Lake Sarez, Pamir Mountains, Tajikistan: Mountain Hazards and Development Assistance

Authors: Alford, Donald, Cunha, Stephen F., and Ives, Jack D.

Source: Mountain Research and Development, 20(1) : 20-23

Published By: International Mountain Society

URL: https://doi.org/10.1659/0276-4741(2000)020[0020:LSPMTM]2.0.CO;2

Mountain Research and Development Vol 20 No 1 Feb 2000: 20–23

Donald Alford
Stephen F. Cunha
Jack D. Ives

Lake Sarez, Pamir Mountains, Tajikistan:

Mountain Hazards and Development Assistance

In the winter of 1911, a massive earthquake-induced landslide in the Pamir Mountains of eastern Tajikistan completely blocked the valley of the Bartang (Murgab) River, a headwater tributary to the Amu Darya River basin. A lake began to grow behind this natural dam and has now reached a length of 60 km. In a worst-case scenario that assumes collapse of the dam, a catastrophic outburst flood from Lake Sarez would destroy the villages and infrastructure in the Amu Darya basin between the lake and the Aral Sea, affecting an area inhabited by more than five million people across a distance of over 2000 km. But local populations in the mountain valleys face further, more immediate and pressing hazards; the annual cycle of rockfalls, debris flows, avalanches, and flooding constantly impinges on human activities. Development assistance is thus needed on a small, participatory scale in the form of enhancing existing local emergency response infrastructure. Moreover, monitoring Lake Sarez and designing an early warning system seem more appropriate measures than extremely costly engineering solutions to stabilize the dam, especially since collapse of the dam was assumed to be extremely unlikely.

FIGURE 1 Usoi dam and Lake Sarez in August 1992, seen approximately from the same angle as in the 1940 picture below. (Photo by S. F. Cunha)

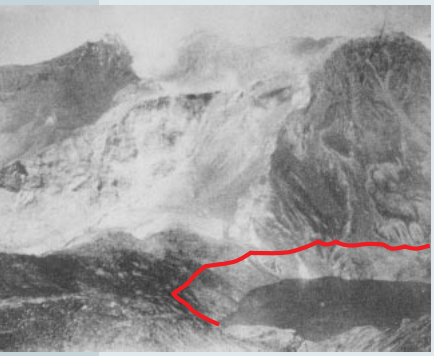

FIGURE 2 View toward the southeast from the top of the Usoi dam, Lake Sarez, in about 1940. The line shows the approximate level of the water in 1992. (Photo courtesy of S. F. Cunha)

A major natural hazard in a socially, politically, and economically isolated area

The Usoi landslide dam, named after the village of Usoi, which was completely buried by the 1911 landslide in Tajikistan, has a total volume estimated at approximately 2 km^3 with a maximum height above the original valley floor of 500 m to 700 m. The lake that formed behind the Usoi dam rose at an initial rate of approximately 75 m/y. This lake was named for the village of Sarez, drowned by the rising water. Lake Sarez is now over 60 km in length with a maximum depth in excess of 500 m and a total volume of approximately 17 km^3. Today the surface of the lake is close to 3200 m asl, surrounded by peaks rising to more than 6000 m asl. The Usoi dam is the highest dam, natural or man-made, on earth (Figures 1 and 2).

FIGURE 3 Lake Sarez is located in the Pamir Mountains of eastern Tajikistan, one of a number of Central Asian republics created by the Soviet Union in the early part of the 20th century. (Map by Andreas Brodbeck)

Landslide-generated Lake Sarez, and its potential to destroy downstream riparians as far as the Aral Sea, presents a major dilemma to the governments of the riparian republics along the Amu Darya as well as to international development agencies. Apart from the magnitude of the physical problem, historical, social, economic, and political factors make for a complex and urgent challenge to be met (see Figure 3).

Central Asia is slowly emerging from decades under the former Soviet Union. The countries of the region—Tajikistan, Uzbekistan, Kyrgyzstan, Kazakhstan, and Turkmenistan—were all created by the Soviet Union to more effectively administer a region formerly controlled by a series of Khanates located along the ancient Silk Road plus territories with no clear political allegiance but contested for by Imperial Russia, the British Empire, China, and Afghanistan during the days of the so-called Great Game. The region is defined by some of the highest mountain ranges on earth—the Pamir, Tien Shan, Karakorum, and HinduKush—and by the problems they represent in terms of the social, economic, and political isolation of the peoples living among them. The topographic complexity and general inaccessibility of these large mountain ranges, coupled with the many political and economic problems associated with the transition from Soviet control, also create problems for the development assistance community. The political, social, and economic marginalization of mountain peoples in Central Asia makes it difficult to design assistance programs while working through a central government located in a distant lowland. The complex, three-dimensional environmental mosaic of large mountain ranges complicates application of generic solutions and renders their success problematic. Tajikistan, as one of the smallest and poorest of the former Soviet Socialist republics, is particularly disadvantaged.

No simple, near-term technical solution

The major engineering required to reduce the hazard posed by the lake has been judged by development agencies to be far too expensive. Yet this is the approach advocated by most of the Central Asian republics. A regional conference aiming to consider the Lake Sarez problem was jointly convened in late

FIGURE 4 The 1999 United Nations/World Bank hazards reconnaissance party have just arrived at Lake Sarez, 3200 m asl, by helicopter from Dushanbe, capital of Tajikistan. (Photo by J. D. Ives)

"A high-magnitude, low-frequency event, such as a major earthquake or an outburst flood, would totally overwhelm the existing response capabilities of the region, probably as far downstream as the Aral Sea, and would require massive assistance from the international community."

"The low-magnitude, high-frequency events are usually dealt with at the local or regional level; minimal assistance, in the form of enhancement of the rudimentary emergency response infrastructure that already exists, would greatly improve the lives of the local mountain people."

1997 in Dushanbe, Tajikistan, by the International Organization for Migration and Focus Humanitarian Assistance. It was attended primarily by representatives from the Central Asian republics, and the papers presented reflected a pro-engineering agenda. A second conference, convened by Focus Humanitarian Assistance in Washington, DC, in the summer of 1998, was attended by Western geoscientists and representatives from USAID and the World Bank. On this occasion, it was concluded that there was insufficient information on many aspects of the problem and that a reconnaissance of the lake and the Bartang valley was advisable. This was undertaken in October 1998 and led to the conclusion that there were no obvious signs of instability in the Usoi Dam. Installation of a monitoring program and an early warning system for the downstream villages was proposed as a high priority. In early 1999, the World Bank began preliminary planning to implement these recommendations.

In June 1999, a second reconnaissance was organized by the UN International Decade for Natural Disaster Reduction (IDNDR) Secretariat in conjunction with the World Bank. This mission consisted of a combined group of Western and Tajik scientists who studied both the dam and lake as well as the inhabitants and environment of the Bartang valley for approximately 200 km downstream. On this occasion, it was concluded that, in the near- to midterm, the probability of a massive outburst flood from Lake Sarez was remote. Nevertheless, it was fully realized that, should such a flood occur, the impact on the downstream valleys would be catastrophic.

Irrespective of such a high-magnitude event, it was apparent that virtually all human habitations in these mountains are subject to a set of hazards associated with earthquakes, slope instability, and flooding. These are the common elements linking the hazard represented by Lake Sarez with those faced by individual villages, the primary differences being ones of magnitude and frequency. Furthermore, other high-magnitude events are known to have occurred in the Pamir Mountains, which have a long history of outburst floods. Many valleys, such as the Obi Hingou, Obi Mazar, Goonm River, and the Yazgulum River, display geomorphic evidence of former major landslides, including blockage and subsequent outburst.

These hazards bracket the extremes on a continuum ranging from high-magnitude, low-frequency events, as represented by Lake Sarez itself, to low-magnitude, high-frequency events, such as rockfalls, debris flows, and seasonal flooding, faced by virtually all villages every year. A high-magnitude, low-frequency event, such as a major earthquake or an outburst flood, would totally overwhelm the existing response capabilities of the region, probably as far downstream as the Aral Sea, and would require massive assistance from the international community. On the other hand, the low-magnitude, high-frequency events are usually dealt with at the local or regional level; minimal assistance, in the form of enhancement of the rudimentary emergency response infrastructure that already exists, would greatly improve the lives of the local mountain people. The possibility of a major outburst flood from Lake Sarez has received sufficient attention to produce at least gross estimates of its consequent social and economic damages; such, in effect, would represent one of the largest natural catastrophes in human history. However, the cumulative costs of the annual cycle of rockfalls, debris flows, avalanches, and flooding remain unstudied and unquantified. This element of the problem is the more acute because the Ismaili communities along the Bartang River, numbering about 7000 persons, are already under severe stress since the withdrawal of Soviet support.

A proposed plan of action

The consensus of the members of the June 1999 reconnaissance was that there are no simple, near-term technical solutions to the hazard represented by Lake Sarez. The most appropriate immediate responses should be the following:

1. The design and installation of an early warning system to alert inhabitants of

the upper Amu Darya basin of the likelihood of any outburst flood;
2. The initiation of a monitoring program at Lake Sarez to provide continuous information on the hydrology of the lake and on the stability of the Usoi Dam and surrounding mountain slopes;
3. Development of a series of flood scenarios to determine the degree of risk and vulnerability of downstream villages and infrastructure;
4. The assemblage, organization, and analysis of all existing information using remote sensing and Geographic Information System (GIS) technology; and
5. A socioeconomic analysis, employing villager research participation, of the settlements for about 200 km below the lake.

Preliminary enquiries in the field area suggest that the Pamiri people are hard pressed to produce domestically their basic food requirements. An effective, minimal assistance program of lake monitoring and early warning technology installation, provided the obvious abilities of the local people are correctly utilized, would go a long way toward alleviating this situation in the Bartang valley by increasing income. Moreover, and typical of many semi-isolated communities worldwide that are experiencing some of the negative effects of globalization, political tension, and uncontrolled incorporation into the post–Cold War world, such jewels of mountain culture and human resilience deserve effective assistance.

FIGURE 5 Pamiri family of Basid village in the Bartang valley below Lake Sarez. These are some of the people whose lives would be at risk from a landslide-induced wave overtopping the Usoi dam unless an effective early warning and evacuation procedure is established. (Photo by J. D. Ives)

Finally, the responses proposed above would facilitate dissemination of a better informed assessment of the primary hazard. This is vitally needed to reduce misunderstanding and so avoid the one extreme of complacency and, equally important, the other extreme of exaggerated reaction that, in the worst case, could lead to unjustified enforcement of evacuation of the Bartang valley. It must also be emphasized that Lake Sarez lies in the center of a politically extremely unstable region. Better resolution of the problem, and especially the uncertainty, posed by the lake is considered a wise investment; to mishandle Lake Sarez could prove a very costly mistake.

AUTHORS

Donald Alford
Department of Civil and Environmental Engineering, University of Utah, Salt Lake City, UT, USA. dalford@eng.utah.edu

Don Alford is a hydrologist with extensive consultation experience in Southeast and South Asia. He was leader of the World Bank/United Nations/Focus Humanitarian Assistance team to Lake Sarez in June 1999. He received his PhD in geography (glaciology) from University of Colorado, Boulder.

Stephen F. Cunha
Associate Professor, Geography, Humboldt State University, Arcata, CA 95521, USA. sc10@axe.humboldt.edu

Steve Cunha wrote his PhD dissertation (geography, U of California, Davis) based on fieldwork in the Pamir Mountains, Tajikistan. He has worked extensively in US national parks in California and Alaska.

Jack D. Ives
Honorary Research Professor, Carleton University, Ottawa, ON, Canada. JackIves@pigeon.carleton.ca

Jack Ives retired from U of California, Davis in 1997 but continues his long association with the UNU mountain ecology project. He founded and was editor of MRD *from 1981 until 2000. He obtained his PhD from McGill University, Montreal, Canada in 1956.*