Sea Dayak) people, expanding since the mid twentieth century, when road transport reached it.

Historically, Malay Governors were posted to Sarawak from Brunei, and it was opposition to them that led to James Brooke establishing his independent – but British-derived – government in 1841, by which time Chinese settlers had been farming, trading, and working alluvial gold deposits in the Bau area for several decades. In Singapore in 1823, antimony-bearing material was identified among the ballast of shipments arriving from Sarawak, and subsequently antimony-ore extraction became an increasingly valuable activity. Established in 1856, The Borneo Company (BCL), soon involved itself with mining antimony ore at Bidi and Jambusan, shipping it from Buso. Mercury ore was later found at Tegora, which was a major mining settlement between 1867 and 1896. From 1884, BCL took-over gold mining in the area, increasing extraction in 1898 by use of cyanide; effectively production ceased in 1921 (Lucas, 1949), after which small-scale mining by the Chinese continued (Wilford, 1962). There have been occasional revivals of mining, and investigations continue, but at present there are no active commercial operations, just illegal activities by opportunistic individuals.

Maps

Detailed official topographical and geological maps ***[Note 3]*** are subject to restricted access controls in Sarawak. Earlier maps, dating from the British colonial era, are available (e.g. at Bruno Manser Fond's Sarawak Geoportal), but these lack the details of subsequent substantial urban and rural developments and massive extensions to the road system. Satellite and open-source maps now provide equally good or (arguably) better sources. Outcrops of the known karstic rocks throughout Malaysia have been mapped by a team from the Universiti Malaysia Sabah campus: for comments, see ***[Note 4]***. The approach to producing the maps illustrating this Report is summarized in ***[Note 5]***.

[Note 3] Topographical maps at 1:50,000 scale, published by Director of National Mapping Malaysia in 1973, were based on British Directorate of Overseas Surveys maps from 1955. Series MY512A has been issued since 2016. Distribution of these maps is restricted, although geological maps on the same base may be more readily available, albeit out of date. N.B. All Sarawak Government Departments, and maps, use the Timbalai 1948 datum in official documents, notably Gazette notices for National Parks, Nature Reserves and Wildlife Sanctuaries. This is an ellipsoid model optimized for Borneo: it will be less affected by plate tectonic movement relative to the USA, whereas the WGS coordinates, as used for most online maps, and default for GPS, will drift. Therefore, there is a discrepancy in coordinate locations described in publications including boundary mapping from WGS84 coordinates. The official coordinates currently plot about 200m W in the Fairy Cave area, and will vary across the area, as can be demonstrated by conversion from Timbalai 1948 to WGS84 using parameters available at: https://epsg.io/1852.
Elevation data are also inconsistent because they use different geoid models.

[Note 4] The Sarawak entries in an apparently exhaustive gazetteer of Malaysian limestone outcrops (Liew et al., 2021) have been cross-referenced with our own research and that of Banda et al. (2004). The gazetteer's mykarst-ids are listed for reference, but we have excluded some of their sites in SW Sarawak as of little speleological interest (Small lenses in Padawan Formation: [mykarst-]345, 351, 352, 386, 409, 414, 424-430; small lenses of Kedadom Formation: 411–413, 423, 431, 877; flat (unquarried) areas 331, 332, 338, 343, 344); note that at least one site is misplaced (381 Trumat); and at least seven sites known to us are missing (Tondong, Bukit Young, 10th Mile, Kakad, Mayong, Segon, Kudi). We do not agree with all of their names, but do not expect that everyone will agree with our choices (from Wilford, Banda, topographic maps, or local experience) either: quite apart from names differing by language, oral interpretations can be quite differently transcribed.

[Note 5] The maps compiled for this Report were made using the QGIS Geographical Information System, with Digital Elevation Model (DEM) from the NASA SRTM at 30 metre contour intervals. Coordinate Data System utilized for the maps is the Universal Traverse Mercator, UTM Zone 49N, European Petroleum Survey Group (EPSG) 3249, World Geodetic System, WGS84.

Climate

The area has a high-humidity tropical climate with around 4500mm of rainfall per annum; a NE monsoon imposes higher rainfall between November and February, delivered typically as short, heavy storms. Temperature variations are relatively small, with values generally between 23° and 32°C.
The designated Biogeographical Province is 4.25.12 (Borneo). Indomalaya Realm (Udvardy, 1975).

Geology

Two main karstic limestone units are identified and delineated on the maps produced by the Geological Survey Department of Malaysia (Sarawak):

Bau Limestone Formation (Late Jurassic to Early Cretaceous)
This includes rocks of reef facies, which may have moderate- to steep folding and are massive, pale, high-purity limestones, poorly bedded and jointed, with limited chert and a generally low magnesium content (Banda *et al*., 2004). Intrusive rocks are widespread within the Bau area, where they form prominent hills away from the limestone or more subdued relief within, with dykes represented by elongated corridors. Mineralization is associated with the intrusions, but mostly within the shales rather than in the limestone. Commonly the limestones either overlie older volcanic rock units or are interbedded with shales; much of their outcrop is overlain by alluvial deposits.

As previously mentioned, commercially important quantities of mercury and antimony ores were worked from Bau's Tertiary intrusive rocks (Liechti, 1960), within and adjacent to the limestone outcrops. Gold has been mined for longer, with varying degrees of success, from four geological settings associated with silicification, in some cases involving replacement of the limestone. It occurs within calcitic skarn deposits or in two distinct types of quartz and calcite veins (Percival *et al*., 1990), as well as disseminated within sedimentary deposits (Kirwin and Royle, 2018). Whereas current gold-mining activity is confined to clandestine prospecting in some caves, in 2018 39 mining licences, certificates, and prospecting licences (now believed to be expired) were held by the Bau Project JV (Besra and its Malaysian subsidiary, North Borneo Gold, Gladioli Enterprises, and Golden Celesta) (Stevens and Fulton, 2010; Fulton, 2013, Wright, 2018). Extraction would have been by open pit excavation, as at Tai Parit, where subsequent flooding has created Bau's Tasik Biru (Blue Lake).

Terbat Limestone Formation (Early Permian)
Isolated to the south of the Bau–Serian karst this forms Gunung Selabor, rising to 400m, and isolated outcrops farther to the southeast and north of the Sungai Kedup at Kampong Terbat. It is a fossiliferous, cherty, pale grey to black limestone, which dips steeply (some bedding planes appear to be vertical), with thin shale beds. It is the oldest limestone outcrop known in Sarawak at ~300 million years.

Wilford's career took him away from Borneo in 1968, shortly before plate tectonics became widely accepted as the explanatory basis for large-scale geology. An analysis based on these new ideas, considering the observed stratigraphical, structural, and mineralogical features of the Bau area, was presented by Schuh (1993). Absence of rocks older than late Carboniferous in the Bau–Serian area, along with the apparent lack of tin mineralization, has been interpreted as showing that there is no underlying remnant continental (sialic) crust. Instead, there are ocean-floor deposits derived from a possibly Precambrian landmass to the southeast, succeeded by reef carbonates (including early Permian rocks at Selabor, then Jurassic deposits), not far from a subduction zone that gradually migrated northwards to establish Sundaland (van Bemmelen, 1949). Subsequently the reefs were overwhelmed by inputs of muddy sediments, followed by subaerial emergence and the deposition of the terrestrial conglomerates and sands that dominated Late Cretaceous sedimentation.

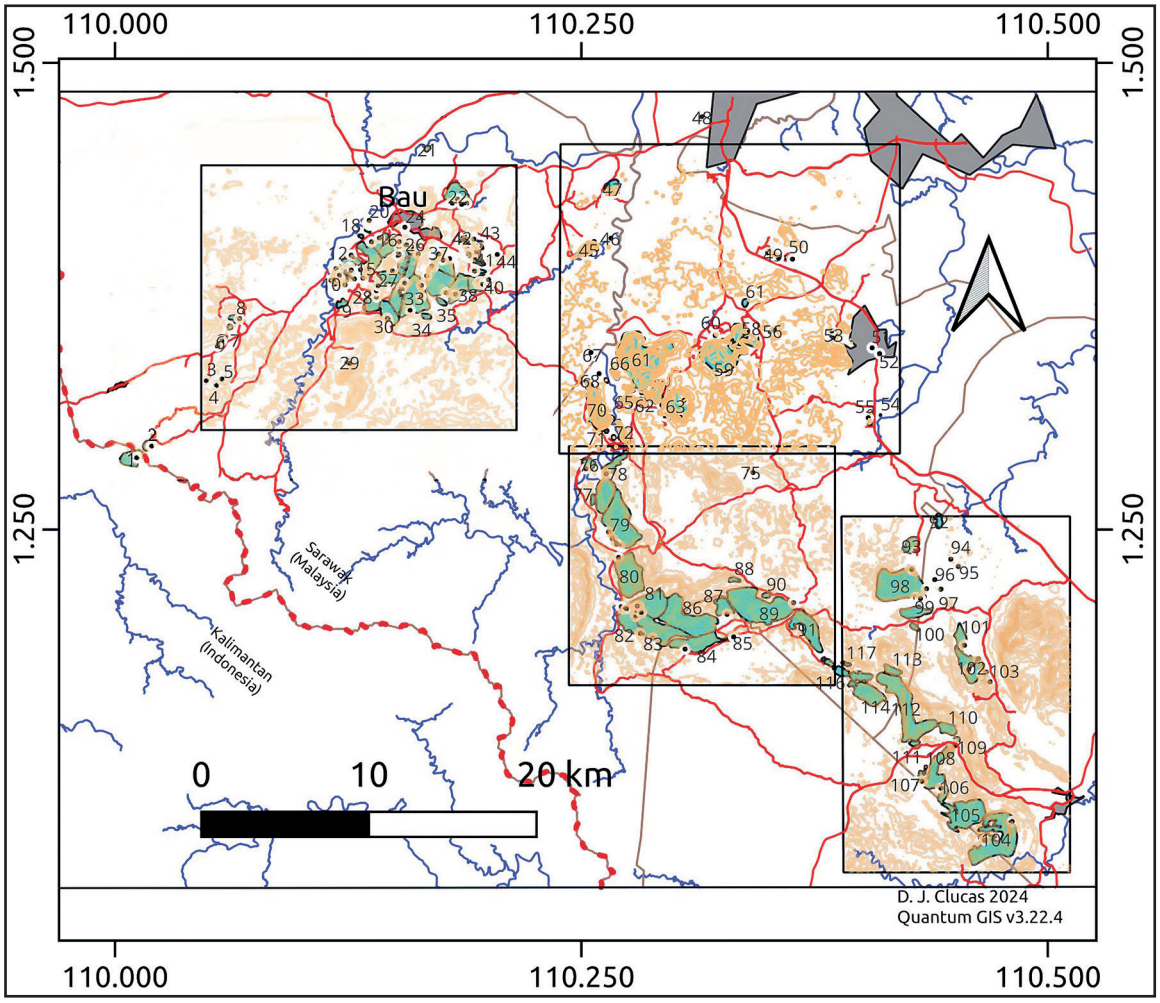

Figure 2:
(*shaded pale blue-green), with:*
Key:
cave entrance locations (black dots + white halo);
contours (brown lines);
rivers (blue lines);
roads (red lines);
towns and other built-up areas (grey shading).

Numbers are Block IDs that are referenced in the Supplementary Data tables (see the box-text that follows the main text).

[D J Clucas, 2024]

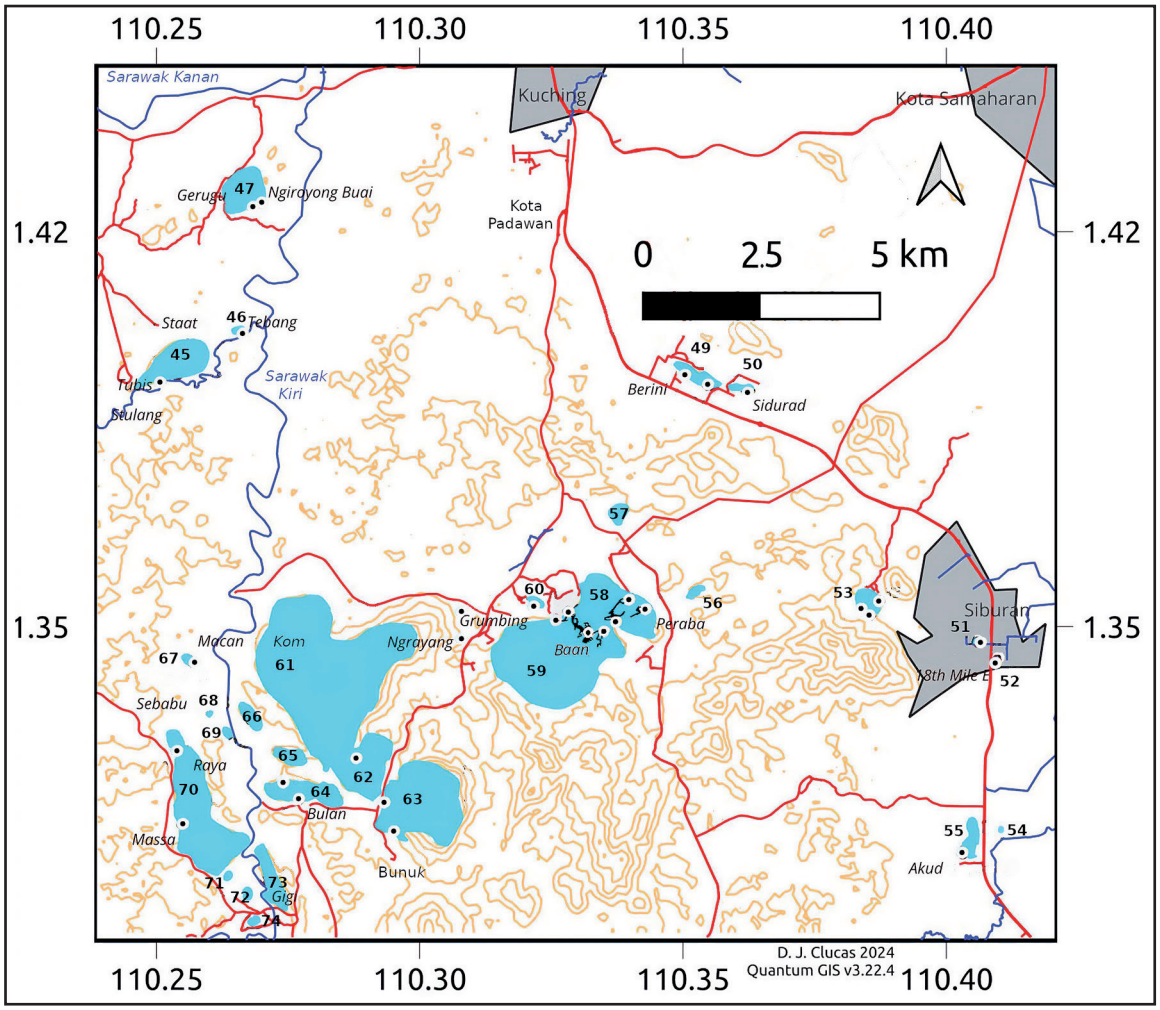

Figure 3:
The karst hills and caves of the Padawan North area (shaded pale blue), with:
Key:
cave entrance locations (black dots + white halo);
surveyed caves (black lines);
contours (brown lines);
rivers (dark blue lines);
roads (red lines);
towns and other built-up areas (grey shading).

Numbers are Block IDs that are referenced in the Supplementary Data tables (see the box-text that follows the main text).

[D J Clucas, 2024.]

Karst and Caves

Karst areas

The limestone hills (Fig.2) cover an area of some 117km^2, with 121 distinct exposed karstic outcrops (including 5 destroyed by quarrying), within a perimeter of about 450km. Many of the exposed outcrops are surrounded by buried karst, generally below little more than a metre of alluvial deposits, where the ground is swampy, with small, stumpy, pinnacles of limestone protruding through the alluvium. Seven quarries are currently in operation, in response to the high demand for road stone and for cement/concrete production; among these, Gunung Merbang is newly licensed. Some of the originally exposed limestone outcrops have been almost completely obliterated, along with their caves and the tropical vegetation and associated biota that they supported. Obtaining reliable information about how much of the karst surviving at outcrop has been scheduled and licenced for quarrying has proved problematical.

Overall, the karst terrain is typically tropical, with dense undergrowth and sharp, jagged edges. Limestone surfaces take several forms, including buried karst, scree slopes and vertical rock faces with thin soils. Active streams contain high loads of carbonic and humic acids, enhancing the erosion of notches along cliff edges, as well as that of some stream caves. Cliff collapse results in formation of steep-sided towers. Reflecting the complex nature of the area, other small karstic outcrops are known or assumed to be present but not recorded beneath dense vegetation (an example is below the graveyard of the church at Kampong Sogo, southeast of Bau). In this Report, karst outcrops are given an **Id** number and divided into named areas: ***Padawan North*** (Fig.3); ***West border and Bau*** (Fig.4); ***Padawan South*** (Fig.5); ***West Serian karst*** (Fig.6). Locations of the small isolated hills of Selabor (Silabur) and Kudi are shown on Figure 1.

Geomorphology

The tropical climate, particularly the high rainfall, results in extreme weathering of the karst. Alluviated limestone flats (rising towards the southeast from only 15 to 30m above sea-level around Bau), punctuated by small, notched blocks, or locally scored by mazes of incised trenches (perhaps collapsed caves), surround steep-sided blocks with rugged, pinnacled surfaces, some of them pitted by small dolines, and some isolated towers. Several large closed-depressions are known, including hidden farmland at Temurang. It appears that there was a post-glacial sea-level drop of about three metres some 6,000 years ago, but major sea-level changes of 10 to 30 metres could have triggered marine erosion of the lower sections of the karst outcrops during the Mid Pleistocene (Liechti, 1960; Wilford, 1964), whereas Schuh (1993) suggests that there was an earlier phase of marine planation at 60–90m.

Caves:

This Report records 487 cave entrances associated with 303, mostly multi-entrance, caves. Whereas more caves are known locally, details may be confidential; Handfield-Jones (2021), for example, has logged more than 700 names and/or entrances. Many caves are no longer active, but some contain streams and sumps (none of them dived). Some are simple passages, some are mazes, most are horizontal, but there are also steep, and vertical, sections that require special safety considerations during exploration. Of particular interest, but still unstudied, is the potential influence on karst development of igneous rock dykes that are intruded into the limestone, particularly in the Bau area. Inorganic sediments within the caves include speleothems, clastic deposits brought in from outside (largely by streams), finer-grained clastic particles infiltrating from the surface, and boulders derived and emplaced by *in-situ* rock failure; to these are added various organic materials, dominantly represented by, or derived from, bird and bat guano.

Archaeologists have located some cave entrances that were previously utilized by humans as shelters and burial sites, with farther reaches commonly explored in search of gold, fertilizer, and birds' nests (Everett, 1879, 1880; Harrisson and Tweedie, 1951; Datan, 1993; Datan and Bellwood, 1993; Gani, 2010).

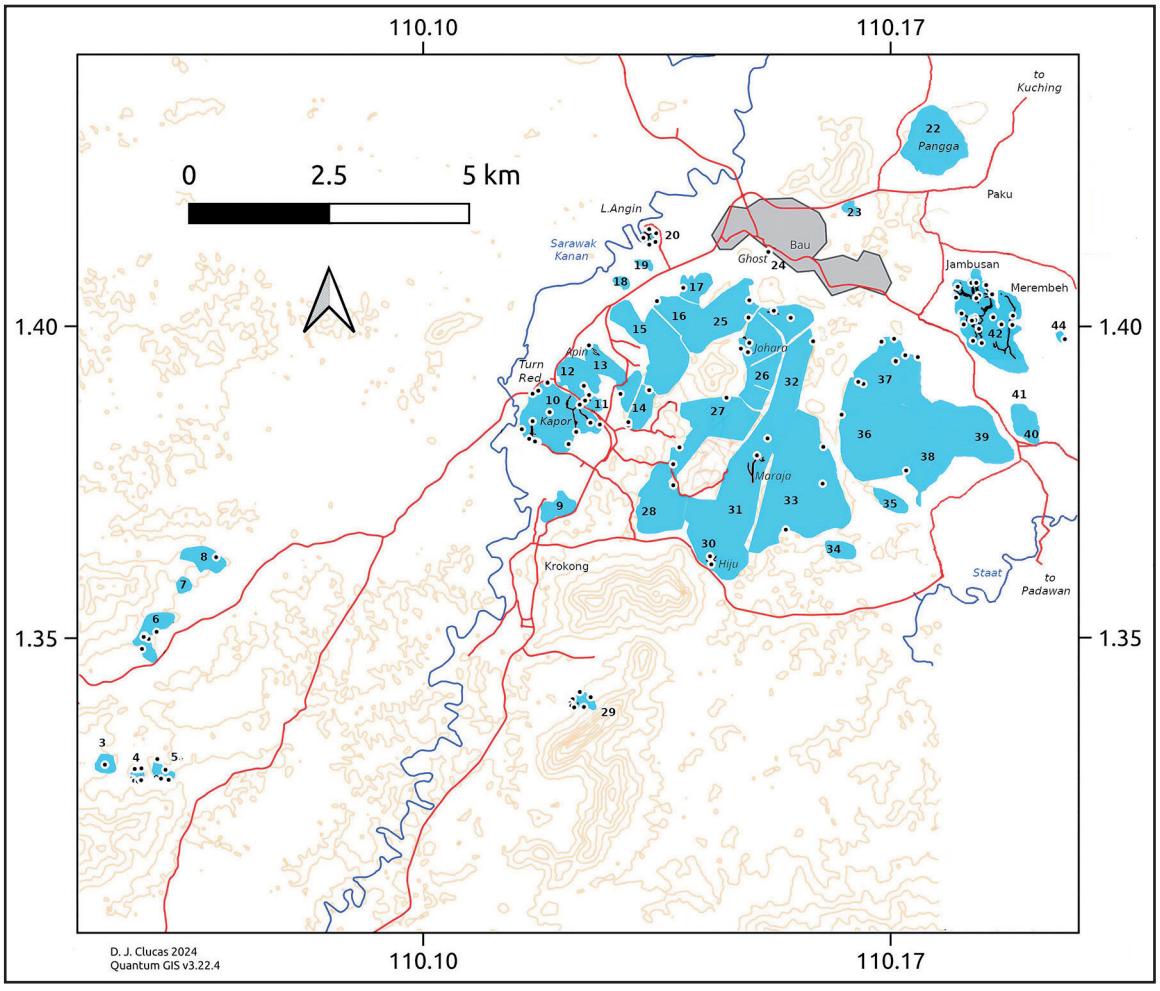

Figure 4:
Karst hills and caves of the West border and Bau areas (shaded pale blue) with:
Key:
cave entrance locations (black dots + white halo);
surveyed caves (black lines)
contours (brown lines);
rivers (dark blue lines);
roads (red lines);
towns and other built-up areas (grey shading).

Numbers are Block IDs that are referenced in the Supplementary Data tables (see the box-text that follows the main text).

[D J Clucas, 2024.]

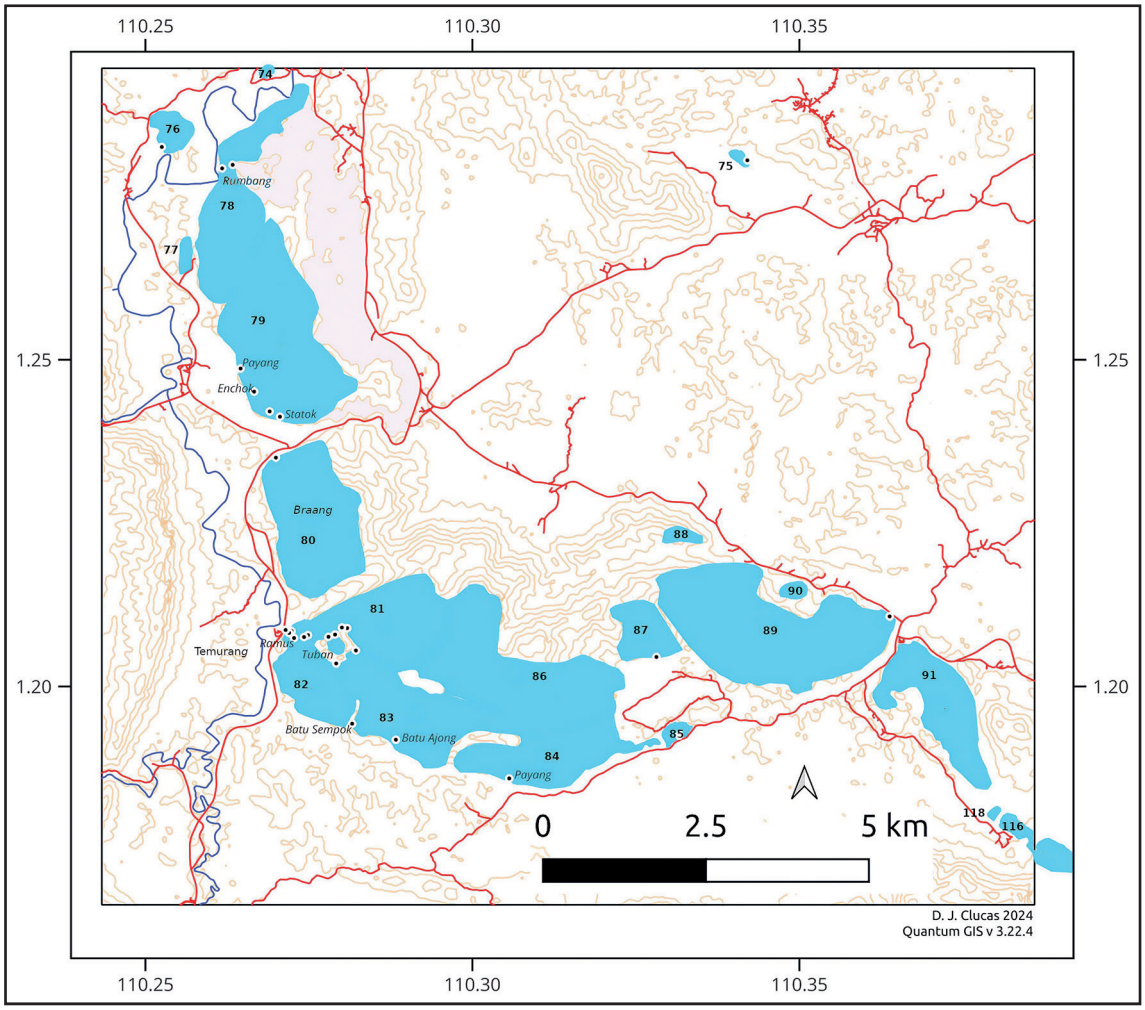

Figure 5:
Karst hills and caves of the Padawan South (Serian) area (shaded pale blue), with:
Key:
cave entrance locations (black dots + white halo); contours (brown lines); rivers (dark blue lines); roads (red lines).

Numbers are Block IDs that are referenced in the Supplementary Data tables (see the box-text that follows the main text).

[D J Clucas, 2024.]

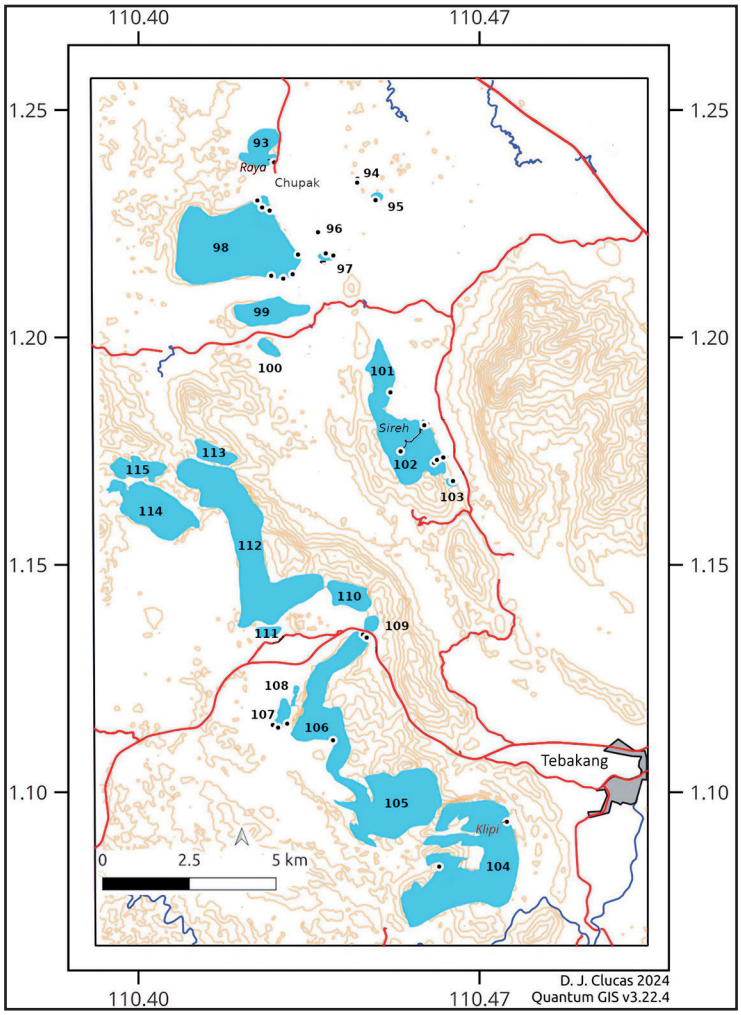

Figure 6 [left]: *Karst hills and caves of the West Serian area (pale blue).*
Key: *cave entrance locations (black dots + white halo); surveyed caves (black lines); contours (brown lines); rivers (dark blue lines); roads (red lines); towns and other built-up areas (grey shading). Black numbers are Block IDs (cf: Figure 5 caption above). [D J Clucas, 2024.]*

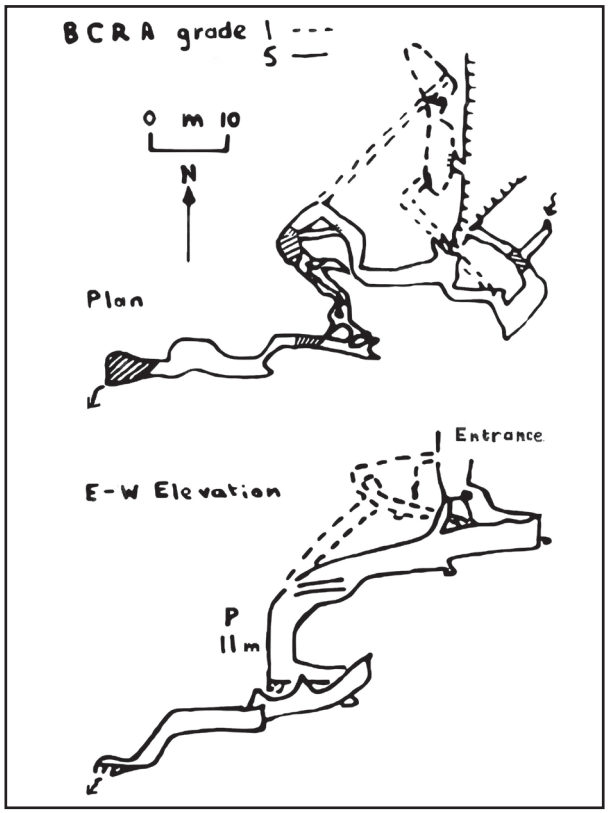

Figure 7: *Pencil-drawn survey of the Penyok Sink in the Padawan North area. [OUCC Expedition 1983.]*

Many caves were mapped between 1949 and 1963 (Wilford, 1964). Whereas some might only have been sketched (Handfield-Jones, 2021), modern resurveys appear virtually identical. Later exploration and mapping included that by British teams during 1980 (Crabtree and Friedrich, 1982) and 1983 (Laverty, 1983). More recently, additional caves have been sketched or surveyed (in part or in whole) by the present authors and others, commonly using laser measuring technology to enable more accurate acquisition of passage dimensions. Similarly, the identification and reporting of entrance locations was formerly laborious and inexact, but more-recent use of GPS technology has both simplified the process and improved the data reliability.

Thus, necessarily, the boundaries of the recorded karst outcrops, the coordinates of entrances, and the cave lengths presented here are generally only approximations: few of them are based upon detailed reports of visits, let alone supported by mapping. Undoubtedly, many more caves await discovery, exploration, and study.

Notable caves

Padawan North

The largest cave currently known in SW Sarawak is Tang Baan between Kota Padawan and Kampong Benuk (Laverty, 1983). With passages up to 100m wide, three distinct levels, and entrances on the west, east, and middle (Tang Raya) of the hill, this should be a prime site for conservation. Sadly, the nearby Peraba has probably been quarried away and surveys (Wilford, 1964; Laverty, 1983) and a single photograph (Wilford, 1964) might be all that remain. Many more caves are known in the hills on both sides of the Borneo Heights Road to Benuk, but only one small pothole has been surveyed (Fig.7). Caves have long been known adjacent to the the Sarawak River south of Semadang (Laverty, 2025); nothing new has been published about them in more than a century and a half, but 2024 saw road access to Rumbang being improved to facilitate tourism. The Kota Pedawan to Tapah section of the Pan (originally Trans-) Borneo Highway passes several small, cavernous outcrops but the Siburan area currently seems to hold most interest speleologically, with several substantial sections of cave now known at different levels in the relatively small T(e)rumat hill, west of Siburan town.

Bau

Gunung Kapor and the adjacent Apin near Bidi have the most cave in the Bau area: Kapor, Bungoh, Turn Red and Umbut caves. Kapor (rebranded as Fairy, or Peri Peri) and Lobang Angin (Wind Cave) are both now run as Nature Reserves, laid out with paths and tourist infrastructure. Bungoh Cave is extensive, but poorly known.

Igneous dykes have weathered away, separating the limestone into many isolated blocks, but currently too few caves are known to allow meaningful assessment of any potential influence on karst development; they are, however, exposed in some of the Johara caves. Though far less accessible, Ngiraja (known to Wilford (1964) and Medway (Cranbrook *et al*., 1967) as Merajah, and one of their main study sites) is carefully guarded by bird-nest harvesters. Southeast of Bau, Jambusan is perhaps the best explored hill, and it contains a varied selection of caves at different levels. Here, the local community has run Merembeh Caving Park since 2022, including providing tourist trips into Gua Posih, an impressive stream cave.

Padawan South

The Temurang community now organizes tourist visits to caves used locally to provide access to agricultural land, hidden in a substantial polje. Wilford did not draw attention to these features, although he mapped the area, perhaps based largely upon photogrammetry with minimal ground truthing. Further north, a spur road was funded in 2024 to create tourist access to Rembang (Rumbang, historically) cave from the Borneo Heights Road rather than the historic Sarawak River approach: despite many early accounts (c.f. Laverty, 2025) the cave has no known survey.

West Serian:

Chupak has at least one substantial cave with community-managed tourism, but Gunung Nambi, with its many entrances, is the main site of speleological interest. Sireh Cave, which has long been known, was surveyed by Wilford (1964), and has yielded important archaeological remains and examples of parietal art. More recently it has been used for activity tourism.

Selabor

After a long history as a mecca for bird nesters, one of the caves here has recently become a significant 'tourist resource' for the community.

Summary data for the limestone areas (details in the Supplementary Data tables – see the box at the end of the main text), their caves and the entrances, are shown in Table 1, and a brief comparison with Sarawak's other two areas known for their caves is provided in ***Note 6***.

[Note 6] *In comparison, Mulu/Buda/Spirit River has a similar outcrop area (c.110km^2) but only 13 distinct blocks with a far smaller perimeter (c.130km) and far more surveyed cave (~400km); Niah is about 50km^2 in 5 blocks with ~25km perimeter and only a few km of cave – as surveyed, incompletely, by Wilford (1964).*

Karst areas of SW Sarawak								
Name	**Villages for information**	**Karst notes**	**Area km^2**	**Perimeter km**	**Blocks**	**Caves**	**Entrances**	**Length km**
West Border	Duyoh, Serikin, Padang Pan	Small isolated hills in remote area	1.95	14.81	8	23	38	2.25
Bau	Bidi, Krokong, Paku, Skiat, Merembeh, Segubang	Large steep-sided blocks with little access to upper levels	24.16	118.51	36	87	191	20.71
Padawan North	Duras, Sikog, Bratan, Git, Bunuk, Semadang, Danu	Large steep-sided blocks with moderate access to upper levels	23.09	84.29	30	80	107	16.67
Padawan South	Bengoh, Temurang, Simpok	Large steep-sided blocks	29.65	102.20	17	55	58	3.74
West Serian	Chupak, Bantang, Pichin, Tebakang	Large steep-sided blocks and isolated hills in remote areas	37.76	127.01	27	42	68	4.47
Selabor	Lobang Batu	Isolated tower with accessible multi-level cave development	0.43	3.38	2	13	22	3.86
Kudi	Semalatong	Isolated low, hollow block surrounded by swamp and oil palms	0.01	0.34	1	2	2	0.001
Totals			**117.05**	**450.54**	**121**	**303**	**488**	**51.70**

Table 1*: Summary statistical data for the areas.*

Figure 8:
Selabor and Storib viewed from the east. [M Laverty.]

Tourism potential

An eBook guide produced by (presumably the local, Samarahan, campus of) Universiti Teknologi MARA covers the whole Kuching Division, comprising Lundu, Bau, Padawan, and Serian districts, and this provides useful background information (UiTM, 2018).

Lobang Angin has been an informal tourist destination for almost two centuries, and a formal one for 25 years. Fairy Cave has become a formal tourist destination during the past 11 years, and D W Gill supervised the equipping of an adjacent limestone cliff, the Batman Wall, for sport climbing. Other caves have been developed by community action, notably at Chupak and Selabor (Fig.8). More recently, adventure tourism has been initiated, commonly associated with private homestay accommodation (e.g.,- at Penot), but also by community action, as at Posih and the Merembeh Caving Park. A canoeing venture operating between Semadang and Danu also offers visits to caves.

Batu Kudi (Kudik) is a tiny exposure of limestone in what was a swamp, but is now a palm-oil plantation. It only appears to have attracted attention in the last decade as recognition of potential tourist interest, and conversion of any 'interest' into 'product opportunity' has grown. It has essentially the same petrifaction story as several other cavernous hills: a longhouse village supposedly being turned to stone for the sin of its inhabitants laughing at an animal sent by a stranger belittled by the villagers' behaviour. A ministerial press release said, "*It can be an interesting camping spot...*", (Borneo Post, 2015): perhaps especially so, considering that a social media post [https://www.wikiloc.com/motorcycling-trails/batu-kudik-simunjan-53031670] shows a sign warning visitors to beware of crocodiles!

Several natural hot springs are active in the area but to what extent they are of karst interest is unknown. The Paku spring is in a pool that was tidied up for recreational use some years ago. Hot springs in the riverbed near Annah Rais were adapted for bathing and have become a popular tourist site during at least the past decade. Panchor Dayak also has hot springs in pools that have been adapted by the community for bathing.

There is major potential for the use of the caves in recreational caving, and by anyone with research interests in archaeology, biospeleology, geology, and geomorphology. The caves and the karst landscape they inhabit can also provide wonderful and inspirational subjects for artists and photographers.

Numerous video recordings have been shared via *YouTube*, recording trips into the well-publicised Fairy, Wind, and Selabor caves, as well as others such as Chupak, Rembang, and Begu caves. Nevertheless, there are no local groups dedicated to cave exploration, and the Malaysian Cave and Karst Conservancy (established in 2015, UIS Member since 2022), which remains small and specialist, has not yet worked in Sarawak.

Summary of the biology of the caves and karst

A huge amount of work has been accomplished on the biota of the karst outcrops by the Sarawak Forestry Corporation (SFC) and others (Yong *et al.,* 2004; SFC, 2023, in press).

- Cave-nesting birds have played a fundamental role in supporting the human economy of karst in Sarawak, and it was from studies in caves around Bau that it was first recognized that certain species of swift use echo-location (Medway, 1959).
- Bat studies have been undertaken in ***Fairy Cave Nature Reserve (NR)*** and elsewhere. (Rahman *et al.,* 2010; Rajasegaran *et al.,* 2018; Kumaran *et al.,* 2006; Mohd-Azlan *et al.,* 2005). ***Wind Cave NR*** contains 14 species of bats including the Dusky Fruit Bat (*Penthetor lucasi*), as well as Black-nest Swiftlets (*Aerodramus maximus*). Amongst the small- to medium-sized trees and shrubs are some very rare palms, including *Arenga pinnata, Arenga undulatifolia* and *Calamus ornatus.* Squirrels, shrews, and a variety of birds can be found along the river adjoining the NR, and on its limestone hill.
- Malacologists (specialists in molluscs including land snails and slugs) have studied many of Sarawak's more than 250 limestone hills (more than half of which are in Bau Serian), including 8 around Bau itself; specifically, some of the caves have recently been investigated (Marzuki *et al.,* 2021). Twelve species of snail are endemic: they have evolved along the limestone outcrops and in the caves, each unique to its own habitat. A detailed study of micro snails from the genus *Georissa* (including *G.silaburensis*) at Gunung Silabur (Selabor) included analysis of shape and DNA from samples collected along a traverse from outside, through part of a cave and then outside again, and the results appear to show speciation in progress within the cave (Khalik *et al.*, 2019).

Re-sampling in the area around (but not in) Rumbang Cave about 130 years after 5 new species had been found there, yielded *Diplommatina rumbangensis sp.nov.* (Nasir *et al*., 2024). Recent research at Kudi(k) has also yielded a new subspecies, *Plectostoma wallacei kudikense s* (Lee *et al*., 2024).

- Also on the outcrop of the Bau Limestone, entomologists have reported results of collecting aquatic and semi-aquatic bugs, and dragonflies (Jongkar, 2004a,b).
- St John (1862) recorded anecdotal from Dyaks describing "*fish that see not*" in a pool deep in Sireh Cave. Subsequently a 3-year Bau Limestone Biodiversity project that started in 2001 noted 10 fish species found in caves (notably *Puntius everetti, Nemachilus saravackensis*, *Silurichthys marmoratus*, and *Clarias leiacanthus*), but no evidence of specific adaptations to a cave environment was found (Jongkar and Lim, 2004). Nevertheless, notable work has been conducted on aquatic faunas, with a total of 81 species comprising fishes, crabs, prawns, snails, and aquatic insects. New records of fish from limestone areas in Sarawak included *Gastromyzon megalepis, Homaloptera stephensoni, Rasbora caudimaculata, Silurichthys hassetti* and *S. phaiosoma.* These records extend the total fish species count of the State's limestones to 79. Among these, six Bornean endemic species were collected: *Rasbora sarawakensis, Puntius sealei, P. kuchingensis, Gastromyzon ctenocephalus, G. punctulatus* and *G. megalepis.* Of the total of 21 species collected, none were confined only to cave systems, though *Cyclocheilichthys apogon, Silurichthys hassetti* and *S. phaiosoma* were commonly found in cave passages.
- Mammal survey work has been carried out in Jambusan Cave (Pathe *et al.,* 2021), and study of fossil brachyuran crabs collected by A H Everett in 1878–1879 was reported by Ng and Cranbrook (2014). Additionally, an investigation of the biodiversity of the small mammals living on the Bau Limestone has been carried out, as reported by Jub *et al.* (2003).
- A survey in the 'Padawan limestone area' recorded various species, including 21 fishes, seven crabs, four prawns, 10 snails and 42 aquatic insects. The finding increases the total species of fishes and crustaceans known from limestone areas in Sarawak to 79 and 29, respectively. The Padawan limestone has a similar aquatic fauna to that of the north Bau karst area, but with a different species composition.
- The Padawan limestone area has high conservation value, supporting several endemic and threatened species, including seven crab and six fish species. Two species of semi-terrestrial crabs, *Stygothelphusa bidiense* and *Terrathelphusa kuchingensis* are listed as Vulnerable and Endangered, respectively, by the International Union for the Conservation of Nature (IUCN) Red Lists. It was also noted that fishes and a few species of snails serve as important supplement food sources for local communities living in the area (Jongkar and Lim, 2004). Three new species of decapod crustaceans have also been recorded (Ng and Jongkar, 2004), as well as a new species of freshwater crab *Thelphusula cristicervix* (Jongkar and Ng, 2014). Two new species of freshwater fish *Gastromyzon ocellatus* and *Betta ibanorum* have also been recorded (Tan and Ng, 2004).
- The limestone cliffs in the area support a wide range of endemic flora, including the rare endemic pitcher plant *Nepenthes northiana*. Eight taxa of Nepenthes have been recorded from the Bau–Serian karst, which includes one limestone obligate and two natural hybrids. The hybrid *N.northiana* and *gracilis* are recorded and described (Lee, 2004).
- The last known collection of cave fauna for specialist identification was made almost 50 years ago (Chapman, 2025), but visitors can expect to see various types of spider, cricket, whip scorpion, centipede, millipede, cockroach, gecko (and their eggs), fish, flies, swiflets, bats, and snakes.

Conservation; status, threats, and mitigation

Status

There are three Totally Protected Areas (TPAs) within the described region, with two other karst outcrops currently under investigation; the non-karstic Semenggoh Nature Reserve is nearby. Many more outcrops of spectacular karst containing important caves deserve consideration as TPAs. The establishment and laws of a TPA are defined within the National Parks and Nature Reserve Ordinance 1998 and the Wildlife Protection Ordinance 1998 and are governed and administered by the Sarawak Forestry Corporation (SFC). There are three categories, National Park (NP), Nature Reserves (NR) and Wildlife Sanctuaries (WS). Many TPAs have a Park Warden appointed with Park Rangers, and some – but only a few – have a Management Plan.

Wind Cave Nature Reserve: (NR)

Constituted in 1999, area 6.16 ha. Gazette No. 3566. A Management Plan was in preparation by SFC in 2023.

Fairy Cave Nature Reserve: (NR)

Notified on 23 April 1998 and constituted in January 2013, area 56 ha. Gazette No 2473, situated near Gunung Kapor. Strangely this area was to the north covering the high ground of the karst but did not include ***Fairy Cave*** even though it had the name of *Fairy Cave NR*. Extension No.1 situated on the high ground south of Gunung Kapor was notified in March 2016 and constituted in February 2023, area 18.13 ha. This borders on the cave. The cave with an area of 0.1 ha was purchased by the State in 2019. Total area of protection is 74.23 ha. The reason for the karst area surrounding the above boundaries not being included in the protected area appears to be the local community claims of ownership under Native Customary Rights (NCR). Gunung Kapor contains other caves. A Gunung Kapor summit trail is open for visitors with special permission from SFC. A Management Plan was in preparation by SFC in 2023.

Dered Krian National Park: (DKNP)

Constituted 2013. 1339 ha. 13.39 km^2. Gazette No 5078. There have been limited studies of vegetation and soils (Razali, R, 2017; Syauqina *et al.,* 2017; Wasli *et al.,* 2017). Total area of the karst outcrop is 19.58 km^2 and therefore 6.19 km^2 is outside the boundary, because this area was claimed by the local community; it contains several community buildings and gardens. It is reported that the local community do conserve the karst and conduct some tourist operations and have prevented illegal quarrying operations.

Sarawak Delta Geopark

Designated in 2022, covers much of the area but excludes Serian and Selabor. As yet this designation has provided little protection, considering that seven major quarries are in operation. Nevertheless, the aspiration to have it recognized as a UNESCO Global Geopark should draw attention to good conservation practice. The total area is stated as 3,112km^2 including sea and land, the land area being 2,685km^2. (Badang *et al*., 2017). A website was set up in 2025 prior to final assessment taking place in June [https://sarawakdeltageopark.sarawak.gov.my/].

Threats

The major threats facing the caves and karst outcrops are quarrying and access to the cave systems for economic and recreational reasons. Biodiversity is threatened by unregulated bird-nest collecting, loss of forest cover for commerce and infrastructure, and by climate change.

1 Continuation of quarrying on a large scale. There are six karst areas where quarrying is taking place:

Gunung Pangga – a huge quarry (commenced in 1963) in a hill with historic links to caves, mining, and archaeology;

Gunung Skunyit – some small caves were surveyed here, before they were destroyed;

***Figure 9**: Colourful, multilingual, graffiti outside Kerusi. [D Clucas.]*

Gunung Staat (Dorod Tubis) – highly visible chunks are being torn from this cavernous mountain;

Mambong – associated with a cement plant that is close to large caves and has probably already destroyed at least one;

Gunung Arip – most of this mountain has been levelled – removing several caves;

Gunung Krian – marble quarry.

2 Bird nest harvesting is a traditional occupation for some of the local population, with many groups claiming ownership of the caves, and some possessing a licence issued by the Sarawak Forestry Corporation (SFC) under the Wild Life Protection Ordinance, 1998 and the Wild Life (Edible Birds' Nests) Rules, 1998. Legally the caves are owned by the State. Over-exploitation has reduced harvests dramatically and the human risks are high (Harrisson and Reavis, 1966).

The damage caused on the cave biota and sediments may be severe but recent construction of bird nest houses has reduced cave exploitation, because the quality and price of the (black) cave nests are less than those of the (white) nests from the houses.

3 Weekend miners are attracted to the caves in the search for gold, resulting in injuries and deaths, the fire brigade is called out to evacuate those injured or retrieve bodies. Whichever local organization claims authority over the cave either erects barbed wire or blocks the entrance with rocks.

***Figure 10**: Graffiti inside Lobang Stulang by the Staat river give a warning in the local language to Kored "not to always take nests from here", [M Laverty.]*

3 Weekend miners are attracted to the caves in the search for gold, resulting in injuries and deaths, the fire brigade is called out to evacuate those injured or retrieve bodies. Whichever local organization claims authority over the cave either erects barbed wire or blocks the entrance with rocks.

4 Some weekend trekkers who explore the caves leave cans, cigarette butts and polystyrene food trays behind them. Hash House Harriers have run trails in the caves. Graffiti are common (Fig.9), in some cases historic, but generally at least unsightly, extending in one case to spray painting a spectacular speleothem red. Local notices may be displayed (Fig.10), and some community leaders offer tourist trips in the caves, but safety and conservation measures are rarely strong.

5 Loss of forest cover cannot but have detrimental effects on the feeding areas of bats and swiftlets, which are the major species involved in pollination and control of large insect populations.

6 There is no reported observation of apparent large-scale harvesting of timber within the karst outcrops, because this practice would be illegal under Sarawak legislation. However, the Bengoh Dam Resettlement Scheme removed a large area of timber cover adjacent to it, with more being removed for the Seropak–Semadang and Semadang–Padawan road constructions and associated ribbon development. A wide corridor cleared for electricity supply lines to Kalimantan also removed some forest cover. Large areas of secondary growth are being lost to private and public development.

7 The proliferation of palm-oil estates around the karst outcrops continues to destroy secondary forest in areas previously used for rice, rubber, and other cultivation, along with the associated biota.

8 Wildfires can lay large areas of the hills waste: the ecology is probably adapted to this to some extent, but consideration of climate change suggests that future effects might be more severe. Several acres of one mountain in the Deref Krian National Park were burnt unintentionally when planned burning for palm-oil planting went out of control in 2015.

Mitigation

Answers towards mitigating the threats would be the establishment of Totally Protected Areas (TPA) as National Parks (NP) or smaller scale Nature Reserves (NR), licencing of the bird-nest collectors and extensive research on the karst biota and detailed mapping and exploration of the caves. Other possibilities would be regular high-profile media coverage explaining the importance of the caves and karst areas as an important part of Sarawak's culture and natural heritage, and their high scientific value. Expansion and further quarry licences should be curtailed, as should further development of palm-oil plantations. The unregulated use of the caves for recreation has caused damage, largely related to graffiti and dropping of rubbish. In view of the clear significance of the karst area in its entirety, along with its tourist potential, a general conservation management plan could be considered.

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Supplementary Material

The online instance of
Cave and Karst Science, Volume 52, Number 2,
includes supplementary material comprising
two data tables relating to this Report,
and
an interactive map with supporting files.