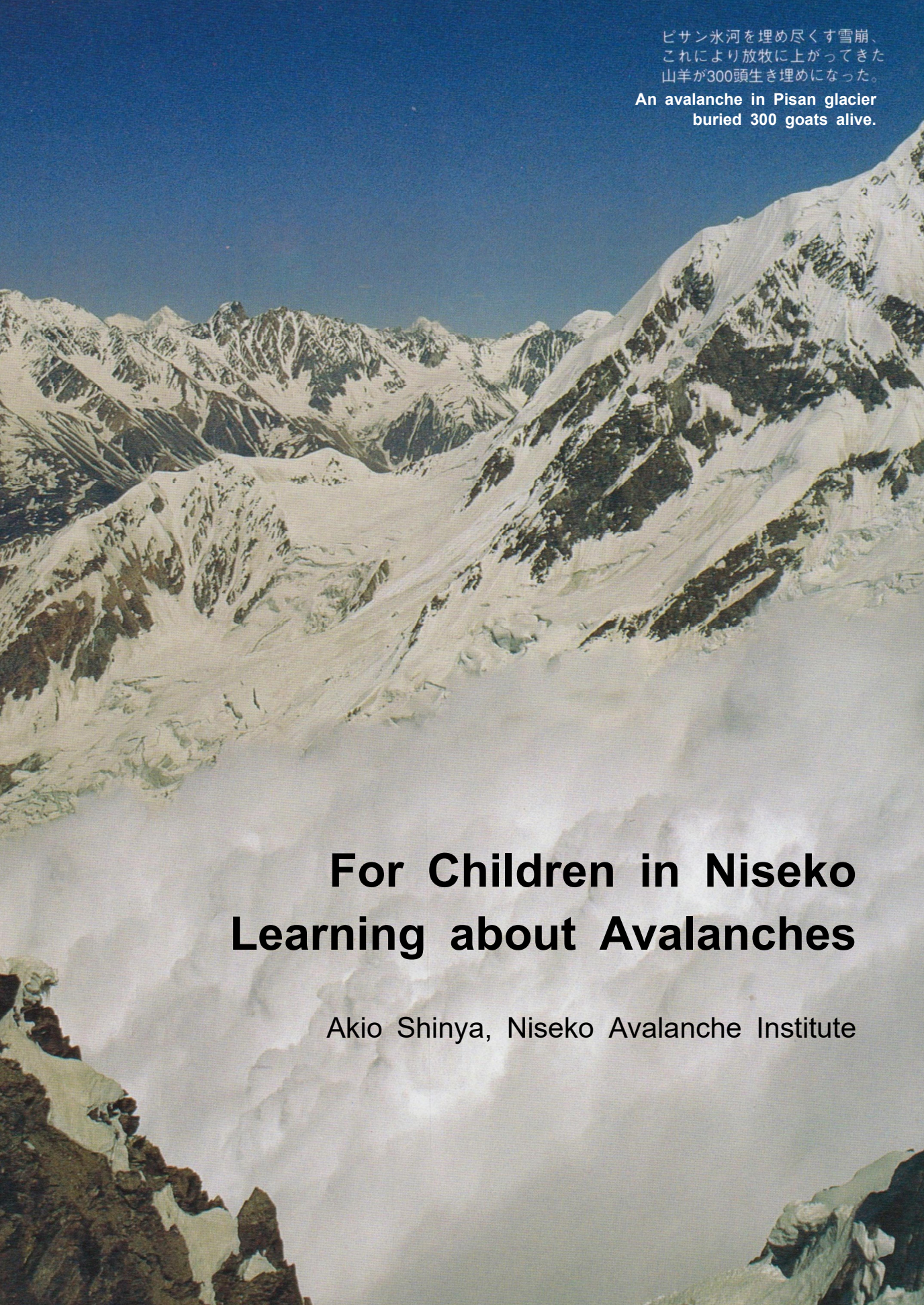



# For Children in Niseko Learning about Avalanches

Akio Shinya, Niseko Avalanche Institute

## To the Children in Niseko

Akio Shinya, Niseko Avalanche Institute

In Japanese, avalanches, known as なだれ（nadare), are a force of nature that is as powerful as earthquakes, tsunamis, and volcanic eruptions. Human beings have long faced natural disasters with wisdom and resilience. However, even in Niseko's mountains, avalanches have lost precious lives. In this guide, I would like to talk about why avalanches occur, how to prevent becoming a victim, and what measures we take to reduce avalanche accidents in the mountains of Niseko.

Snow is lighter than water. Compared to water's relative density of 1.0, snow has a relative density ranging from 0.01 to 0.5. However, snow crystals change as soon as they fall, eventually clumping together and solidifying. As a result, one cubic meter (1m3) of water weighs one ton (1000kg), and the same volume of packed snow can weigh 250 kg or more. Moving through packed snow is much harder than driving through water, like trying to walk through thick pudding or tofu. Even adults are unable to move when they are trapped under consolidated snow. Avalanche is the same. If someone is trapped under packed snow, breathing becomes difficult and suffocates eventually. Snow can suddenly fall like an avalanche from roofs, so avoid playing beneath them. If a family member is clearing snow from a roof, ensure they secure a safety rope around their body to prevent falls. Furthermore, keep small children away from roofs to avoid accidents. (p.16, Image 1)

Every year in Hokkaido, many people lose their lives in snow removal accidents. Although many of us are accustomed to living in snowy conditions, accidents can still happen. Avalanches also occur on a slope that is made from snow plowing. Overhanging snow ledges, called snow cornices, are dangerous as they can collapse unpredictably. Another form of cornice development is when blizzards pile snow over the roads.

Accumulated snow eventually forms snow slabs that are hard as a board. Snowstorms form snowslabs quickly. These are called snowdrifts. Snowdrifts and cornices become stable with time; however, they are unstable and easy to break fo r some time when they are formed. Snowstorms develop snowdrifts on a leeward side of steep slopes, and avalanches occur when these snowdrifts break up suddenly in a wide area. (p.17, Image 2)

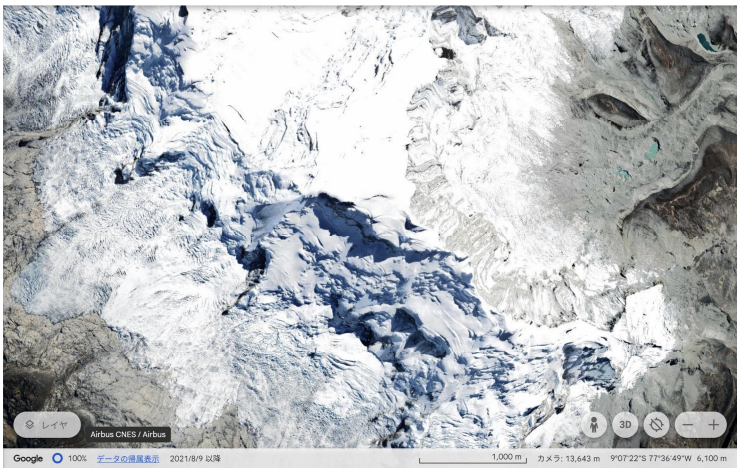
From the 1980s to the 1990s, nearly 10 lives were lost to avalanches. Around this time, I began working on preventing avalanche accidents. Despite Mt. Annupuri being a relatively low mountain at 1308 meters, the fresh snow and accessible ski lifts attract many skiers. As the number of skiers increased, so did the accidents. When accidents occurred, I went on rescue missions, but there were almost no survivors. Avalanche victims leave behind their families. The sorrow of families who suddenly lose their loved ones is overwhelming. Witnessing their sorrow, I became determined to eliminate avalanche accidents. No one should die while enjoying snowy mountains.

Avalanches are a natural phenomenon. In Niseko, most avalanches are surface avalanches, specifically dry-snow slab avalanches. A surface avalanche occurs when a layer in the snowpack slides, causing the snow above it to slide down. The term "slab avalanche" refers to the fact that this type originates from a snow slab. Strong winds or snowstorms can rapidly form snowdrift slabs on leeward slopes. A large section can break apart instantly if skiers traverse these areas, causing a surface slab avalanche.

Other avalanches include full-depth avalanches, in which the entire snowpack slides down the slope, and glacial avalanches, which occur in high mountains such as the Himalayas. Avalanches vary in shape and speed, with large ones traveling up to 100km/h and, in rare cases, exceeding 300km/h. In the following section, we will see some of the disasters and casualties caused by avalanches.

# 1. World's Greatest Avalanche Disaster

In May 1970, a magnitude 7.6 earthquake triggered a glacial avalanche near the summit of Huascar á n, a 6683-meter peak in the Peruvian Andes.The avalanche spanned an elevation of 4000m and traveled over 16 km at 300km/h. This avalanche accumulated mud and rocks and then quickly reached Yungay, a city at the foot of the mountain, and buried the town under six meters of debris. This avalanche killed 40000 lives. Later research has revealed that Yungay, a tourist city in Peru, was often destroyed by avalanches from Huascar á n over the years and rebuilt on the accumulated sediment. (Ryuzo Nitta, *The World of Avalanches*, 1985)




Summit of Huascarán, Peru
the highest peak in South America



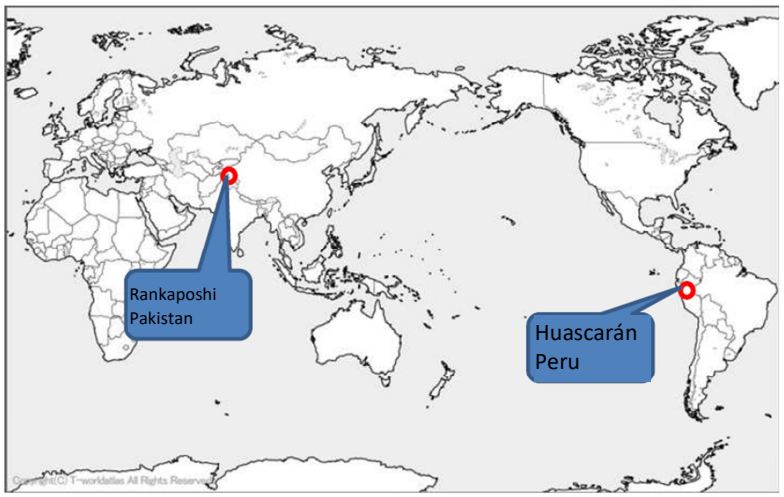

View of Yungay and Huascarán in Peru

# 2. Massive Glacial Avalanche

In July 1992, a glacial avalanche occurred near the summit of Rakaposhi (7783 meters) in the Karakoram Range, Pakistan. The avalanche traveled 8km down the Pisan Glacier, spanning an elevation of 4000 meters. It buried about 300 cattle, goats, and sheep grazing around 3000 meters elevation. The estimated speed was 250 km/h. This news was reported worldwide. I was climbing Rakaposhi at the time and witnessed this avalanche firsthand. On a different day, I was caught in a glacial avalanche and barely escaped by diving into a crevice in the rocks. It was like clinging to the roof of a bullet train in a blizzard.

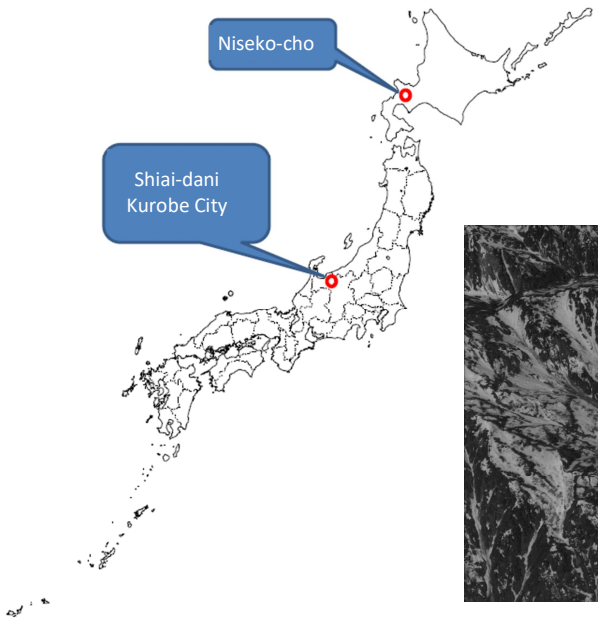



Rakaposhi, in the western Karakoram Range, northern Pakistan



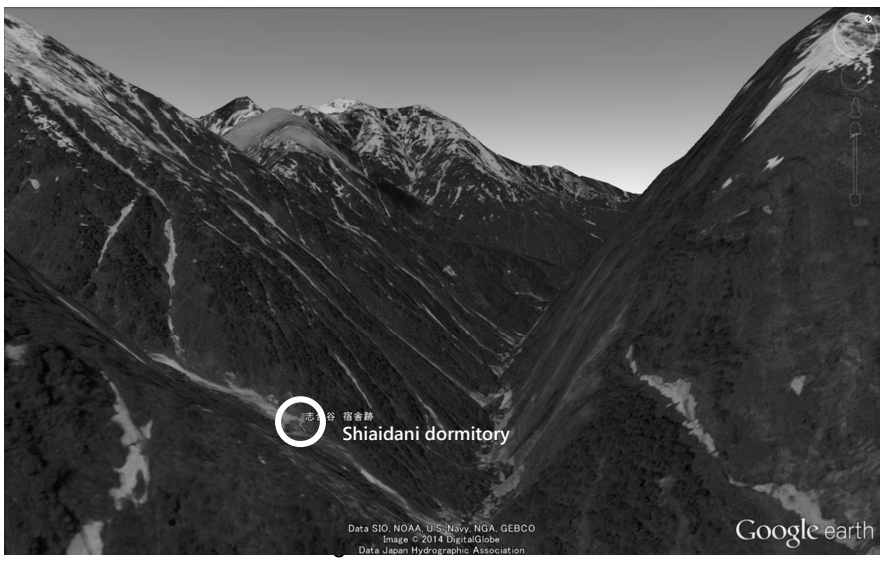
# 3. Kurobe River Avalanche Disaster

In December 1938, an avalanche swept away a dormitory's 3rd and 4th floors at the Kurobe River No. 3 Dam construction site. The wreckage was later found 600 meters away on the opposite slope of the valley. 84 lives were lost in the disaster (ref. Akira Yoshimura, Konetsu Zuido, 1967). This type of avalanche has long been known as powder snow avalanche (hou-nadare or awa-nadare) in Toyama and Niigata. It is believed that such avalanches occur during snowstorms in harsh winter and descende at the speed of 300km/h.





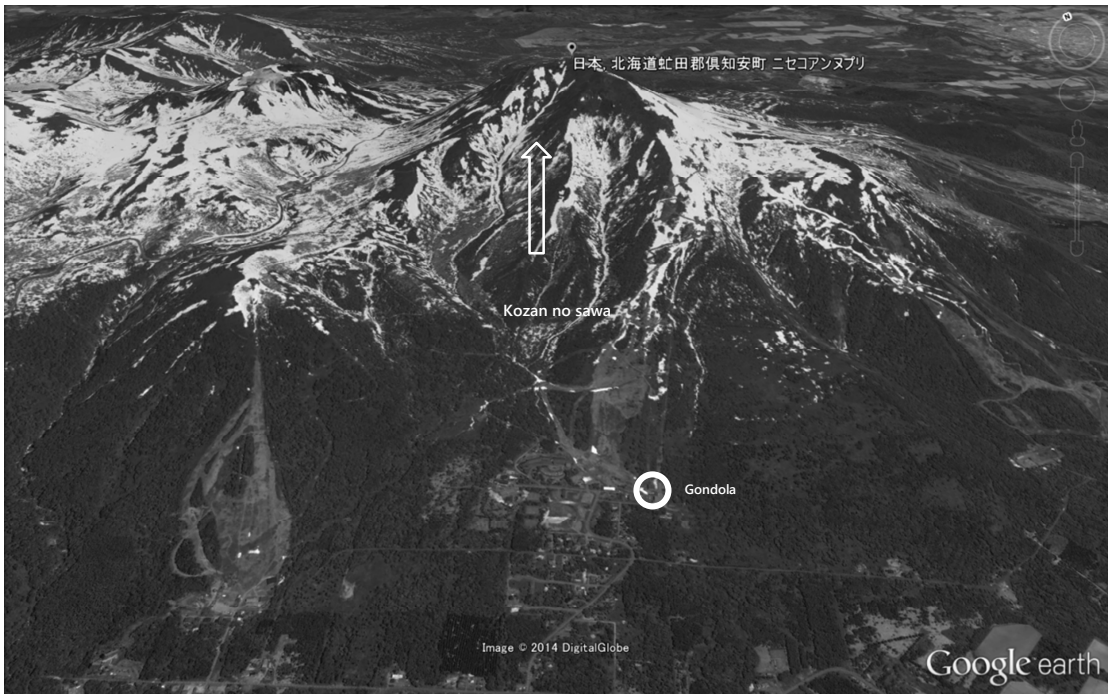





Shiai-dani in Kurobe City, Toyama Prefecture

# 4. Niseko Annupuri Kozan no Sawa Avalanche Accident

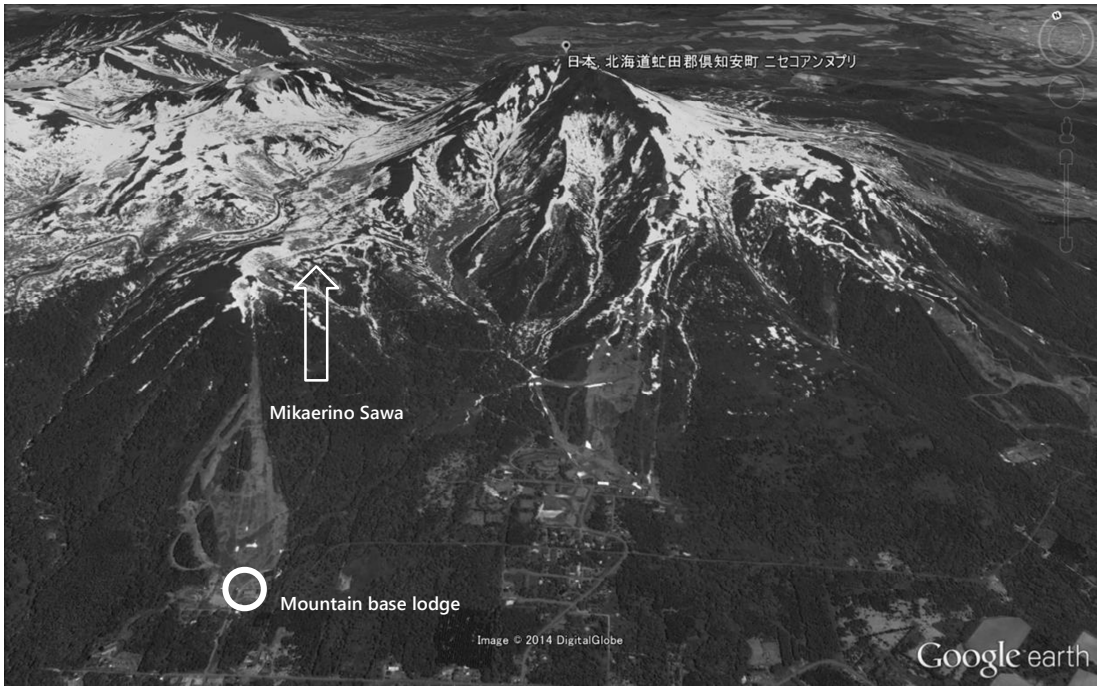
On January 7th, 1985, an avalanche occurred in Kozan no Sawa, a gully on the south side of the mountaintop, resulting in one fatality. The avalanche occurred at the southwest slope just below the mountaintop. It had a length of 100 meters and traveled a distance of 2000 meters at an estimated speed of 150 km/h. The Niseko Moiwa Ski Resort office saw the avalanche as soon as it happened. The accident occurred on a clear morning after a heavy snowstorm the previous day. These gullies are out-of-bounds areas where no avalanche control or patrols are conducted.




Kozan no Sawa, Niseko-Annupuri

# 5. Mikaeri no Sawa Avalanche Accident, Niseko Moiwa Ski Resort Out of Bounds Area

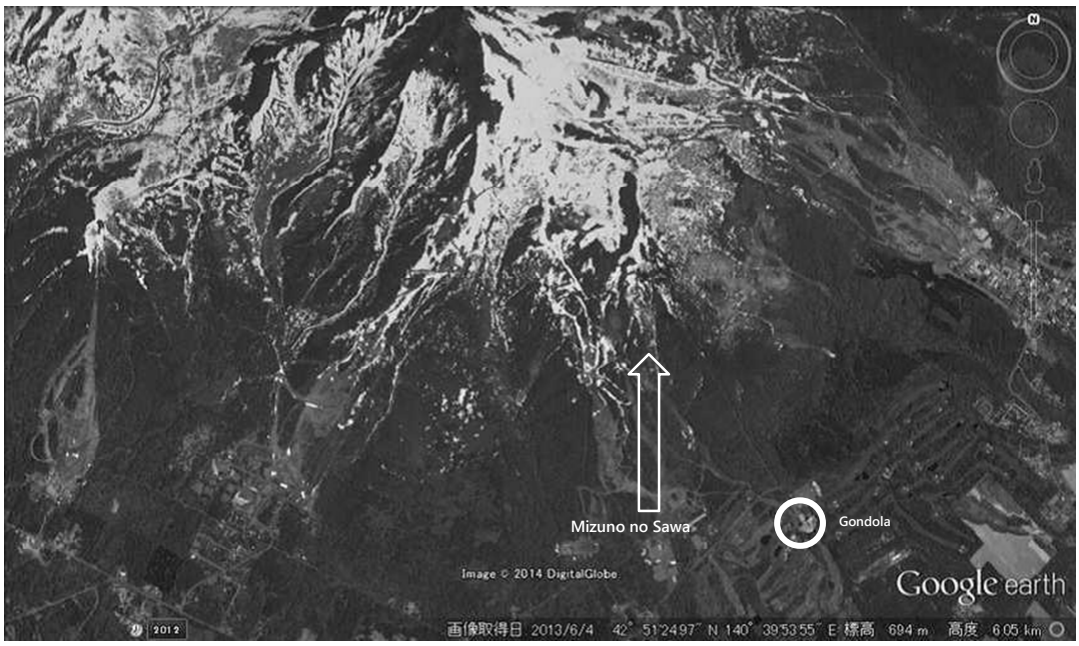
On January 19th, 1991, four Niseko Junior High School students were caught in an avalanche caused by a cornice collapse. They were skiing across from Moiwa Ski Resort to Annupuri Ski Resort. They were swept for 50 meters and buried under the snow but rescued by Tetsuya Aoyama and others from Moiwa Ski Resort. One of the students was at risk of cardiac arrest due to hypothermia. He was quickly taken to Kutchan Kosei Hospital from the Annupuri Ski Resort. Thankfully, he survived. Although there was no snowfall on the day, cornices developed rapidly overnight due to the strong westerly winds.




Mikaeri no Sawa, Niseko Moiwa Ski Resort Out of Bounds Area

# 6. Mizuno no Sawa Avalanche Accident Niseko Higashiyama Ski Resort (Currently Niseko Village Ski Resort)

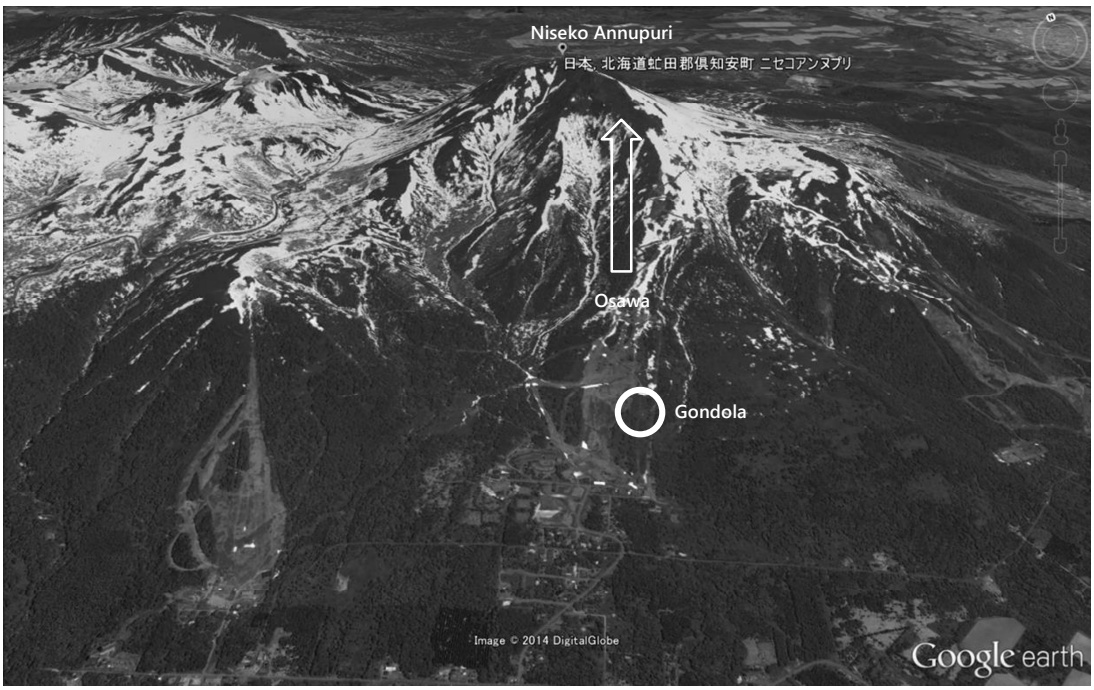
On February 28th, 1992, an avalanche occurred in Higashiyama Mizuno no Sawa at around 900 meters elevation, resulting in one fatality. The avalanche occurred at the starting point of the gully (Mizuno no sawa), spanned 400meters elevation, and traveled a distance of 1500 meters at an estimated speed of 150 km/h. It reached the larch forest near the hotel. The accident happened during an intense blizzard. Previously, on January 15th, 1990, another avalanche occurred in Mizuno no Sawa and killed two lives. At that time, Mizuno no Sawa was a strictly off-limit area. However, many people skied there regularly, which eventually resulted in accidents. Currently, the ski resort conducts avalanche control in Mizuno no Sawa. Since 2015, a gate has been installed there, allowing to ski under the supervision of ski patrols.




Mizuno no Sawa, Niseko Village Ski Resort

# 7. Osawa Avalanche Accident, Niseko Annupuri Ski Resort, Out of Bounds Area

On February 20th, 1995, an avalanche occurred in Annupuri's Osawa at around 900 meters elevation. The avalanche spanned 350 meters elevation and traveled a distance of 1000 meters with an estimated speed of 100 km/h. One person was killed in this avalanche. This was the first snowboarder's fatal avalanche accident in Japan. It was a stormy day, but the Annupuri chair lifts were operating. The victim followed the tracks of experienced riders into Osawa and got caught in an avalanche.




Osawa, Niseko Annupuri Ski Resort out of bounds area

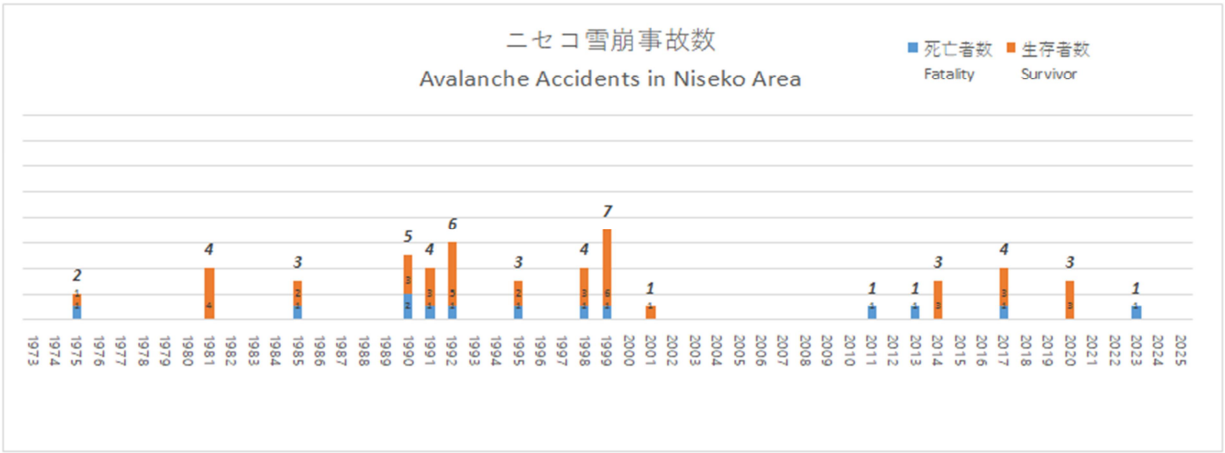
We have now seen some avalanche disasters. It is rare to survive from avalanche accidents. There is no way to escape from an avalanche that swoops down on you. If you survive, it is only because you are lucky. You should be thankful as it is nothing more than mere luck. Then, how can we avoid getting caught in an avalanche? The people who lost their lives may know the answer to this, but they cannot speak anymore.

There are many different types of avalanches. Some, like the one on Mount Huascarán in the Peruvian Andes, have taken the lives of tens of thousands of people. On the other hand, even small avalanches of just a few dozen meters can cause people to suffocate and die. Many people died in the pyroclastic flow from Mt. Unzen and the big tsunami in Sanriku because they were unable to escape in time. Even young children who knew nothing about the situation lost their lives. I feel a strong sense of powerlessness and anger whenever I am at an avalanche scene. "Why did you go into the mountains on a day like this? Why didn't you escape?" There are times when you should not go into the mountains.

A large avalanche is like a white pyroclastic flow. It approaches at a tremendous speed that exceeds our expectations. If you are unfortunate enough to encounter one, you should think of nothing but running away. If you still get caught in one, do everything to survive. In many cases, people survived by quick actions, such as grabbing onto a tree or swimming to avoid being buried deep under the snow. However, in the end, luck is the difference between life and death. We must keep in mind that we stand nochance against the power of nature, and we must remain cautious and humble.

# Niseko Rules

About 80% of accidents occur during or right after a snowstorm. To avoid accidents, it is essential to remember that avalanches are more likely to occur on snowstorm days. Do not ski on steep slopes during snowstorms or when it's windy. These are avalanche nests. In Niseko, there are the Niseko Rules: the gates are closed when a storm gets stronger. Once the snowstorm has calmed down, the gates will be open again after some time. This is to prevent people from going into avalanche-prone areas. At first, people often ignored the rules, but now, most people follow them. As a result, the number of accidents decreased. However, there is no 100% safety on the mountains. The rules are a minimum promise. Always go out from the gates when you ski out of bounds. Do not duck ropes. If one person does it, many will follow, eventually leading to accidents. If the gates are open, anyone can ski out of bounds. But please remember, once you are out of the gates, it's a mountain, not a ski resort. Beware of many other hazards besides avalanches.



# The Cause of Avalanches

Why do avalanches occur in the first place? Although not a scientist, I am taking scientific approaches to analyzing avalanches and accident prevention. Avalanches are natural phenomena, but accidents happen when people are involved.

In inland mountains with primarily clear weather, the interval between snowfall is long. Due to the cold from radiative cooling and the heat from solar reflection, the snow crystals on and near the surface change rapidly. When the new snow falls, the temperature difference between the new and old snow creates a layer called "depth hoar." This layer is a collection of ice grains that do not stick together and sometimes develop further and remain in the snow for a long time. As more snow falls on this depth hoar layer, the snow's weight suddenly collapses, triggering an avalanche. Many avalanches that occur, regardless of weather, in cold inland mountains are caused by the depth hoar. Depth hoars can also develop on steep coastal slopes with little snowfall and are easily recognized.

There are many different layers of snow besides the depth hoar. For example, as a low-pressure system approaches, it creates a specific type of snow layer, such as "Hail." Yellow dust and soot emissions from China can also form layers in the snow. Surface avalanches are caused by snow layers formed by various snowfall forms. Layers that trigger avalanches are called "weak layers." Today's avalanche science explains that these horizontally structured weak layers are the reason for surface avalanches.

# Niseko Avalanche Accidents Prevention

However, as I continued seeing accidents, I began questioning this. Avalanche risks increase when a snowstorm starts and decrease when it stops. I began to focus on the change in snowfall as a realistic way to prevent accidents. Instead of judging by the weak layers of snow, I thought it was possible to identify the time of day when avalanches are most likely to occur based on snowfall transitions.

We have achieved reducing accidents by measuring risks based on this theory. We collect various data, such as identifying weak layers by cross-sectional observation, a snowcat inspection of slab formation and stability, observation of snow crystals, weather maps and upper-level weather maps from the previous day, satellite photos, weather radar images, wind speed and wave height changes at lighthouses on the Japan Sea, wind speed and temperature at the summit of Niseko Annupuri. Also, the ski patrols and snowcat operators provide us with morning weather data and current conditions at the mountain base. Considering human activity is also important in opening and closing the gates, we repeatedly remind skiers and snowboarders not to overlook the risks of avalanches on Niseko Avalanche Information.

Why are avalanches more likely to occur during or immediately after a snowstorm? I think it is due to the fragility of the slabs. Slabs formed by snowstorms are hard and many times heavier than the ones created without wind. When a slab rapidly develops and is given some stimulation, the impact transmits quickly on a steep slope, and a large area breaks instantly. An avalanche then occurs. A developing slab is very unstable. From observations in Niseko, this is particularly true when wind and snow exceed 18 m/s. Generally, this is when the ski lifts automatically stop by the wind sensor system. However, when the wind speed is under 12 m/s, slabs develop slowly and stabilize at once.

I call the unstable elements of a developing slab during a snowstorm "weak line." I believe that the rapture of this weak line causes the avalanche accidents in Niseko. Unlike a weak layer, a weak line is not a horizontal layer. It is a line running in all directions. For avalanche prediction in areas with heavy snowfall, such as Niseko, it is crucial to identify the unstable period of forming new slabs. I believe a layer is the result of stabilized snow accumulation. Therefore, evaluation risk judgments based

on snow layers alone is not a realistic way to avoid avalanche risks. We should also pay attention to changes in snowfall patterns, called snowfall transition. In any case, the rapid slab development can quickly increase the risk of avalanches on steep slopes. We are waiting for researchers to prove a scientific study on the structure and changes of the slab development.

In Japanese, the Chinese character for "observation" is said to have been derived from the ancient oracle bone script, which represents an owl. Owls turn their heads freely and carefully observe their surroundings. The word "observation" probably includes looking closely at something through a magnifying glass as small as a snowflake but also paying attention to things more broadly. I hope those who spend the most wonderful time of their childhood in Niseko will become people with warm hearts and broad perspectives like owls.

Image 1

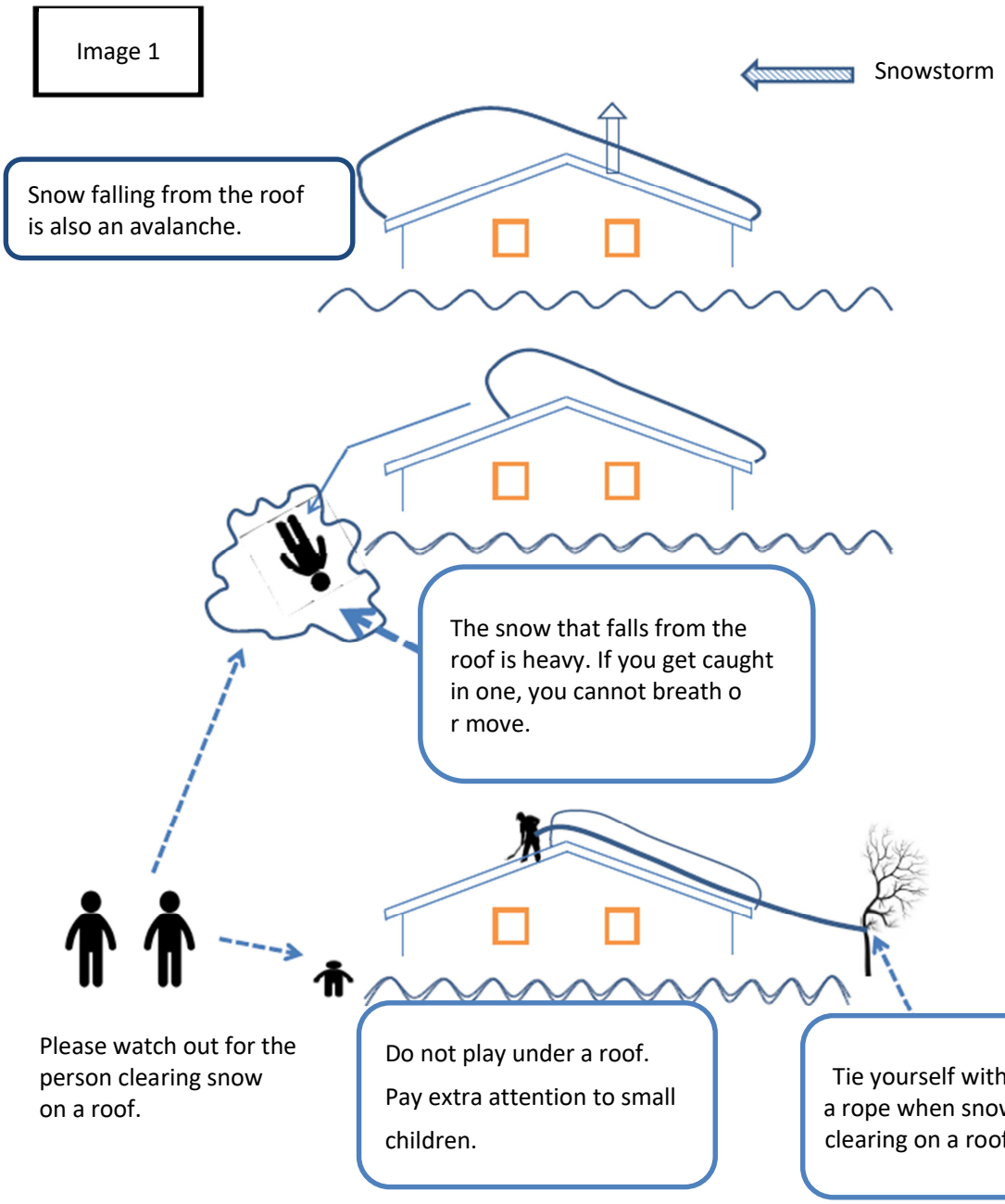

Snowstorm
Snow falling from the roof is also an avalanche.
The snow that falls from the roof is heavy. If you get caught in one, you cannot breath o r move.
Please watch out for the person clearing snow on a roof.
Do not play under a roof.
Pay extra attention to small children.
Tie yourself with a rope when snow clearing on a roof.

Image 2

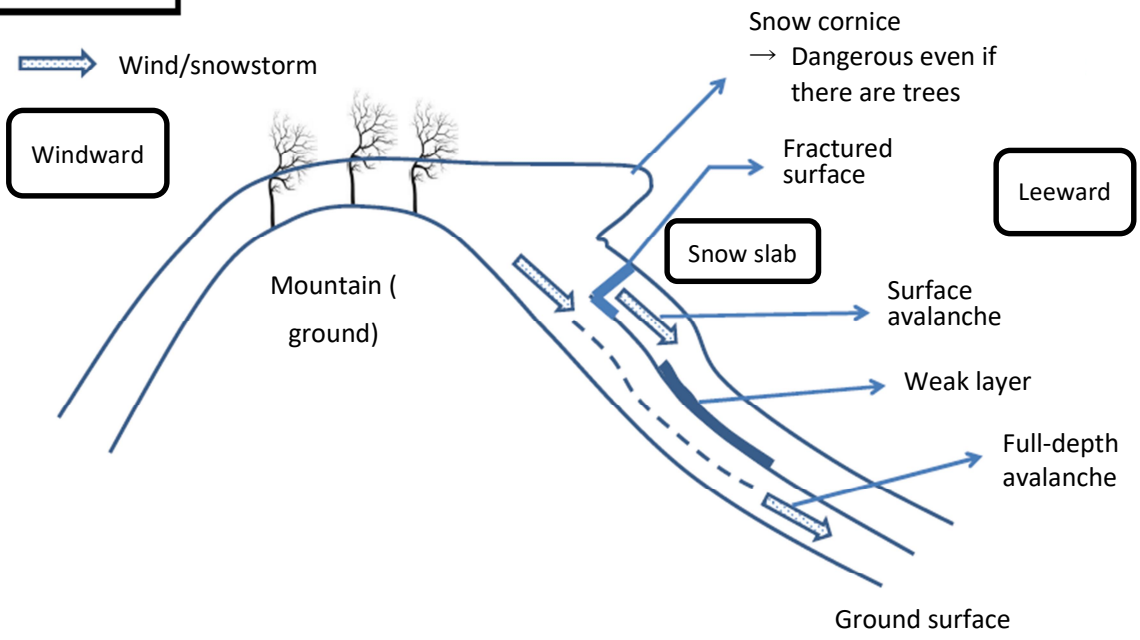
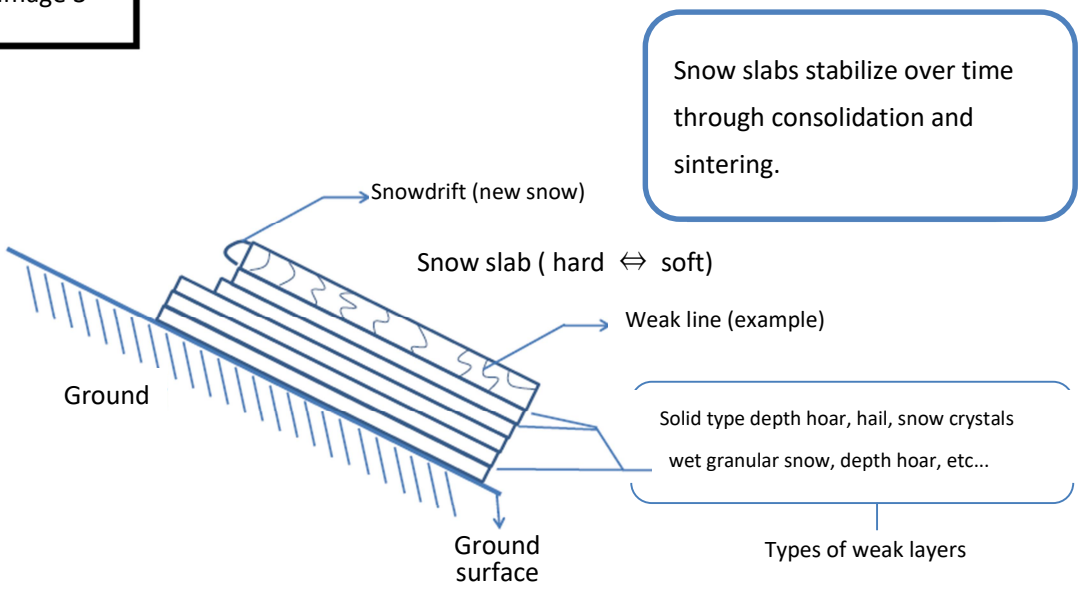



Image 3



# Side Notes for Parents

Snowdrifts are structurally unstable when they develop on leeward slopes during snowstorms. In Niseko, we call this instability of snow slab a "weak line" to help prevent accidents.

Most avalanche accidents occur during bad weather, on days when large amounts of new snow are falling. Niseko assesses slab development and stability based on slope aspect and elevation, reducing accidents in out-of-bounds areas by managing gates and alerting people. The snow in Japan is excellent, and people have the freedom to ski here.

Since most accidents occur during bad weather, such as snowstorms, we hope that people who ski out of bounds will pay attention to these "weak lines" and "weak layers."

Many accidents occur in bad weather. If everyone takes precautions, we can reduce the number of accidents. Avalanches are a natural phenomenon, but accidents happen when people are involved.

The National Research Institute for Earth Science and Disaster Resilience (Snow and Ice Disaster Resilience Research Institute, Niigata Nagaoka) is working on scientific proof of this hypothesis. Do not be overconfident in your knowledge and skills.

## Summary (Safety tips for Children)

① If you see someone playing under a roof edge, warn them.

② Follow the rules when skiing/snowboarding in the mountains.

③ Do not go to the mountains alone.

④ Do not leave your friends behind.

⑤ If you see someone in trouble, help them.

⑥ Avalanches occur on snowstorm days.

# Niseko Rules

① ! Always use gates when entering backcountry areas.

② ! Do not duck boundary ropes.

③ ! Everyone skiing/snowboarding in backcountry areas should wear a helmet and carry an avalanche beacon.

④ ! Backcountry skiing/snowboarding is prohibited when gates are closed.

⑤ ! Never enter off-limits areas at any time.

⑥ ! Elementary school children are not allowed in backcountry areas unless accompanied by an elder companion.

＜Supplementary Section＞

- A minimum of ¥100,000 will be charged for search and rescue operations in backcountry areas.
- Rules violators may be banned from using the resort facilities by having their lift-pass confiscated and/or refused to reissue a new pass.
- Many past accidents have occurred during bad weather conditions. Always be cautious and never overestimate your self or equipment. Make sure to obey the ski patrol's instructions. Beware of crevasses and trees. Mountains are never 100% safe.
- The Niseko Avalanche Information is the area's official information. The hazzard level is estimated using systems and methods developed by Niseko Avalanche Institute.
- Carrying an avalanche beacon, a probe and shovel is very highly recommended. This equipment may save not only your life bu your buddy's too.