China : Hubei Yiba Highway Project

Cave Biodiversity Study, June 2008

Draft Report v1.0

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Fieldwork

Two field trips have taken place to investigate cave ecosystems in the vicinity of the Yiba highway. The first was in December 2007, consisting of Professor Liu Sheng-Xiang, Deng Qing-Wei, Xi Rong, Jiao Kai-Hong, Li Hai-Lan and Luo Quan and five others for half a month, with a second trip made by Professor Liu Sheng-Xiang, Deng Qing-Wei, Guo Lin and Xi Rong along with Duncan Collis from 27th June to 1st July 2008. This report is primarily based on the latter fieldwork, but makes reference to the earlier investigation's report [1].

Cave maps

Cave maps can illustrate the relative positions of underground passages and surface features. In the case of this project, it is important to determine if runoff from the highway will flow or seep into the caves, and accurate cave maps could help determine this.

During the winter investigation, BCRA Grade 1 surveys (no measurements taken, survey drawn from memory) of five caves (Duandongzi Cave, Longwang Cave, Huangwen Cave, Kunyan Cave and Shujiacao Sinkhole #1).

Due to shortage of time during the summer fieldwork, no cave further cave mapping was undertaken, except for a BCRA Grade 2 (bearings taken and distances estimated in cave) of Duandongzi. This confirmed that the cave trends East for around 100m, away from the highway. Of the other caves visited in the summer, Shujiacao Sinkholes #1 and #2 both have lateral extents of only about 10m, whilst the more extensive Dadongyan Cave is separated from the highway by a deep valley.

Collection of specimens

Winter 2007/2008

119 plant specimens, 11 vertebrate specimens and 15 invertebrate specimens were collected. [1] Generally the cooler, drier winter months are not good times to collect invertebrates.

Summer 2008

Professor Liu Sheng-Xiang and his students collected vertebrates and the larger invertebrates.

Duncan Collis collected smaller invertebrates (38 specimens). Photographs of several of these specimens are available in Appendix A. It was agreed that 24 specimens representative of this collection would be made available to Professor Tian Mingyi (Department of Entomology, College of Natural Resources & Environment, South China Agricultural University) in Guangzhou. They were delivered by Deng Qingwei on 7th July.

Prof. Liu will report in due course on the specimens he collected with his students, and representative specimens from the collection will be made available to Professor Tian.

The overall collection is probably truncated (missing some species that were present in the cave) due to shortage of time, and some species are represented by only one or two specimens.

The specimens await expert evaluation. Initial assessment indicates that several specimens may be troglobitic, as they display adaptations such as lack of pigmentation, vestigial eyes or long antennae. The recommendations made in this report are based on this assumption.

Caves

Overview

A total of sixteen caves were identified by Professor Liu's investigation in the winter [1]. Eight of these were visited in the winter, two were revisited in the summer and a further two were visited for the first time in the summer. The scope of this report is limited largely to those four caves which were visited in the summer.

The caves are distributed among the following areas along the route of the proposed highway:

- Huanghua Town, Yichang City
- Gaolan Beauty Spot, Xingshan County
- Shijiaba Town, Xingshan County
- Shujiacao Village, Yanduhe Town, Badong County

Cave Number	*Cave Name*	*Area*	*Visited in Winter*	*Visited in Summer*
16H-E1-1	Lianghekou Cave	Huanghua		
16H-E1-2	Guiyan Cave	Huanghua		
16H-E1-3	Duandongzi Cave	Huanghua	Yes	Yes
16H-E1-4	Dadongyan Cave	Huanghua		Yes
16H-E1-5	Longwang Cave	Huanghua	Yes	
16H-E2-6	Huangwen Cave	Gaolan	Yes	
16H-E2-7	Gaolan Cave #1	Gaolan	Yes	
16H-E2-8	Gaolan Cave #2	Gaolan	Yes	
16H-E2-9	Gaolan Cave #3	Gaolan	Yes	
16H-E2-10	Gaolan Cave #4	Gaolan		
16H-E2-11	Gaolan Cave #5	Gaolan		
16H-E2-12	Kunyan Cave	Shijiaba	Yes	
16H-E3-13	Shujiacao Sinkhole #1	Yanduhe	Yes	Yes
16H-E3-14	Shujiacao Sinkhole #2	Yanduhe		Yes
16H-E3-15	Shujiacao Sinkhole #3	Yanduhe		

Cave Number	*Cave Name*	*Area*	*Visited in Winter*	*Visited in Summer*
16H-E3-16	Shujiacao Sinkhole #4	Yanduhe		

16H-E1-3 Duandongzi Cave

Description

The entrance is a few metres above river level on the north bank of the river, and is accessed via a stooping-height culvert under provincial highway 312. Boulders almost block the cave at the end of the culvert. The cave is a seasonal rising, and consists of around 100m of passage trending East, mostly crawling or stooping, via a breakdown chamber to a final upstream sump. There was no flowing water at the time of the visit in the summer. The cave contains numerous deposits of organic material deposited by the seasonally active stream (dead leaves & wood) as well as guano in places. There are several shallow pools.

Specimens

A total of 24 invertebrate specimens were collected by Duncan Collis, including Araneae (spiders), Pseudoscorpiones (pseudoscorpions), Diplopoda (millipedes), Coleoptera (beetles), Orthoptera (crickets), Collembola (springtails) and Isopoda (pill bugs) [see Appendix A]. Further specimens were collected by Professor Liu and his students, including Caridea (Shrimps). Also seen in the cave but not collected were Murinae (rats and mice), Chiroptera (bats), Diptera (flies) and Scutigeromorpha (house centipedes).

Potential impact

As a river separates Duandongzi Cave from the highway, and a rough magnetic survey confirms that the cave trends away from the highway, there should be no impact on the cave due to highway runoff. As the cave lies only 500m from the line of the highway, vibrations from blasting could affect bats in the cave.

16H-E1-4 Dadongyan Cave

Description

The entrance is high in the cliffs on the north side of the river above provincial highway 312. The entrance is large (around 10m diameter), and the cave consists of at least 800m of approximately 5m-wide abandoned phreatic passage, and locals say its total length is approx. 2km. The cave environment has been heavily degraded by years of human activity including use as a burial site and more recently development as a showcave. The showcave development features concrete walkways, dams, pumps, pipes, lights, and loud music, and has led to pollution of the cave by paint, oil, cigarette ends and litter.

Specimens

A total of 6 specimens of Orthoptera (crickets), Araneae (spiders) and non-glowing worms with a sticky web were collected by Professor Liu and his students. Chiroptera (bats) were observed just inside the entrance, and black fish were seen in an oily pool around 800m in.

Potential impact

As a river separates Dadongyan Cave from the highway, there should be no impact on the cave due to runoff from the highway. As the cave lies only 300m from the line of the highway, vibrations from blasting could affect bats in the cave.

16H-E3-13 Shujiacao Sinkhole #1

Description

The entrance is a ~4m diameter shaft in a depression in the valley floor. The cave descends around 20m in three steps to reach around 10m of horizontal passage with several shafts leading upwards towards the surface. At the bottom the cave is choked with sediment and there is no way on. There are small amounts of dead wood at the bottom of the cave.

Specimens

A total of 9 specimens were collected by Duncan Collis, consisting of Araneae (spiders), Diplopoda (millipedes), Lepidoptera (moths), Collembola (springtails) and Gastropoda (snails) [see Appendix A]. Further specimens were collected by Professor Liu's students, including Araneae (spiders), Lepidoptera (moths) and Gastropoda (snails).

Potential impact

The cave entrance is below the level of the highway, thus direct runoff from the highway could have an impact on the cave environment. As the cave lies only 200m from the line of the highway, vibrations from blasting could affect bats in the cave.

16H-E3-14 Shujiacao Sinkhole #2

Description

The entrance is around 1.7m high and 1m wide in a jumble of large boulders at the edge of a field in the valley floor. There appears to be at least one other smaller entrance among the boulders and a small shaft entrance from an upper level of terraced fields. A short section of horizontal passage among the boulders leads to the head of a ~10m deep shaft, with the upper entrance visible above. At the bottom of the shaft there are approximately 10m of horizontal passage with several shafts leading upwards towards the surface. All potential ways on are choked with sediment, and there are small quantities of dead wood at the bottom of the cave.

Specimens

Duncan Collis collected 5 specimens of Araneae (spiders), Diplopoda (millipedes), Coleoptera (beetles) and Orthoptera (crickets) [see Appendix A]. Further specimens were collected by Professor Liu's students, including Araneae (spiders), Anura (toads) and Lacertilia (lizards).

Potential impact

The cave entrance is below the level of the highway, thus direct runoff from the highway could have an impact on the cave environment. As the cave lies only 300m from the line of the highway, vibrations from blasting could affect bats in the cave.

Unknown caves

There must unquestionably be more caves in the area than those identified so far; however finding them caves may prove extremely time consuming as the terrain is steep and heavily vegetated. It is worth noting that even in karst areas where cave explorers have been actively searching for and exploring caves for decades new discoveries are frequently made, and it is never possible to say with confidence that all caves (or any given proportion of them) in a particular area of karst have been found.

Potential impact

Where the highway crosses karst lands, it can be assumed that rainwater/point-source contaminant runoff from the highway will sink underground, even when no obvious sinkhole is visible. Such sinking water will enter caves, and may have an adverse effect on the cave environment.

Highway construction may create new entrances into previously unknown caves, changing airflow patterns and allowing water to flow in or out of the caves in new places.

It is probable that unknown caves near the highway may contain bats, which could be disturbed by vibrations caused by blasting.

Recommendations

The following recommendations are made on the assumption that the route of the highway has already been selected, and aim to reduce and mitigate its impact on cave ecosystems in the karst areas it crosses.

To reduce the impact of highway construction on the known cave ecosystems investigated during the summer of 2008, specific protection measures should be taken, as detailed below. Additional presumptive measures will reduce the potential impact on the ecosystems of as-yet unknown caves. One of the known caves (Duandongzi Cave) will not be affected by the highway, and could be given protection in mitigation of possible degradation of as-yet unknown caves.

Temporary measures should be used to reduce the impact of the construction phase of the highway, while further long-term measures should be used to reduce the impact of the highway in operation.

This report does not address specifics of the design and implementation of the recommended measures

for sediment and runoff control; a suitably qualified and experienced engineer should be consulted in this matter.

Protection of known caves

This section only considers caves which were investigated during the summer of 2008.

16H-E1-3 Duandongzi Cave

Duandongzi Cave will not be affected by the highway, and contains considerable biodiversity. It could be protected in mitigation of degradation that might be caused to as-yet-unknown caves by construction of the highway. Protection should consist of a grille in the culvert at the entrance, designed to prevent human access but to allow the passage of bats and not to impede the flow of water. The watershed of the cave should be identified and protected by controlling activity that could affect groundwater quality (for example, deforestation, quarrying, construction or changes in farming practices). It appears likely that the watershed may consist largely of steep, heavily vegetated mountainsides.

16H-E1-4 Dadongyan Cave

Dadongyan Cave will not be affected by the highway, but its environment has already been degraded by human activity. No steps need be taken to protect it.

16H-E3-13, 16H-E3-14 Shujiacao Sinkholes #1 and #2

Shujiacao Sinkholes #1 and #2 both contain likely cave-adapted lifeforms and could be affected by the highway. Before construction begins a buffer zone within which vegetation cover is maintained, of at least 30m radius, should be established around each sinkhole. Currently some of this land is farmed; it should be allowed to revert to its natural state (replanting may be used to help achieve this). As the highway will be upslope of the sinkholes, runoff and sediment control measures (such as silt fences and filter strips) should be set up between the highway construction site and the buffer zones in order to prevent runoff from the construction site from carrying sediment into the sinkholes.

These measures should be maintained during the construction phase, and then removed (unless this would cause further sediment disturbance). The buffer zones should remain in force after construction has finished.

An existing unsurfaced road passes close to both sinkholes, crossing the buffer zones. Construction traffic should not use this road as it would negate the effectiveness of the buffer zones at preventing runoff and sediment from entering the sinkhole.

Temporary measures

Runoff control

Staging areas should be created for workers and storage of plant, materials and fuel/oil. Ideally these should be situated away from sinkholes, caves or other karst features. To control runoff from staging

areas, measures should be put in place such as filter strips and detention ponds.

Waste management

Waste material, including human waste, waste food, wash water and excess concrete should not be disposed of in the karst areas. All waste materials left over at the end of the construction phase should be removed from the karst areas and properly disposed of.

Caves found during construction

It is likely that during construction of the highway, previously unknown caves may be found by being dug or blasted into or during surveying operations ahead of construction. In some cases (typically those where the cave has been opened by blasting, and lies directly on the line of the highway) it will be necessary for the cave to be filled to ensure the safety of the highway; in these instances construction should be paused while a cave map is made and a biological inventory of the cave made.

Caves found during construction which do not need to be filled should be promptly subjected to an environmental impact assessment, and and appropriate protection plan drawn up.

In mitigation of possible degradation to unknown caves, Duandongzi Cave (which will not be affected by the highway) could be given protection by fitting a grille to the end of the culvert at the entrance.

Blasting

Vibrations from blasting operations may disturb roosting bats. If this occurs during winter roosting when some species of bats hibernate, the disturbed bats may die. Vibrations from blasting may also cause young bats to fall from cave roofs and die. Limiting the size and number of explosive charges in each blast will reduce this effect.

Long-term measures

Runoff control

The impact of the highway on cave ecosystems once it is in operation will primarily be via rainwater runoff. Control of runoff is therefore a key means of protection for cave environments. Where the highway crosses karst, it should be assumed than any runoff may enter caves and have the potential to cause harm. Changes in the amount of runoff, the sediment load and the temperature of the water can all affect cave ecosystems, as can contaminants in the runoff such as oil, brake fluid, metals, etc.

Runoff and sediments should be controlled by appropriate use of measures such as filter strips and detention ponds

Service station management

Service stations on the highway are a potential source of pollution, both from refreshment facilities (human waste, waste food and cooking oil) and fuel stations (leakage or spillage of fuel or oil). The

best solution would be to avoid siting service stations in the karst areas if possible. If service stations must be placed on karst, a waste management plan must be implemented which prevents waste from entering the groundwater. Storage facilities for fuel, oil, etc, should be designed so that spilled or leaked material does not enter the groundwater, and should be maintained and inspected regularly to minimise the risk of leakage.

References

[1] Liu Sheng-Xiang The Investigation Report on Cave Biodiversity in the Karst Region along the Yichang-Badong Section in Hubei Province of the Shanghai-Chengdu Expressway in the Winter. 2008

[2] Washington State Department of Transport. Highway Runoff Manual. Olympia, Washington State, 2006

[3] "Management Recommendations for Construction." Missouri Department of Conservation Online. 2008. Missouri Department of Conservation. 6 July 2008 <http://mdc.mo.gov/nathis/caves/manag_construc.htm>