Research

The demise of Kilimanjaro's glaciers

Climber Jack Ballard traverses the crater near the remnants of a glacier.
LISA DENSMORE

DUST FILLED MY EYES, MY NOSE, MY EARS, AND EVERY PORE OF MY body. A scant two days into a seven-day climb, it permeated my clothes, my cameras, my sleeping bag, and all 12 kilos of my personal gear, which had been meticulously weighed at the trailhead. I thought that it was a good thing I had eaten some of my snacks. Otherwise, the oppressive dust would have surely put me over my weight limit. This dust would be but one of the many surprises of Mount Kilimanjaro.

Peering over the tents, I contemplated the legendary peak, the roof of Africa, a slumbering volcano, and, some say, the poster mountain for global warming. Clouds swirled around Kibo, the massive crater-summit that scraped the sky at 19,340 feet. My turn to attempt that towering height was now at hand, though we still had several miles and a substantial amount of elevation to go before reaching that lofty point. From our camp on Shira Plateau at 12,621 feet, the top of mountain appeared as a broad flat plateau atop a rocky escarpment, a cone whose apex had been lopped off. A few isolated patches of snow brightened the otherwise barren cliffs. Kilimanjaro was a powerful magnet that had fascinated me since I began hiking in the Adirondacks as a teenager.

The view was surreal. I could only see the top of Kilimanjaro to the east and another volcano, Mount Meru, to the south. They stood like sister islands in an endless sea of clouds with a most unusual tide. It ebbed and flowed up and down, rather than in and out, sometimes rising above Kili's summit and sometimes resting barely above the rainforest that grew thickly around the mountain's base. Kilimanjaro is such a dominant landmass that it generates its own daily weather pattern. Every morning the peak is clear, then as the equatorial sun warms the atmosphere (Kili is only 3 degrees south latitude), the air rises, pulling moisture upward. By mid-afternoon, clouds obscure the peak. Then, after sunset, the phenomenon reverses. The air cools, and the clouds sink back to the top of the rainforest. Interestingly, the moisture captured by the clouds seems to stay there, at least during the dry season from mid-January through the end of October. This lack of precipitation is an important part of the debate surrounding the reason for the rapid disappearance of Kilimanjaro's glaciers.

I glanced at the cover of my guidebook, *Kilimanjaro: The Trekking Guide to Africa's Highest Mountain* by Henry Stedman (Trailblazer Publications, 2006). The cover shot showed a decidedly different mountain than the one before me. Kilimanjaro's summit wore a distinctive cap of solid white. A lacy mantle of snow draped at least halfway down its sides in every direction. One

glacier extended nearly to the mountain's forested flank. The upper mountain was certainly more white than brown. Assuming the cover image was taken a year or two before 2003, the initial publication date of the guidebook, the amount of glacial recession on Kilimanjaro within the last decade was staggering. Davis, one of my two guides, confirmed my observation.

"When I began guiding on Kilimanjaro, six years ago, we walked on snow above Shira Plateau," said Davis, "You will not walk on snow."

His statement shocked me. Even though I had witnessed glacial recession in many mountain ranges around the world while skiing and trekking and had read extensively about Kilimanjaro's glaciers before this trip, the pace of the melting came as another of the mountain's surprises.

I had come to Kili for three reasons: to stand atop the highest peak in Africa, to test my tolerance for high altitudes (my highest climb before this was over Punta Union Pass at 15,400 feet in Peru's Cordillera Blanca), and to observe and photograph the state of the glaciers. Kilimanjaro, after all, is an icon frequently invoked in discussions of climate change. Before my departure, dozens of acquaintances asked, "Are you going to Kilimanjaro to see the glaciers before they disappear?" As I stared at the pittance of snow on the mountain's massive buttresses, I thought it a good thing I had not delayed this trip by even a year or two. There wasn't much left.

A month before my departure, one of those friends gave me another book, *The Breach: Kilimanjaro and the Quest of Self* by Rob Taylor (Putnam Publishing, 1981), a true story about two world-class climbers, the author and Harley Warner, who attempted to climb Kilimanjaro via the Western Breach route in 1978. The Taylor-Warner expedition faced an extremely technical mountaineering ascent. In his book, Taylor saw a decidedly different peak from his camp on Shira Plateau:

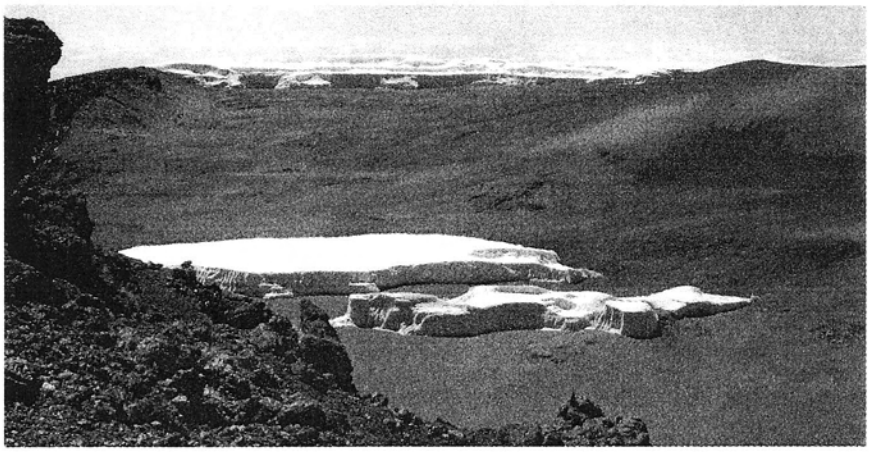
> Suddenly, there in the distance, rising up in front of us, is the Breach Wall, a great gash in the uniformity of Kilimanjaro's side. Though still two days' march away, there it stands, immense, towering, straining to touch the sun. The Breach Wall is a study in contrasts, hanging white ice fields shimmering in the morning light, alternating with black vertical cliff bands of rock embellished with the most incredible and unlikely-looking icicles, dangling down hundreds of feet.

My route would also scale the Western Breach, which reopened in December 2007 after a dozen years of closure because of glacial recession. As this steep approach to the rim of the crater melted out, it became precariously unstable. Now that the glacier was gone, it allowed a more challenging, less-peopled route for experienced trekkers who didn't mind a bit of rock scrambling. It was no longer the technical climb that Taylor and Warner had faced, though it would require confidence and sure-footedness on the rock and scree, and similar timing. If we didn't get through the breach into the summit crater before the sun warmed and loosened the rock, we would be in real danger, but this was hardly the glaciated route of the 1970s.

I traveled to Kilimanjaro with three other Americans. We chose the Western Breach, a variation on the popular Machame route, because it was a lesser-used approach. There are six primary "up" routes (Machame, Umbwe, Marangu, Rongai, Lemosho, and Shira) and two "down" routes (Marangu and Mweke) on Kilimanjaro that all 35,000 people who climb the mountain each year must follow. Everyone sleeps in the same designated campsites, which become enormous tent cities each night. The number of people on Kilimanjaro was my third surprise. The fact that you must use porters to carry your gear, four to five porters per paying trekker, only adds to the endless current of people flowing up and down the mountain on a given day. Countless porters lope up the trail, their transistor radios blaring Tanzanian Top 40. The music relieves their minds from their loads, which are frequently balanced atop their heads. No iPods and ear buds here. If you are looking for a quiet wilderness experience on a big mountain, Kilimanjaro will disappoint you.

We departed Shira Plateau the next morning, heading toward the peak. The terrain grew increasingly rocky. At first, spindly trees and Seussian lobelia punctuated the otherwise waist-high heath. By mid-morning, the flora had mostly disappeared. Lava boulders lay strewn across the moonscape, spewed from the volcano during a prehistoric eruption. Indeed, our guides called this part of the mountain "Moon Land," though it was not completely devoid of life. Clumps of tenacious everlastings and small yellow-flowered succulents somehow survived this cold, waterless alpine desert in the shade of the rocks.

As we approached Lava Tower, our next camp at the base of Kili's summit cone, I stepped over a narrow rivulet that flowed from a feeble acre of glacier on the cliffs above me. I watched a distinct line of brown water get closer and closer, soon overtaking the clear water at my feet. My other guide, Robinson,



View of the crater and the remains of the glaciers from atop Uhuru Peak.
LISA DENSMORE

explained that each day, the sun warmed the glacier enough to release water. The water was brown because it carried sediments long trapped in the ice. I happened to arrive at this streamlet just as the glacial water caught up to the clear water. The flow was little more than a trickle and a glaring reminder that when Kilimanjaro's glaciers disappear, it will cause more than just scientific and public chatter about the effects of global warming. True hardship will occur in local villages as runoff from Kilimanjaro's ice sheets are their source of water for drinking, irrigation, and hydropower.

Some climatologists believe that pending drought in the lowlands is the result of a multi-decade drought on the mountain that is the main cause of the dramatic decline of its glaciers. Others say the drought is a secondary reason behind regional climate change in the lowlands. There is no doubt that the glaciers are rapidly retreating, 26 percent since 2000, 85 percent since 1912. But is it because of global warming or drought? Which is the primary cause and which is the accelerant?

A 2009 study based on research by Lonnie G. Thompson, PhD, a glaciologist from Ohio State University, favors climate change. Using special cylinders, Thompson's team extracted columns of ice from the surface to deep within Kili's ice sheets. The deepest portion of each sample was estimated at 11,700 years old, when the glaciers first formed, and was solid ice. The newer surface ice, only a few hundred years old, contained bubbles, a sign that significant melting and freezing had occurred, probably because of

increased levels of solar radiation. However, increased levels of solar radiation should not assume higher temperatures.

The article "Climate Debate Gets Its Icon: Mount Kilimanjaro" (*The New York Times*, March 23, 2004) cites research by Stephen L. Hastenrath, professor emeritus at the University of Wisconsin, on nearby Mount Kenya, which uncovered evidence of increased solar radiation as a reason why the African ice sheets are melting. Unlike Kilimanjaro, where most of its glaciers are exposed to the sun, Mount Kenya's glaciers lie in both sun and shade. Hastenrath found that from 1899 to 1962 shaded ice on Mount Kenya had changed little, whereas exposed ice had melted dramatically. However, in the last 50 years, the ice in both sunny and shaded areas declined, which Hastenrath concluded was not from global warming per se, but from a decrease in cloud cover, that is, lower amounts of water vapor in the air.

Standing at Lava Tower at 15,230 feet just after sunset, it was hard to imagine anything melting on the summit of Kilimanjaro. It had been a chilly hike from Shira Plateau. I had thrown on my down parka at every rest stop. I wore it now, along with several layers of fleece. Frost already lay heavily on our tents. It was going to be a bitter night. Consistent below-freezing temperatures caused by high elevation allowed glaciers to form in tropical regions of the world in the first place, all of which have been retreating at a rapid pace. It didn't make sense. Unlike the warmer temperatures that have contributed significantly to the decline of mid-latitude glaciers, the average temperature atop Kilimanjaro has risen only 0.1 degree since 1979. It's not just cold on the summit, it's downright frigid, rarely above –3 degrees Fahrenheit.

Despite this, it does not have to be above freezing for a glacier to contract. Frozen water can evaporate through a process called sublimation. Sublimation occurs when the moisture in the air is less than moisture available on the glacier's surface. Apparently, Kili's daily swathing in the clouds is not enough to counteract the rate of sublimation. At the top of the troposphere, where Kili sits, the air is uncommonly dry. Even during the rainy season, the clouds have not released enough snow to rejuvenate the glaciers, apparently for a very long time. In 1880, when Hans Meyer and Ludwig Purtscheller became the first Europeans to reach the summit, Kilimanjaro's ice sheets covered 20 square kilometers. By 1912, they had receded to 12 square kilometers. In 1953, only 6 square kilometers remained. In other words, Kili's glaciers had already declined by 70 percent before the Industrial Revolution and the supposed start of the global warming crisis. Today, they cover less than 2 square kilometers.

Our fourth day was short. Lava Tower marked the point where we departed the Machame route and began our ascent to the Western Breach. We could see the breach, a notch in the volcano's rim where we would pass into the crater. We ascended the scree and talus to our fourth campsite at Arrow Glacier at 15,981 feet, where no glacier remains. We gained only 700 feet in elevation that day to acclimate before reaching the summit. I was glad for it, not just for myself, but for two of my climbing companions. One struggled with digestive problems, and another confessed to having thrown up the night before. They both needed an easy day.

We awoke at 5 A.M. the next day and began climbing an hour later, a leisurely departure by Kilimanjaro standards. Groups on other routes begin their summit day just after midnight to reach the summit by 9 A.M. Though they don't face the potential rockfall that we would on our route, they must descend a lengthy 10,000 feet before day's end. Our strategy required us to get through the Western Breach before 11 A.M., reach Uhuru Peak, the highest point on the mountain, by early afternoon, then camp in the crater. Only our two guides, our cook, and eight hearty porters would accompany us. We would carry only the food, clothing, and gear necessary for the final ascent and night in the crater. Our other eight porters would meet us at Barafu Hut on the southeastern side of the mountain, partway down the Mweke Route, the day after tomorrow.

My CamelBak hose froze instantly as we shouldered our packs and began the slow, metered climb. Davis and Robinson sang to us in gray predawn light. I could see the rocks before me as I calculated each handhold and carefully placed step. I couldn't feel my fingers or toes. I had expected it to be cold, but the biting, penetrating chill was yet another Kilimanjaro surprise. I was climbing, working hard physically, but I couldn't get warm.

The lights from scattered villages twinkled through the thin cloud cover below us. As dawn broke, Mount Meru glowed warmly across the pinkish clouds. We slowly gained a rib of rock and more stable footing. All was calm. We were insignificant ants on an enormous sleeping elephant. I watched the sun reach a broad swath of cliff to our right. I craved its relative warmth, but dreaded its arrival, fearing the mountain would awaken and start spitting rock at us. The need to get through the breach before the sunlight spread further across the mountain begged a faster pace, but my heart threatened to pound out of my chest at the smallest attempt to increase my speed.

We crested ledge after rocky ledge, then suddenly we passed through the breach. A broad ashen plain lay before us. To my left, I could see a large

snowfield with tiny probes sticking out of it, the devices used by researchers to monitor the shrinking snowfields. Large iceberg-like chunks of glacier rose here and there from the barren crater floor. We turned right, heading southeast along the inside rim of the crater. I veered toward the remains of an ice sheet that had once been wedded to the glacier on the opposite side of the crater. Its sheer walls were barely 12 feet high at this point, though they rose 50 feet farther ahead. Scientists believe that Kili's flat top and the fact that its summit glaciers have such steep sides have contributed to their dramatic decline.

"Stunning vertical walls . . . tower over the visitor to Kibo's summit," wrote Georg Kaser, a renowned glaciologist at the University of Innsbruck, Austria, and his colleague Phillip W. Mote, in 2007 in *American Scientist*, "These edges cannot grow horizontally but lose mass constantly to ablation [sublimation, wind erosion, and calving] when they are exposed to sun, even though the air temperature is below freezing. Once developed, the near-vertical edges will retreat until the ice is gone since no snow can accumulate on these walls."

Ironically, global warming might aid the regeneration of Kili's glaciers. If summit temperatures were to periodically warm above 32 degrees F, the sheer edges of the ice walls would eventually soften and flatten, creating surfaces onto which snow could accumulate. As I worked my way up the crater wall, heading toward Uhuru Peak, I doubted that would happen any time soon. Subfreezing air stung my face and burned my lungs. I made it to crater rim, then glanced down at the patches of glacier, the land-locked icebergs, and the larger glacier at the north end of the plateau. I turned to traverse the last quarter-mile to Kilimanjaro's apex, thankful for clear skies and calm air, though perhaps I should have wished for more clouds if it would have meant saving the glaciers.

According to Thompson, it wouldn't matter much. In his most recent scientific paper (September 2009), "Glacier Loss on Kilimanjaro Continues Unabated," Thompson and his colleagues at the Byrd Polar Research Center at Ohio State University present evidence that drier, less cloudy conditions are not enough to account for the rate of glacial retreat. "The climatological conditions currently driving the loss of Kilimanjaro's ice fields are clearly unique within an 11,700-year perspective," the team wrote. "These observations suggest warmer near-surface conditions observed in the region, coupled with observed vertical amplification of temperature in lower latitudes are playing an important role." In other words, warming in the nearby lowlands is affecting the rate of glacial melt up high.

Mote and Kaser agree that warmer average temperatures at lower elevations contribute to the ice shrinkage, but only secondarily and late in the process. "An additional clue about the pacing of ice loss comes from water levels in nearby Lake Victoria," Mote and Kaser said. "Long-term records and proxy evidence of lake levels indicate a substantial decline in regional precipitation at the end of the nineteenth century after some considerably wetter decades. . . . The larger ice caps described by Victorian-era explorers were more likely the product of an unusually wet period than of cooler global temperatures."

So the debate continues, neither side denying the fact that Kilimanjaro's glaciers are rapidly disappearing, and both sides concluding that more research is necessary to determine the primary cause, global warming or drought. At the current rate of glacial recession, Kili's summit will be bare by 2024, perhaps sooner. As I stood on the roof of Africa, I felt lightheaded, perhaps from the accomplishment of getting there, perhaps from the lack of oxygen, but mostly because I had seen Kili's famous white mantle before it completely disappeared.

—Lisa Densmore

Professional writer and photographer Lisa Densmore climbed Kilimanjaro in August 2009. Her latest books, *Hiking the Adirondacks*, *Hiking the White Mountains*, and *Backpacker Magazine's Predicting Weather* (FalconGuides, 2010) are available from most bookstores including the AMC's gift shops and through her website, www.DensmoreDesigns.com. Contact the AMC Visitor Center at Pinkham Notch to find out when Lisa's next slideshow and talk is scheduled.