

CONSERVATION OF KARST IN BELIZE

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Karst areas in Belize are coming under increasing pressure from agriculture and other commerce. Opportunely protected karst areas are incorporated within forest reserves, national parks, wildlife sanctuaries, nature reserves, archaeological reserves, private conservation and management areas, and special development areas.

The total area of karst afforded nominal protection is about 3400 km², or about 68% of the total. Incorporating special development areas, the protected karst area is about 4300 km², or 86% of the total. Even the more conservative percentage is unparalleled in Central America and the Caribbean, and perhaps the world.

Significant protected karst areas include the Chiquibul, Blue Hole and Five Blues Lake national parks, the Bladen, Aquas Turbias and Tapir Mountain nature reserves, the Monkey Bay Wildlife Sanctuary, the Rio Bravo Conservation and Management Area, and the Caracol, Xunantunich, Cahal Pech and El Pilar archaeological reserves. Extensive karst areas are located within the Vaca, Columbia River, Sibun, and Manatee forest reserves. The Manatee and Cayo West special development areas have considerable karstic components.

Throughout the world, karst landscapes are increasingly subject to human impacts (Gillieson & Smith, 1989; Sauro et al., 1991; Williams, 1993; Ford, 1993). Karst regions in the Caribbean and in Central America have come under particular pressures from agricultural and industrial expansion (Day, 1993a), and the karst of Belize is itself experiencing increasing environmental stress (Day, 1987, 1991, 1993b; Day & Rosen, 1989).

General issues of human encroachment and accelerating land "development" aside, karst landscapes in Belize and elsewhere merit conservation for a variety of reasons. Many are areas of special scientific interest; others are areas of outstanding natural beauty. They often represent significant floral and faunal refuges, and they function as valuable hydrologic reservoirs. Many are of archaeological significance, and they are all intrinsically fragile, being susceptible to rapid deterioration of soil, water and other natural resources. Particular challenges to the integrity of karst terrains in Belize include increases in agricultural development, especially citrus cultivation, indiscriminate forest clearance, quarrying, and water contamination. Caves are at risk from this general suite of impacts, plus increasing recreational activities and rampant looting of archaeological artifacts.

At the same time, there is increasing awareness in Belize of the need to establish protected areas, which are set aside for specific purposes and generally managed for conservation of resources (Nicolait, 1995). Sixty-two percent of land in Belize is under public ownership, and about 28% is demarcated as government forest reserves (Nicolait, 1991). Currently, conservation areas include twenty forest reserves, seven national parks, two wildlife sanctuaries, four nature reserves, and five archaeological reserves, plus at least twenty private conserva-

tion and management areas and six special development areas (Figure 1; Table 1). These protected areas and sites in Belize encompass a wide range of designations and purposes, but collectively they account for over 30% of Belize's land area (Nicolait, 1992). Many of these protected areas include karst landscapes, and it is upon them that this paper is focused.

KARST DISTRIBUTION

Carbonate bedrock underlies over 50% of Belize's land area of approximately 23,000 km², but not all of this is extensively karstified. In particular, Tertiary limestones, which underlie the northern 35% of the country give rise to karst only locally, notably in the Rio Bravo area in the northwest of the Orange Walk District and in the Yalbac Hills of the Cayo District (see location map on page 68, and Miller's Figure 4 in this issue).

Karst topography is more pronounced on the Cretaceous limestones which flank the Maya Mountains. Karst covers about 2,000 km² in a belt that is located north and west of the Maya Mountains and south of the Belize River Valley (Day, 1993b), and a similar area of karst is developed south of the Maya Mountains, primarily in the Toledo District (see Miller's Figure 4). In total, the karst area of Belize accrues to about 5,000 km², or about 22% of the country's land area (Day, 1993a).

PROTECTED AREAS LEGISLATION

Valuable general reviews of Belize's protected areas and the legislation pertaining to them are provided by Munro (1983), Zisman (1989), Zisman and Munro (1989), and

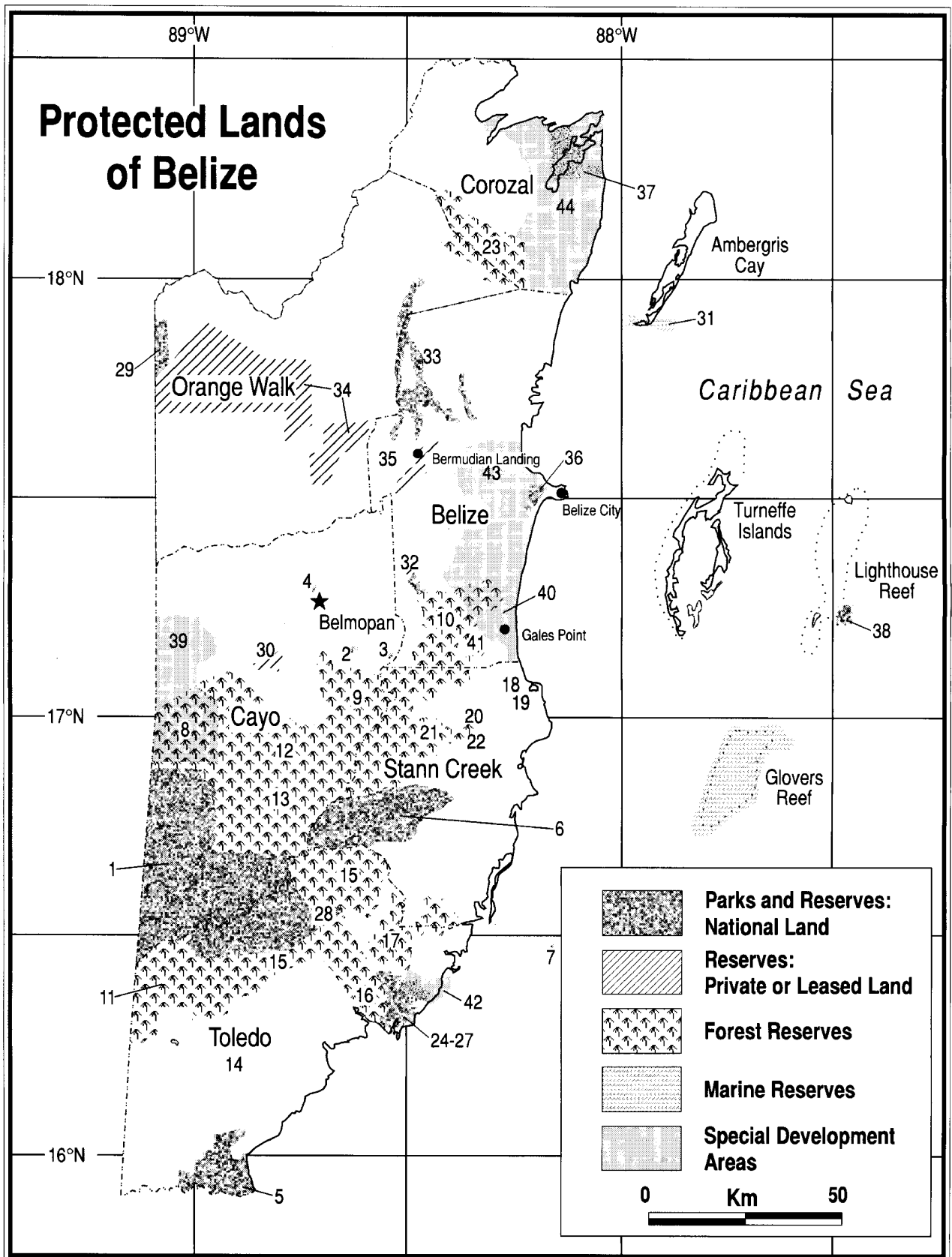


Figure 1.

Table 1. Conservation Areas in Belize
(numbers correspond to those on Figure 1)

National Parks	Area (ha)	Karst
1 Chiquibul	186,490	Mostly
2 Blue Hole	233	All
3 Five Blues Lake	358	All
4 Guanacaste	21	Little
5 Sarstoon	16,600	None
6 Cockscomb Basin	41,540	None
7 Laughing Bird Caye	1	Reef
Forest Reserves		
8 Vaca	21,000	Mostly
9 Sibun	42,975	Little
10 Manatee	45,789	Mostly
11 Columbia River	44,030	Some
12 Mountain Pine Ridge	51,500	Little
13 Chiquibul	184,900	Little
14 Machaca	2,300	None
15 Maya Mountain	92,700	None
16 Deep River	59,100	Some
17 Swasey Bladen	6,200	Some
18 Grants Works A	3,240	Some
19 Grants Works B	1,360	Some
20 Silk Grass	2,641	None
21 Sittee River	38,008	None
22 Commerce Bight	2,778	None
23 Freshwater Creek	30,000	Little
24 Mango Creek		None
25 Mango Creek 2		None
26 Mango Creek 3		None
27 Mango Creek 4		None
(Total Mango Creek Area)	23,228	
Nature Reserves		
28 Bladen	40,000	Some
29 Aguas Turbias	3,642	Mostly
30 Tapir Mountain	2,729	All
31 Hol Chan Marine	1,215	Reef
Wildlife Sanctuaries		
32 Monkey Bay	1,037	Mostly
33 Crooked Tree	6,478	Little
Other Reserves		
34 Rio Bravo	101,000	Some
35 Bermudian Landing	4,664	None
36 Burdon Canal	8	None
37 Shipstern	8,906	Little
National Monuments		
38 Half Moon Caye	18	Reef
Special Development Areas		
39 Cayo West	43,354	Mostly
40 Manatee	47,350	Mostly
41 Manatee West	48,000	Mostly
42 Monkey River	50,000	None
43 Burrel Boom-Hattieville	40,485	Little
44 Corozal East	79,453	Little

Nicolait (1995). Only legislation that is of particular relevance to the conservation of karst areas is considered here.

In a general context, environmental conservation and rational natural resource utilization are promulgated under the Environmental Protection Act of 1992. Although there are no formal criteria governing the designation of protected areas in Belize, certain elements are deemed important: "...richness in biodiversity, populations of endangered species, importance to watershed management, unusual or scenic features, presence of Maya ruins and ancient monuments, and value for recreation and ecotourism" (Nicolait, 1995).

One piece of important pre-independence (1981) legislation is the Forest Ordinance, first enacted in 1926, then revised in 1958 and 1980 (Zisman, 1989; Nicolait, 1995). The Forest Ordinance provides for the establishment of forest reserves, which are intended for forest production and watershed protection, and for the licensing and regulation of forestry activities (G.O.B., 1992). Several of the 20 forest reserves include karst landscapes, notably Vaca, Sibun, Manatee, and Columbia River.

The National Parks Systems Act, enacted in 1981 and entered into force in January 1982, provides the legal basis for the creation of national parks, nature reserves, wildlife sanctuaries and natural monuments (Nicolait, 1995). The Chief Forest Officer is responsible for administration of the National Parks System, and ultimate authority for the designation of protected areas under this act is currently lodged with the Minister of Natural Resources, although this is subject to change by Prime Ministerial fiat (Nicolait, 1995). Significantly, the existing language of the National Park Systems Act (Part II, 3-2) "...empowers the Minister to alter or vary any protected area established under the act or to declare it to cease to be a protected area" (Nicolait, 1995).

Under the National Parks Systems Act, national parks are established for protection and conservation of natural resources and scenic areas for the good of the public (GOB, 1993a). Although these lands cannot be sold or leased for agricultural or industrial use, logging, energy exploration, and tourism developments may be allowed by permit or concession. This also applies to natural monuments, areas conserving significant natural features of particular value for research, education, and public appreciation (GOB, 1993a). Significant karst is developed within several of the seven national parks, notably Chiquibul, Blue Hole and Five Blues Lake (Figure 1; Table 1).

Nature reserves provide for the protection of biological resources and to maintain undisturbed habitats and ecosystems for scientific study and provision of genetic banks (GOB, 1993a). By contrast, wildlife sanctuaries are conservation areas devoted to more specific biotic goals requiring greater human manipulation (GOB, 1993a). The Wildlife Protection Act of 1981 specifically regulates faunal protection. Nature reserves and wildlife sanctuaries with significant karst terrain include Bladen, Aguas Turbias, and Tapir Mountain (Figure 1;

Table 1).

Archaeological reserves are established to protect ancient and historical sites for scientific study, education and recreation (Nicolait, 1995). Nominal protection of such sites is provided by the Ancient Monuments and Antiquities Ordinance of 1971. Since all caves are potential or actual archeological sites, access to them is restricted and exploration or excavation requires permission from the Commissioner of Archaeology. Specific archaeological reserves in karst terrain include the Maya sites at Caracol, Xunantunich, Cahal Pech, and El Pilar.

Under the auspices of the Land Utilization Act of 1991, Special Development Areas (SDAs) are zoned for land use on the basis of the following: 1) protection of the environment, forestry, and recreational land, 2) avoidance of unsuitable and unfeasible development on marginal or poorly-accessed land, 3) identification and protection of viable agricultural land, 4) accommodation of rural residential use, and 5) necessary urban expansion (GOB, 1993b). Three SDAs have received ministerial approval and three others have been approved locally and are under consideration by the Land Utilization Authority. Those with significant karstic components are Manatee, Manatee West, and Cayo West (Figure 1; Table 1).

In general then, Belize possesses a sound legislative base for the designation and conservation of protected areas, and has to date established 44 such areas (Table 1), although not all of these encompass karst landscapes. Problems remain in that protected areas can be dereserved by ministerial decision, no single ministry is responsible for protected areas creation or maintenance, and human and financial resources are inadequate for planning, management, and enforcement of regulations (Day, 1987; Nicolait, 1995).

CONSERVATION OF KARST

Conservation of karst in Belize has been effected largely by indirect means. Very few karst areas or sites are protected primarily because they are recognized for their scientific importance, and in many cases it is unclear whether protected limestone tracts are even recognized as being karst landscapes. The coincidence between protected areas and karst terrain is largely opportune, although it reflects the areal extent and the relative inaccessibility of the karst landscapes and their significance in other contexts. Although protected areas legislation is in place, de facto enforcement of regulations is hampered by lack of human and financial resources.

In particular, karst in Belize is afforded protection because of its importance as forest and wildlife reserves, because of its archaeological significance, because of its potential value in ecotourism, and because of its inherent unsuitability for large-scale mechanized agriculture. This notwithstanding, some 15% of Belizean karst is currently under agriculture (Day, 1993a) and many of the karst areas are coming under increased resource pressures, especially clearance for citrus cultivation and small-scale mixed farming (Day, 1993b).

These pressures are particularly acute in the Boundary Fault Karst Area and the Yalbac Hills (see Miller's Figure 4, this issue).

Much of the Belizean karst is conserved because of its forest resources. Approximately 66% of Belize has some broadleaf tree cover, and at least 33% of that is on steep slopes which require protection (GOB, 1993b). Belize is a participant in the United Nations Tropical Forest Action Plan (TFAP), and in May 1992 began a \$14 million Forest Planning and Management Project which is designed "...to provide for the identification and rational allocation of land for forest, agriculture and other uses; and to ensure the national forest estate will be managed on a sustainable basis and provide an adequate return on investment" (GOB, 1993b, p.13). Under the auspices of TFAP, a project funded by the United States Agency for International Development, the Natural Resource Management and Protection Project aims to identify critical habitat areas requiring protection. Forested karst areas under particular pressure include those in the forest reserves of the Cayo and Toledo districts (Figure 1).

Karst areas are also conserved in order to ensure safe drinking water supplies under the government's Rural Water Supply and Sanitation Programme. In small dispersed communities, handpump wells are installed at an overall ratio of 1 per 10 families (GOB, 1993b). In larger and more cohesive settlements, electric pumps recharge elevated holding tanks from which water is distributed by gravity feed (G.O.B., 1993b). Contamination of karst aquifers is an increasing problem as a result of increased agriculture in the Cayo and Orange Walk Districts (Figure 1).

Increasingly, karst areas are protected because they correspond with important floral and faunal reservoirs and have a role to play in maintaining biodiversity. Wildlands and wildlife conservation also have an important economic component in the form of ecotourism. Along similar lines, pre-European Maya archaeological sites are an increasing focus of visitor activity, and these sites are "...almost exclusively in limestone areas" (Hartshorn et al., 1984, p.21). Despite the nominal protection accorded by law, looting of archeological sites, including caves, remains a serious problem (Hartshorn et al., 1984), particularly in the sparsely populated forest reserves of the Cayo and Toledo districts (Figure 1).

One traditionally important factor in karst and other land conservation in Belize is the low population density, which at about 8 persons per square kilometer is the lowest in the karstlands of Central America and the Caribbean (Day, 1993a). Contributory factors include the concentration of population in urban centers in non-karst regions, and the ruggedness and relative inaccessibility of many karst locales.

Including both public and private land reserves, the total area of karst landscape in Belize which is afforded at least some degree of protection is approximately 3,400 km², or about 68% of the total karst extent. Incorporating karst terrain within designated Special Development Areas, the protected

karst area rises to about 4,300 km², or 86% of the total karst region. Even the former, more conservative percentage of karst terrain under at least some measure of conservation is unparalleled in Central America and the Caribbean, and perhaps throughout the world.

PROTECTED KARST AREAS

The following is a summary of the protected areas that encompass significant karst landscapes in terms of extent, scientific interest and accessibility. Other, smaller karst areas are also protected but are not considered in detail here.

The largest area of protected karst in Belize is in the Chiquibul National Park, designated in 1991, which covers 186,490 ha (1,865 km²) in the western Cayo District (Figure 1). Formerly part of the Chiquibul Forest Reserve, the park surrounds the important Caracol Archaeological Reserve, and also incorporates parts of the extensive Chiquibul Cave System, the total surveyed length of which exceeds 55 km (Miller, 1990). Development pressures here are minor, but archaeological looting is a serious problem.

The Rio Bravo Conservation and Management Area in the Orange Walk District (Figure 1) encompasses approximately 101,000 ha (1,010 km²) of private and public land (Zisman, 1989; Nicolait, 1991; GOB, 1992; anon, 1994). It is managed by the Programme for Belize, a non-governmental organization established in 1988 and whose overall goal is "...to promote the conservation of the natural heritage of Belize and to promote wise use of its natural resources" (anon, 1994:19). The main threats to karst in the northern districts are agricultural development and water contamination.

The Vaca Forest Reserve, designated in 1991, covers 21,000 ha (210 km²) in the Cayo District, adjoining the Chiquibul National Park and the Cayo West Special Development Area (Figure 1). The reserve contains extensive fluviokarst and significant evidence of Maya occupation (Alt, 1994; Reeder, 1993). Small areas of karst, which include the Rio Frio caves, occur in the adjacent Mountain Pine Ridge Forest Reserve.

The Bladen Nature Reserve, created in 1991, covers some 40,000 ha (400 km²) on the southern fringes of the Maya Mountains in the Toledo District (Figure 1). The karst in the southern part of the Reserve is rugged and little-explored, containing at least one Maya site, named Quebrada del Oro (Nicolait, 1991). The Columbia River Forest Reserve, also in the Toledo District (Figure 1), covers some 44,030 ha (440 km²), part of which is karst, around the upper reaches of the Rio Grande (Zisman, 1989). Within the Forest Reserve, a 2,340 ha (23 km²) nature reserve within the karst was gazetted in 1968 but abandoned in 1978 (Zisman, 1989). Karst in the southern districts is subject to logging and agricultural expansion pressures.

Two small but significant karst areas protected in the eastern Cayo District are the Blue Hole and Five Blues Lake

national parks in the Boundary Fault Karst Area (Figure 1). The Blue Hole itself is a karst window, and has been a site of scientific and tourist attention at least since completion of the Hummingbird Highway in 1954 (Day, 1987; 1992). The Blue Hole National Park, established in 1986 and managed by the Belize Audubon Society (BAS), covers 233 ha (2.3 km²) and also incorporates St. Herman's, Petroglyph, and Mountain Cow caves (Zisman, 1989), receiving some 6,000 visitors annually (BAS, 1993). Five Blues Lake National Park was established in 1991 and covers 358 ha (3.6 km²) centered on the 3 ha (0.03 km²) sinkhole lake after which the park is named. Additional karst is conserved within the adjacent 42,967 ha (430 km²) Sibun Forest Reserve (Figure 1). The karst along the Hummingbird Highway have come under increasing pressure in recent years from a combination of agricultural and population growth, mining, and recreation (Day, 1987, 1993b).

Tapir Mountain Nature Reserve, known until 1994 as Society Hall Nature Preserve, was established in 1986 and covers 2,729 ha (27 km²) of little-known karst north of the Mountain Pine Ridge between Barton Creek and Roaring Creek in the Cayo District (Figure 1). The Reserve is managed by the Belize Audubon Society. The Monkey Bay Wildlife Sanctuary, straddling the Sibun River in the western Belize District, was established in 1991 and covers 1,037 ha (10 km²), including cockpit and tower karst with several caves, adjacent to the 45,789 ha (458 km²) Manatee Forest Reserve (Figure 1), which also contains extensive karst. The Aguas Turbias Nature Reserve, of which a portion is karstic, covers 3,642 ha (3.6 km²) in the northwestern corner of the Orange Walk District bordering both Mexico and Guatemala (Figure 1).

The Manatee Special Development Area extends over 47,350 ha (474 km²) in the coastal Belize District south of the Sibun River (Figure 1), where it encompasses the cockpit and tower karst in the eastern extent of the Sibun-Manatee Karst Area. The Cayo West Special Development Area covers 43,354 ha (434 km²) in the western Cayo District (Figure 1), incorporating subdued karst terrain in the upper Belize River Valley and more dramatic karst abutting the Vaca Forest Preserve.

CONCLUSION

As karst landscapes in Belize come under increasing human pressure, it seems appropriate to enact conservation measures to protect the karst environment, particularly the forests, wildlife, soils, water, and archeological resources, all of which have scientific, aesthetic, and economic significance. Belize has a sound legislative base for establishment of a variety of protected areas, and has afforded at least some measure of protection to over 30% of its land area. Within this, some 68% of the karst landscape has received some degree of protection, a figure far surpassing that of any other country in the region. Much of the karst is not widely recognized as such,

and is conserved indirectly because of its overall environmental value. Its future conservation is not assured, but dynamic protection of its attendant forest, wildlife and archeological resources is encouraging.

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