Karst and Coastal Development: A Digital Cave Survey Tool for Municipal and Tourism Planning in Quintana Roo, Mexico

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Abstract

Cave exploration and survey in the northeastern karst of Quintana Roo reveals an increasingly complex network of dry and underwater caves. Over 1500 kilometers of underwater and dry cave passage is documented within a developing coastal region earmarked for municipal and touristic growth. Both urban and tourist hubs maintain a complex relationship between the demands for public infrastructure, prudent use of undeveloped lands, and the sensitive character of the region's karst environment. As coastal municipalities and tourist resorts grow in the region, encounters with dry and underwater caves, karst windows, and a widespread karst aquifer occurs with increasing frequency.

Government and non-governmental agencies can invite local speleological survey groups to share geo-referenced cave survey data or cave mapping products to assist in planning for future regional growth. Revealing cave passage and entrance locations creates a problematic arena for survey groups. Sensitive cave survey data may drift through layers of government bureaucracy reaching land speculators, resort developers, and perhaps even lawbreakers searching for historical antiquities. Vulnerable landowners in possession of desirable karst windows may also suffer uninvited scrutiny by municipal agents.

We propose an alternative method in sharing geo-referenced karst survey data as defined by cave areas. A geo-referenced survey software plot is analyzed by our QEXF software, producing a buffered Google Earth software KML file displaying user defined boundaries for a cave. Survey plot and entrance Global Positioning System locations are removed from the KML file. Cave surveyors control sensitive data while allowing the public to produce reasonably accurate cave area maps within the Google Earth software environment.

Introduction

The Riviera Maya, originally named as the Costa Turquesa, was once a backwater collection of small fishing collectives, coconut plantations, and cattle cooperatives. Slash and burn farming and subsistence hunting on this karst plain supplemented the diet of what was a modest and retiring community. Located on the eastern coast of Quintana Roo Mexico, this region has grown to become a prime destination for world tourism. Resorts, modern highways, and urban centers have developed within a narrow coastal zone of mangrove and scrub jungle that accommodates a collection of fragile fresh water drainage zones. Over many years speleologists, cave divers, hydrologists and ocean divers have collected diverse sets of complimentary data supporting the concept of this area's broad and shallow aquifer drainage region.

The Quintana Roo Speleological Survey (QRSS) archives these observations and cave survey data. Today we find the most common ecotourism activities include an increased use of wild dry and underwater caves. Those activities are becoming an integral part of the local tourism industry. Municipalities and public services continue to grow in order to support the burgeoning
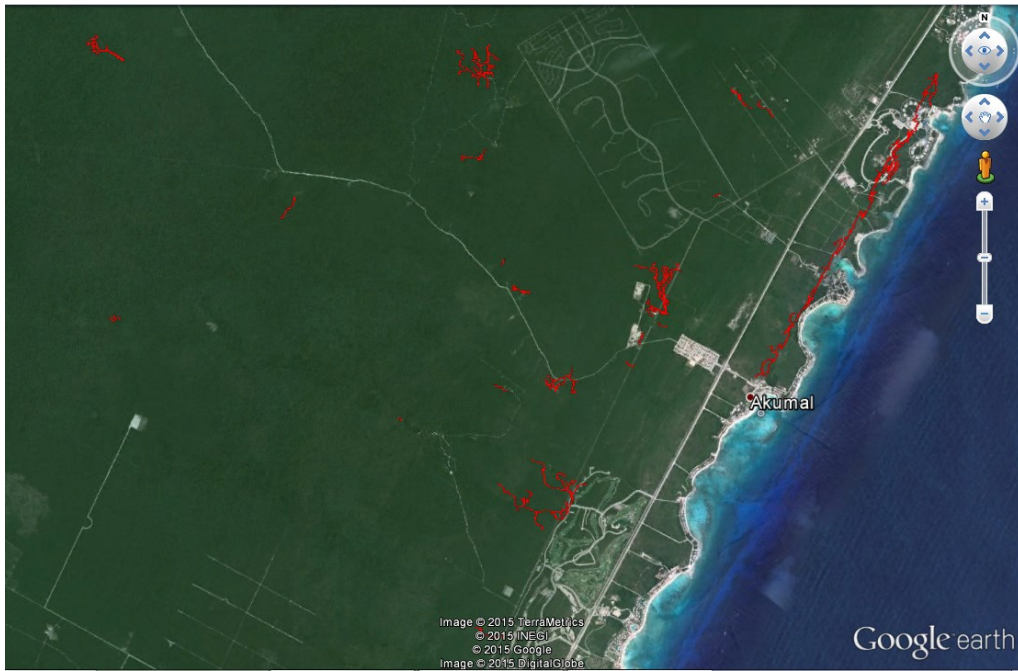
Figure 1. Google Earth KML Cave Line Plot Image

Figure 2. Google Earth KML Cave Area Image

tourism base. As the coast develops, QRSS receives many requests for cave locations and survey data from local governments, land developers, and environmental groups.

Georeferenced cave survey data or cave plot and KML file facsimiles are generally not suitable media when distributing information about the underground karst environment with the public (Figure 1). Survey data in this form is often misinterpreted, leading the public and government officials to reach false assumptions about cave and the aquifer

environments. In the wrong hands cave location data have encouraged surface excavations into existing underwater cave passage for ecotourism companies.

Methods

A georeferenced survey plot file compiled by Compass Cave Survey Software. The operator edits the QEXF Parameter file before the Compass plot file is analyzed by QEXF software. Parameters include the size of the cave area buffer centered on the basic survey line plot. The cave plot can remain in the buffered zone or be removed. Color buffers may be ignored or added to indicate a range of exploration dates. The buffer zone may be transparent, or absent with just an outline.

QEXF will process the Compass plot file though defined user values creating a simple Google Earth KML file (Figure 2). The QEXF KML file is bitmap-based; all cave georeferencing is removed.

Discussion

The QEXF program has been used with success on many occasions. Responding to requests for cave survey information are straightforward. Permission to disclose survey data information from groups who have shared data with the QRSS is not required. Landowners will continue to have issues with land developers and municipality offices should their property contain a significant karst window(s).