

Cadastral survey for the effective management of Cave in Korea

Jong-hyun YOON, Young-ho LEE, Republic of Korea

Key words: Cadastral survey, Natural cave, Natural resource management

SUMMARY

Lately several natural caves have been developed as tourist spots for people in South Korea. Thus the number of people is visiting and lots of facilities have been established around the caves.

Furthermore, each municipality in South Korea has recognized the importance of the caves in terms of tour resources for the purpose of beneficiary by decentralization of political power since 1980. But it is very restrictive to establish the facilities on the ground from viewpoint of stability, because most of natural caves which are very long and divided into several branches in South Korea are located under the ground.

However, currently the supply of the map which relates with a natural cave location is coming to accomplish in compliance with the part groups (Cartography enterprises, sightseeing enterprises etc.) monopolistically, these problems which indicate inaccurate positioning information of natural caves are operating with the restriction of the possibility of establishing facilities and the cause of development limit.

Therefore, in this paper it is the main objective to provide central or local governments with the base map through the accurate positioning information and inspection of existing cave location from the cadastral survey in order to manage effectively the natural caves.

On this account, the natural caves in South Korea registered in the UNESCO were surveyed and the result from the existing positioning information is about 160m differences from the starting point to the arrival point.

Hereafter for the proper management of the natural resources, the accurate registration of the cave and its understanding as a state-owned land should be necessary.

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1. INTRODUCTION

Lately we are in the turning point making a change from 2-Dimensional plane cadastre where the ground objects on a parcel are simply registered into multi-dimensional cadastre where effective management for cadastral object is possible through the registration and management of building or facilities above/under the ground. The technologies of visualization for the 3D objects have already been developed throughout all over the world and on the basis of this fact, the necessities of the registration and management for the 3D objects have been on the rise.

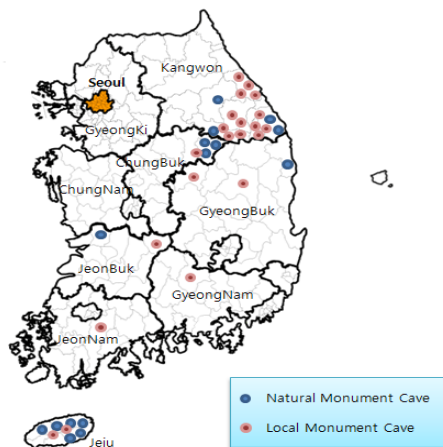
New legislation for 3D cadastre is being drafted and several pilot projects (19 cases in South Korea) have already been promoted in order to realize the 3D cadastre in South Korea. In this context, cadastral survey for effective management of the caves where located below the surface among the natural resources in South Korea shows hereafter the possibility for not only the development but also the preservation of the natural caves on the basis of the cadastral map with accurate location.

2. NATURAL CAVES IN SOUTH KOREA

2.1 Current status of the caves

Natural caves in South Korea are classified as limestone, lava, sea cave, etc. The large number of the caves was made of limestone through the process of their formation. There is no exact answer about how many caves exist in Korea because the exploration about the number of natural caves does not be completely accomplished. However, approximately around

1,000~2,000 natural caves continuously developing in Korean peninsula are estimated. Particularly most of these caves are located in Kangwon province, Chungbuk province and Jeju Island.



Among the caves, only 270 caves (488 in Kangwon, 89 in Chungbuk, 21 in Gyeongbuk, 1 in Jeonnam and 159 in Jeju Island) have the information of the location and the size. Therefore the ratio of the recognized caves out of the whole is relatively small.

Figure 1 Natural & Local Monument Cave in Korea

Some natural caves are registered as the Natural Monument or Local Monument. The caves designated as the Natural Monument in South Korea are 22. 7 out of 22 are located in Jeju Island and only 8 Natural Monument Caves are opened as tourist spots to the public.

Other 23 natural caves are designated as the Local Monument and 3 out of 23 are opened to the public and 20 out of 23 are not developed yet. Figure 1 shows us the distribution map of Natural Monument and Local Monument Cave in South Korea.

In the case of ‘Mt. Halla Natural Preservation District in Jeju Island’, Jeju Volcanic Island and Lava Tubes together are registered as the UNESCO World Heritage (Jun, 2007) to be preserved as Natural resources for the world. As Jeju Island is covered by volcanic areas, almost all the natural caves in Jeju are lava caves.

The total 16 caves which are opened to the public comprise 11 natural caves which are registered as Natural Monument and local monument and 5 general caves are making a big contribution by a local tax collection in relation with surrounding tourist spots.

2.2 Development of Korean Caves

2.2.1 Self-Reliance Ratio of local finance

Decentralization of political power in Korea has been pushed ahead since 1980, as a result local governments were established since 1995. The overall profit structure of the local governments can be divided into two parts, central governmental funding and creation of self-finance. There are 230 municipalities in South Korea comprised of 75 cities, 86 counties and 69 districts (in Metropolitan). They have performed their budgets and administrative duties in close relation to the central government.

However, the Self-Reliance Ratio of local governmental finance in the most of local governments except Seoul Metropolitan city and other 5 mega polis remains only 20-30% (see Figure 2) and these municipalities have tried to do their best to secure stable finances in order to improve their Self-Reliance Ratio of local finance by inviting new enterprises and establishing local development plans.

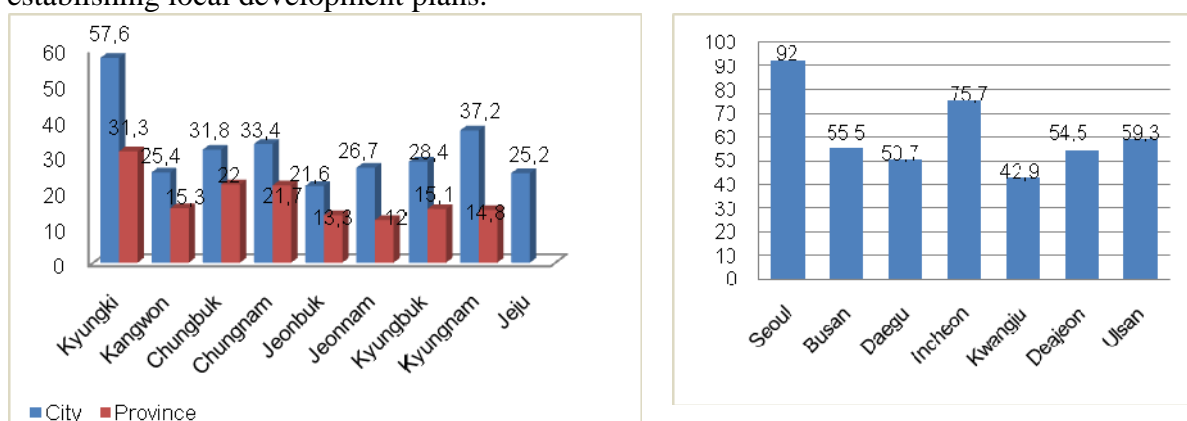


Figure 2 the Self-Reliance Ratio of the Local finance in Korea

As a result, Kangwon, Chungchong and Jeju municipalities where natural caves are distributed throughout the areas strongly want to create new stable revenue resource by using these caves. It seems that the open and the development of these natural caves will play an important role in the Self-Reliance Ratio of local government's finance.

2.2.2 Status of Cave Development

There are 16 caves opened to the public among all the natural caves in South Korea. They are making a big contribution as another source of revenue resources by attracting tourist into the caves. Most of the caves opened to the public have been designated as the Natural Monument and expansive areas including these caves are assigned as Natural Monument District.

In the case of Hyeopjae & Ssangyong caves (#236 Natural Monument, Jeju), in 2008, 0.95 million tourists visited the caves and 4.6 billion won income (Korean currency) of admission fee was generated. As another case, there were 0.68 million attendance and 3.3 billion won income were produced in the Hwansun & Daekuem cave (#178 Natural Monument in Samchuk, Kangwon), according to the statement of Cultural Heritage Administration of Korea.

Current status of the caves opened to the public among the natural caves in Korea is shown in <table 1> below

<Table 1> Current Status of the opened natural caves in Korea (2008)

	No.	Title	Total admission(billion won) /Entrance (million)	Admission(won)
Natural Monument	98	Jeju Manjang	0.56 / 0.516	2,000
	155	Uljin Sungryu	0.55 / 0.207	3,000
	178	Samchuk Hwansun	1.34 / 0.444	4,000
		DaeKuem	1.94 / 0.238	12,000
	219	Youngwol Gossi	0.27 / 0.106	3,000
	236	Jeju Hanlim lava	4.6 / 0.95	7,000
	256	Danyang Gosu	1.58 / 0.51	4,000
261	Danyang ondal	0.77 / 0.22	5,000	
Local Monument	Kangwon33	Jungsun Hwaam	1.0 / 0.359	5,000
	Kangwon39	Taebaek Yongyeon	0.25 / 0.103	3,500
	Chungbuk19	CheonDong	0.2 / 0.10	4,000

(Source: adopted from Cultural Heritage Administration of Korea)

Jeju Island took in around 5.2 billion won from tourist in 2008 by using only two opened-caves according to 2008 statistics. With the admission revenue of opened-caves, economic

effect related to other tourist attraction sites gave an important role to locating financial resources for each municipality.

3. Remarkable issues in Cave management

In this paper not internal problems like changes of circumstance in cave according to development but external problems caused by uncertain position of caves are focused on. Adverse reactions are also produced in the middle of the development because accurate cave positioning did not be surveyed about the natural caves in South Korea on the basis of cadastral map. Therefore, these problems above in relation to the development in Jeju Island especially will be shown in this paper.

It was investigated that a considerable number of lava caves in Jeju which were registered as the UNESCO World Natural Heritage had the risk of collapse due to the construction of the road.

According to the Jeju Cave Institute, the direction of about 150 lava caves where they located in East and West of Jeju city, east area of Seoguiipo city in Jeju Island was investigated from last 1994 to Mar, 2009. Consequently, 24 lava caves were confirmed as they passed under the road at 103 spots without any consideration based on the cadastral maps.

Western areas of Seoguiipo city where 8 lava caves like Majang, Susan, etc. are located in the intersection of the 23 points under the 1 national road, 2 local roads and other 20 roads. Amongst the caves where they were designated as the Natural Monument it was investigated that the road was established above the 8 branches of this cave.

On account of increase of traffic, various developments and natural prolonged weathering collapses of caves have been accelerated. Therefore, lava caves located under the surface in Jeju Island were examined that they are currently in the stage of collapse. In this case, possibility where the dent accident by ceiling collapse will occur is high when heavy equipments pass on the road or a construction is under development on this road.

In accordance with this reason, cave collapse is accelerating. Caves have been changed into the river with the collapse of the cave ceiling.

In addition to these facts, natural resources were damaged by wind power plant complex in Jeju Island. In other words, collapse risk of Susan cave (#467 Natural Monument) comes to the force according to the discovery of the branch caves at the site where wind power plants will be established.

This was caused by the inaccurate positioning of natural caves under the ground when developments were started. It is very important to secure the stability from a viewpoint of tourist resource development as well as establishment of wind power plant or road.

Besides when some areas are designated as the Natural Monument District, the inside development of these areas is limited by the regulation called 'Natural preservation law' in

Korea. In this district, it is impossible to establish some facilities or buildings for financial purpose. In order to solve these problems it is necessary to perform the cadastral surveying to locate the exact position of the caves.

4. Effective cave management using cadastral survey

In this research, cadastral survey was performed by Korea Cadastral Survey Corporation (KCSC) in order to manage efficiently the natural caves as mentioned above for Susan cave in Jeju Island. Susan cave was designated as #456 Korean Natural Monument last Feb, 2007 and is located in Susan-ri, Sungsan, southern Jeju. The total length of the cave is 4,520m and this is the third longest cave in Korea following the Manjang (7,460m) and the Billemot (7,033m) cave.

Cadastral survey for Susan cave was planned on the basis of the result from Korean Cave Institute (KCI) and about 400 control points were established by GPS surveying. This survey was performed for the vertical cave which it has an entrance with 1m width and 8-9m vertical length. It was impossible to make closure loop of control points for cadastral survey due to the specific character of the cave (in this project double-run loop was used) and there were lots of difficulties on the process of survey because it is not easy to secure clear view sight.

On this account, the natural caves in Korea, which are registered in the UNESCO were surveyed in order to set up the reserve areas for Susan cave (4.5Km) and the result after performing the cadastral survey the existing positioning information is about 85m differences at the drilling point and 160m differences from the starting point to the arrival point (see Figure 3).

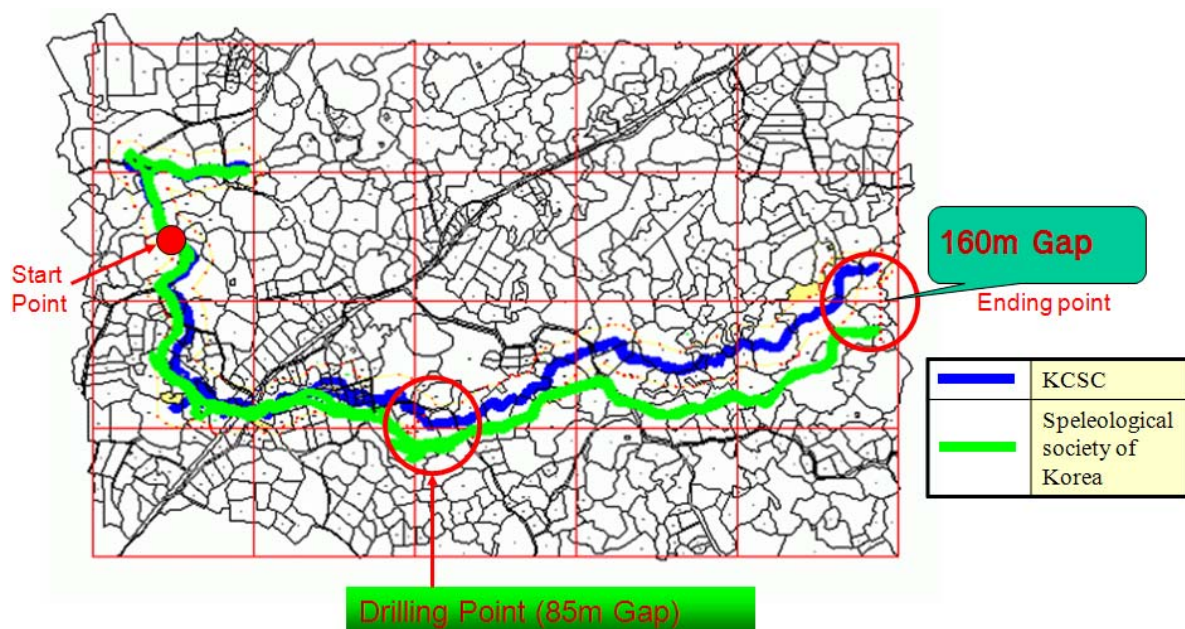


Figure 3. Comparison of different surveying results.

In order to check these gaps on the ground, 20m vertical excavation was performed by drilling machine in the middle of the cave. At this point, drilling ball was dropped into the bottom of the inside cave through the vacant space. And cadastral survey on the ground was performed to check this point based on the used control points.

To verify the accuracy of surveying result inside the cave, comparison between the coordinates of cave inside and ground were checked. Consequently, the same surveying result was confirmed.



Figure 4. Confirmation of different surveying results

This cadastral survey will play an important role in development or management of natural caves to provide end users with accurate positioning information of the caves by correcting wrong result made by the existing geographic surveying (cartography) in order to make a profit by establishing buildings or facilities.

All kinds of plans for facilities and buildings should be designed on the basis of cadastral survey because the surveying performances are closely related to the individuals' ownership. Therefore accurate positioning of caves is very important to invigorate the tourism and this information will play an essential role in the stable investment by external enterprises.

5. Recommendation

According to the registration of the UNESCO's World Natural Heritage, the result of cadastral surveying for these natural caves is expected to show the management of the natural caves in keeping pace with the necessity of systematic cave management. Also it will make it possible to enact legislation in order to establish the facilities and the limit of the weight of traffic using the sign announced that where round roads across the surface of caves in Jeju are located.

By marking the accurate location of caves on the (cadastral) map, the provision of positioning information for natural caves will play an important role in efficient management of caves as

Natural resource as well as facilities on the ground using the accurate cadastral survey against geographical map provided by some groups monopolistically.

In order to manage efficiently the natural caves, these caves being controlled by Central or local government should be understood as a state-owned land and registered correctly. Consequently, Cave GIS (Geographic Information System) should be established for nationwide natural caves using the state-of-the-art surveying technology on the basis of cadastral survey. And also it should be established to preserve or manage the Korean natural caves as the World Natural Heritage.

As I mentioned above, the accurate surveying outcome based on the cadastral survey will make it possible to preserve or protect the natural caves such as establishment of road, wind power plants or buildings when we have to manage it systematically. Also this will be another opportunity when municipalities where they need to create revenue for their local finance manage the caves as tourist spots. The accurate result of cadastral survey contributes to the creation of the revenue of the municipalities through the development of buildings, roads, plants, etc.

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BIOGRAPHICAL NOTES

Jong-hyun YOON is a researcher at Land information team, Cadastral Research Institute. He was acquired a Master Degree from ITC, the Netherlands. His professional interests are an establishment of Korean cadastral system in relation to service delivery system via Internet and cadastral reformation in Korea.

Young-ho LEE is an assistant manager at the business development team, Korea Cadastral Survey Corporation. He was acquired a Master Degree from ITC, the Netherlands. His professional interests are improvement quality of cadastral information based on survey measurement as well as distribution of cadastral data via Internet.

CONTACTS

Jong-hyun YOON
Cadastral Research Institute
#815 Manhattan Bldg., Yeoido-dong, Yeoundungpo-gu
Seoul
Republic of Korea
Tel. + 82 2 3774 2344
Fax + 82 2 3774 2319
Email: yunjh@kcsc.co.kr
Web site: <http://www.cari.re.kr>

Young-ho LEE
Korea Cadastral Survey Corporation
45 Yeoido-dong, Yeoundungpo-gu
Seoul
Republic of Korea
Tel. + 82 2 3774 1208
Fax + 82 2 3774 1229
Email: horey@kcsc.co.kr
Web site: <http://www.kcsc.co.kr>