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A Glacial Lake Study and Recent Mountaineering Conditions in the Bhutan Himalaya

1. Introduction

Most of the Bhutanese being Tibetan Buddhist adore “Tsho” as a religious place, as well as the mountain, megalith, water fall, and so on. The word “Tsho” means “lake” in Tibetan language. After the Little Ice Age, most of the glaciers have shrunk, and glacial lakes have appeared and expanded due to the global warming. Abrupt appearance of such natural dammed lakes in unstable conditions, glacial lake outburst floods (GLOF) have occurred from many mountain glaciers in the world. As shown in Figure 1 and Table 1, there are several GLOF events after the termination of Little Ice Age in the Bhutan Himalaya. Bhutanese, then fear the glacial lakes because impounded water will be able to significant sources of the flood. This reason is different from original meaning as religious awe. Appropriate evaluation for glacial lakes should be therefore implemented. In order to study for correct glacier/glacial lake condition and provide technical cooperation with Bhutanese researchers,



Fig. 1 Topographical map of Bhutan. The map was created by Mr. Tatsuro Chiba (Asia Air Survey Co., LTD.) on Google Earth using Red Relief Image Map method (RRIM, Chiba et al., 2008) with SRTM DEM. The map expresses regional difference in geomorphological condition, such as deep valley in the great Himalaya, dendritic valleys and erosion fronts in southern half of Bhutan. M: Mangde Chhu. C: Chamkhar Chhu. Solid circle: Outburst glacier lakes after the little ice age termination (see Table. 1).

an international joint project was launched in October 2008. The joint project* entitled “Study on Glacial Lake Outburst Floods in the Bhutan Himalayas” which belongs to a disaster prevention program of SATREPS (Science and Technology Research Partnership for Sustainable Development), is supported by Japan International Cooperation Agency (JICA) and Japan Science and Technology Agency (JST). The author has been dispatched by this project as JICA long term expert in the Glaciological division on Department of Geology Mines (DGM) in Thimphu. In this article, I firstly introduce the tentative result of our project. Furthermore, I mention recent information regarding the trekking in the Bhutan Himalaya which was obtained from two years in Thimphu and field survey in the mountains.

Table 1 GLOF events after the termination of little ice age in the Bhutan Himalaya

Date	Glacier/Lake name	Basin	Cause of outburst / Remarks	Information source References
after the termination of LIA to the mid 20th Century	Upper Chhukam Tsho N 27.837°, E 89.374°	Mo Chhu western headwaters	Chhukam Tsho may also outburst	This study. Field survey in 2011
after the termination of LIA to the mid 20th Century	Cogalung Glacier N 28.073°, E 90.623° (Tibetan side)	Kuri Chhu western headwaters	GLOF occurrence is implied from obvious denuded valley in satellite images.	CORONA satellite photo (Komori et al., 2005)
after the termination of LIA to the mid 20th Century	N 28.301°, E 90.743° (Tibetan side)	Kuri Chhu western headwaters	GLOF occurrence is implied from obvious denuded valley in satellite images.	This study
1957	Tarina glacier lake (western lake)	Pho Chhu western headwaters	Glacier ice avalanche	Gansser (1987) Iwata (1998)
1994, Oct.	Luggey Tsho	Pho Chhu eastern headwaters	moraine dam failure or lateral moraine plunge into the lake	Watanabe and Rothacher (1994)
2009, Apr.	Tshojo Glacier	Pho Chhu eastern headwaters	small event	Satellite data, Field survey in 2009 & 2010

Upper three events are implied from the characteristics of topography and sediment in/around the moraine.

2. GLOF research project

2.1 Background of the project

Glacier and glacial lake description and ringing an alarm of the GLOF in Bhutan were initiated by Gansser from the 1960's (e.g. Gansser, 1983). After GLOF event in Luggey Tsho in 1994, glacial lake study and mitigation works have been intensively conducted by DGM, Indian agency and foreign researchers. Outline of these studies was reviewed by Iwata (2007) in Japanese Alpine News. It is notable that International Centre for Integrated Mountain Development (ICIMOD) wrapped up an inventory of glacier and glacial lake in Bhutan (Mool et al., 2001) based on satellite data. The inventory shows that Bhutan has 2,674 glacial lakes and 24 hazardous lakes. Later the number of the hazardous glacial lakes subsequently increased to “25” after the publication, because rapid expanding Thorthormi lake was included. “2,674” and “25” has been referred as symbolic number which can be used as explanatory material for recent severe condition due to the global warming in the Bhutan Himalaya. However this pioneer work has to be admired, the extraction of the glacial lakes and evaluation of hazardous condition in the inventory is necessary for reinvestigation. Because the inventory works were carried out by an inconsistent procedure with limited low resolution satellite

data, and lack of the field data except Lunana area. Consequently, our project has aimed to following subject;

- 1) Capacity development in technic for field survey, remote sensing, GIS, geophysical exploration and geo-tech analysis regarding GLOF hazard mitigation
- 2) Inventory works of glacial lakes and re-evaluation for potential of GLOF in Bhutan Himalaya
- 3) Risk evaluation for the triggering of outburst and GLOF related phenomena
- 4) GLOF Hazard mapping and to propose a plan of an early warning system in the Mangde Chhu basin

3. Field survey

As mentioned above, main subjects of our project are field survey, satellite data analysis and hazard mapping regarding glacial lake, landslide and active fault. I mention here, the preliminary results of the field surveyed in glaciated area. The other result will be reported in the institute bulletin of DGM “Bhutan geology” .

3.1 The headwaters in Mangde Chhu

The field surveyed area especially covers the headwaters of Mangde Chhu (Fig. 1, Photo. 1). The area lies along with most of eastern part of the snowman trek which is a one of the longest trekking route in the Himalayas. The field surveys were completed in the autumn 2009 and 2010, and have been



Photo. 1 Bird's eye view of the Mangde Chhu headwaters and Tibetan Plateau (back side). Glacial lakes in the near side of photo were surveyed in 2009 and 2010. Photo taken by Mr. Konagaya (Kawasaki Geological Engineering Co. Ltd.) from chartered Druk Air in 2002. High ridges from Gangkar Puensum is pictured right.

planned for 2011 again. Every tour requires traveling an approximately 400 kilometers and crossing some mountain passes over 5,000 meters. The highest pass during the tour is Gopu La (EL. 5,470 m, “La” means the pass) at the western entrance of the upper Mangde Chhu basin from Lunana. Our tasks were to carry out the bathymetric survey for glacial lakes, geophysical exploration, setting an automatic weather station (AWS) and determination of exact volume in recent glaciers retreating.

1) Bathymetric survey.

The bathymetries on the lakes were carried out by inflatable boat with depth-sounder function of a fish finder (Photo. 2 and 3). We have selected target lakes from the list of “potential dangerous lakes” in previous inventory in Mool et al., (2001), and vulnerable or risky lakes which were defined by remote sensing technic using satellite DEM data (Fujita, 2011. Advanced manuscript has been prepared). The archived bathymetric maps show that 1) in most cases, the deepest part lies at upper



Photo. 2 Bathymetric survey in the Mangde Chhu headwaters. Photo taken in September 2010. The peak in the right back is Chumhari Kang



Photo. 3 Bathymetric survey in Tsholim lake, Pho Chhu headwaters. Photo taken in September 2010. The peak in the back is the western peak of Mt. Namshila, which was scaled by Chuba University in 1985.

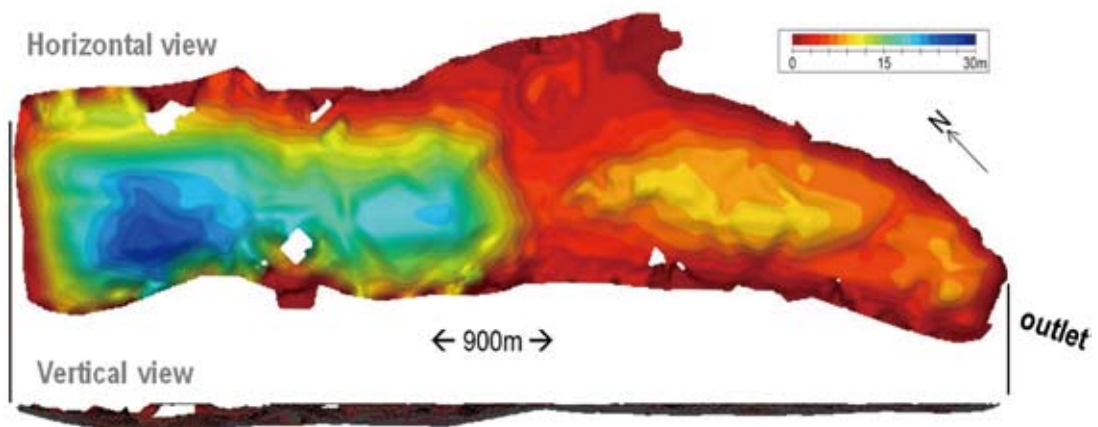


Fig. 2 Bathymetric map of a glacial lake in the Mangde Chhu head water (Zanam C) . Deepest part, -26 m was measured at the upper part (left in the figure). On the other hand, the lower half (right in the figure) shows relatively shallow -6 ~ 10 m. Instead of the usual ball shaped profile in a lot of peoples imagination and some web-sites , actual profiles in most of the glacial lakes shows very shallow.

part of the lake, 2) the lower part of the lake is 10 ~ 20 meters deep at the most, 3) some lakes have threshold sill(s) which are formed by submerged moraine near the lower part of the lake(Fig. 2). The flood analysis and hazard mapping will be considered at latter half of this project. In the light of these topographic characteristics, water discharge volume in case of the outburst flood can be estimated with more precision. The preliminary flood analyses show that the risks from GLOF are lower than originally expected in the Mangde Chhu basin (Koike, 2011).

2) Monitoring of glacier variation and lake inventory works

Dr. Tsukihara took precious photographs along the reconnaissance in 1984. Furthermore, Dr. Naito also obtained the photographs in 2002 at same point where Dr. Tsukihara took the photos as “repeat

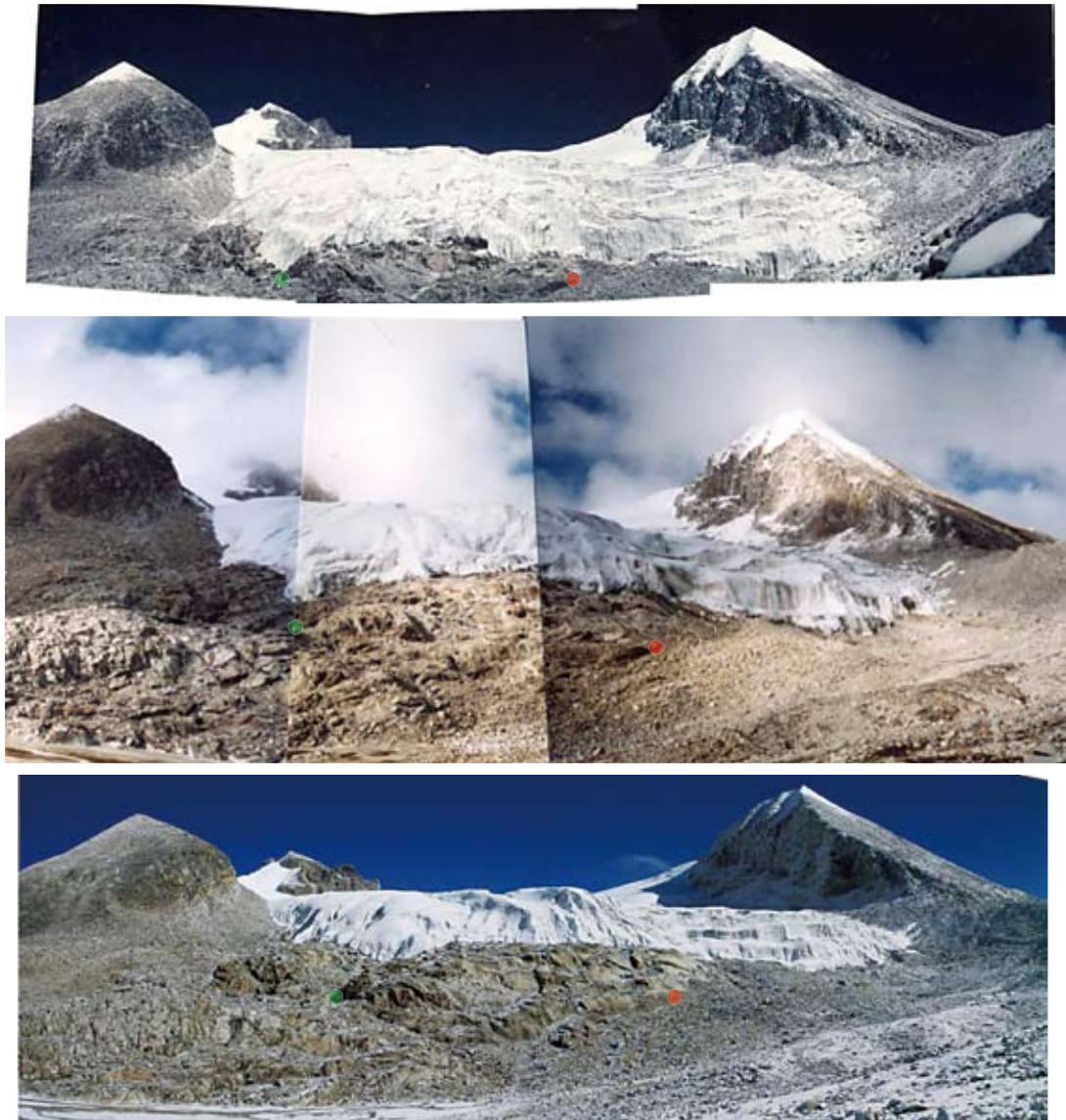


Photo. 4 Glacier ice variation since 1983 in southern Gophu La.(28.005° N, 90.300° E) Photo taken by Dr. Tsukihara in 1999, Dr. Naito in 1999 and this study in 2009. Green and red solid circle are corresponding points of each photographs.

photography” (Naito, 2003). In this project, we try to reacquire the photographs in 2009 and 2010. Comparing these photographs, it shows that the glaciers have been retreated sharply almost 40-60 meters since 1984 (Photo. 4). Detail estimation will be carried out using the photogrammetric analysis in this project.

On the other hand, satellite data group in our project have been extracted the glacier lakes from 2.5 m high resolution pan-sharpened ALOS PRISM and AVNIR-2 satellite data between 2006 and 2011. A sequence of the preparation, the remote sensing data was processed under complex and consistent procedure. The extractions of the lakes have been screened with following definitions; 1) Glacial lakes are laid between the terminus of the mother glacier and the Little Ice Age moraine. 2) The lakes are located within 2 km of the Little Ice Age moraine down-valley. 3) Minimum lake size which will be registered is 0.01 km². Remote sensing research group has already published as glacial lake inventory in particular Mangde Chhu basin (Ukita et al., 2011; JAXA, 2011). However, this inventory is of course reliable rather than previous study by ICIMOD. The inventory works for the other basin in Bhutan will take longer time. Hence, Bhutanese colleagues will join to extraction work along with Japanese researchers as an advanced training.

3) Meteorological observation.

We established an AWS in the moraine dame of Zanam F Lake (EL. 5,230 m, N27 ° 58.23' , E90 ° 20.15'). Principal data observed from October 2009 to October 2010 is as follows; Annual mean air temperature: -3.5 ° C, Annual surface soil temperature: +0.7 ° C, Annual precipitation: 820.0 mm, Maximum and second maximum snow depth: 43.4 cm (30th, March) and 38 cm (8th, October). Latter



Photo. 5 Installation work of the automatic weather station on the moraine in September 2009 . The station had been keep stable condition except for the theft of tensioning wires by the local people. Lightly snow dusted ridge in the back in the photo is 5,500 ~ 5,400 m peaks (27.965° N, 90.335° E).

the heavy snow fall was caused by record cyclogenesis in this season. Due to the heavy snow fall our field trip was held up for few days. It was recorded by AWS that the snow has remained for at least 40 days in sunny spot on the moraine. Annual mean temperature and precipitation in the other AWS (EL. 4130 m, N28° 4.77', E90° 12.44', established by Nagoya Univ. and maintained by DGM, distant of 17 km from Zanam F) are +3.1 ° C and 782.8 mm, respectively. Temperature lapse rate of both the station is 6.0 ° C/km.

3.2 The headwaters in Chamkhar Chhu

The eastern and western headwaters in the Chamkhar Chhu basin have 4 glacial lakes that are evaluated as “potential dangerous lakes” by Mool et al., (2001). In order to verify the field condition of these lakes, we have carried out land and bathymetric survey. Chubda Tsho (EL. 4,870 m, 28° 01.3' N, 90° 42.4' E), one of the biggest glacial lakes in Bhutan shows relatively safe condition, because moraine dame is stable and water depth in lower half is shallow. Phudung Tsho (EL. 5,040 m, 27° 56.4' N, 90° 32.1' E) also shows stable since dam body in fact consists of basement rocks. These evaluations can be made by only field survey. On the other hand, supraglacial lakes (EL. 47,00 m, 28° 00' N, 90° 32.5' E) appear with unstable debris on Burtsham Glacier that is fed from the southeastern foot of the mount Gangkhar Punesum. As described later, abrupt water discharge from even supraglacial lakes terrify the people in the downstream. Hence, further observation and secular variation of ice/water condition are required.

In the trekking route along the western headwaters, there should be a magnificent view of the Gangkhar Punesum via U-shaped valley. However the view was opened only a moment during the field survey due to the monsoon season and lack of time. Furthermore, we had to abandon a reconnaissance to western route from the Bamurpa, south of the Burtsham Glacier to Gangkhar Punesum BC via “Jumbo jet valley” which is mentioned as the alternating route with question mark in the trekking guide book (Bart, 2008). I seek for the information regarding this route, if somebody know, please feel free to share with the author. In addition, however the piston course along Chamkhar Chhu is minor. I recommend especially western route to busy and low stamina trekkers, because the visitors can access the glacier and return only about 1 week without crossing the high pass.

3.3 Recent GLOF event in the Bhutan Himalaya

In 29th April 2009, unusual water discharged occurred from Tshojo glacier in Lunana Gewoq (“Gewoq” is an equivalent to Japanese “gun”) in the Pho Chhu headwaters. The source of the discharge, Tshojo glacier of 15 km in length and 20 km² in area is one of the biggest glaciers in Bhutan. The lower part of the glacier is a typical debris covered glacier. According to the major newspaper in Bhutan “Kuensel”, the flood was noticed and informed as follows;

- A staff of basic health unit in Lhedi where is 3 km downstream from Tshojo outlet had heard the roaring sound from Pho Chhu at 3 AM.
- He found flood form Gotey Chhu, a western tributary of Pho Chhu.
- He rushed to Tanza main settlement in Lunana and inform the incident for Dzongkhag (“Dzongkhag” is equivalents to a Japanese prefecture) via radio transmission.
- Dzongkhag officer distributed the warning information regarding the flood to citizens living at Punakha and Wangdi Phodrang Dzongkhag through mobile phone.

In 1994, both Dzongkhag has experienced GLOF hazard from Luggey Tsho in Lunana (Watanabe and Rothacher, 1996). During that GLOF event in 1994, 21 people were found to be dead and Dzongkhag main office (Phunakha Dzong) was isolated by flood river.

Since the GLOF experienced citizens were thrown into a commotion and they are always panicked by

next GLOF event. In 2009, some of the people who were living along the lower river terrace of Phuna-Tsang Chhu tried to evacuate with all their belongings on hearing the next GLOF but it was a rumor that the big glacier lakes flooded from Lunana, spread in the town. Finally, there was no damage even along murky and swollen river. However such disturbance is first experience since 1994 GLOF. A discharge meter in Pho Chhu recorded that risen water volume has more than 0.5 million m³ around few days. Hence, this value shows discharge volume of the water in this event, because the discharge records from the other catchment area were static.

On the other hand, I also need to describe field evidences which were obtained from satellite data and field survey in 2009 and 2010. There are deep eroded channels on the glacier and fan shaped deposit at the front of the outlet (Gotey Chhu). These characteristic shows that some catastrophic event definitely occurred on the glacier.

Sedimentological and geomorphological aspects are as follows;

- 1) Debris fan is remained in the front of terminal moraine (Photo. 6).
- 2) There are many debris lobes which consist of well sorted sand and gravel.
- 3) The lobes overtop the bank of the channel and bush as well as river mouth of Gotey Chhu.
- 4) Upper sources of the lobes and channel are abruptly disrupted.
- 5) Small sand/gravel mound remain at upper end in the channel (Photo. 7).



Photo. 6 Fan shaped deposition (yellow arrow) in the front of the terminal moraine. Table mountain is seen behind the moraine. Photo taken by Mr. Dowchu Drukpa (DGM) in September 2009.



Photo. 7 Sand and gravel mound at the far end of the debris flow channel. In contrast to the mound, a vent also remains with a small amount of water (right).

The characteristic 1, 2 and 3 proves that some debris flow occurred on the glacier, 4 and 5 shows that debris flow originated from intra-glacier as the sand/gravel fountain, respectively. In other words, flood water with large quantity of debris was transported from upper stream via intra-glacier channel (Fig. 3). However our field survey found out fresh empty pond at the upper stream on the glacier (Photo. 8). The estimated volume of the empty lake pond is not enough to discharge the estimated volume of the water at down stream. We could not obtain reliable evidence of the source of the flood water. After the field survey, remote sensing analysis using straddled satellite data by Dr. Yamanokuchi, Remote Sensing Technology Center of Japan, shows abrupt disappearance of a supraglacial lake at 5.5 km upstream from the outlet (Yamanokuchi et al., 2011). A Vanished lake is strong evidence of a small GLOF event which was a source of the water and sand/debris fountain and flow near the outlet.



Photo. 8 A dried up depression and intra-glacial channel (back right) on the lower part of Tshojo Glacier. Glacial ices are exposed on the northwest ward of depression wall.

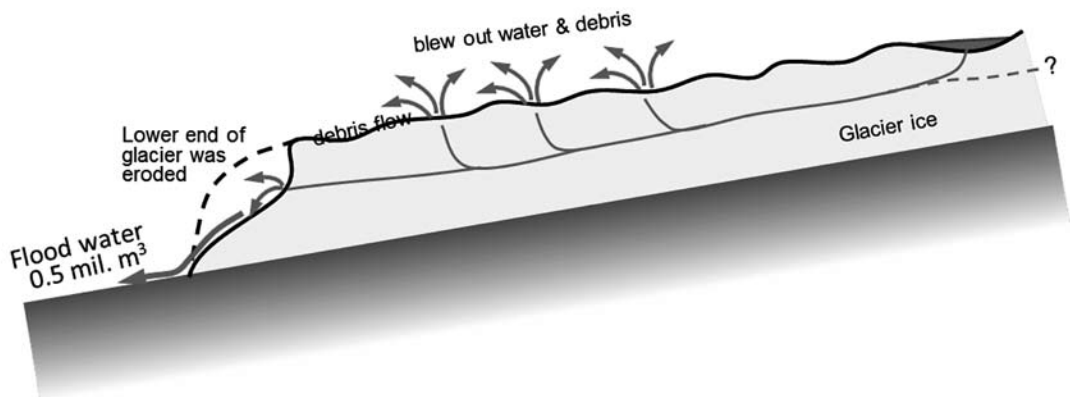


Fig. 3 Schematic profile of Tshojo outburst event in 2009. Horizontal to vertical ratio is not real. Thickness of the glacier ice was elongated.

Such unique GLOF event on the debris covered glaciers was documented in GLOF on Lipmoshar glacier, central Nepal in 1991 (Yamada and Sharma, 1993 Fujiwara and Gomi, 1995). According to CORONA satellite photo and recent satellite data, the location of the sources of a GLOF and the condition of devastated valley in Mingbo valley, eastern Nepal in 1977 (Fushimi et al., 1985) seems to be similar phenomenon of Tshojo GLOF.

4. Recent conditions of the trekking in Bhutan

4.1 Guide, agent and transportation by Horses and Yaks.

Public tourism and mountaineering were opened to foreign people in Bhutan from 1983. After 11 years, climbing over 6,000 m peak, so called adventurous mountaineering is closed with the last expedition in Masa Gang by British and American team (Bart, 2008). Since the abandon, mountaineering specialized guides and agents in Bhutan have not developed. The guide, Mr. Karchung and Yeshi who managed and attended the first successful expedition of Masa Gang by Academic Alpine Club of Kyoto University of course retreats from the field and occupies an administrative position.

As compared with Nepal, the most of trekking guides are pleasant too but poor experience. Our field survey was also stressed out by even licensed guide and agent in Guides Association of Bhutan and Tourism Council of Bhutan. If you want to select adequate guide and agent, you have to evaluate



Photo. 9 Glacial lake complex in Lunana. B: Bechung glacier. R: Raphstreng glacier (completely changed into a green colored glacial lake). T: Thorthormi glacier. Yellow arrow: Luggye glacier. Red arrow: Mitigation works site by UNDP GEF project (Photo. 10). Black arrow: Mt. Gangkar Puensum. Most foreside is hidden by Mt. Chumhari Kang (Photo. 2). Left ridge in the photo is the peaks leading out of the table mountain. Photo taken in September 2009 from 28.105° N, 90.222° E)



Photo. 10 GLOF hazard mitigation works in Thorthormi Tsho, Lunana. Photo taken by Mr. Karma Toeb (DGM).



Photo. 11 Packing and loading in the first morning of the post monsoon. Equipment transportations were depended on horses on the snow and over 5,000 meters high. Photo taken in September 2010. Left peak in the photo is Mt. Namshila (Photo. 3).

their knowledge and technic in the emergency condition, and negotiation ability with local key person (i.e. houseman and yak herder). In general, experienced guides in high season charge over 3,000 Ngultrum (Ngultrum is equivalent to an Indian Rupee). Rapidly increased young guides who have experience less than 10 years as freelance mostly charge around 2,000 Ngultrum. The cost of both well experienced and not experienced guides in off season will be almost half respectively.

As for the transportation, unlike the trekking in Nepal, each 25 kg of two packs are carried by horses and/or yaks. According to recent information, the horseman and Yak herder charge around 800 Ngultrum per a house/yak in Gasa, Laya and Bhumtang, and around 500 Ngultrum in Paro. The animal hiring price unfortunately has been increased caused by local economic inflation due to the employment growth by the lake drainage project in UNDP (Photo. 9 and 10) and trade boom of local specialty Cordyceps. Especially, recent babble economy in Laya and Lunana, and a shortage of successors in mountain villages have made very difficult to yak hiring (Photo. 11).

4.2 The impacts of cyclone and low-pressure system in mountains

In May, 2009 the rain storm in a couple of days from Cyclone Aila caused Bhutanese worst meteorological disaster. The storm devastated especially rivers in the central and west Bhutan. After the storm, trekking route near the rivers and gullies became prone to be washed away from a bit of swollen stream and rain fall. Our field work in September and October 2010 along the snowman trek needed to request for reconstruction of a bridge to Gasa Dzongkhag and was hung up few days due to minor repair works on the route by ourselves. We also found around ten natural dammed lakes along Chamkhar Chhu which were created by huge amount of debris from tributary valley during the storm (Photo. 12). Some of the trekking routes submerge under the natural dammed lake. Hence advance confirmation of route condition, minor repairing along the way and climb up a detour will be required for the next few years (Photo. 13).

There seems to be little report regarding heavy snow accident under the low pressure and cyclone in Bhutan. The trekkers need to cross over 5,000 meters high mountain passes along Snowman Trek. According to the information from a mountain guide, during the above mentioned snow in October 2009, at least one trekking group was trapped few days before closing the pass and finally rescued by a helicopter from Lunana. In the same time, a Bhutanese laborer from closed UNDP Lunana project had also stranded on the snowing way due to frostbitten feet, because he does not have adequate equipment and knowledge of countermeasure to the frostbite from the employer and support donor. The injured person was finally brought down by piggybacks of our team.

According to a report from a trekking agent, three trekking groups were trapped in extraordinary snow fall due to a storm of cyclone in 1995. Over 20 foreigners were finally rescued by helicopter from Lingshi, Laya and Lunana. This storm may correspond to unforgettable bad weather because the heavy snow results the avalanche tragedies in the Nepal Himalaya in November 1995. Such emergency transport in Bhutan by helicopter from Indian army or private company in Nepal is mostly requested from the case of high altitude sickness of foreigner. Over 80 percent in the case have been occurred around Jomohari trek and Laya village.



Photo. 12 A landslide dam in Chamkhar Chhu. Debris flow from the right bank dammed up the main river. Photo taken in July 2010.



Photo. 13 Unintended repair work and risky pass along the stream due to the washing out of river bank. Original route was existed on the outcrop (right). Photo taken the early September 2010 in the south of Gasa.

4.3 Height of the peaks in Bhutan Himalaya

There is no reliable and detailed mountaineering map in Bhutan, unlike the Nepal and Indian

Table 2 The revised height of major peaks in the Bhutan Himalaya (tentative result)

Mountain Name	Height in meters (this study) *	height difference from existing data	Location	
Jomolhari	7100	-200	Southeastern end of Paro Chhu	27.82424° 89.26947°
Jitchu Drake	6670	0 ~ -130 m	Southeastern end of Paro Chhu	27.85304° 89.32846°
KhangBum	5900	-600	Southeast of Lingshi	27.78856° 89.55790°
Masa Gang	6550	-250	Eastern end of Mo Chu headwaters	28.17115° 89.76703°
Tsebda Kang (Tsenda Kang)	7090	0 ~ -30	Upper Tarina eastern lake	28.17172° 89.94233°
Teri Gang	7100	0 ~ -20	Upper end of Wache glacier	28.18672° 89.95747°
Singey Kang	6930	0 ~ -70	Upper end of Raphstreng glacier, Lunana	28.14837° 90.21889°
Kangphu Gang	6890	-50 ~ -300	Upper end of Thorthormi glacier, Lunana	28.15663° 90.29581°
Chumhari Kang	6580	-300 ~ -400	Upper end of Shasha Chhu (Photo. 3)	28.08086° 90.36745°
Gangkar Puensum	7520	-20 ~ -50	Mangde Chhu headwaters	28.04878° 90.45456°
Chura Gang	6320	- 600 ~ -700 m	Chamkhar Chhu eastern headwaters	28.05084° 90.75188°

*: Height data and height difference are tentative value. The value should be revised further

Himalaya. Some existing literatures and previous issue of this journal referred to the wrong altitudes of mountain peaks (e.g. Hori, 1986; Kurita, 1988; Yamauchi, 2011). The displayed elevation of major peak in hundreds of meters is not unusual. Such a problem is not surprisingly in Bhutan, because the government are revising official topographic map with a scale of 1 to 50,000 in even piedmont.

As a trial, I randomly measured elevation of the peaks over 6,000 m using DEM (digital elevation model) by SRTM (Shuttle Radar Topography Mission) on Google Earth. Table 2 showing large discrepancy between the elevation in the previous study, map (Kohli, 1985; Bart, 2008; Yamauchi, 2011) and present study. The accuracy of SRTM in height direction which is almost 10 m at plane and gentle slope (Sun, et al., 2003), will be close to 20 m at 40~45 degree slope (personal communication from Dr. Nuimura, Nagoya University). Although, the discrepancies in Table 2 thus require further validation, most of the elevation in the map will be corrected in future. Remote sensing expert in our project has generated high resolution DEM data from PRISM data in ALOS satellite. Further reliable elevation will be put even for minor peaks 4,000~5,000 m. I would like to report these result as original mountaineering map in next occasion.

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