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Russian Data Illuminate World Mapping

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As we enter the information revolution's second decade, one of the simplest requirements for geospatial data users continues to be one of the most vexing—getting good 3-D data. High-resolution imagery users want to orthorectify their products; simulation and modeling folks need digital elevation models (DEMs); and a new wave of users taking advantage of increasingly user-friendly GIS software systems are thrilled to move from 2-D to 3-D presentations. But for users whose territory falls outside the United States—where there are public domain data policies and a fully digitized (often free) national database of large-scale mapping—DEM solutions can be frustratingly expensive, complex or nonexistent. That is, until one considers Russian data.

Throughout the Cold War, American and Soviet military behemoths confronted each other globally. Underlying this confrontation was a quest by each to map the Earth at large scales. While the United States may have prevailed politically with the Berlin Wall's collapse and the USSR's breakup in 1991, the Soviets prevailed overwhelmingly on the cartographic front. Today, the implications are significant for people seeking DEMs.

Soviet Mapping History

Two facts contributed to Soviet supremacy in global mapping: the sheer size of the Soviet Empire, the core of which was Russia itself, and the world-class intellectual traditions of Russian/ Soviet mathematicians, geodesists, physicists and engineers. Covering one-sixth of the Earth's land mass, the Soviet Empire dominated the northern and eastern hemispheres. Once it was mapped, there was comparatively little mapping left to do. The Soviet tradition in the natural sciences provided a conceptual framework for a global approach. Following World War II, Academician F.N. Krasovsky calculated a global spheroid, with a datum set to 1942 Pulkova (just outside Leningrad), which has proved to be stunningly accurate, considering that it was introduced before satellites could confirm his predictions. This was the first modern global geodesic system introduced by anyone, and it's still used today. (The Russians recently

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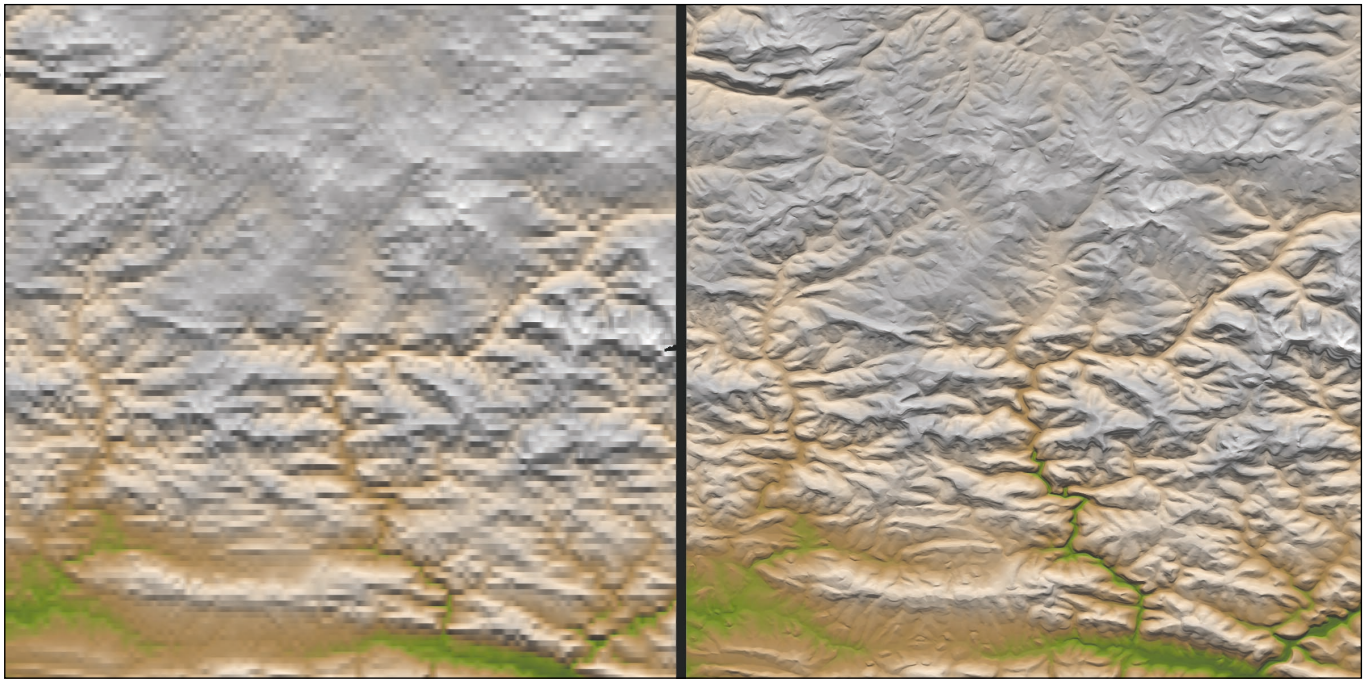

Figure 1. These DEMs were produced from U.S. (left) and Soviet (right) 1:1,000,000-scale source maps.

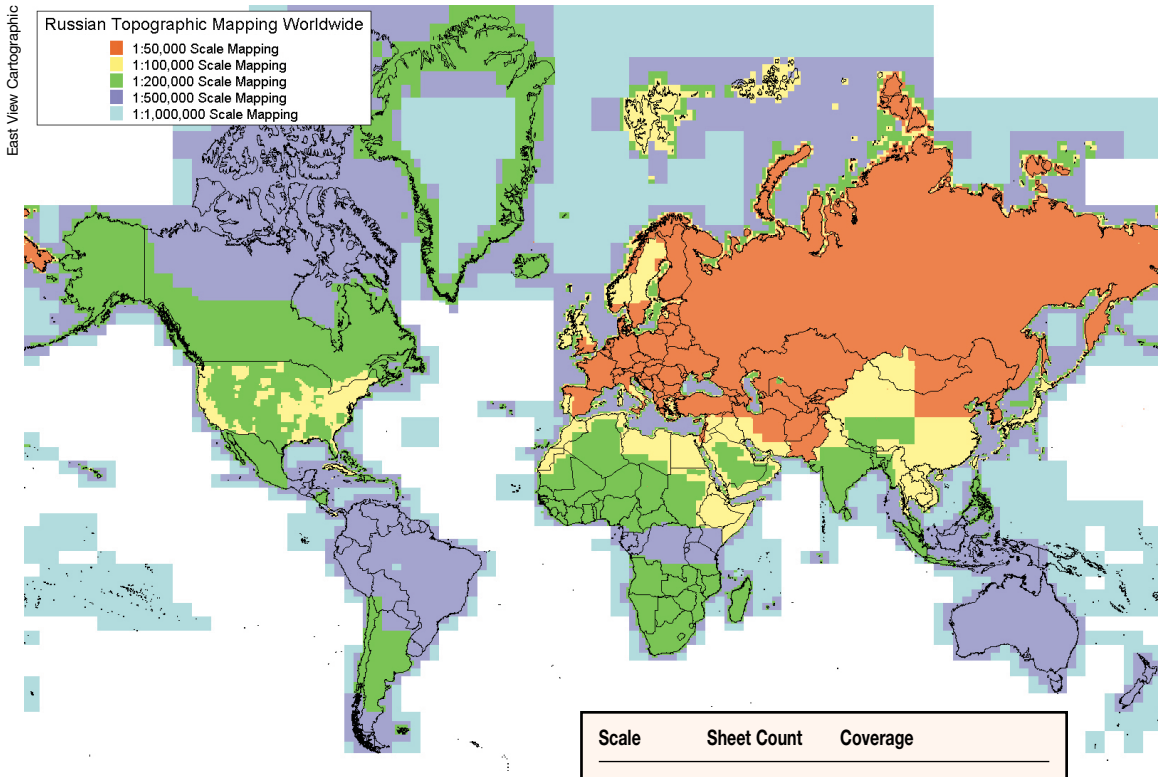

Figure 2. Worldwide Russian topographic mapping.

improved the system with the PZ-90 datum, which will be introduced soon).

Soviet victory in World War II and quick development of the Cold War thereafter expanded the importance of Soviet global topographic mapping. The Soviet Empire grew to encompass Eastern Europe, and communism soon expanded into China. In general, the Soviets took an intense interest in all things global, as decolonization proceeded across Africa and Asia. All these areas were the subject of potential military operations, and all required systematic mapping from Moscow's perspective.

Technology weighed in as well, especially with the Soviet expansion into space. Some Russian generals considered orbiting satellites an ideal remote sensing platform to support large-scale global topographic mapping. The TK-250 system of the 1970s and the TK-350 system launched in 1984 have provided unsurpassed global coverage of stereo imagery to support 1:50,000-scale topographic mapping anywhere on Earth. These TK imagery archives provided the Russians with the photogrammetric basis for modern topographic mapping efforts. It was an imagery asset wholly designed for and dedicated to global topographic mapping, as opposed to military intelligence. As such, it represented a singular achievement in military (or civilian) cartography. The United States never had a satellite program wholly dedicated to cartography.

Methodological differences in cartography and military strategy also played a role. The "Russian school" of cartography invariably begins with large-scale mapping and proceeds step-by-step to smaller-scale mapping. Consequently, there is a carry-over of accuracy and detail that contrasts with more haphazard, less systematic U.S. approaches to global mapping. In the case of elevation data, the result is scale-for-scale Soviet/Russian superiority in accuracy and detail.

Scale	Sheet Count	Coverage
1:1,000,000	1109	Complete
1:500,000	3088	Complete
1:200,000	18,056	Nearly complete
1:100,000	38,783	Nearly complete for Asia, Europe, most of northern Africa and large portions of North America
1:50,000	106,944	Complete for Former Soviet Union and Europe, most of Far East and Middle East
1:25,000	ca. 225,000	Complete for Former Soviet Union and much of eastern Europe

Table 1. Soviet/Russian Global Topographic Mapping

Soviet military traditions gave primacy to ground detail. Essentially, the Russians attack from the ground, and the United States attacks from the air. This essential difference in warfare culture is reflected in respective topographic map quality. Mapping requirements are quite different if you plan to walk/drive over the ground or fly over it at supersonic speeds. The differences are stark when comparing equal-resolution DEMs produced from either side's similar-scale topographic maps (Figure 1).

Soviet Mapping Results

When combined with their domestic mapping—all based on aerial photography but produced to the same specifications as extra-territorial mapping—Soviet topographic mapping covers the world as outlined in Table 1 (Figure 2).

Even though the Soviets won the mapping battle, they lost the Cold War. By the early 1990s, Soviet military mapping was at a comparative standstill, having run out of money and collapsing into bankruptcy like other elements of that society. The central-control collapse resulted in a windfall of bizarre opportunities. Soviet weapons suddenly became available. Soldiers and mid-/high-level officers sold everything from hand grenades to submarines. Soviet military maps were also on the selling block, mostly from large stockpiles in the Baltic states. By 1993, these maps had entered the commercial map trade en masse.

But it took awhile for the maps' significance to be understood. There were so many maps that no one library could buy them all, so their dissemination was piecemeal. Being previously unknown, the maps created suspicion as to their accuracy. Intentional distortions of Stalin- and Brezhnev-era small-scale political administrative maps tainted many people's attitude about map accuracy, especially for DEM creation. The fact that the map text was in Russian didn't help.

Russian Data Enter the Market

With the Cold War over, and the cat out of the bag with respect to cartographic secrecy, the Russians began to take increasingly pragmatic attitudes toward commercialization of geospatial data. The most well-known aspect of this was the 1994 release of KVR-1000 2-meter imagery for commercial sale and the 1998 launch of the Kometa mission with significant civilian-tasked imagery collection efforts (SPIN-2 program). Less known were Russian efforts to provide high-resolution DEMs from the TK-350 archive, as well as a Moscow-sanctioned sale of various geospatial data.

Outside of Russia, the telecommunications industry was building cellular telephone networks in virtually every country. Telecom engineers and network planners soon discovered the advantages of using Soviet topographic maps for their global coverage and exceptional elevation data accuracy. Other advantages also became apparent. First, even in countries with well-developed mapping, such as China, secrecy surrounding domestic maps made them impossible to share with telecom engineers. But Soviet maps were usable. Second, in most Western European countries, the crazy quilt of national copyright and licensing regulations made using public-domain Soviet maps far more expedient. Consequently, DEMs from Soviet maps became an overnight sensation in this market sector. In fact, the 1:200,000-scale series is considered the workhorse of first-generation mobile telephone network planning around the world.

The telecom boom came and went, but it made engineers, service bureaus and numerous end users aware of the utility of DEMs extracted from Soviet sources, maps and stereo TK-350 imagery.

Since September 11, a new global challenge has emerged. While much of the challenge is being met with the U.S. military's own geospatial creations, as a practical matter, most of this imagery remains off limits to commercial use. Yet numerous end-users—news media, United Nations and various humanitarian/development organizations—have a compelling interest in the same territories that are subject to the war on terrorism.


"All the News That's Fit to Print"

The New York Times

WEDNESDAY, DECEMBER 12, 2001

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National Edition

ONE DOLLAR

Man Held Since August Is Accused of Helping In Sept. 11 Terror Plot

Public Is Wary But Supportive On Rights Curbs

AL QAEDA FORCES SET TO GIVE UP; BIN LADEN IS IN 'SHRINKING AREA'

Bin Laden and Al Qaeda

U.S. and Afghan tribal forces

Pakistani troops

KEY

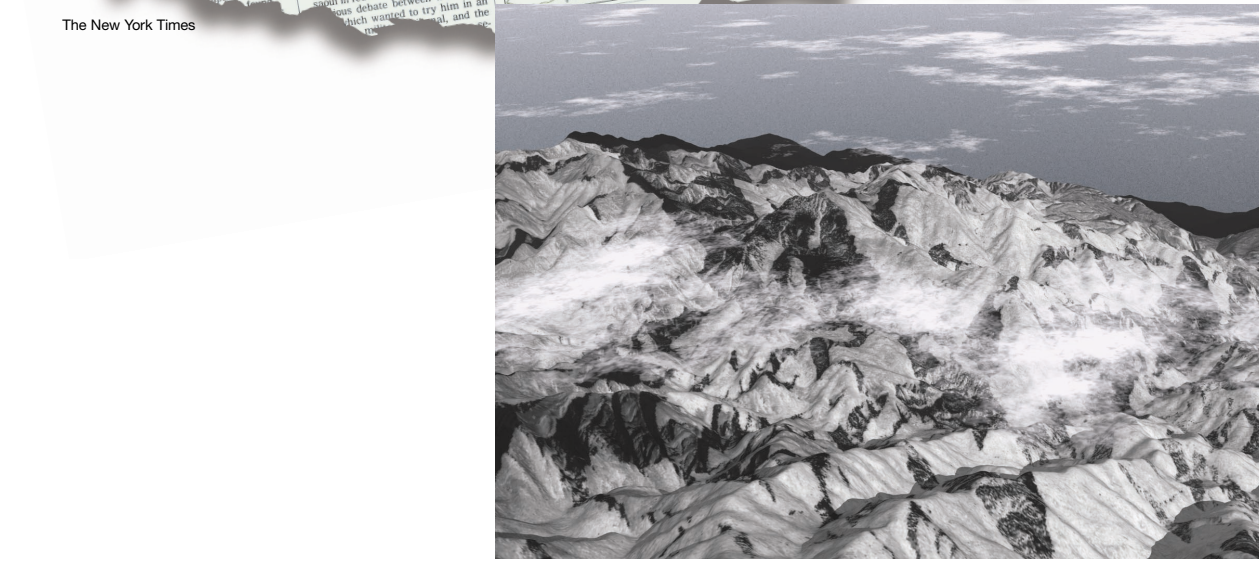
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Figure 3. The New York Times' *front page featured a DEM of Tora Bora, Afghanistan, on Dec. 1, 2001. A rendered image of Tora Bora is also shown.*

East View Cartographic, DigitalGlobe

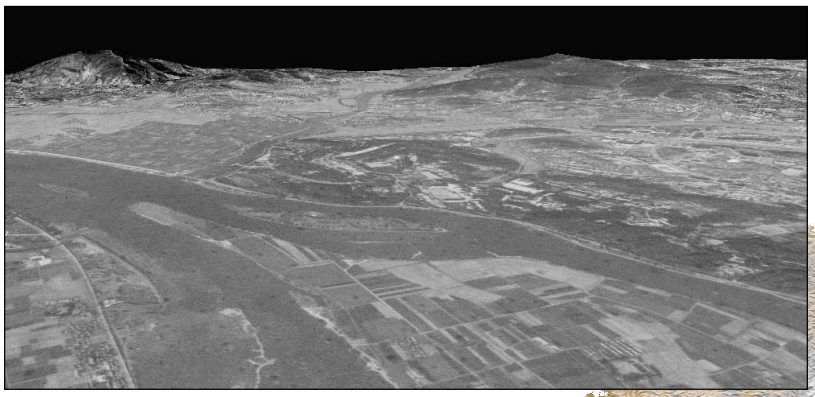

Figure 4. This orthorectified image-draped DEM shows Pyongyang, North Korea.

The rapid organization of Operation Enduring Freedom in Afghanistan provided an exceptional opportunity for Russian DEMs. Afghanistan's extreme terrain was an essential part of the story, with Al-Qaeda and Taliban fighters hiding in caves and other mountainous redoubts. Because the Russians had been active in the country, there was a ready supply of highly detailed 1:50,000-scale topographic maps with 10-meter contour intervals. When digitized, these highly detailed maps sprang to life.

Several battles and assaults dominated the news—the battle for Mazar-I-Sharif, the Tora Bora bombing and attack on Shah-I-Kot. The Tora Bora event was legendary because it was the first time in media history that a DEM was used in a major world newspaper's (*The New York Times*) front-page graphic. As such, it set a new standard in the news graphic design business. Built by East View Cartographic Inc. (EVC, *Minneapolis*) from a 1:50,000-scale Soviet map of Tora Bora, Afghanistan, the DEM passed the tests of time, cost and quick delivery. As a result, the *Times* got the visual scoop (Figure 3).

Currently, the world's attention is focused on Iraq and North Korea (Figure 4). Both are covered by large-scale Soviet mapping and stereo imagery. With the Afghanistan experience so fresh, there's no question that analysts will make good use of Russian DEMs of these new international hot spots.