AA2018-9

AIRCRAFT ACCIDENT
INVESTIGATION REPORT

YAMANASHI PREFECTURAL
POLICE HEADQUARTERS
J A 1 1 0 Y

November 29, 2018

Japan Transport Safety Board

The objective of the investigation conducted by the Japan Transport Safety Board in accordance with the Act for Establishment of the Japan Transport Safety Board and with Annex 13 to the Convention on International Civil Aviation is to determine the causes of an accident and damage incidental to such an accident, thereby preventing future accidents and reducing damage. It is not the purpose of the investigation to apportion blame or liability.

Kazuhiro Nakahashi
Chairman
Japan Transport Safety Board

Note:

This report is a translation of the Japanese original investigation report. The text in Japanese shall prevail in the interpretation of the report.

AIRCRAFT ACCIDENT INVESTIGATION REPORT

FATAL ACCIDENT CAUSED BY THE AIRCRAFT DURING RESCUE ACTIVITIES TABAYAMA VILLAGE, KITATSURU-GUN, YAMANASHI PREFECTURE, JAPAN AT ABOUT 13:50 JST, MAY 14, 2017

YAMANASHI PREFECTURAL POLICE HEADQUARTERS BELL 412EP (ROTORCRAFT), JA110Y

October 12, 2018

Adopted by the Japan Transport Safety Board

Chairman Kazuhiro Nakahashi
Member Toru Miyashita
Member Toshiyuki Ishikawa
Member Yuichi Marui
Member Keiji Tanaka
Member Miwa Nakanishi

1. PROCESS AND PROGRESS OF THE INVESTIGATION

1.1 Summary of the Accident	A Bell 412EP, registered JA110Y, operated by the Yamanashi Prefectural Police Headquarters, conducted a rescue operation on Sunday, May 14, 2017, when one rescuee was fatally injured and three search and rescue (SAR) team members sustained minor injuries.
1.2 Outline of the Accident Investigation	On May 15, 2017, the Japan Transport Safety Board (JTSB) designated an investigator-in-charge and other two investigators to investigate this accident. An accredited representative and an adviser of the United States, as the State of Design and Manufacture of the helicopter involved in the accident, participated in the investigation. Comments were invited from parties relevant to the cause of the accident and the Relevant State.

2. FACTUAL INFORMATION

2.1 History of the Flight	According to the statements of the Pilot in Command (PIC), the co-pilot, the crew and rescue workers on the ground, the history of the flight is summarized as follows: At about 13:10 (JST: UTC + 9hrs, unless otherwise stated all times are

indicated in JST on a 24-hour clock), on Sunday, May 14, 2017, a Bell 412EP, registered JA110Y, operated by the Yamanashi Prefectural Police Headquarters, took off from the Yamanashi Prefectural Police Helipad to rescue a mountaineering accident sufferer (hereinafter referred to as "the rescuee"), with the co-pilot taking charge of flying. The PIC took the left hand pilot seat, the co-pilot took the right hand pilot seat, a mechanic (Hoist operator[1]) and a rescuer took each seat in the aft.

Photo 1: JA110Y

The helicopter flew over along the Komuro River to the site where the survivor was found. The PIC found the smoke emitted from near the site on his right side and turned the nose of the helicopter in the direction of the smoke. As the smoke was not streaming in the wind, the PIC judged that the wind was virtually calm around the target site. Although being unable to check visually the target site while hovering for five minutes in the vicinity of the site, the PIC could confirm the target with a flash light from a rescue worker on the ground. From the cockpit, both pilots were not able to find the possible position for the rescuer to descend by hoist, but the hoist operator found the possible position in the rear right direction, and the helicopter commenced to move to the right rear to fly toward the dry mountain stream under the guidance of the hoist operator.

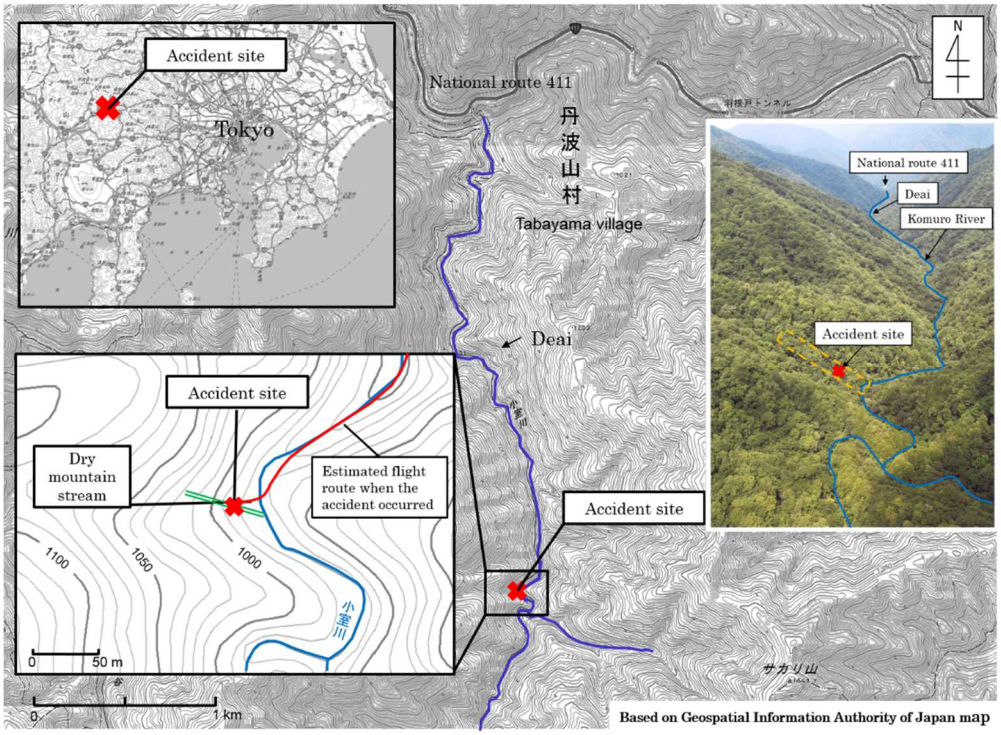


Figure1: Accident site

1: "Hoist" means a winch operated by an electric motor or a hydraulic motor, which is used for descending or lifting personnel at the time of rescue activities when a helicopter is hovering. "Hoist operator" is a person who handles the hoist.

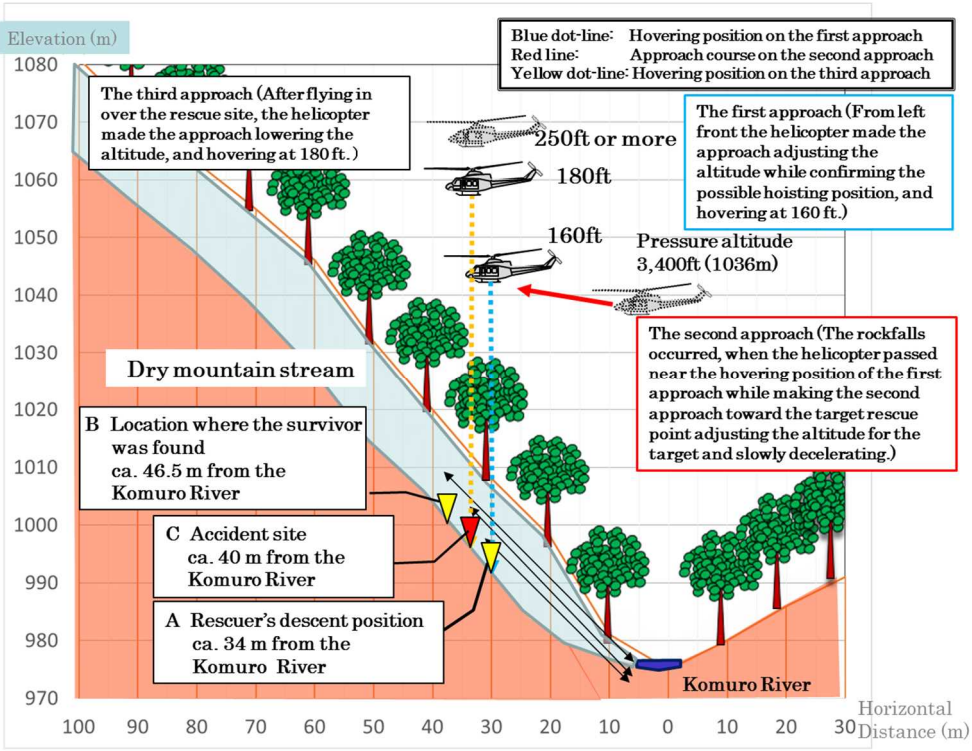


Figure2: Vertical cross section chart of the vicinity of the accident site and approach procedure taken by the helicopter

Adjusting the altitude for the target, the helicopter made the first approach from the west side at a low speed until it arrived over the dry mountain stream. At 49 m (160 ft) AGL, the helicopter kept hovering over the vicinity of about 34 m upward (upstream side) along the steep slope of the dry mountain stream (Figure 2, Point A) from the Komuro River, and about 12 m downward from the survivor. Although the surrounding area around the hovering point was covered with trees, the rescuer descended to the target point through the airspace between trees, which was created by bending those trees with the wind pressure of the downwash[2]. Afterward, the helicopter once disengaged from the hovering point and kept waiting over the target position. After descending, the rescuer found the survivor and rescue workers on the ground (Figure 2: Point B). The rescuer confirmed that the survivor had a clear consciousness, although his condition was frail with the left foot suspected to be broken. Therefore, the rescuer judged that it was possible to conduct a hoist rescue operation. But the location where the survivor was found was too narrow to conduct the hoist rescue operation, therefore the rescuer decided to hoist the survivor after moving the survivor six meters downward (Figure 2: Point C, about 40 m from the Komuro River).

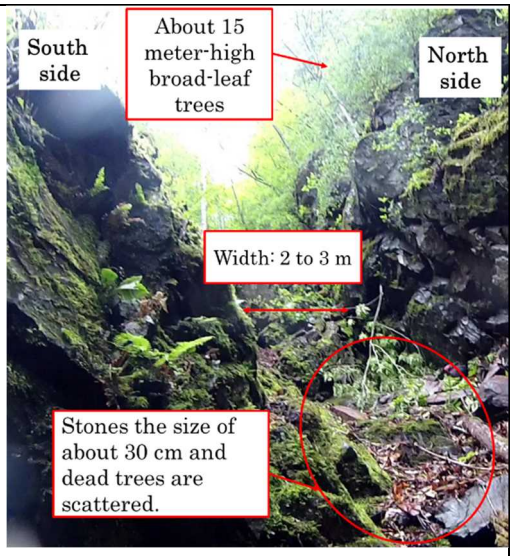
On the second approach, after confirming the preparation status on the ground rescue operation, The helicopter controlled the pressure altitude from 3,400 ft in order to keep hovering over the target rescue point at the intended 160 ft AGL (The altitude mentioned hereinafter means the above ground level

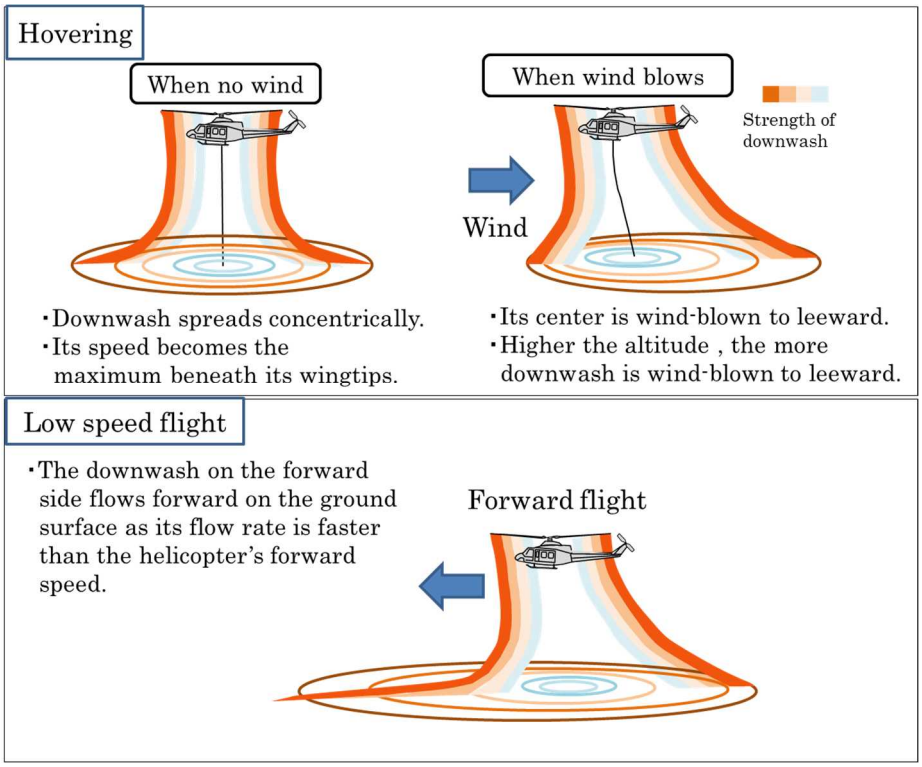
2: "Downwash" means air flow generated by the main rotors of a helicopter.

	(AGL) altitude.) by referring to the hovering position on the first approach. In this way, while slowing down, the helicopter made a forward approach toward the dry mountain stream and came close to immediately over the rescue point. When the rescuer looked up and confirmed the approach of the helicopter, the wind pressure increased, the branches of trees, along the dry mountain stream, were broken, and many rocks rolled down. Something hit the sunglasses of the rescuer and injured his face. Unlike on the first approach, the downwash was so strong that the three rescue workers were not able to breathe and the two rescue workers among the three were injured because something hit their bodies. The rescuer looked at the survivor to find him unconscious with lying on the back on the slope. His face was covered with broken tree branches and a large rock about 30 cm in size was placed on his abdomen. Immediately, the rescuer made a radio contact with the helicopter and asked the helicopter to temporarily leave the site. But it was unable enough to establish effective communication with the crew members on board due to the effects of the strong downwash, and the rescuer signaled with his hands to stow the hoist cable back. Seeing the hand signal, the hoist operator thought some trouble might be happening on the ground and told the PIC that they needed to temporarily leave the site. The helicopter left the site again and kept waiting over the site. Judging that a swift transport of the survivor by the helicopter should be necessary, as the survivor did not come back to consciousness, the rescuer informed the helicopter of his judgment by radio. Taking into account the effect of the downwash, the helicopter made the third approach to the rescue point at about 250 ft to 300 ft, a little higher altitude than on the second approach. Even though the helicopter kept hovering just above the rescue point, the trees around there did not bend with the wind pressure of the downwash. Covered with those trees, the rescue point was not able to be visually confirmed from the helicopter. Accordingly, the helicopter descended its altitude gradually. When the helicopter had the trees bent with its wind pressure at about 180 ft, the rescuer on the ground was visually confirmed from the helicopter. Therefore, the helicopter continued hovering at 180 ft to conduct the hoist rescue operation for the survivor. At this time, the wind velocity of the downwash was the same as that on the first approach and there were no falling rocks and trees. This accident occurred at about 13:50 on May 14, 2017, in Tanbayama Village Kitatsuru-Gun, Yamanashi Prefecture (35° 46' 20" N, 138°52' 18" E).
2.2 Injuries to Persons	(1) One rescuee was fatally injured. Cause of death: Death from hemorrhagic shock due to right thoracic organ damage (2) One rescuer and two rescue workers sustained minor injuries.
2.3 Damage to Aircraft	Extent of Damage: None
2.4 Personnel Information	(1) Pilot in Command Male, Age 50 Commercial pilot certificate (Rotorcraft) March 9,1994

	Pilot competency assessment expiry of practicable period for flight March 27, 2018 Type of rating for Bell 212 March 27, 2014 Class 1 aviation medical certificate Validity date: October 8, 2017 Total flight time 4,386 hours and 15 minutes Flight time on the same type of aircraft 461 hours and 35 minutes Flight time in the last 30 days 13 hours 5 minutes (2) Co-Pilot Male, Age 36 Commercial pilot certificate (Rotorcraft) June 2, 2009 Pilot competency assessment expiry of practicable period for flight March 2, 2019 Type of rating for Bell 212 March 2, 2015 Class 1 aviation medical certificate Validity date: January 27, 2018 Total flight time 1,118 hours and 15minutes Flight time on the same type of aircraft 813 hours and 10minutes Flight time in the last 30 days 20 hours 35minutes (3) Mechanic (Hoist operator) Male, Age 57 Number of times dispatched for searches / rescues About 650 times Number of times dispatched for hoist rescue operations[3] About 950 times (4) Rescuer Male, Age 35 Number of times dispatched for searches / rescues 15 times Number of times dispatched for hoist rescue operations 29 times
2.5 Aircraft Information	(1) Type: Bell 412EP; Serial number: 36321; Date of manufacture: June 19, 2003 (2) When the accident occurred, the weight and the balance of the helicopter were both estimated to have been within the allowable range.
2.6 Meteorological Information	According to the statement of the PIC, it was cloudy weather with virtually calm wind, the visibility was about 10 km, and the outside air temperature was 14℃ (3,300 ft).

3: The hoist rescue operations were conducted several times at a rescue activity. That is why the number of times dispatched for hoist rescue operations exceeds the number of times dispatched for searches / rescues, here.

2.7 Accident Site	The dry mountain stream, the accident site, is a steep slope with about 50-degree average inclination (Vicinity of the accident site: 52-degree average inclination) at an elevation of about 1,000 m. And the stream is about two to three meters wide with a bank wall about 15 m in height on each side, forming V-shaped trough-like terrain. From geological point of view, rockfalls were likely to happen in this site where the stream was composed of mudstone in the southern part and sandstone in the north part, the upper part of those bank walls were covered with broad-leaf trees (approximately 15 to 30 meters high), and there were scattering stones the size of about 30 cm on its soft ground.  Photo 2: Upper side of the accident site
2.8 Other Necessary Issues	(1) Image on the video camera After descending to the ground, the rescuer started video shooting with the camera attached to the flank of his helmet. The video partly recorded how the helicopter made the approach to the accident site as well as the condition of the downwash at the time of the accident. The approach speed of the helicopter was calculated from the record on the video camera images as follows; as shown in Appended Figure, from 10'00" after the video shooting started, the helicopter commenced approaching at about 2 kt. At 10'10" after the start, it decreased the speed down to about 1 kt. It was confirmed that when the helicopter continued approaching in a roundabout way from 10'14" after the start, the first fall of the tree branches occurred. In addition, it was confirmed with the bending direction of the weeds on the ground that the downwash direction had changed. Up until 10'15" after the start, the weeds had been blowing with the downwash toward the mountain, but at about 10'28" after the start, contrarily they were blowing toward the valley. It was confirmed that the trees seen immediately above the video camera started to bend with the downwash at about 10'38" after the start and that the second fall of tree branches and rockfalls occurred at 10'52" after the start. (See Appended Figure: Analysis based on the images on video camera) (2) Calculation of the approach speed based on sound information The approaching sound of the helicopter, which consists of several sources, is generated largely by rotating main rotors. The sound of rotating main rotors was recorded together with the image on the video camera attached to the rescuer's helmet. The approach speed of the helicopter on the second one was calculated by analyzing the frequency of the sound information by means of the Doppler effect in which closer a sound source

	approaches, higher the frequency of waves becomes. As a result, when recording the sound of the main rotors started from 08'25" after the start, the approach speed was at about 65 kt. At 09'02" after the start, it was at about 40 kt. At 09'23" after the start, it was at about 28 kt. In addition, at 09'50" after the start, the shrubs and trees on the slope started to bend with the wind upward from below. At 10'07" after the start, the frequency changed totally, and the change in downwash sound was recorded on the video together with the fluttering sound of the shrubs and trees around the accident site, during this time the deceleration rate was about 0.6 to 0.7 kt/sec. (3) Effect of the downwash during hovering and low speed flight As the flow speed of the downwash generated by the main rotors becomes the maximum beneath its wingtips, the downwash effect beneath the wingtips is greater than the effect just beneath the center position of the main rotors.  Figure 3: Image of spreading of downwash of the helicopter When the wind blows, all the airflow including downwash generated by hovering flows to leeward. But when no wind, there is no wind effect and the airflow is generated by downwash as if to flow along the ground surface. Therefore, the downwash has a reaching effect on the whole circumference immediately beneath the hovering position. When a helicopter flies at a low speed in the range where the downwash reaches the ground surface, the downwash flows forward on the ground surface as its flow rate is faster than the forward speed of the helicopter.

3. ANALYSIS

3.1 Involvement of Weather	Yes

3.2 Involvement of Pilots	Yes
3.3 Involvement of Aircraft	None
3.4 Analysis of Findings	(1) Effect of topography and geology <1> Narrow V-shaped trough-like terrain The dry mountain stream, the accident site, is a narrow steep slope and V-shaped trough-like terrain in which winds is likely to blow through. It is somewhat likely that the velocity and direction of the wind blowing through the stream might have changed due to the effect of the helicopter downwash. <2> Possibilities of rockfalls It is somewhat likely that the downwash of the helicopter–which swayed the trees growing on both banks of the stream and broke some tree branches–triggered the rockfalls, because the geological condition of the stream, the accident site, was fragile as surrounded by the banks composed of mudstone and sandstone, and there were scattering stones the size of about 30 cm and dead trees on its soft ground. (2) Influence of weather As described in 2.6 and 2.8 (3), the wind was virtually calm at the accident site. Therefore, it is probable that under this weather condition, the downwash was likely to flow in the direction of the forward flight, when the helicopter made the approach at a low altitude to keep hovering over the site. (3)Hovering altitude's effect on the downwash strength As described in 2.1, the helicopter made the approach three times for hovering over the vicinity of the accident site. On the first approach, moving to the right rear direction toward the possible position for the rescuer to descend while adjusting the altitude after confirming the position of the survivor, the helicopter kept hovering at about 160 ft AGL and the rescuer descended to the target position about six meters downward from the accident site. At this time, rescue workers on the ground did not feel strong downwash. On the second approach, the helicopter flew forward to the dry mountain stream and came close to immediately over the rescue point while slowing down and referring to the hovering position on the first approach so that it would be able to keep hovering over the target rescue point at 160 ft, when the rockfalls occurred and the rescue workers felt downwash so strong that they could not breath. The helicopter made the third approach at about 250 ft or more and continued hovering at 180 ft immediately over the vicinity of the location where the rescuee was. Comparing the altitude on those three approaches, the hovering altitude was the same on the first and the second, but on the second approach, strong downwash was generated. The hovering altitude was different on the first and the third, but the wind velocity of those was almost same. Based on those facts, it is probable that the contributing factor of the strong downwash generation was not a difference in hovering altitude but different ways of the approach to

the hovering position.

(4)Factors of change in direction and speed of downwash flow on the second approach

It is probable that according to the speed data obtained from the descriptions in 2.1 and 2.8 (1) and (2), the relation between the position and the speed of the helicopter on the approach to the dry mountain stream is, as shown in Figure 4, as follows:

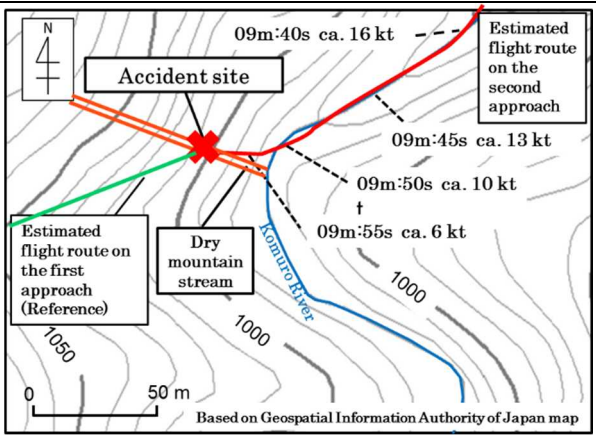


Figure 4: Position and velocity of the helicopter on the second approach

At 09'50" after the video shooting started, the approach speed was at 10 kt, afterward, the helicopter flew at a low speed of the deceleration rate of less than 1 kt and got close to the rescue position. It is somewhat likely that this way of approach probably required the helicopter to keep a near-hovering status, and as a result, rescue workers on the ground felt strong downwash that was different from on the first approach.

It is probable that as described in 2.8 (1), when the helicopter was on the approach at a low speed between 10'07" and 10'15" after the start, the downwash generated in the forward side of the helicopter was blowing through the dry mountain stream, as shown in Figure 5 <1>, from the valley to the mountain. It is also probable that at around 10'28" after the start, when the helicopter went forward and took roundabout toward the mountain, the downwash flow direction changed, and as shown in Figure 5 <2>, it was blowing down directly to the valley. It is somewhat likely that at about 10'38" after the start, as described in 2.8 (3), when the trees just above the site bent with the wind, the strong downwash flow from the wingtips of the main rotors reached the vicinity of the rockfalls occurrence site located upstream, and triggered the rockfalls.

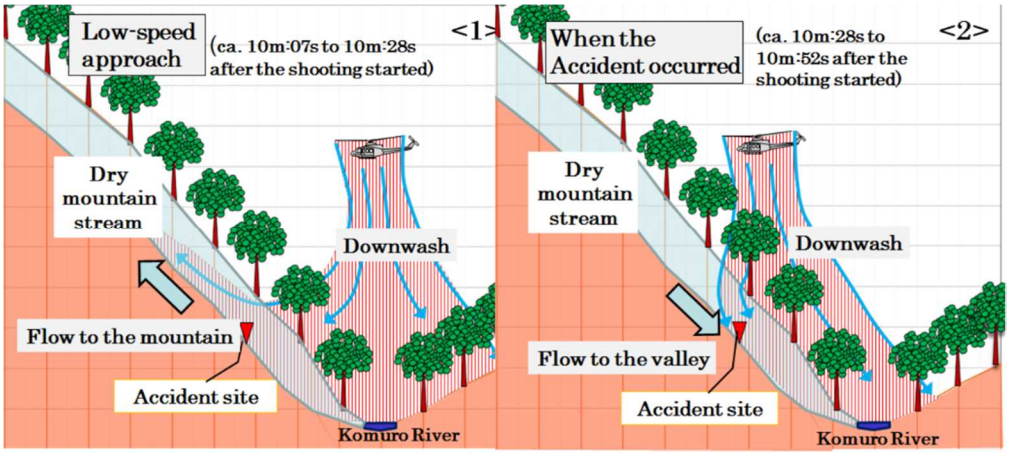


Figure 5: Image of the downwash of the helicopter

(5)Judgment and flight operation by the PIC

As an appropriate landing site could not be found near the survivor, the

	PIC decided to conduct the hoist rescue operation by having the rescuer descend. Although the survivor could not walk with his injured left foot, the rescuer judged the condition of the survivor as possible for hoist rescue and moved the survivor to the site possible for the hoist rescue operation. The location of the survivor was not able to be visually confirmed by the PIC directly and the PIC did not recognize the site was the V-shaped trough-like stream. It is probable that on the second approach, in order to keep hovering at the target altitude as soon as possible, by referring to the hovering position on the first approach, the PIC flew the helicopter toward the dry mountain stream while slowing down the speed and approached immediately above the rescue position. (6) Prevention of similar accidents At the time of the hoist rescue operation to lift a survivor from the forest, it is necessary to fully take into account the topographical specific features and winds in the vicinity of the rescue site in order that the downwash effect on the ground should be eased as much as possible.

4. PROBABLE CAUSES

In this accident, it is highly probable that when the helicopter made the approach to the survivor during rescue activities in the mountains, the tree branches were broken and the rockfalls occurred due to the downwash, and some of those falling trees and rocks hit the survivor and the SAR team members.

Regarding the occurrence of falling rocks and broken tree branches, it is somewhat likely that the those facts–which the rescue site was steep and narrow V-shaped trough-like terrain and the helicopter made the approach at a slow speed and at a shallow angle toward the rescue position –may have contributed to the situation where the flow direction and speed significantly changed.

5. SAFETY ACTIONS

The Yamanashi Prefectural Police took the following safety actions after this accident.

(1) Ensuring the safety management system on the rescue site

(2) Enhancing the knowledge on safety risks in the organizations concerning SAR operations
   a. Risks entailed in helicopter operations
   b. Risks entailed in SAR operations in the mountains

(3) Collecting information on the risks on the rescue site and the information sharing in the organizations concerning SAR operations
   a. Improvement of rules for information sharing
   b. Development of communication systems for timely information sharing

(4) Thoroughly implementing measures to avoid risks on the rescue site
   a. Devising measures in order to grasp the situation on the ground
   b. Carefully making a judgment on the situation in relation to the availability of low-altitude hovering

Appended Figure: Analysis based on the images on video camera

Length of time after shooting started (mm'ss")	Situations and sound recorded on the video
08'25"	The video shooting started.
09'50"	The shrubs and trees on the slope started to bend with the wind.
10'00"	The helicopter was confirmed on the video.
10'07"	The helicopter kept hovering ahead of the accident site. The fluttering sound of the shrubs and trees around the accident site changed.
10'10"	The helicopter commenced moving in a roundabout way.
10'14"	The first fall of the tree branches occurred.
10'15"	The downwash flow blew up from the valley to the mountain.
10'28"	The direction changed and it started blowing down from the mountain to the valley.
10'38"	After changing its heading rightward about 30degrees, the helicopter approached just above the site.
10'46"	The helicopter kept hovering over the vicinity of the accident site.
10'52"	The second fall of the tree branches and rocks occurred. (Occurrence site of falling tree branches and rocks: Point A)

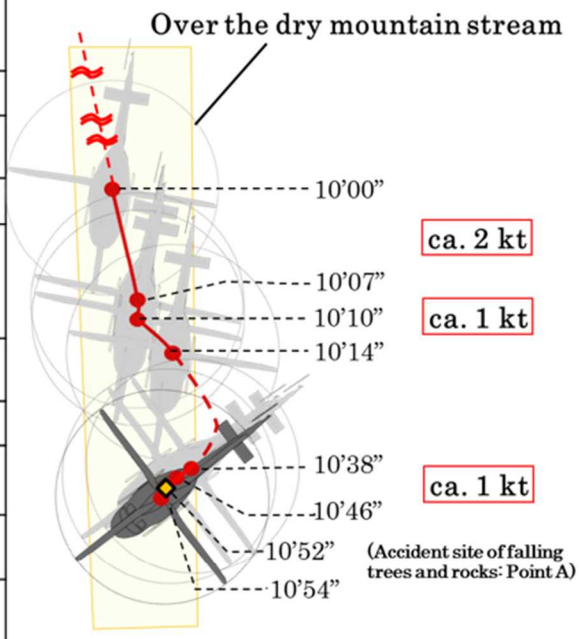
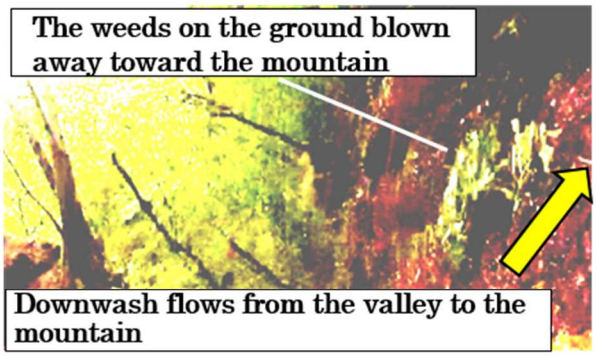


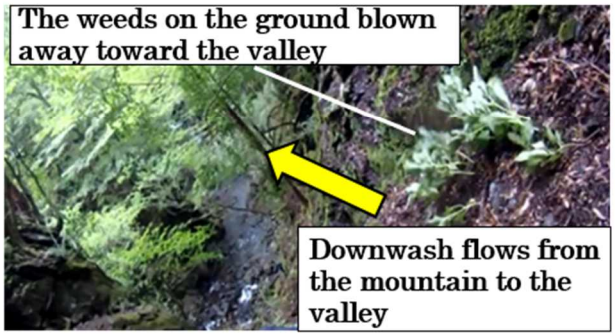
Image of the helicopter on the approach

10'07" Hovering ahead of the accident site



10'15" Approaching

10'38" Approaching just above the site



10'28" Approaching