Zhopu Lake

Western Sichuan Province, China

Zhopu Lake Report
Prepared for the American Alpine Club

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Zhopu Lake Mapping Project

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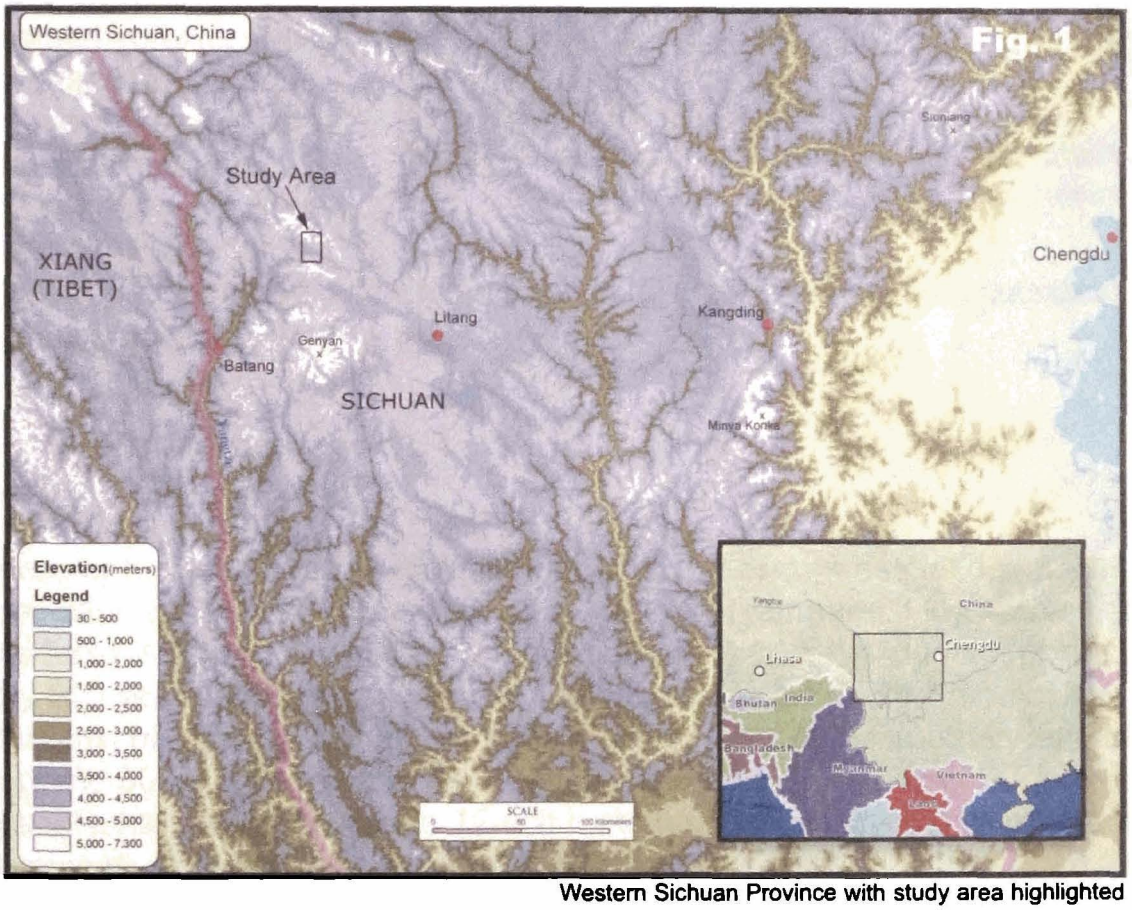
The goal of this mapping project was to provide an initial overview of Zhopu Lake. Land cover classification, trails, roads and other topographical features were mapped and analysis was completed using multispectral Landsat Thematic Mapper (ETM+). Computer classification of the Landsat Imagery was used to identify land cover classes surrounding the lake and natural communities. Topological features were created using year 2000 SRTM data. A field survey was conducted to verify classifications and to gather more detailed biological data for the characterization of the ecological communities. The product of this effort is a vegetation classification, land cover map including major topological features. Our goal was to initiate an environmental awareness of the area so that future visitors as well as local inhabitants will contribute to the preservation of the Jarjinjabo area.

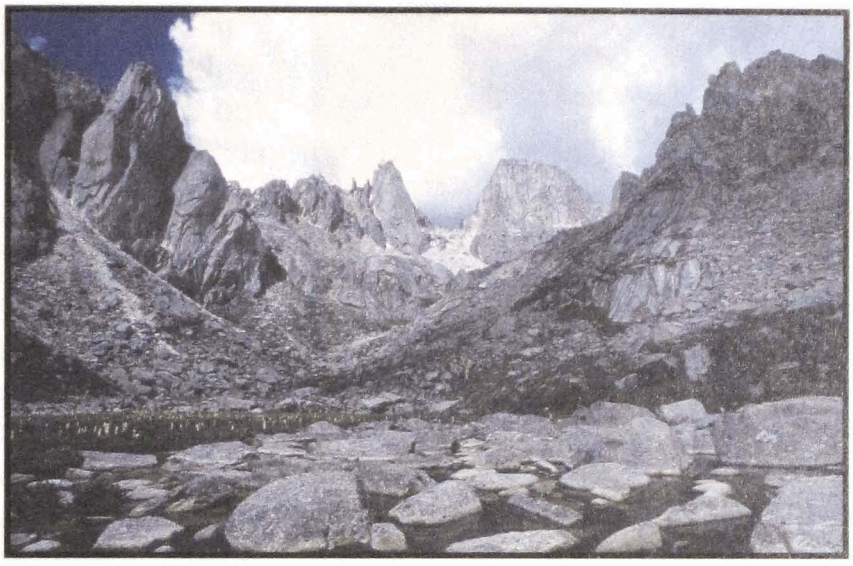


Western Sichuan Province with study area highlighted

The Western Sichuan Province of China is a remote and mountainous area. From the late 1950's to 2001 most of the region was considered off limits to foreign travel without special permits. In 2001 restrictions were removed and foreigners are now permitted to travel freely throughout the region. The area contains a large number of mountains many of which have not been explored, climbed or skied. As virgin mountain terrain throughout the world diminishes, this area of China will gain in popularity.

The objective of our mapping project was to initiate environmental awareness of the Jarjinjabo area before the area became negatively impacted by visitors. Through a baseline map of vegetation classes and topological features, we hope to positively influence how and where visitor impact should occur. It is also hoped that this information will be used by the local inhabitants and the climbing community of China to establish minimal impact visitor behavior and community managed sustainable use of natural resources.

Overall Goals



Janmo and Jabo formations north of Zhopu Lake. Photo: Tommy Chandler

The goals of this trip were to climb and explore around the Jabo and Janmo formations just north of the lake and also complete the mapping project around the lake. We had approximately 12 days of excellent weather out of 16 days and proceeded to establish several new lines and variations of existing routes up both the Jabo and Janmo spires. We also completed the first ascent up the dramatic lone spire atop of Janmo. The mapping project was completed over a several day period while in basecamp. Overall the trip was a success with respect to climbing and the mapping project.

Study Area

The remoteness of the area has sheltered it from any type of commercial development. The local population consists of Tibetan families that live in permanent log houses and nomadic style tents. A monastery at the northern end of the lake has been in existence for approximately 800 years and houses between 30 and 50 male Buddhist monks and about 20 female Buddhist monks. Two small permanent settlements at the southern end of the lake house around 50 adults and children. There is no electricity. Many of the homes have small solar panels that are connected to 12-volt batteries that generate power for a light bulb in the evenings. Potable water is taken directly from the stream and lake and there are no toilet facilities. Human waste is not buried and is often in close proximity of surface water. The recent arrival of prepackaged consumer foods has brought an influx of non-biodegradable trash. The local inhabitants are not yet aware or concerned of the permanence of the plastic containers. Surrounding the lake is approximately 452 acres (182 hectares) of old growth Spruce and Juniper. The remote location, use of handsaws and the low demand of timber by locals has contributed to the preservation of the forest. The Buddhist cultural influence has also contributed to the preservation of the surrounding land.

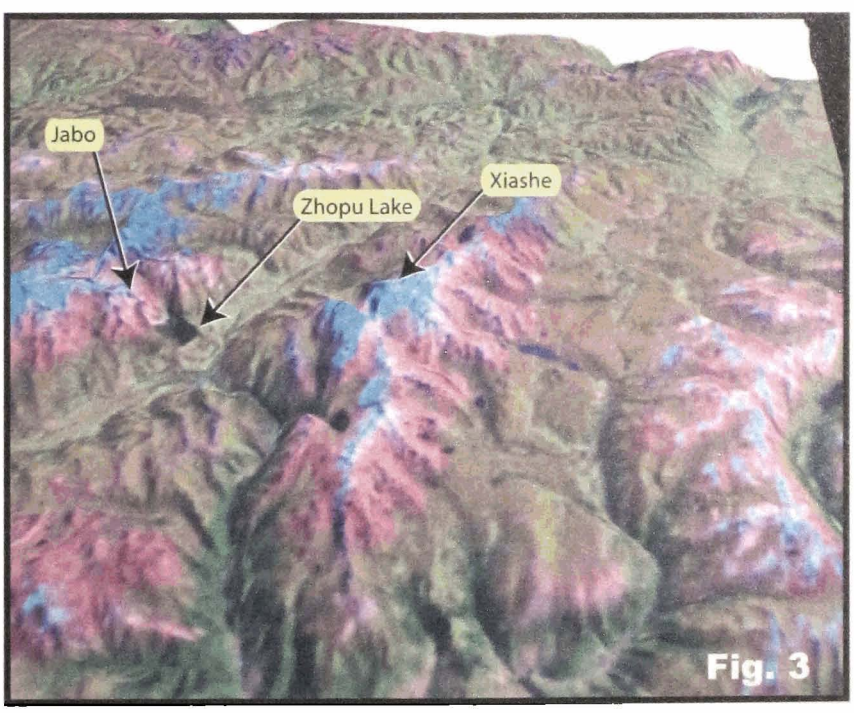
Also of consequence is the August 1998 Sichuan logging ban in natural forests and is part of the Chinese Natural Forest Protection Program (Winkler, 2004).

The Jarjinjabo area is currently designated as a Sichuan Province Park although the boundaries are not well defined. Foreign visitors must pay a small entrance fee to enter the park but it is obvious that no improvements are being made to the parks infrastructure. Currently there are several mines operating on the south side of the valley but the impact of the mines is outside the scope of this project.

Landsat ETM+ Subset Image of Study Area (bands 7,4,2)

The study area lies between 30°27'N to 30°32'N and 99°31'E to 99°34'E and covers an area of approximately 76 sq. km. Zhopu Lake is centered at 30°29'N and 99°32'E and covers an area of approximately 262 acres (106 hectares). Elevation ranges from 4080 meters to approximately 5382 meters (Summit of Jabo). In general the land is divided between an upper Alpine zone and a lower more vegetated zone. The Alpine Zone starts at approximately 4680 meters and is characterized by sparse vegetation and is dominated by rock outcrops, talus, scree and snow. The lower more vegetated zone is characterized by pasture/grasses, shrubs and mature conifers. The lower pasture/grasslands and shrubs up to approximately 4600 meters is heavily grazed by yaks.

The climate in this area is influenced by the seasonal Indian monsoon during the summer and is very moist; 80% of the annual precipitation occurs between June and September . Winters are characterized as colder and dryer with snow. Overall the area would be considered a temperate high mountain climate (Winkler, 2004).



Data Sources

An orthorectified landsat ETM+ image (WRS Path: 132, WRS Row: 39) was purchased from Earth Observing System Data Gateway (EOS). The data in-

cluded Bands 1,2,3,4,5,6,7,8 with a cloud cover of 0%. The Acquisition Date was 2000/10/06 with a sun azimuth of 146 and sun elevation of 48.8.

DEM data was obtained from the Shuttle Radar Topography Mission (SRTM). This data consisted of 90 meter elevation data. Several voids existed in the data and they were removed using the SRTM Void Killer and GTOPO30 data. Figure 3 shows a section of the landsat image draped over the SRTM DEM.

While in the field GPS points were collected using a handheld computer and GPS. Point data for roads, some trails, lake elevation and camping areas and buildings was collected. Photographs and video images were taken of flora and groundcover to aid in identification.

Initial Processing

The landsat ETM+ image was orthorectified at the processing center with a Projection of UTM, Zone 47 North and Datum of WGS-84. An initial unsupervised classification was performed on a subset of the satellite image. This was done to provide an initial look at the types of vegetation within the study area. From studying photos of the area it was determined that typical landcover could be divided into 5 classes; forest, grass, shrubs, bare ground/ rock and water. This gave us an idea of the distribution of landcover. Randomly generated test sites were created from classification polygons. These sites would be checked during the trip to validate the actual ground cover.

Field Work

Field work consisted of checking the distinct vegetation cover. Satellite imagery as well as the unsupervised classifications were loaded into a pocket computer and utilizing a Trimble GPS unit and Esri Arcpad the unsupervised classification data and satellite imagery was checked against actual ground vegetation. The panchromatic band of the landsat image was the highest spatial resolution image (15 meters) we could obtain for the area. Taking into account the 15 m spatial resolution, it appeared that distinct features on the orthorectified landsat imagery accurately correlated to collected GPS lat long coordinates. Known vegetation cover was then identified in the field and located on the orthorectified image. Photos and video of plants and groundcover were then collected to help in the identification of flora. Approximately 60 points were collected using this method. Coordinate points for several trails, roads and buildings were also collected. For the accuracy assessment, randomly generated points from classification polygons were checked for actual groundcover. This data was later used to generate the error matrix. Due to time constraints and rugged terrain only 83 points were checked. Most of these were in close proximity of the lake.

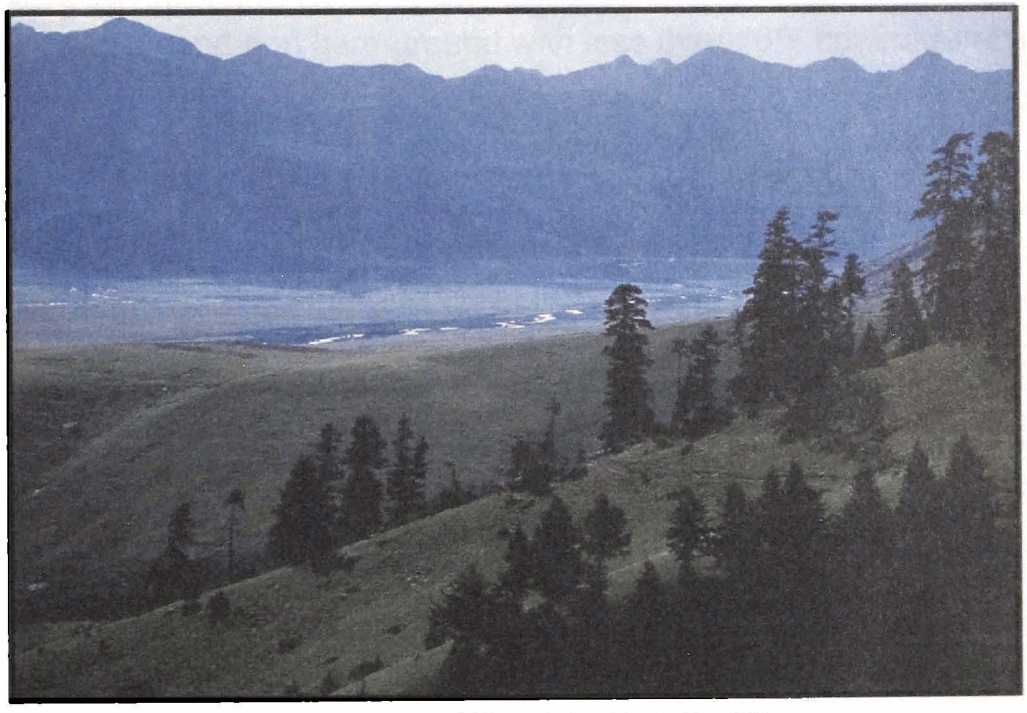
Method

Using the above data and information, a new supervised classification was then created. In order to isolate vegetation from non-vegetation, a normalized difference vegetation index or NDVI was generated on the Landsat Imagery. This ratio separated vegetated areas from non-vegetated areas. A mask was then created and a supervised classification was generated on the vegetated section of the Landsat image. The non-vegetated areas of the image

were combined and classified as bare rock and snow. Shade on northwest slopes created a problem for classification. In order to properly classify shade areas. A DEM was used to create a hillshade using the sun azimuth and sun elevation. This hillshade was compared to the landsat imagery. Areas that were shaded in the hillshade were examined and compared to the landsat image. From observations on the ground, vegetation cover in the shaded areas was relatively homogenous. Spectral profiles of the shaded areas were compared to the spectral profiles of illuminated areas where vegetation cover was the same. A decrease in the brightness values was observed but similar profiles existed. From this comparison, the classification of areas in shaded areas was changed to the appropriate illuminated vegetation classification. Areas where no match could be made were designated as unclassified.

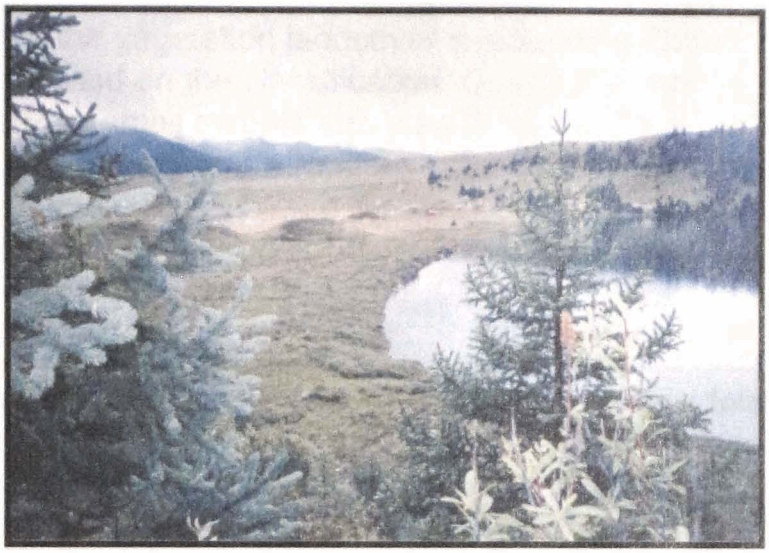
Landcover Classes

For the purposes of this project the LCWG/AARS land classification system is used. This system is promoted by The Land Cover Working Group (LCWG) of the Asian Association on Remote Sensing (AARS) (ref. http://asiaserv.cr.chiba-u.ac.jp/cd/index.htm). The Land Cover LCWG of AARS was established in October 1993. The objectives of the production of land cover database of Asia by the LCWG, AARS is to study global land cover changes and to promote management of land use and planning for social needs (Tateishi et. al.)



Moraine east of Zhopu Lake. Photo: Ben Ditto

Evergreen Forest (16)
Forest canopy cover is > 60%. Tree height exceeds 3 meters.
Forests are dominated by species such as *Picea balfouriana*, *Juniperus* and *Quercus aquifolioides*. Forest cover in this area is remarkably preserved. Probably due to the presence of the Monastery. Old growth trees dominate with no evidence of commercial timbering apparent in the surrounding area. In less dense forest cover, grazing occurs.


Southern end of Zhopu Lake. Photo: J. Knight

Natural Grassland / Pasture (132)
Tree and shrub cover is less than 10%. Dominated by graminoids and herbs.
Heavy grazing occurs on all natural grasslands/pasture. Some observed species were; *Pedicularis*, *Primula, Lancea, Meconopsis, Gentiana, Kobresia*

Deciduous and Evergreen Shrubland (92)
Shrub canopy cover is > 60%. Tree height is less than 3 meters. Some observed species were; *Juniperus, rhododendron, and Potentilla*

Non-Vegetation Bare Ground and Rock (190-194)
Exposed rock, talus, scree sand and bare ground with less than 10% coverage at any time of year.

Inland Water (222)

Area of Classified Landcover

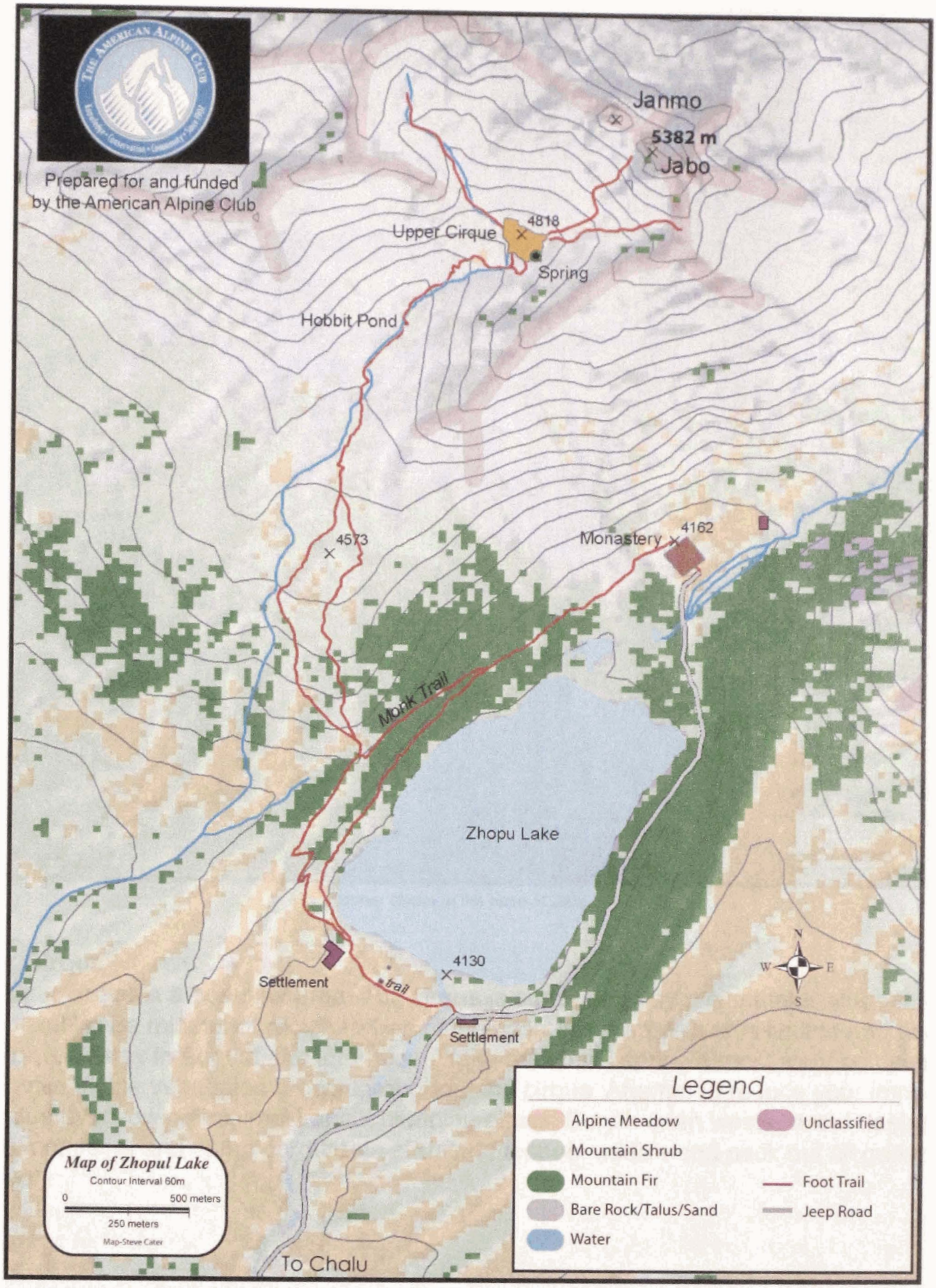
Class ID	Acres	Hectares
Shrub	6451.0	2610.68
Bare rock/Snow	5602.0	2267.10
Grassland/Pasture	3405.0	1377.98
Evergreen Forest	1019.0	412.38
Water	421.0	170.9
Unclassified	39.2	15.8

Vegetation Map

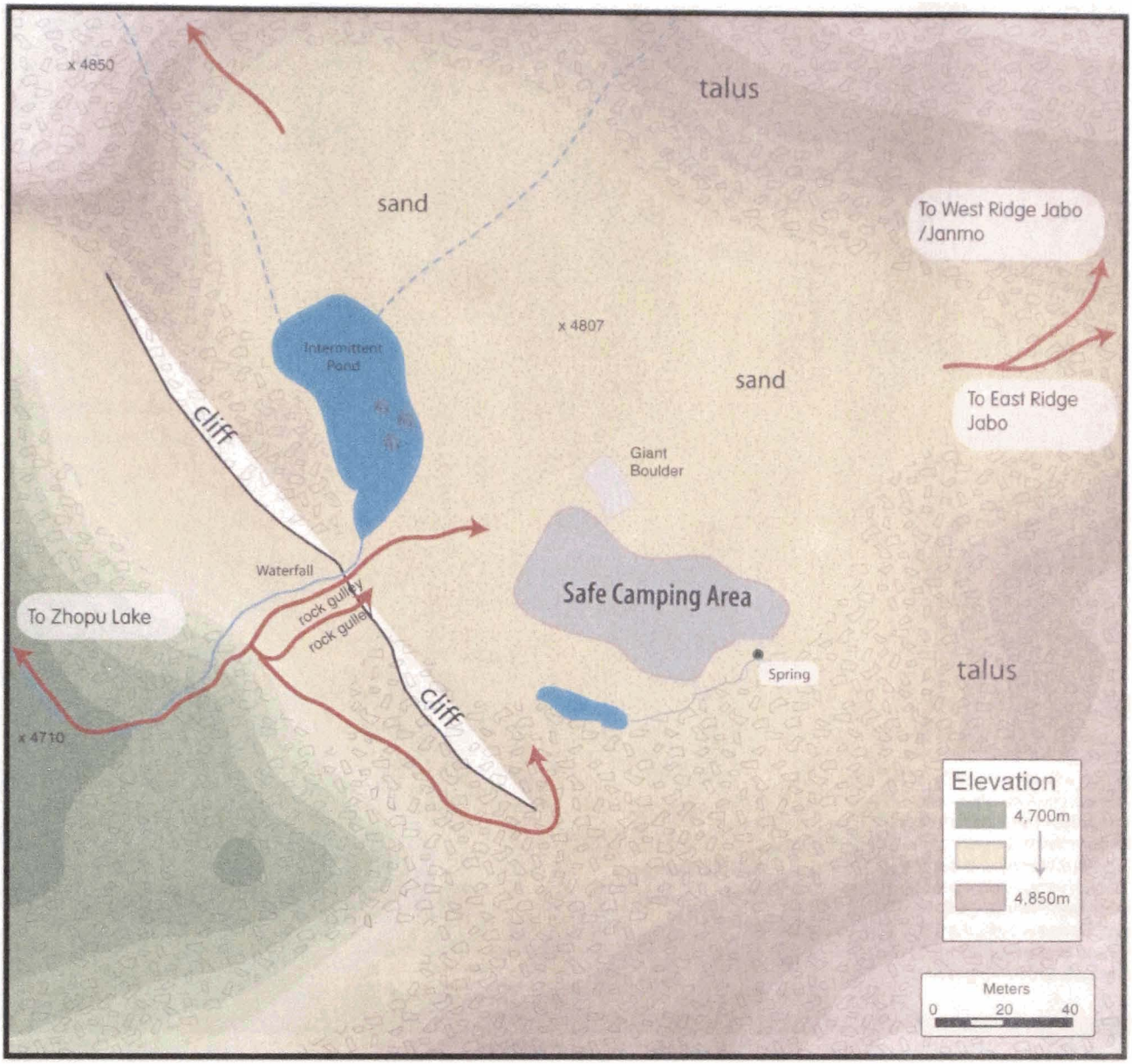
The resulting map (following page) shows the vegetation landcover surrounding Zhopu Lake. An accuracy assessment was performed on the classification. Due to the short amount of time and the rugged terrain a very small sample size was used for the assessment. All of the test sites were selected randomly using a random point generator but the target areas were located near the lake and divided between the meadow, forest, water and shrub landcover. The bare rock, talus and snow classification was not assessed due to time constraints and elevation.

Classification	Alpine Meadow	Mountain Shrub	Mountain Fir	Water	Row Total
Alpine Meadow	8	1	0	0	9
Mountain Shrub	1	20	6	0	27
Mountain Fir	1	5	21	0	27
Bare Rock/Talus	0	0	0	0	0
Water	0	0	0	20	20
Column Total	10	26	27	20	83

Overall Accuracy	69/83 = 83%	
Producer's Accuracy		
Alpine Meadow	8/10 = 80%	20% omission error
Mountain Shrub	20/26 = 76%	24% omission error
Mountain Fir	21/27 = 77%	23% omission error
Bare Rock/Talus	n/a	
Water	20/20 = 100%	0% omission error
User's Accuracy		
Alpine Meadow	8/9 = 88%	12% commission error
Mountain Shrub	20/27 = 74%	26% commission error
Mountain Fir	21/27 = 74%	26% commission error
Bare Rock/Talus	n/a	n/a
Water	100%	0% commission error



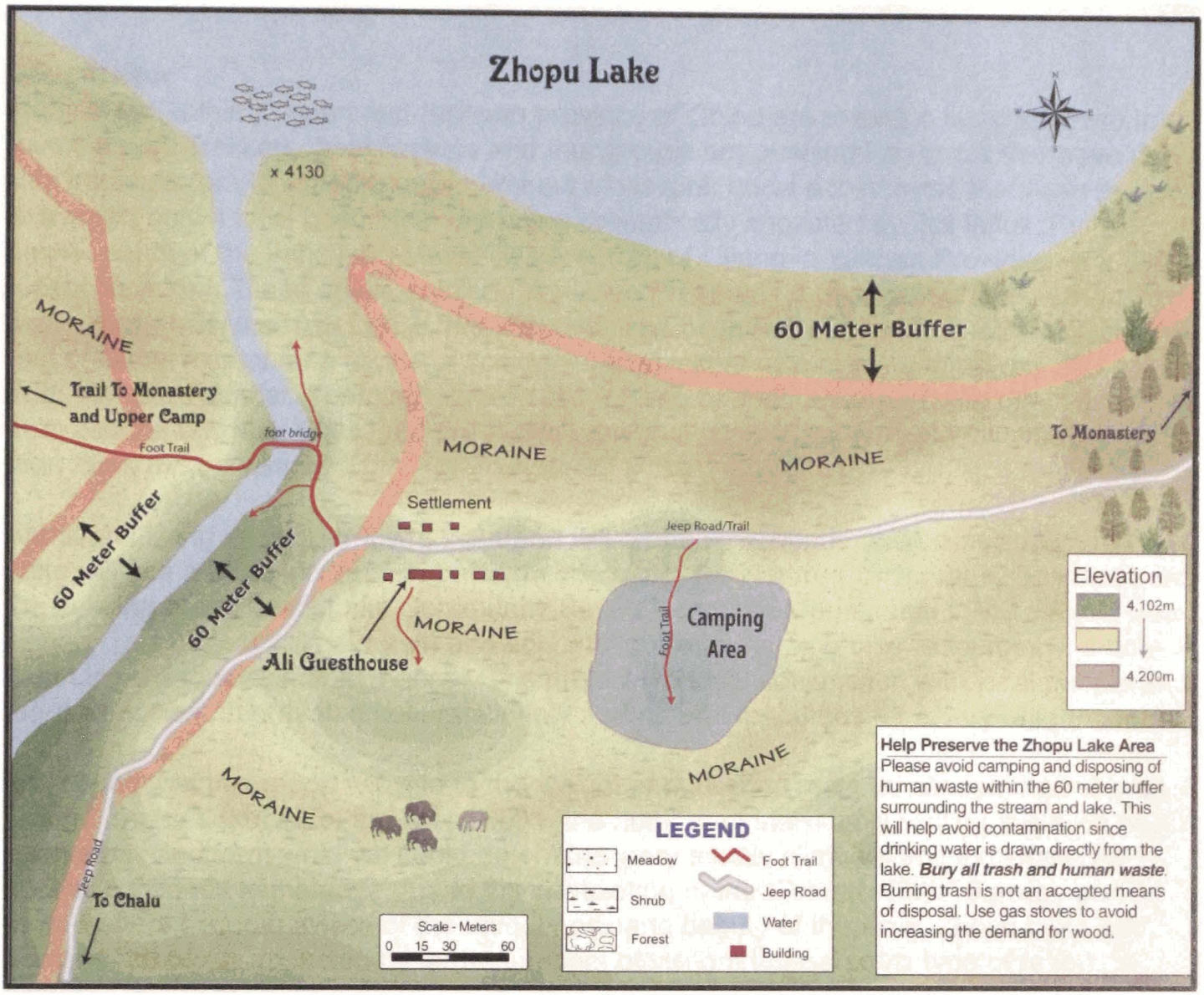
Resulting landcover map showing distribution of vegetation classes.



Upper cirque at the base of Jabo.

Upper Cirque

The upper cirque is a beautiful area. The cirque is surrounded by a giant talus slope that is very unstable. Be mindful of rockfall when camping in this area. Water is limited and during our two week stay in August, the intermittent lake and small spring almost went completely dry. Fragile alpine vegetation grows throughout the cirque. Attempt to reduce your impact at the cirque by following minimal impact camping ethics. Bury human waste, avoid destroying vegetation, travel and camp on durable surfaces, respect wildlife and pack out all garbage and trash.



Southern end of Zhopu Lake .

Visitor Information

There are several accommodation options for climbers and trekkers to Zhopu Lake. It is possible to rent a small room at the southern end of the lake from a local man named Ali. This is a very basic accommodation and consists of a bare room with limited cooking facilities. No toilets, running water or power exist. It is also possible to camp near Ali's guest house. The above map shows a camping area near the settlement. Please bury all human waste and paper. Another option is to stay at the Monastery. Again toilet facilities, running water or power are none existent. The monks run a small shop where basic goods may be purchased. Avoid camping and disposing of human waste within 60 meters of the lake. Do not leave valuables or equipment inside or around your tent. Several cases of theft have occurred in the past year. Fishing is illegal as well as swimming or bathing in the lake. Burning trash is also not allowed. It is highly recommended that you bury all trash and emphasis this to the locals. One of our last days at Zhopu Lake was spent picking up trash and burying it in a pit. The locals were excited to help and if other visitors continue to show enthusiasm about keeping the area clean maybe it will become an accepted practice.

Conclusion

Many areas within Yunnan and Sichuan province of China are seeing a huge increase in tourist travel. Trekkers, backpackers and tour groups are pushing into areas that have very little infrastructure to support large numbers of visitors. Local ecosystems that have evolved to support only a local population are being dramatically impacted by this influx. For example, south of the Jarjinjabo Massif lies the town of Lijiang in Yunnan Province. In a recent New York Times article entitled, "A Village Preserves A Shangri-La", the author writes that, "*Until the mid-1990's, the 280,000 Naxi living in the area were isolated from the rest of China except for a trickle of scraggly backpackers who made a three-day bus trip from Yunnan's capital, Kunming. But in 1995, Lijiang opened an airport with direct flights from several Chinese cities, and the trickle grew to a flood. Last year, the city had more than three million visitors.*"

Although Lijiang is a larger town, this trend will probably continue and areas such as Zhopu Lake will see a huge increase in traffic. In one case, the Nature Conservancy has facilitated the building of the Lashi Lake Community-Based Resource Management Pilot Project near Lijiang. This project will help train and educate locals to manage their resources in a non-destructive and sustainable manner. The project works in conjunction with local people and the government to preserve cultural identity and natural resources for a very unique area.

It is hoped that this report will add to the weight of published material concerning the area around Zhopu Lake. As of the fall of 2004, the number of individuals visiting this area has been small and from what we could determine were mostly climbers and explorers. As access continues to increase due to the completion of the Sichuan-Tibet Highway and as more visitors become aware of the uniqueness and beauty of the area, Zhopu Lake will become adversely impacted by large numbers of visitors unless some type of resource planning and conservation goals are initiated.

Copies of this report will be sent to the American Alpine Club, Sichuan Mountaineering Association, The Nature Conservancy and The Japanese Alpine Club. Copies of the large Zhopu Lake map will be translated into Chinese and mailed to a contact in China who will then forward the maps to the Zhopu Lake Monastery. It is hoped that these maps will be posted at the Monastery for visitors to reference when staying at Zhopu Lake. Low impact camping techniques and environmental preservation suggestions will be included on the maps to help reduce impact by visitors.

Change is inevitable but the path of change may be good or bad and with proper planning, education and objective use of science it is hoped that the inevitable changes that will occur at Zhopu Lake will be those of preservation and conservation.

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Acknowledgments

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Photo credits: Tommy Chandler, tommy@tommychandler.net and Ben Ditto, benjaminbditto@yahoo.com.

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