

Progress Toward Remediation of Uranium Tailings in Mailuu-Suu, Kyrgyzstan

*P.B. Buckley, J. Ranville, B.D. Honeyman, D.K. Smith,
N. Rosenberg, R.B. Knapp*

This article was submitted to
Tailings and Mine Waste '03
Vail, CO
October 12-15, 2003

July 9, 2003

U.S. Department of Energy

Lawrence
Livermore
National
Laboratory

DISCLAIMER

This document was prepared as an account of work sponsored by an agency of the United States Government. Neither the United States Government nor the University of California nor any of their employees, makes any warranty, express or implied, or assumes any legal liability or responsibility for the accuracy, completeness, or usefulness of any information, apparatus, product, or process disclosed, or represents that its use would not infringe privately owned rights. Reference herein to any specific commercial product, process, or service by trade name, trademark, manufacturer, or otherwise, does not necessarily constitute or imply its endorsement, recommendation, or favoring by the United States Government or the University of California. The views and opinions of authors expressed herein do not necessarily state or reflect those of the United States Government or the University of California, and shall not be used for advertising or product endorsement purposes.

This is a preprint of a paper intended for publication in a journal or proceedings. Since changes may be made before publication, this preprint is made available with the understanding that it will not be cited or reproduced without the permission of the author.

This report has been reproduced directly from the best available copy.

Available electronically at <http://www.doc.gov/bridge>

Available for a processing fee to U.S. Department of Energy
And its contractors in paper from
U.S. Department of Energy
Office of Scientific and Technical Information
P.O. Box 62
Oak Ridge, TN 37831-0062
Telephone: (865) 576-8401
Facsimile: (865) 576-5728
E-mail: reports@adonis.osti.gov

Available for the sale to the public from
U.S. Department of Commerce
National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: (800) 553-6847
Facsimile: (703) 605-6900
E-mail: orders@ntis.fedworld.gov
Online ordering: <http://www.ntis.gov/ordering.htm>

OR

Lawrence Livermore National Laboratory
Technical Information Department's Digital Library
<http://www.llnl.gov/tid/Library.html>

Progress Toward Remediation of Uranium Tailings in Mailuu-Suu, Kyrgyzstan

P.B. Buckley & J. Ranville

Department of Chemistry and Geochemistry; and Laboratory for Applied & Environmental Radiochemistry, Division of Environmental Science and Engineering, Colorado School of Mines, Golden, CO 80401, USA

B.D. Honeyman

Laboratory for Applied & Environmental Radiochemistry, Division of Environmental Science and Engineering, Colorado School of Mines, Golden, CO 80401, USA

D.K. Smith, N. Rosenberg, and R.B. Knapp

Lawrence Livermore National Laboratory, Livermore, CA 94550, USA

ABSTRACT: The town of Mailuu-Suu in Kyrgyzstan inherited 23 distinct tailings deposits from Soviet-Era uranium mining operations. Mailuu-Suu is located in the narrow landslide-prone valley of the Mailuu-Suu River about 25 km from the Uzbekistan border. Large-scale release of the radioactive tailings, as a result of landslides, could lead to irreversible contamination of the river and downstream areas. The Mailuu-Suu River is a tributary to the Syr-Darya River, the Fergana Valley's main source of irrigation water. The Fergana Valley is a key agricultural region and major population center that spans Kyrgyzstan, Tajikistan, and Uzbekistan. The trans-boundary nature of the Mailuu-Suu tailings issue presents an opportunity for collaboration among these Central Asian states. A cooperative approach to addressing environmental issues such as Mailuu-Suu may contribute to the region's stability by facilitating peaceful associations. Experience from remediation of sites in the U.S. under the Uranium Mill Tailings Remediation Action Project (UMTRA) will be useful in progressing toward remediation at Mailuu-Suu.

1 INTRODUCTION

Kyrgyzstan was an important provider of uranium to the former Soviet Union beginning in the mid-1940s. Two decades of mining operations at the Mailuu-Suu site resulted in the generation of 23 tailings piles and 13 waste rock dumps. At the time, the risks to human health and the environment from the tailings were incompletely understood. This lack of information and limited technology resulted in tailings being stored under conditions that were unprotected and unstable.

The tailings are close to the town of Mailuu-Suu and on or near the banks of the Mailuu-Suu River and its tributaries. Today, the main concerns are that massive landslides will either block the river and cause flooding of the tailings or transport tailings into the river. Scientists and government officials have expressed concern that the tailings represent an immediate threat to the population and environment (Alioshin et al. 2002, Karimov 1997, Toralieva 2002).

The governments of Kyrgyzstan, Tajikistan, and Uzbekistan recognize the Mailuu-Suu site as a high priority environmental threat to the region (Knapp & Rosenberg 2003). Lack of funding prevents the newly formed state from conducting a thorough

nature of the Mailuu-Suu tailings issue presents an opportunity for collaboration among these Central Asian states. A collaborative approach to remediation of Mailuu-Suu tailings may facilitate regional cooperation, adding to the region's stability.

The United States Department of Energy (DOE) has 20 years of experience rehabilitating uranium tailings sites. Knowledge obtained from the Uranium Mill Tailings Remedial Action (UMTRA) project may help to develop technical and management approaches to the issues at Mailuu-Suu. UMTRA, which included 22 sites in ten states, was a joint project between the U.S. Federal, State and Tribal governments.

In this paper, a detailed review of the site and main concerns associated with the tailings at Mailuu-Suu are given. The focus is primarily on physical hazards such as risks associated with landslides and flooding of the tailings impoundments. The idea of environmental peacemaking as a catalyst to promote cooperative relations is discussed. Information gained from UMTRA is used to give a qualitative sense of the risk associated with the Mailuu-Suu site.

Mailuu-Suu in Kyrgyzstan was established in 1946 to overcome the uranium shortage for the former Soviet Union's weapons program. It was one of the first 'nuclear towns' where uranium ore was mined and processed. The crushed ore was sent to one of several uranium extraction plants where the initial leaching steps took place (Bunnenberg 2002). The resulting pre-concentrate was sent to the Hydro-Metallurgical plant in Kara-Balta, Kyrgyzstan. Radioactive tailings were stockpiled in 23 separate piles (identified as tailings 1-23) in various locations around Mailuu-Suu. Figure 1 shows a detailed map of the tailings and former mill sites.

Prior to 1991, when the Soviet Union collapsed, all mining activities, including tailings supervision and maintenance, were controlled by the USSR

Ministry of Non-Ferrous Metallurgy and Ministry of Medium Machine Building (Djenchuraev 1999). Original documentation about the content and structure of the tailings impoundments is missing or inaccessible.

In 1999, the tailings came under the jurisdiction of Kyrgyzstan's Ministry of Ecology and Extreme Situations (MES). Today, one full-time person supervises the tailings through visual observation alone (TICP 2002). Currently, open access to the tailings is possible due to the removal of fencing for personal use. Livestock commonly graze on and around the tailings while human foot traffic is also evident.

A recent site visit showed that the original drainage systems, installed to manage percolation water, are no longer functioning. A single layer of clay,

Mills and Tailings Dumps at Mailii Su

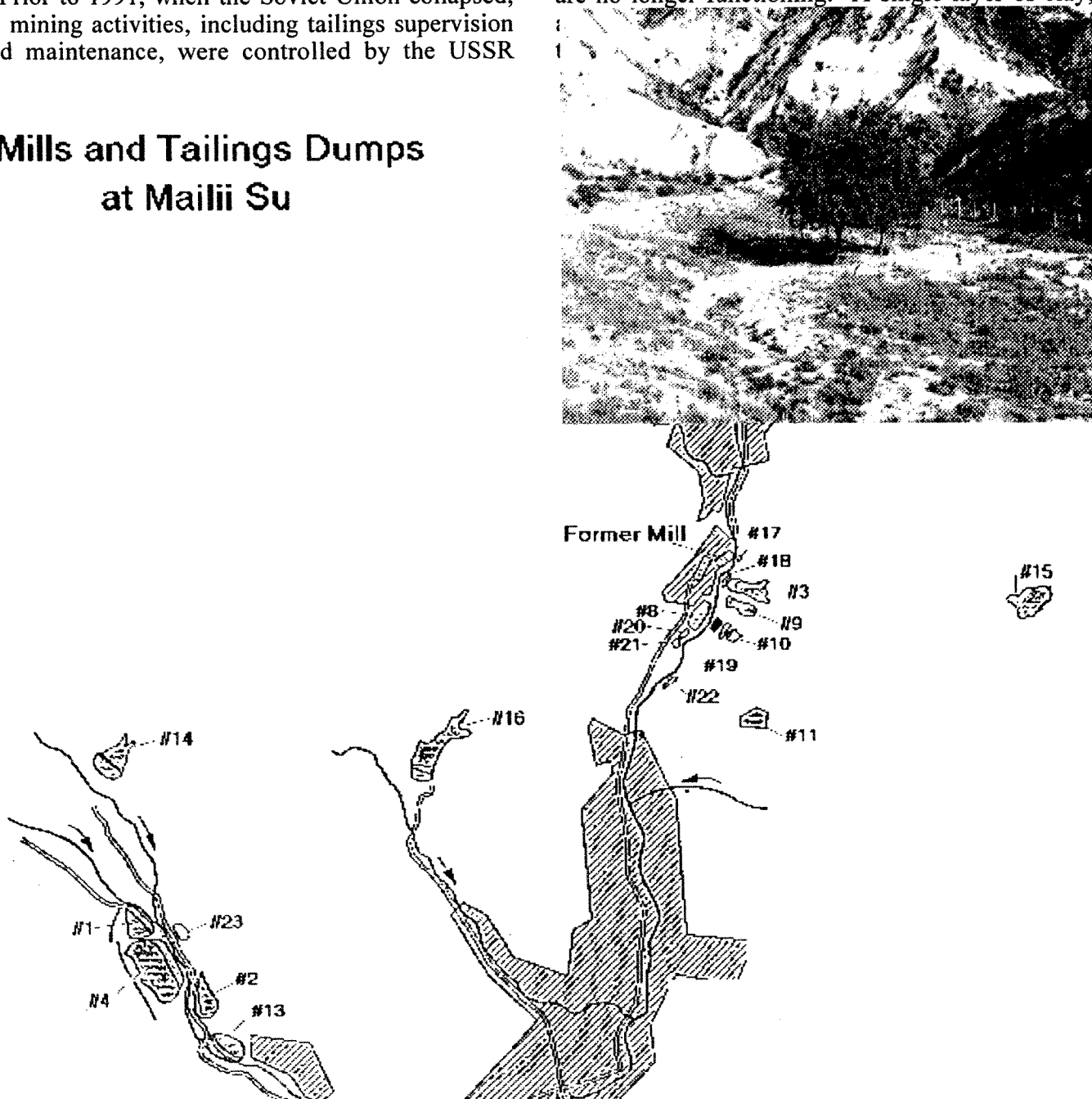


Figure 1. Map of the tailings impoundments and former mills. The remaining mill is now an electric bulb production plant.

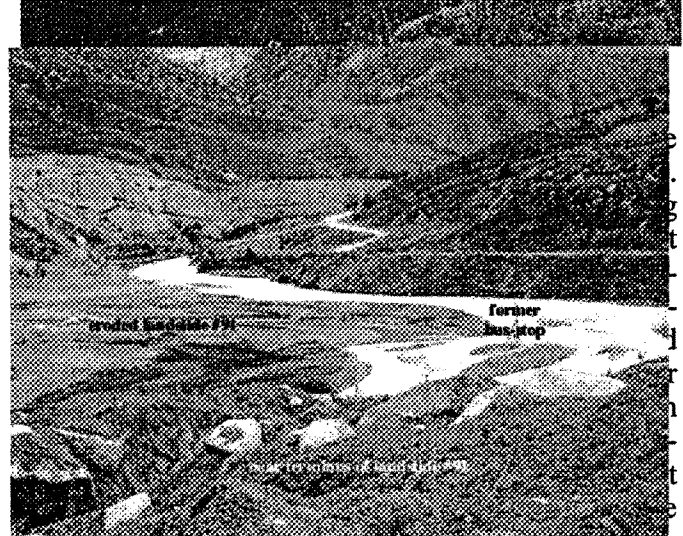
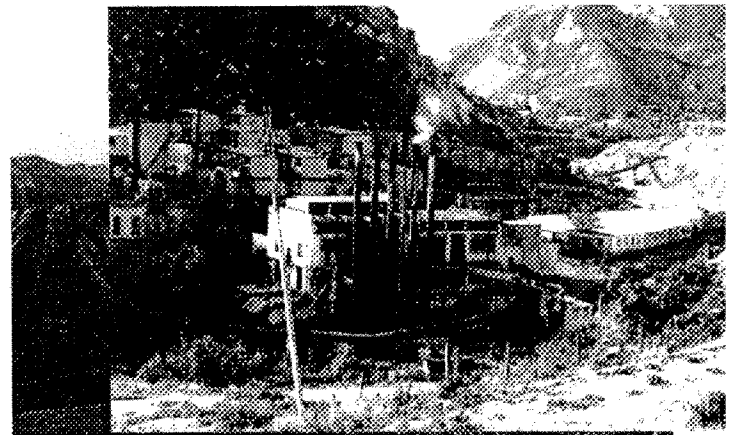
increasing the risk of exposure to radon (fig. 2).

Mailuu-Suu (population approximately 26,000) is located in the narrow landslide-prone valley of the Mailuu-Suu River (Fig. 3). The town is about 60 km northwest of Jalal-Abad and approximately 25 km from the Uzbekistan border. The Mailuu-Suu River is a tributary to the Syr-Daria River, the Fergana Valley's main source of irrigation water. The Fergana Valley, only 20 km downstream, is a critical agricultural area and a densely populated region that spans Kyrgyzstan, Tajikistan, and Uzbekistan (Fig. 4). A large-scale release of radioactive tailings could lead to irreversible contamination of the river

Figure 3. The town of Mailuu-Suu in the narrow river valley.

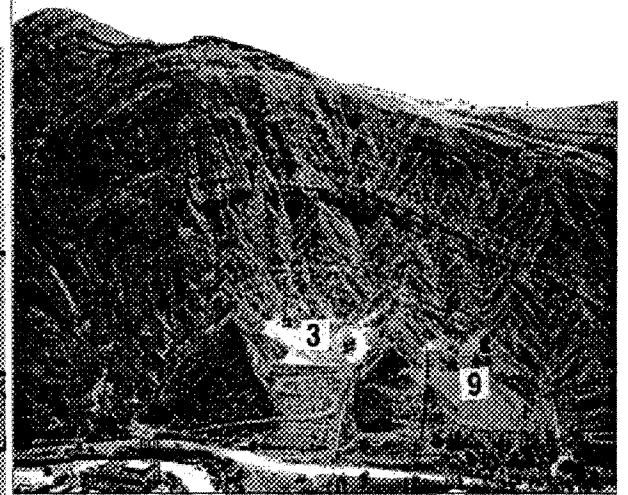
and downstream areas.

Most tailings in Mailuu-Suu are located about 3 km upstream from the urban area, near the river or in small side canyons. In total, the piles cover an area of roughly 100 acres and have a volume of about 2 million m³. Individual tailings impoundments have volumes ranging from 1,000 m³ (tailings 17) to 1.4 million m³ (tailings 7). The larger tailings deposits are positioned in side canyons where the mountain slopes act as barriers. Dams, generally accepted to be inadequate to contain the tailings, are constructed out of gravel, soil and even tailings material. Some smaller tailings piles, upstream of the downtown area, are located within 500 meters of homes and in the river flood plains. Many of the tailings are in high-risk areas while landslides and floods have already damaged others.



and Natural Resources (BGR) (Boettcher, pers. comm.). Five continuous geosensors were placed within potential landslides that threaten tailings 3,5,7,8,9 and 17. The data has shown a correlation between rainfall and rock mass displacement.

In 1993, a massive landslide barricaded the river and flooded the downstream areas. It was necessary to blast the



buildings, roads and utilities.

flooding (Bunnenberg 2002). In May 2002, the 'Tectonik' landslide, located on the left side of the Mailuu-Suu River about 1.2 km upstream of downtown Mailuu-Suu, blocked the river. Flooding of nearby tailings was prevented when the river created a path around the landslide dam (Kabar 2002).

One of the uranium extraction plants was converted to an electric bulb factory when mining operations ceased (Fig. 6). The plant, known as Isolite, continues to operate today despite frequent damage by landslides and rock fall. Moving the plant to another location would be an economic blow to Mailuu-Suu due to the lack of a suitable replacement site in the area.

3 HIGH PRIORITY TAILINGS

Tailings 3 is located across the river from the Isolite factory. This impoundment is of particular concern because it contains approximately 60% of the total radioactivity found at the Mailuu-Suu site (Schmidt 1997). The high radioactivity resulted from inefficient extraction techniques used for processing high-uranium containing ores from Saxony in the former German Democratic Republic (Bunnenberg 2002, Schmidt 1997). Figure 7 reveals the hazardous location of tailings 3, making it clear why this impoundment is a high priority for remedial actions.

Rehabilitation of tailings 3 is the focus of a EU-TACIS funded project. Assessment activities are currently in progress to determine if stabilization in-place or relocation is the most appropriate action.

bulb plant. Across the river, Photo courtesy of Gerhard Schmidt, Heppenheim/Germany, copyright 1997.

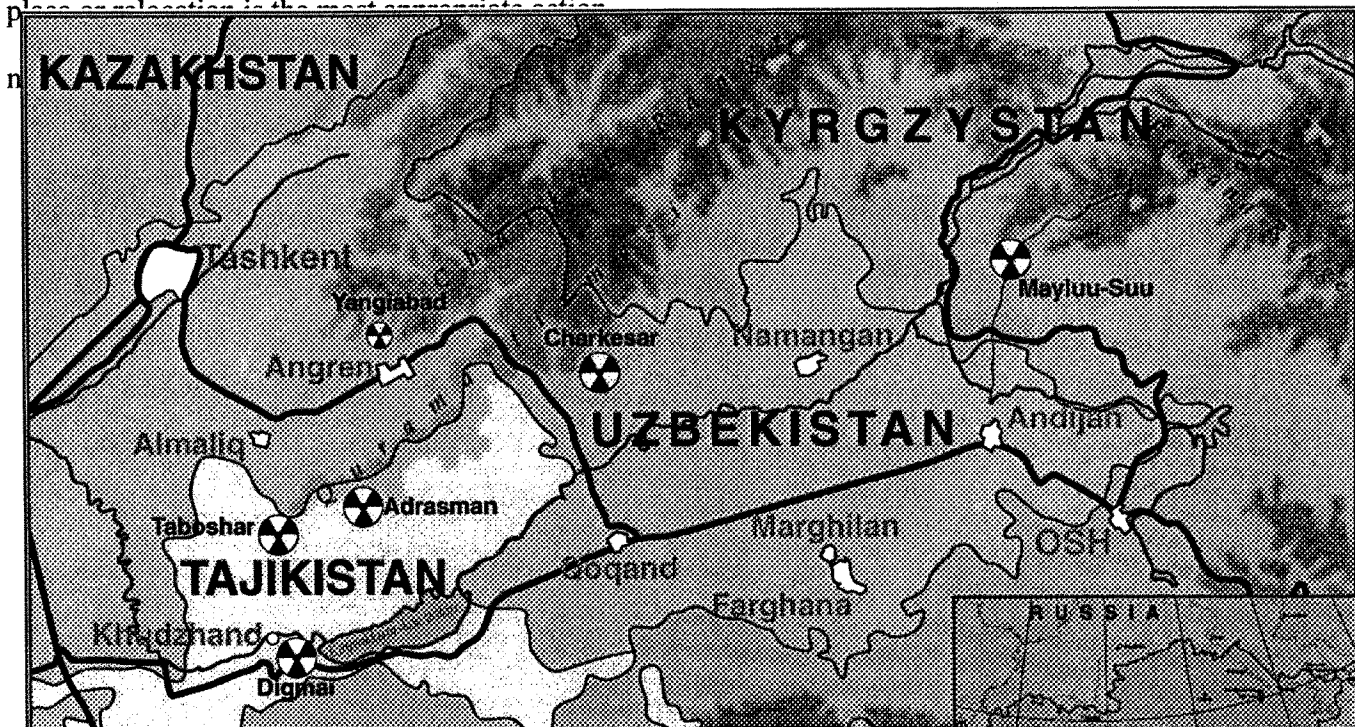


Figure 7. The hazardous location of tailings 3 with the Mailuu-Suu River and road in the foreground. Tailings pile 3 contains approximately 60% of the total radioactivity at Mailuu-Suu. Photo is from "Radiation Ecology of Mailuu-Suu," by Yu.G.Alioshin, I.A.Torgoev and V.A. Losev. Ilim Bishkek. 96pp. (in Russian). ISBN 5-8355-1119-1.

4 TRANS-BOUNDARY ISSUE

Mailuu-Suu tailings piles are located entirely in Kyrgyzstan but have a trans-boundary nature. With

Figure 8. Photo taken from tailings 5 looking out at a narrow section of the Mailuu-Suu river. A blockage of the river at this point could result in flooding of tailings 5 and 7. Photo courtesy of Gerhard Schmidt, Heppenheim/Germany, copyright 1997.



stream and Kazakhstan is the downstream riparian area (Weinthal 2002). In the past, contaminants deposited in downstream countries have added to existing tensions over upstream water management (Carius et al. 2003a). The political and socio-economic stability of the region could be compromised by displacement of tailings into the Mailuu-Suu River, sending radioactive material into the densely populated Fergana Valley.

Although the Fergana Valley spans only 5% of Central Asia, 20% of the total population lives in the region (Carius et al. 2003b). The Fergana Valley is also one of the most ethnically diverse regions in Central Asia. The high population density and ethnic tensions have contributed to sometimes-violent disputes (Anderson 1999). Analysts believe increased conflict in the region may result as people are forced to compete for limited, over-stressed resources (Tabysheva 1999).

The trans-boundary environmental threat posed by Mailuu-Suu tailings can be considered an opportunity to promote good neighborly relations between Kyrgyzstan, Tajikistan and Uzbekistan. Mailuu-Suu is only one of six major uranium tailings sites in and around the Fergana Valley (Fig. 9). Successful development of technical and management capabilities that lead to the remediation of Mailuu-Suu tailings can serve as a model for other sites.

5 ENVIRONMENT & SECURITY

Environmental degradation is often a catalyst for conflicts rather than the direct cause (Conca 2002). Stress to the environment can intensify social cleavages and political crises, exposing national and international security to substantial risk. Working together to solve these mutual problems can help reduce doubt, suspicion, divergent interests, and short sightedness.

Internationally, environmental cooperation is being recognized as a valuable asset for promoting constructive relations with the ultimate goal of extending these partnerships to other areas. A few of the programs aimed at addressing environmental security in Central Asia have been implemented by the Organization for Security and Cooperation in Europe (OSCE), the United Nations and the United States.

In 2002, the United Nations Economic Program (UNEP), the United Nations Development Program (UNDP) and the OSCE launched the Environment and Security Initiative. This project seeks to understand the interconnections between environment and security (Carius et al. 2003a). Central Asia was chosen for a pilot study due to the complexity of environmental and socio-economic issues that together may destabilize the region. The UNEP, UNDP and

ENVIRONMENTAL NATIONAL LABORATORY under the DOE initiated a program to facilitate cooperative science and technology programs that will reduce environmental stresses in Central Asia (Rosenberg 2002). The project goals are to produce engineering designs, develop management strategies and pursue international donor support. The initial report titled, "Multilateral Approach to the Priority Issues at Mailuu-Suu: 1-Background Information", roughly quantifies the risks to human health at Mailuu-Suu by comparison to UMTRA sites. The assessment shows Mailuu-Suu to be a greater risk than any U.S. uranium tailings site.

6 UMTRA

Neither the Soviet Union nor the United States had a thorough understanding of the consequences of the growing waste piles generated from their aggressive mining operations. In both countries the exposed tailings were often placed on the banks of major rivers, susceptible to flooding, and close to population centers. In Kyrgyzstan and the U.S. the tailings were at times used as construction material (U.S. DOE-EM 1999 & Vandenhove et al. 2000).

In 1978, the United States Congress passed the Uranium Mill Tailings Radiation Control Act (UMTRCA), which designated 24 inactive uranium mill sites and vicinal properties for cleanup (Public Law 95-604, November 8 1978, 92 Stat. 3021; 42 USC § 7901 *et seq.*). The DOE, through the Uranium Mill Tailings Remedial Action (UMTRA) project, was given responsibility for reducing levels of contamination in the surface water and groundwater at the sites. The UMTRA program consisted of two separate projects, the surface project and the groundwater compliance project. The surface project was completed in 1999 while the groundwater project is ongoing.

The cleanup was a cooperative effort between the Federal government, State governments and Indian tribes. Under the act, the Federal government paid 100% of the assessment costs and 90% of the remedial action costs, while the affected state paid the remaining 10% for remediation. The Federal government paid 100% of the cleanup costs for sites on Indian land. Two sites in North Dakota were delisted as no-action sites.

Tailings were either stabilized in-place or excavated and relocated to isolated disposal sites. During the 20-year project, more than 33 million m³ of material was stabilized in-place and significant quantities of tailings were relocated to disposal sites (U.S. DOE-EM 1999). Over 5,000 vicinal properties underwent rehabilitation due to the spread of radioactive tailings.

In comparison, the total radioactivity associated with any single UMTRA site is less than 3,000 Ci.

The 1999 UMTRA End-of-Project report estimates that 1,300 deaths were prevented by reduction in radon and radiation exposure over the next 100 years. When considering volume, total radioactivity and proximity to population centers, an estimated 600 deaths will be prevented by taking remedial actions at the Mailuu-Suu site.

Cost estimates for clean-up activities at Mailuu-Suu vary widely from \$12 million to \$50 million dollars. Total cost for remediation of 22 sites was approximately \$1.5 billion dollars (U.S. DOE-ID 2002).

7 PROGRESS

A lack of funding prevents the newly formed state from conducting a thorough characterization at Mailuu-Suu. The Prime Minister of Kyrgyzstan acknowledges the need for assistance in solving the Mailuu-Suu crisis, recognizing that Kyrgyzstan is in no position to protect the ecological security of the entire region (OSCE 2003).

The regional nature of Mailuu-Suu has drawn much attention from international organizations in the recent past. Assessment activities have been conducted by organizations such as the World Bank, the EU and the Belgian Nuclear Research Center.

A recent EU-TACIS funded study to assess the actual risks associated with the tailings has included food, soil and water sampling. Feasibility studies to determine the best rehabilitation approaches to the highest priority impoundments are being conducted (Vandenhove et al. 2002). The gamma monitoring results showed that a person at the point of maximum exposure for 2 hours a day would receive an external dose rate greater than 1 mSv/yr at tailings 3,4,5,13 and 18. The study concluded that tailings 13 and the associated waste rock dump were in immediate need of fencing due to a dose rate of 13.62 mSv/yr, under the above conditions.

In April 2003, over 60 experts attended a scientific assessment meeting to form an international task force focused on the Mailuu-Suu site and how best to proceed. A key conclusion reached by the forum was the need to construct a database to compile the increasing amount of environmental and geological information pertaining to the Mailuu-Suu site.

In addition, the World Bank announced their intent to allocate \$5 million to address Mailuu-Suu tailings issues. The World Bank is on a funding track to commence rehabilitation work of the highest priority elements in 2004.

8 CONCLUSIONS

Government officials in Kyrgyzstan, Tajikistan and Uzbekistan identify the Mailuu-Suu tailings as an environmental threat that must be addressed. The trans-boundary nature of Mailuu-Suu tailings is an opportunity to promote environmental cooperation between these Central Asian states. The partnerships developed through rehabilitation of Mailuu-Suu tailings can be carried over to similar sites in the region and into other areas. Management experience and technical information gained from cleanup of UMTRA sites in the U.S. will assist in the progressing toward remediation at Mailuu-Suu.

Avoidance of emergency scenarios requires that rehabilitation of tailings move forward as quickly as possible. These newly formed states require assistance implementing trans-boundary projects such as Mailuu-Suu.

9 ACKNOWLEDGMENTS

This work was performed under the auspices of the U. S. Department of Energy by the University of California, Lawrence Livermore National Laboratory under Contract No. W-7405-Eng-48.

Special thanks to Gerhard Schmidt for permission to use of his tailings map and photographs and to Nurlan Djenchuraev and Hildegard Vandenhove for their assistance and commitment to addressing the issues at Mailuu-Suu.

REFERENCES

- Alioshin, Y. G., Torgoev, I.A. & Schmidt G. Environmental Risk Management at Uranium Tailings Ponds in Mailuu Suu, Kyrgyzstan. 2002. In Markel et al (eds), *Proceedings of the International Conference on Uranium Mining and Hydrology III and the International Mine Water Association Symposium, Freiberg, 15-21 Sept 2002*. Berlin: Springer.
- Karimov, I. 1997. *Uzbekistan on the Threshold of the Twenty-First Century*. London; New York: RoutledgeCurzon.
- Toralieva, G. 2002. Kyrgyz Officials Fear Radioactive Spill. Kabar News Agency. 12 May 2002. Bishkek: Kyrgyzstan.
- Knapp, R.B. & Rosenberg, N. 2003. Multilateral Approach to the Priority Issues at Mailuu-Suu: 1-Background Information. *UCRL-ID-151949*. Livermore: LLNL, U.S. Department of Energy.
- Bunnenberg, C. 2000. Management of Radioactive Wastes. In *Environmental Performance Reviews Series No 9: Kyrgyzstan*. pp 51-67. Geneva: United Nations – Economic Commission for Europe.
- Djenchuraev, N. 1999. Current Environmental Issues Associated with Mining Wastes in Kyrgyzstan. *MSc Thesis*. Budapest: Central European University.
- TICP-Media Focus. 2003. The EU, Kazakhstan & Kyrgyzstan.

- Knapp, K.E., Richardson J.H., Rosenberg N., Smith D., Thompson A.F.B., Sarnogor A., Duisebayer B., Janecky D. 2002. Radioactive Tailings Issues in Kyrgyzstan and Kazakhstan. In *Proceedings of Tailings and Mine Waste '02, Fort Collins, 27-30 Jan 2002*. Rotterdam: Balkema.
- Torgoev, I.A., Alioshin, Y.G., Losev, V., Havenith, H.B., & Jongmans, D. 2001. Geophysical Prospecting as Monitoring Tool of Landslides and Uranium Waste Dumps in Maily-Say, Kyrgyzstan. *European Geophysical Society. XXVI General Assembly, Nice, 26-30 March 2001*. European Geophysical Society, Nice: France
- Boettcher, G. 2003. Personal Communication.
- Kabar News Agency. 2002. Landslides Again in South Kyrgyzstan. 13 May 2002. Bishkek: Kyrgyzstan.
- Schmidt, G. 1997. Anlagenzustand und radiologische Bewertung der früheren Urangewinnungsanlagen am Standort Mailii Su (Kirgisistan). Institute for Applied Hydrology, Darmstadt: Germany.
- Weinthal, E. 2002. The Promises and Pitfalls of Environmental Peacemaking in the Aral Sea Basin. In K. Conca, & G.D. Dabelko (eds), *Environmental Peacemaking*. pp 86-119. Washington D.C.: Woodrow Wilson Center Press.
- Carius, A., Feil, M., Switzer, J., Rekacewicz, P., Rucevska, I., Sevaldsen, P., Simonett, O., Kluser, S., Del Pietro, D., & Witt, R. 2003a. Environment and Security: Transforming Risks into Cooperation- The Case of Central Asia and South Eastern Europe. UNEP, UNDP, OSCE.
- Carius, A., Feil, M. & Tänzler, D. 2003b. Addressing Environmental Risk in Central Asia. UNDP/Regional Bureau for Europe and the CIS. Berlin: Germany.
- Anderson, J. 1999. *Kyrgyzstan Central Asia's Island of Democracy?*. Amsterdam: Harwood Academic Publishers.
- Tabyschalieva, A. 1999. The Challenge of Regional Cooperation in Central Asia: Preventing Ethnic Conflict in the Fergana Valley. Washington D.C.: United States Institute for Peace Press
- Conca, K. 2002. The Case for Environmental Peacemaking. In K. Conca, & G.D. Dabelko (eds), *Environmental Peacemaking*. pp 1-22. Washington D.C.: Woodrow Wilson Center Press.
- Rosenberg, N. 2002. Science and Technology to Advance Regional Security in Central Asia. *UCRL-JC-147631*. Livermore: LLNL, U.S. Department of Energy.
- U.S. Department of Energy- Environmental Restoration Division. 1999. Uranium Mill Tailings Remedial Action Surface Project 1978-1999, End-of Project Report. *DOE/AL/62350-500*. Report prepared by Jacobs Engineering Group, Inc. Albuquerque: New Mexico.
- Vandenhove, H. Vandecasteele, C.M. & Collard G. 2000. Conclusions and Recommendations of the SCOPE-RADSITE Workshop on Remediation Achievements After Uranium Mining and Milling. September 2000. Munich: Germany.
- U.S. Department of Energy- Idaho Operations Office. 2002. Strategic Plan- 2002 and Beyond, U.S. DOE *02-GA50438*. Idaho Falls: Idaho Operations Office, U.S. Department of Energy.
- OSCE Online 2003. OSCE Meeting Focuses on Acute Danger
- Vandenhove, H., Collard, G., Quenec'h, J., Vandecasteele, C., Imanakunov S., Naravagov A., Savosin M, Torgoev I., Mirzachev M., Mombekov O., Zeevaert, T., & Vanmarcke H., Mailuu-Suu Tailings problems and options for remediation. 2002. In Markel et al (eds), *Proceedings of the International Conference on Uranium Mining and Hydrology III and the International Mine Water Association Symposium, Freiberg, 15-21 Sept 2002*. Berlin: Springer.