

Building Networks of Trust through Collaborative Science

Livermore researchers are spearheading projects with foreign colleagues to help bridge cultural differences and strengthen regional security, trust, and scientific expertise.

PROGRESS in science and technology is readily acknowledged for dramatically improving human health and increasing standards of living. However, science and technology can also serve as powerful tools for advancing regional security and building a network of trust among nations. Lawrence Livermore scientists are using science- and technology-based cooperative projects as a means of helping foreign colleagues work together to curb nuclear smuggling, understand earthquake hazards, prepare for disasters, and prevent massive environmental damage.

“We want to foster communication among scientists in two regions that are of particular concern for nuclear proliferation—Central Asia and the Middle

East,” says Jay Zucca, a leader in Livermore’s Proliferation and Terrorism Prevention Program, which is part of the Nonproliferation, Arms Control, and International Security (NAI) Directorate. “Science and technology can build bridges between nations and cultures while serving the societies in them.” By engaging scientists in young or unstable nations or troubled regions, these collaborations can help foster openness, make the region more attractive to outside investment, prevent the proliferation of weapons of mass destruction (WMD), and reduce the influence of terrorist groups.

Livermore-led collaborative projects are supported by U.S. and European government agencies, the United Nations, the World Bank, and private organizations.

The projects bring together scientists in a geographic region to work on high-priority technical issues that cross national boundaries. In many cases, the projects are the first time scientists from the different nations have worked together. About a dozen employees from Livermore’s NAI, Chemistry and Materials Science, and Energy and Environment directorates participate in the collaborations. The

A village elder (back to camera) discusses water needs with (from left) Livermore scientists Jeff Richardson and Andy Tompson and an interpreter. The group is standing over a well that supplies briny water. In the background (upper left, p. 4), a cistern holds the village’s water, which is currently supplied by truck.



majority of work is done by regional participants, thereby strengthening the area's science and technology.

Geophysicist Richard Knapp, who heads Livermore's work in Central Asia, notes that U.S. preeminence in science and technology is highly regarded in the region. Because of this widespread admiration, American scientists can assist U.S. policy goals in Central Asia and the Middle East by helping to bridge cultural differences, thereby easing regional tensions.

Knapp notes that projects headed by Livermore employees earn high marks from the collaborators because Laboratory scientists are experts in their fields and are interested in true collaboration. "We don't just bring knowledge," he says. "We ask

questions, listen, show respect, and work with them as partners."

Central Asia Pivotal

Many projects are sited in Central Asia. Funding comes from the U.S. departments of State, Defense, and Energy, and partners include the World Bank, the Organization for Security and Co-operation in Europe (OSCE), and the International Atomic Energy Agency. Many Central Asian science institutes and government agencies also participate in these collaborations.

Central Asia is a region of 60 million people. Throughout history, it has served as a center for transporting goods between Europe and Russia to the north, the Middle

East and South Asia to the south, and China to the east (where the ancient Silk Road is one of the world's oldest trade routes). The region remains a nexus through which illicit trade in drugs, conventional arms, and potentially WMD can flow. Since the terrorist attacks of September 11, 2001, Central Asia has become particularly important to U.S. counterterrorism and nonproliferation efforts because it shares borders with Afghanistan, Iran, Pakistan, Russia, and China.

Central Asian nations generally have developing economies, uncertain internal stabilities, and poor relations with each other. Political instabilities in this area could lead to conflicts involving militant factions, proliferation of WMD, and civil war. "Afghanistan is an example of a state that was failing," says Livermore geochemist Nina Rosenberg. "It shows that we can't afford to ignore the nations of Central Asia."

Livermore's objectives in Central Asia are to help reduce the flow of illicit nuclear materials, enhance regional stability, and build regional technical cooperation. "Through our work, we helped lay a foundation of respect and trust across the region," says Rosenberg. She notes that although the region's science and technology infrastructure has suffered since these nations gained their independence more than a decade ago, scientists are still influential at high levels of government.

Detecting Nuclear Materials

Laboratory researchers have been working with Uzbekistan because of its central location. For example, they are providing the technology and training needed so Uzbek personnel can prevent the smuggling of nuclear materials and people across its borders. Since 1998, the Uzbekistan Customs Services, Border Guards, Institute of Nuclear Physics, and Ministry of Defense have collaborated with a Livermore team to install an integrated, national system of radiation portal monitors



Central Asia is important to U.S. counterterrorism and nonproliferation objectives because the region shares borders with Afghanistan, Iran, Pakistan, Russia, and China. (Courtesy of the University of Texas Libraries, University of Texas at Austin.)

at the international ports of entry. In addition to Knapp, the project team includes Jeff Richardson, who leads Livermore's Proliferation and Terrorism Prevention Program, and scientists Arden Dougan, Dave Herr, and Stan Erikson. The project is supported by the U.S. Defense Threat Reduction Agency's (DTRA's) Weapons of Mass Destruction Proliferation Prevention Initiative.

The Livermore and Uzbek team prioritized the Uzbek ports of entry and installed pilot monitoring systems in four high-priority international ports of entry: those on the borders with Kazakhstan, Afghanistan, and Turkmenistan and one at the Tashkent International Airport. The team also trained Uzbek customs personnel on using this equipment to detect nuclear smuggling. The portal monitors detect gamma and neutron radiation from shipping containers, vehicles, and objects carried by pedestrians. Radiation levels exceeding a set threshold activate an alarm. The portal monitors also provide continuous video surveillance. Officials at the national Uzbek command center can check the

status of every detector and follow any incident over video monitors.

Using the pilot systems, Uzbek officials intercepted two illicit shipments of radiological materials. With funding from DTRA, the project is expanding to include all 41 ports of entry. Other Central Asian nations are considering nuclear detection systems similar to those in Uzbekistan. Detectors are also being installed in Russia and Kazakhstan under a Department of Energy– (DOE-) funded program called the Second Line of Defense.

The U.S. Central Command (CENTCOM) is an important Department of Defense partner in Central Asia and provides funding for Livermore's work in the region. Since 2001, Rosenberg and Knapp have provided technical advice, given talks, and cochaired panels at CENTCOM's annual Central Asia States conferences. At a recent conference, participants discussed applying technical expertise and equipment for monitoring WMD materials to prevent cross-border trafficking in drugs, terrorists, and conventional weapons. Conference

participants also considered different approaches to integrate WMD experts more fully into civilian research and teaching at universities.

Preventing Environmental Disasters

One common concern for the nations in Central Asia is threats from environmental disasters that could potentially affect regional stability. For example, during the Soviet era, this region was an important source of uranium ore. Uranium mine tailings—the radioactive and toxic waste from past mining operations—are common throughout the region and threaten human health and the environment. The threat is especially acute in the Fergana Valley, a region that includes significant parts of Kyrgyzstan, Uzbekistan, and Tajikistan. The Fergana Valley is a politically unstable area and has been a center of Islamic extremism. The area is densely populated, and unemployment is high, which further contribute to the instability.

The former Soviet uranium mining site at Mailuu-Suu in Kyrgyzstan, near the Uzbekistan border, has the highest priority.



A Livermore team has been working with Uzbek officials to install an integrated, national system of radiation portal monitors at international ports of entry. (a) Vitaliy Petrenko, from Uzbekistan's Institute of Nuclear Physics, walks by a pedestrian radiation portal monitor at the Gisht-Kuprik port of entry, which is just north of Tashkent on the border with Kazakhstan. (b) A truck leaving Uzbekistan drives by a radiation portal monitor at the Alat port of entry, which is on the border with Turkmenistan and is a major route to Iran.

The site includes 23 impoundments of radioactive debris that are precariously poised on the banks of the Mailuu-Suu River. The area is prone to huge landslides, and a landslide involving the tailing wastes could threaten the health and livelihoods of millions of people in three nations.

Rosenberg helped create a database of historical information to support rehabilitation efforts at Mailuu-Suu. A series of workshops in 2003 was cosponsored by Kyrgyzstan, OSCE, and Lawrence Livermore. The workshops were attended by senior government and technical officials from Kyrgyzstan, Tajikistan, Uzbekistan, Kazakhstan,

Russia, Germany, and the U.S. and from international organizations. One attendee was from the Ministry for Atomic Energy of the Russian Federation. Says Knapp, “For the first time, the ministry opened its Cold War files about Mailuu-Suu.”

A workshop in October 2003 in Bishkek, Kyrgyzstan, pioneered a new climate of cooperation. During the workshop, the Bishkek Declaration was signed by regional and international representatives promising to cooperate on common uranium legacy issues. The declaration also created a steering committee, of which Knapp is a founding member. The Laboratory’s efforts helped

bring about a \$12-million grant from the World Bank and other organizations to increase the safety of the Mailuu-Suu uranium tailings.

The steering committee met again in September 2004 in conjunction with a workshop on “The Fergana Valley: Key Technical Legacy Issues,” which was sponsored by Livermore (with DOE funding) and the Embassy of the Republic of Uzbekistan in Washington, DC. The committee met with regional ambassadors and U.S. government agency representatives, who agreed that the uranium legacy issues in Tajikistan posed a great threat to the Fergana Valley. As a result,

This uranium mill tailings impoundment at Mailuu-Suu, Kyrgyzstan, on the banks of the Mailuu-Suu River, is one of 23 such impoundments in the Mailuu-Suu Canyon. The canyon is prone to massive landslides (in background), and the river flows into the Fergana Valley, about 25 kilometers downstream.



the World Bank is considering expanding its program at Mailuu-Suu to Tajikistan, with Livermore help.

Expanding Efforts

Livermore leads another Soviet legacy project, Kaji-Say, a uranium tailings impoundment on the shores of Issyk-Kol, a large freshwater lake of great economic and spiritual importance to Kyrgyzstan. Livermore experts are advisors to a project, funded by the State Department through DOE, to protect the lake from radioactive contamination. The project is also designed to demonstrate the technical expertise of Kyrgyz scientists and help them develop Western-style project management skills.

In addition, Livermore has a partnership with Kazatomprom, the Kazakhstan national company that supplies uranium fuel to nuclear power plants in Europe and Asia. Laboratory hydrologist Andy Tompson is advising environmental managers at the Ulba Metallurgical Plant, which was once part of the Soviet nuclear weapons complex but, since 1997, has been part of Kazatomprom. The plant stores nuclear and beryllium wastes in slurry form in lined ponds. In 2004, a team of chemists from Kazatomprom visited the Laboratory to confer on computer techniques for modeling the waste situation and to study Livermore's pump-and-treat methods of cleaning contaminated groundwater.

Tompson is also advising scientists studying the migration of radionuclides that remain after decades of nuclear tests at Semipalatinsk, the former Soviet test center in Kazakhstan. "We share our experiences about studying similar nuclear transport issues at DOE's Nevada Test Site and at the proposed Yucca Mountain nuclear waste site," says Tompson. "We also learn from their experiences."

No Boundaries for Seismic Activity

Central Asia is among the most seismically active regions on Earth. In the

last 50 years, the region has suffered several devastating and economically debilitating earthquakes. Livermore seismologist Eileen Vergino says, "The political, economic, and life disruptions and damage caused by earthquakes are of grave concern for this region."

To help address those threats, Livermore scientists are participating in the Central Asia Seismic Risk Initiative (CASRI). The initiative's focus is assessing seismic hazards and mitigating risks in Central Asia through scientific cooperation. CASRI is modeled after the highly successful Caucasus Seismic Information Network project, of which Livermore is a partner. Says Vergino, "Through CASRI, we are expanding the cooperative work we are doing in the Caucasus to Central Asia."

CASRI's goal is to have regional scientists share seismic, geologic, and geophysical data and develop regional hazards models. The scientists will use

these models to advise their governments on the best ways to mitigate the effects of a damaging earthquake. Another key goal is to help educate a new generation of seismic experts in the area.

The Middle East and Arabian Gulf are the focus of cooperative seismology projects that promote understanding among regional nations, including Israel. A strong collaboration between Livermore and the U.S. Geological Survey (USGS) makes possible conferences, data exchanges, and seismic tests and helps strengthen national seismic networks. The results include improved assessment of earthquake hazards, revised building codes, and better construction methods. The U.S. also obtains data for improved seismic models to support its goals in monitoring compliance with nuclear arms agreements.

Livermore seismologist Keith Nakanishi points out that seismology is inherently an international science because seismic waves



This dinner was hosted by the Kyrgyzstan Minister of Ecology and Emergencies to celebrate the signing of the Bishkek Declaration in October 2003. The dinner was attended by the Tajikistan Minister of Industry, ministerial representatives from Uzbekistan and Kazakhstan, and technical representatives from Russia, Germany, Kyrgyzstan, and Lawrence Livermore.

do not stop at political boundaries. As a result, he says, “Concern about seismic hazards catalyzes regional cooperation.”

Cooperation between countries is crucial in better defining the effects of earthquakes and in determining an area’s geologic structure. By measuring seismic waves and studying those data, scientists can determine the earthquake mechanism that generated the seismic signals, the location of the earthquake, and the physical properties of the geologic media through which the waves pass. This information can be used to mitigate the effects of damaging earthquakes, better define the location of subsurface faults, and recognize areas that are prone to earthquake damage.

Nakanishi says that in the Arabian Gulf region, Saudi Arabia, Kuwait, and Oman have high-quality seismic networks, but other nations have sparse networks—or none at all—and do not share data. Livermore is helping build a virtual regional data network that combines national technical resources so seismic researchers can electronically share data following an earthquake.

Meetings are held in the eastern Mediterranean region under United Nations sponsorship and are open to all regional participants, including Israel, Arab nations, Turkey, Cyprus, and Iran. Topics include group analysis of seismic data and discussions of mitigating effects from damaging earthquakes. (See *S&TR*, March 2000, pp. 21–23.)

Working with United Arab Emirates

Two earthquakes and many aftershocks struck the northern part of the United Arab Emirates (UAE) in early 2002. Because no national seismic network exists, no local seismic data were recorded. In May 2003, a Livermore team led by Arthur Rodgers deployed two Livermore seismic stations in the UAE as part of a joint research project on seismology with the United Arab Emirates University. Data collected by these stations are helping scientists at the university and Livermore to understand the Earth’s crust in the northern Emirates. “We hope this effort will be the first step toward developing seismologic expertise in the UAE and forming a foundation for a national seismic network,” says Nakanishi.

Livermore, the USGS, and the University of Sharjah in the UAE organized the first Gulf Seismic Forum, which was held at the university in February 2004. More than 90 participants attended from throughout the region, Canada, South Africa, Switzerland, Turkey, the United Kingdom, and the U.S.

Trips to Oman and Qatar have led to a potential expansion of seismic cooperation in the Gulf region. While Oman has a modern seismic network, Qatar has only a small network and little analysis capability. However, Qatar is important in monitoring seismicity in the Gulf region. Livermore is therefore proposing to work with Qatar on advanced data processing procedures.

Livermore researchers are also helping Iraq to rejoin the regional seismic community. “Iraq has a long tradition in seismology, and Iraqi seismologists are well trained,” says Nakanishi. The nation installed and operated the first seismic network in the Arab world. Three stations are still in operation. Livermore is collaborating with the Earthquake Center at the University of Arkansas at Little Rock to preserve Iraqi seismic data recorded during the past 20 years.

In addition to the work on earthquakes, Livermore is collaborating with the Gulf



Livermore seismologist Arthur Rodgers checks on a seismic station erected at Al Hayl, United Arab Emirates, as part of a joint project between the Laboratory and United Arab Emirates University. The enclosure contains seismic equipment powered by the solar cell to the left.

Cooperation Council (GCC) nations of Qatar, UAE, and Kuwait to enhance the council's ability to respond to an act of terrorism involving WMD. This project, which has funding from DOE's National Nuclear Security Administration, assesses current GCC national and regional capabilities and evaluates personnel training. As part of this effort, Livermore scientists from the National Atmospheric Release Advisory Center are working with the GCC to plan responses to different scenarios involving WMD and to train personnel as emergency responders. The Laboratory hosted a workshop on radiological emergencies for Qatar experts in December 2004. Livermore experts are also working with colleagues in Dubai on techniques to detect WMD smuggling through its ports.

The Common Problem of Water

Water issues are common to every nation in the Middle East and Arabian Gulf. "Water problems are acute and are transboundary," says Tompson. "Supplies are not adequate for the large and growing populations of the area." In addition, water issues can be complex and invite distrust among nations.

Middle East water experts have attended Livermore-sponsored workshops in Amman, Jordan, and in Livermore. Tompson says it is especially gratifying to see Israeli, Jordanian, and Palestinian scientists working together. "The name of the game is building relationships," says Tompson. "It's the foundation for everything we do."

Tompson participated in an effort to test a solar-powered, portable desalinization unit that would improve the quality of water supplies in Middle Eastern villages. Many village wells are salty either because they are close to the ocean or because of the geochemical nature of the aquifer. Water treated by portable desalinization devices could be stored in cisterns and the

neighboring villages could share the equipment.

Livermore experts are collaborating with a group of Israeli and Palestinian scientists who are studying water taken from the Jordan River. "The goal in this project is to understand how groundwater and surface water are interacting," says Tompson. "For example, if I drill a well near the Jordan River, am I lowering the river's water level?"

Tompson, in collaboration with the Jordanian Ministry of Water and Irrigation, Jordan University of Science and Technology, and the Royal Society for Conservation of Nature, has visited Jordan many times since 1998 to help people understand the workings of groundwater.

One focus of his visits is Jordan's Azraq Basin. A well-known oasis is located at the basin's topological low point and, thus, has traditionally enjoyed high groundwater levels, springs, and verdant wetlands. However, the increased drilling of water wells in the basin is starting to dry up the oasis. A Livermore team built tabletop models to illustrate how groundwater levels and well drilling are interconnected. These models were copied by the Jordanians and are now being used by students and government agencies.

With Livermore support, a Jordanian college student working on her master's degree developed a simplified version of a Livermore supercomputer program that simulates groundwater movement. The



Dignitaries at the opening session of the Gulf Seismic Forum included Sheikh Sultan bin Mohammed bin Sultan Al Qasimi (center front, in gold robes), the Crown Prince and Deputy Ruler of Sharjah, United Arab Emirates; Major General Mohammed Salim Kardous Al Amri (on the Crown Prince's right, in uniform), director general of the Directorate of Civil Defence at the Ministry of Interior; and Ismail Al Bishri (on the Crown Prince's left), the chancellor of the University of Sharjah. At the far right is Livermore seismologist Arthur Rodgers.

student is currently a Fulbright scholar at the University of California at Berkeley, where she is obtaining a Ph.D. in civil engineering with a specialty in hydrology.

The Laboratory may extend this water effort to Syria. Tompson has met with representatives from the Syrian ministries of education, irrigation, and environment and two Syrian universities to plan future visits and collaborative work. In September 2004, Tompson was one of the first American scientists to visit Libya following the cessation of an international boycott. Under DOE and State Department sponsorship, he attended a workshop on water issues and nuclear medicine.

The seismic and hydrologic work in the Middle East has established a foundation

for other Laboratory efforts. For example, Livermore researchers are working with countries on the Arabian Gulf to address various issues related to radiologic emergencies.

Cooperation in South Asia

Livermore seismic experts are having success in fostering cooperation among South Asian nations. The area has many earthquakes, numerous seismic stations, and good expertise in seismology. Regional meetings, which included participants from both India's and Pakistan's atomic research centers, resulted in agreements for nations to share seismic fault data and to jointly process data from earthquakes that occur along borders.

In October 2003, Livermore researchers participated in a South Asian seismic workshop in Colombo, Sri Lanka, which included participants from China, Iran, Afghanistan, Pakistan, India, Nepal, Bangladesh, and Sri Lanka. Another meeting was held in Bangladesh in September 2004. These meetings focused on collaborative research in mapping earthquake faults and determining earthquake locations along border regions.

"We want to help these nations build a regional seismic fault map," says Nakanishi. "Earthquakes that occur on or near national borders are a particular problem because the stations in one country do not adequately cover the area involved. Data from neighboring countries

Livermore hydrologist Andy Tompson demonstrates to Jordanian students how the water table is affected when wells are drilled.



is needed to give a complete picture of seismic activity. We can't fully understand a region's seismicity if nations don't share seismic data." Yet too often, seismic data are withheld as if they were classified information.

The Sumatra earthquake on December 26, 2004, and the resulting tsunami emphasize the importance of sharing seismic data. Even relatively aseismic countries such as Sri Lanka are vulnerable to the devastating effects from earthquakes. An efficient system that allows countries in the region to exchange data and quickly release warnings to at-risk populations might mitigate some of the danger. Fostering the exchange of information is an important goal of regional cooperation.

Enhanced Stability, More Trust

Knapp notes that nongovernmental agencies are helping to advance regional stability and improve the networks of trust. The ways in which U.S. policy goals in

Central Asia can be strengthened through science and technology were discussed at a February 2003 workshop, which was sponsored by the American Association for the Advancement of Science and Livermore's Center for Global Security Research.

Livermore is also partnering with the Brookings Institution to foster and promote science and technology cooperation between the U.S. and Islamic nations. An Islamic Forum, organized by Brookings and cosponsored by Livermore, is scheduled to take place this month in Doha, Qatar. A follow-on meeting, the Samarkand Dialogues, will be held later this year at the site of a 15th-century observatory in Uzbekistan, and participants are expected from 10 Islamic nations. The forum's theme is how science and technology can bridge the Western and Islamic worlds.

"Livermore researchers are developing networks of trust," says Knapp. Increased

trust through science and technology collaborations benefits the U.S. by reducing regional stress, which might otherwise lead to conditions that promote terrorism or WMD proliferation. As a result, nations enjoy enhanced levels of security, standards of living, and scientific and technological expertise.

—*Arnie Heller*

Key Words: Central Asia, Central Asia Seismic Risk Initiative (CASRI), Defense Threat Reduction Agency (DTRA), earthquakes, Middle East, seismology, South Asia, United Arab Emirates (UAE), uranium processing, U.S. Central Command (CENTCOM), water issues, weapons of mass destruction (WMD).

For further information contact Richard Knapp (925) 423-3328 (knapp4@llnl.gov) or Keith Nakanishi (925) 422-3923 (nakanishi1@llnl.gov).



The mountains south of Bishkek, Kyrgyzstan.