ONE PLANET MANY PEOPLE

Atlas of Our Changing Environment

Credit: Olga Tutubalina/UNEP

Mount Dzhimarai-Khokh, elevation 4 780 metres (15 682 feet), towers above the Kolka Cirque. Rock and ice falling from the steep walls of the cirque since the end of July 2002, eventually triggered the collapse of the Kolka Glacier.

NASA Image by Jesse Allen and Robert Simmon based on MODIS data

Case Study: Collapse of the Kolka Glacier 20 September 2002

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Running east to west across the narrow isthmus of land between the Caspian Sea to the east and the Black Sea to the west, the Caucasus Mountains make a physical barricade between southern Russia to the north and the countries of Georgia and Azerbaijan to the south. In their center, a series of 5 000-metre-plus (16 000-feet-plus) summits stretch between two extinct volcanic giants: Mt. Elbrus at the western limit and Mt. Kazbek at the eastern. On the lower slopes, snow disappears in July and returns again in October. On the summit, winter is permanent. Glaciers cover peaks and steep-walled basins called cirques. The remote, sparsely populated area is popular with tourists and backpackers.

Elevations reach 5 642 metres (18 511 feet), and glaciers accumulate from heavy snowfall in the steep mountain valleys. Around Mount Kazbek, a dormant volcano, glaciers intermittently collapse, burying the landscape below under rock and ice. The latest of such collapses happened in 2002. Rebecca Lindsey, science writer with NASA's Earth Observatory, in close collaboration with Russian scientists Olga Tutubalina, Dmitry Petrakov (Moscow State University), and Sergey Chernomorets (University Centre for Engineering Geodynamics and Monitoring) compiled the details of this event.

On the evening of 20 September 2002, in a cirque just west of Mt. Kazbek, chunks of rock and hanging glacier on the north face of Mt. Dzhimarai-Khokh tumbled onto the Kolka glacier below. Kolka shattered, setting off a massive avalanche of ice, snow, and rocks that poured into the Genaldon River valley. Hurtling downriver nearly 13 km (8 miles), the avalanche exploded into the Karmadon Depression, a small bowl of land between two mountain ridges, and swallowed the village of Nizhniy Karmadon and several other settlements.

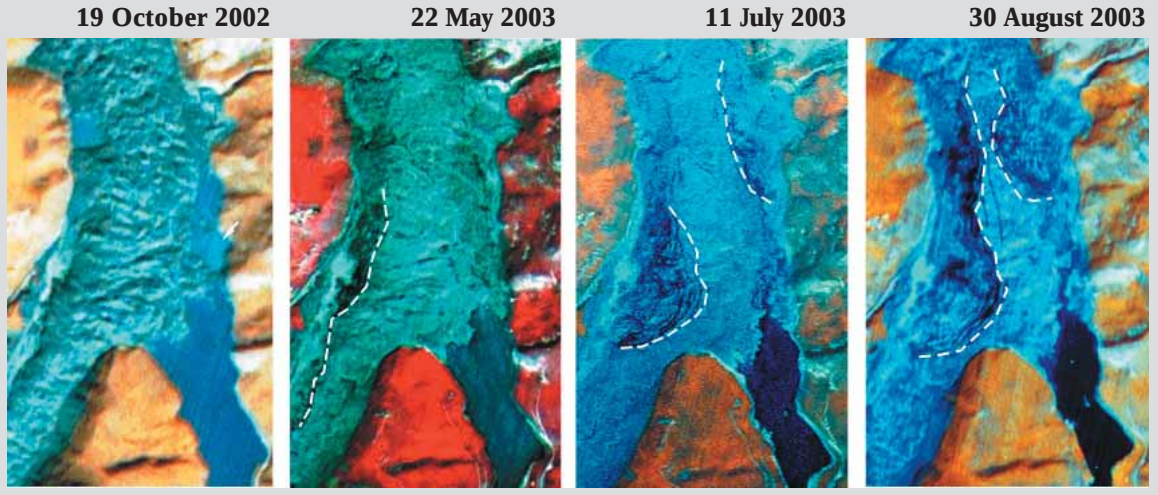
At the northern end of the depression, the churning mass of debris reached a choke point: the Gates of Karmadon, the narrow entrance to a steep-walled gorge. Gigantic blocks of ice and rock jammed into the narrow slot, and water and mud sluiced through. Trapped by the blockage, avalanche debris crashed like waves against the mountains and then finally cemented into a towering dam of dirty ice and rock, creating lakes upstream. At least 125 people were lost beneath the ice.

The Kolka Glacier collapse partially filled the Karmadon Depression with ice, mud, and rocks, destroying much of the village of Karmadon. The debris swept in through the Genaldon River Valley and backed up at the entrance to a narrow gorge. The debris acted as a dam, creating lakes upstream. Boulders, pebbles, and mud covered the surface of the debris flow, resulting in treacherous footing. The pathless maze of debris was only one of many hazards that slowed exploration of the disaster area.

Scratches on the surface of rocks of the Maili Glacier's moraine show the violence of the event. The avalanche, moving up to 180 kilometres per hour (112 mph), scoured the rocks below, leaving parallel grooves called "striations." Striations are typically observed in the bedrock underlying glaciers, created by the slow, scouring action of rocks caught beneath the ice.

Large-scale avalanches and glacial collapses are not uncommon on the slopes of Mount Kazbek and nearby peaks. The Kolka Glacier collapsed in 1902, surged in 1969, and collapsed again in 2002. Evidence, including historical accounts, indicates similar events have happened in neighboring valleys as well.

After the collapse, people speculated that something called a glacial surge had triggered the Kolka collapse. In 1902, a more significant collapse at Kolka Glacier killed 32 people. Despite a history of disasters there, routine monitoring of the Kolka Glacier cirque ended in the late 1980s.



This sequence of images from the Indian Remote Sensing (IRS) satellites showed that the lakes (except Lake Saniba) were draining gradually through crevasses in the ice mass, and were not likely to cause subsequent catastrophic floods. *Credit: IRS*

Credit: Sergey Chernomorets/UNEP

The rapidly rising water was a continuing danger, threatening a sudden outburst that would cause flooding downstream.

Russian researchers evaluated the risk of future danger at the disaster site using a time-series of satellite images collected in the year following the disaster. Satellite imagery was crucial throughout the late fall and winter of 2002 and 2003, when dangerous weather prevented on-site observations of the ice-dammed lakes.

Russian scientists combined satellite data with ground observations to create maps of the Kolka Glacier Cirque. The IRS Satellite image (acquired 11 July 2003) shows details of the cirque, including scars caused by post-collapse rockfall, a large remnant of the Kolka Glacier, ice cliffs high above the floor of the cirque, displaced porous ice, the Maili Glacier, a temporary lake, and deposits of rubble left along the path of the collapsing glacier.

There is uncertainty also about what triggered the collapse of rocks and hanging glaciers on Mount Dzhimarai-Khokh. Two small earthquakes jarred the region in the months before the collapse, probably destabilized the hanging glaciers. In the first days after the collapse, an Emercom (Russian Emergencies Ministry) crew flew to the site via helicopter, but was forced to evacuate immediately when the crew detected an overpowering smell of sulfur-containing gas. It seems there may be some fumaroles—volcanic vents—on the face of Mount Dzhimarai-Khokh in the area where the hanging glacier collapsed.

Based on the available data and observations, the scientists say they don't expect any additional catastrophic processes within the next 10 to 20 years. The remaining lakes will likely continue to drain through crevasses and channels being cut through the ice mass, and as they drain, the risk of flooding decreases.

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Source: http://earthobservatory.nasa.gov/Study/Kolka/kolka.html

Credit: Digital Globe

The area covered by ice and debris dwarfed the hamlet of Karmadon, and the Genaldon River disappeared completely. (The outline corresponds to the detailed image above.)

Credit: Olga Tutubalina, Dmitry Petrakov, Sergey Chernomorets/UNEP