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JOURNEY THROUGH A DOOMED LAND

Exploring Chernobyl's still-deadly ruins

By Alan Weisman

On May 27 the government of Ukraine reversed its decision to close down Chernobyl's two remaining active nuclear reactors. Defying pressure from its anxious European neighbors, the newly formed republic resolved that its wrecked economy and urgent need for electricity compelled it to operate the plants indefinitely, despite the risk of further damage to its land, water, and people. Such was the level of international concern that immediately after the announcement was made, the Group of Seven industrialized nations placed the matter on the agenda for their summer meeting in Naples.

In the eight years since the deadliest nuclear accident in history, thousands of new safety violations have been reported at Chernobyl. Radiation continues to leak into the surrounding countryside, and cancer rates in Ukraine, as well as in bordering Belarus and Russia, far exceed earlier predictions. The unexpected resurgence of other diseases suggests that human immune systems in the region have been badly weakened. Reports announcing the births of six-legged cows and human children without skulls have also appeared in the press, though their link to Chernobyl is harder to prove. For the most part, these news items have flickered briefly in the papers and disappeared without comment. But reading the news of Chernobyl's latest reprieve on a gray morning at my home in Gloucester, Massachusetts, I recalled a deceptively golden afternoon in northern Ukraine last summer as I leaned on a bridge over the Pripyat River, eight miles downstream from the Chernobyl nuclear power station. I was traveling through the former Soviet Union at the time, in the company of a group of American and local scientists intent upon making a map for survival in an irradiated landscape.

A FISHERMAN ON THE IRRADIATED PRIPYAT RIVER

Below the bridge where I stood, a marsh hawk glided over the willows lining the Pripyat's sandy banks, which flattened into a broad floodplain covered with meadow grass, daisies, and purple lupine. I wandered over to check the list of birds that Kit Larsen, a systems analyst from the University of Oregon, was compiling. He had just added three species of raptors, a black tern, wagtails, stilts, and some mallards to the hooded crows, magpies, and a European goldfinch we'd observed earlier singing in a stand of maples. "It's the best birding I've done in the ex–Soviet Union," he said with a baffled shrug.

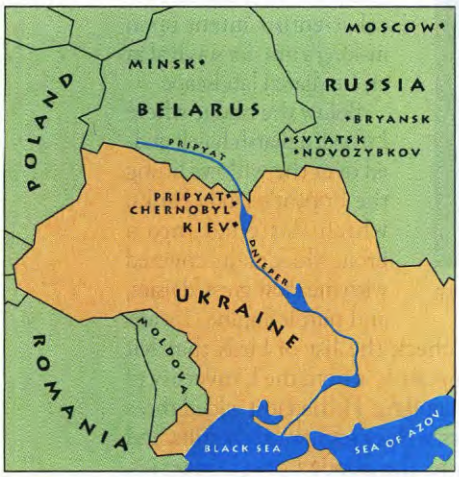
Alan Weisman is a contributing editor of the Los Angeles Times Magazine. *He is currently at work on books about the future of energy and the legacy of his Ukrainian ancestry.*

Photograph by Fabienne Bouville

We couldn't figure it out. A breeze arose; we'd been instructed by our host, Andriy Demydenko, Ukraine's deputy minister of the environment, to close our eyes and hold our breath whenever the wind blew. We'd also been warned not to smell the flowers. The reason for our caution and for our puzzlement at the vibrant wildlife loomed on the horizon. The insistent beeping of our Geiger counters confirmed that swirling invisibly around us was ten times the earth's normal background radiation.

Until April 26, 1986, Chernobyl was on the verge of becoming the world's most potent nuclear dynamo, boasting a half dozen gigawatt reactors capable of providing electricity to 7 million consumers. But shortly after midnight on that day, the plant's number 4 reactor exploded, venting at least one hundred times more radiation into the atmosphere than the atomic bomb that leveled Hiroshima. Five years later, the world panicked again as fire stormed through Chernobyl's number 2 reactor, devouring its turbine room but failing to reach its core. In the years since design flaws and mismanagement shattered the Soviet fantasy of nuclear safety, it had become apparent that the repercussions of Chernobyl would be worse—and extend farther over space and time—than anyone had imagined. Nevertheless, we could see blinking lights indicating that number 1 and number 3 were still on-line, pumping power to Kiev and Odessa and across borders to Western Europe, via transmission lines permanently soaked in radioactivity.

To reach the banks of the Pripyat, our government van cleared the first security checkpoint about twenty miles from Chernobyl. Beyond the barricade, the orderly collective fields of wheat, flax, and potatoes north of Kiev gave way abruptly to an expanse of unkempt scrubland. Seven miles south of the power station, after our impromptu birding expedition, we reached another checkpoint, where we were ushered into a concrete building and instructed to leave our clothes and jewelry in lockers. Wearing paper slippers and undershorts, we shuffled down a long corridor to a guarded steel doorway. On the other side, an identical bank of lockers contained long-sleeve cotton shirts, coveralls, heavy leather shoes, breathing filters, and surgical caps to protect our hair from specks of airborne plutonium. We then boarded a bus so contaminated that it would never be allowed to leave this restricted zone and rode toward the huge steel-and-concrete container known as the sarcophagus, which encases the hot remains of reactor number 4. Accompanying us was Ukrainian nuclear physicist Vladimir Tikhii, who had helped track Chernobyl's spreading radioactive stain in the immediate aftermath of the disaster, as well as two of Larsen's University of Oregon colleagues: ecologist John Baldwin and landscape architect David Hulse.



At the destroyed reactor, our instruments registered several hundred times the normal background radiation. The gray walls of the sarcophagus, more than ten stories high and fifty-nine feet thick in places, had been patched so often they resembled the tarred, caulked hull of a derelict ship. Coils of concertina wire, cyclone fencing, and floodlights surrounded the structure, and the grit at our feet still contained tiny particles of uranium fuel and plutonium discharged during the accident.

Of the 100,000 men who built the vault in 1986, several thousand died from radiation poisoning. Despite their labors, more than 11,000 square feet of leaks have formed, and a French construction firm that was recently contracted to erect another tomb around the first one warned it could never be completely sealed. Nor could radioactive runoff from Chernobyl's cooling ponds, impounded by dikes hastily constructed at enormous cost along the Pripyat, be kept from seeping into the watershed. Once there, the runoff flows directly to the Dnieper River, Ukraine's Mississippi, the source of drinking and irrigation water for 38 million people.

Even more hopeless is the task of recovering the massive amounts of deadly radionuclides dumped by wind and rain clouds over 50,000 square miles of prime farmland across Ukraine, Belarus, and Russia—much more farmland than these precarious new nations can afford to abandon. The fallout consisted mainly of radioactive cesium 137 and strontium 90, by-products of uranium fission with thirty-year half-lives that will significantly irradiate the region's soil and food chain until at least the year 2135. This is why Larsen, Hulse, and Baldwin had come. With colleagues from Moscow State University, they had devised a computer program to help rural Russians near the Ukrainian border confront the inescapable prospect of a radioactive future by giving them access to information that governments have routinely kept secret. Now, with Demydenko and Tikhii, they were in Ukraine to try to do the same. Yet amid acres of radioactive

A VIEW OF THE ABANDONED TOWN OF CHERNOBYL, WITH THE NUCLEAR POWER STATION VISIBLE IN THE BACKGROUND

machinery, which stood rusting beneath a peeling sign that exalted the V. I. Lenin Chernobyl Nuclear Power Station as a "Victory for Communism," the notion that any technology could solve human problems was hard to sustain.

In the glum silence, I became aware of the twitter of nesting barn swallows over the staccato accompaniment of the Geiger counters. Larsen and I watched the birds flit among radioactive construction cranes sacrificed to the cause of the sarcophagus. Chernobyl's birds, Vladimir Tikhii explained, were absent when he was taking lethal water samples from the Pripyat River in 1986, but the first of them returned a year after the disaster. With few humans or predators to bother them, they now seemed to be flourishing. For that matter, a large population of radioactive roe deer was thriving in the surrounding forests. The towns of Chernobyl and Pripyat, from which 50,000 stricken workers and their families had been evacuated on the afternoon of April 27, 1986, were also being reclaimed by nature. Once-trimmed hedges had run wild, their foliage so dense that many houses were nearly covered; when we drove through Chernobyl's silent streets, branches of unpruned chestnut trees grazed the sides of our bus. "Plants," Tikhii mused, "are sometimes stimulated by radiation."

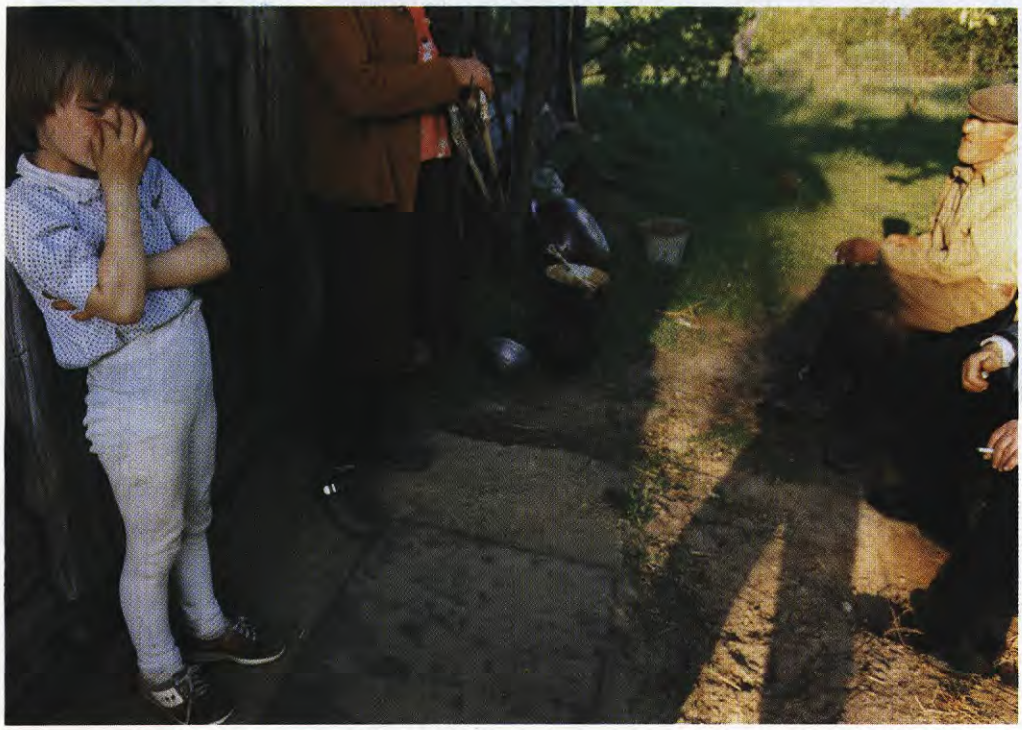
"The plants and animals here may *appear* healthy," Demydenko interrupted, "but who knows what their life expectancy will be or what chromosomal deviations will erupt in future generations?" Demydenko, a tall, bearded physicist, was one of many former Soviet scientists transformed into the unfamiliar role of bureaucrat. "Birds can't understand the risk they take here. Since radiation can't be smelled or felt, sometimes even we can't imagine it damaging us."

Despite the fact that the presence of radiation in the landscape will give rise to thousands of latent cancers, ravaged immune systems, and inherited genetic damage over the coming decades, both Ukraine and Russia intend to build more nuclear reactors. The strategy has only deepened the sense of foreboding that already pervades the two societies. Standing in front of Chernobyl's boarded-up Ukrainian church, I asked Demydenko whether the project designed by the Oregon scientists would make a real difference in people's lives. "We have a totalitarian legacy of citizens not making decisions—since long before the 1917 socialist revolution, some-

Photograph by Conti / S. Bukowski / Sipa Press

one always made them for us," he said." To teach people to use information democratically, we have to educate a new generation. It doesn't happen overnight."

Twice while John Baldwin was a student intern at Great Lakes Laboratory during the 1970s the Cuyahoga River caught fire. From the river's origin near Akron, Ohio, to its befouled mouth on Lake Erie, Baldwin sampled untreated sludge and industrial acids gushing from every outfall along its length. Appalled, he forsook ideas of a career in cancer research to dedicate himself to a natural environment under assault. Years later, as director of environmental studies at the University of Oregon, he helped found the International Society for Environmental Education. Among the members was Dmitri Kavtaradze of Moscow State University, designer of a prototype Russian village he had named Ecopolis. Kavtaradze believed that the Soviet system was more suited than Western capitalism to nurturing ecological security, a notion he reconsidered after Chernobyl.



A FARM FAMILY LIVING WITHIN THE TWENTY-MILE IRRADIATED ZONE NEAR CHERNOBYL

Two years after the reactor exploded in 1986, Kavtaradze became chief ecologist at the Ministry of Education under Gennady Yagodin, a close adviser to Mikhail Gorbachev. Yagodin, a nuclear chemist, had served as a deputy director of the Vienna-based International Atomic Energy Agency, whose initial report on Chernobyl, issued several months after the accident, was broadly denounced for its uncritical acceptance of grossly underestimated government figures. As these accusations were gradually proved correct, Soviet officials enlisted foreign advisers to staunch the damage. In the winter of 1990, Kavtaradze called John Baldwin and asked him about geographic information systems, or GIS, a three-dimensional, computerized technique for easily conveying complex information about landscapes. Baldwin described a new GIS program developed by a colleague at Oregon that sounded perfect for the purpose at hand. Could Baldwin bring him to Moscow to meet Kavtaradze's boss?

The new system was the brainchild of David Hulse, a landscape-architecture professor. In 1987, Hulse and software developer Kit Larsen had simulated a section of the Columbia River Gorge that had been designated a National Scenic Area but whose use was being contested by recreation, lumbering, farming, and fishing interests. By superimposing computerized maps of these activities, Hulse and Larsen created land-use scenarios that preserved both the gorge's scenic beauty and the livelihoods of its residents.

In March 1991, nearly five years after Chernobyl, Baldwin, Hulse, and Kavtaradze found themselves being chauffeured in a Volga limousine into a building near the Kremlin. Gennady Yagodin had assembled sixty apparatchiks around a vast conference table for a demonstration of Hulse's Columbia River Gorge GIS. Everyone now knew that Soviet estimates that the health of just 209 people had been endangered by Chernobyl had fallen short by 4 or 5 million: independent researchers with Geiger counters and dosimeters had confirmed that large portions of western Russia, Ukraine, and Belarus (then Byelorussia) were drenched with fallout. Government officials, apparently concerned more about political consequences than the public good, had known all along that people were unwittingly plowing radioactive dust, eating radioactive vegetables, and feeding radioactive hay to their cows.

Because the main contaminant, cesium 137, is a chemical analogue to calcium, it was concentrating in cows' milk, the source of 80 percent of a rural Soviet child's protein. Although hun-

Photograph by Fabienne Bouville

dreds of families were evacuated from the most radioactive villages, it had been impossible to relocate several million. Those who remained behind had to know what they could safely eat, where likely hot spots of radioactive accumulation were located, which crops were best to grow, and how soil could be treated to minimize the transfer of radiation to humans. Could Hulse's landscape-mapping technology, Gennady Yagodin wanted to know, be adapted to teach people living downwind from the Chernobyl reactor?

"We'd need maps," Hulse had replied. He meant detailed topographic maps, routinely purchased at home from the U.S. Geological Survey, but classified as military secrets in the Soviet Union. The prospect of the Defense Ministry releasing them to Americans seemed far-fetched. But one of the phones on Yagodin's desk linked him directly to Mikhail Gorbachev's office. "You'll get them," he nodded.

The Soviet Union, Yagodin informed Baldwin and Hulse, would pledge 500,000 rubles to fund a project to create a multilayered computer rendering of the landscape around Chernobyl. No one knew, of course, that the Soviet Union would soon vanish or that the ruble, now the currency of a new country, Russia, would be devalued several hundredfold. The value of Yagodin's grant plummeted from $750,000 to $16,000 and kept dropping. Everything changed, except for the intractable matter of Chernobyl, which was now located in independent Ukraine. Regardless of who claimed the land, it remained radioactive.

In June 1993, in Dmitri Kavtaradze's laboratory at Moscow State University, Baldwin, Hulse, Larsen, and a complement of Russian experts applied final flourishes to the Chernobyl Project's GIS, which had been revived by private grants from the United States. On my way to join them, I stopped by a sagging building on Petrovsky Street that houses the Moscow chapter of Chernobyl Union, a survivors' organization. Inside an office so cramped that I had to sidle between the desks and bookshelves, I shook hands with two former nuclear-construction engineers, Evgeny Akimov and Serafim Bulgakov, who had helped supervise work on the Chernobyl sarcophagus. They were known as "liquidators"—the designation given the 600,000 Russians and Ukrainians who had served on the disaster cleanup. According to a dog-eared Soviet government handbook they showed me, liquidators were entitled to free passage on subways and buses, 50 percent rent reduction, early retirement, and pay bonuses. Widows, orphans, and evacuees received additional catastrophe benefits. But the strapped new governments of Russia and Ukraine had been unable to fulfill all these obligations. To compensate, the men had taken to selling scratch-and-win Super Jackpot lottery tickets for an international drawing. The proceeds, the ticket read, went to the Children of Chernobyl Fund.

The two engineers spoke hopefully, but they were clearly embarrassed at having to huckster for cash. Akimov opened his scrapbook of the glory days: 100,000 men, building something that had never before been built. For their courageous toil they had been fed banquets of special foods like caviar and smoked fish. Bulgakov spotted a photograph of his volunteer brigade, posed under a banner reading, TIME GIVES BIRTH TO HEROES. THE PLACE: CHERNOBYL! He located himself among the faces of his comrades, most of whom were now dead. Just six years later, this gray man with watery blue eyes who became exhausted after walking ten minutes could well have been the father of the proud worker in the picture.

GOVERNMENT OFFICIALS KNEW ALL ALONG THAT PEOPLE WERE PLOWING RADIOACTIVE DUST, EATING RADIOACTIVE VEGETABLES, AND FEEDING RADIOACTIVE HAY TO THEIR COWS

"In thirty years working at nuclear stations," Akimov said, "I saw many micro-Chernobyls. Accidents occur when people's minds are elsewhere. Today, everything costs ten times what it used to. If I tried working in a nuclear plant while worrying about the price of sausage to feed my children," he added, "how could I keep my mind on the job?"

When I arrived at his Moscow State laboratory later that afternoon, Dmitri Kavtaradze was showing John Baldwin a graph demonstrating that as the apparent risk of a military confrontation subsides, people's perception of ecological risk increases. Kavtaradze, pink-skinned with a brushy mustache, spoke fluent English that favored adjectives and metaphors. "The collapse of the U.S.S.R.," he told me, "left us like the man whose wife honestly admits her adultery—wiser but less happy."

Next door, Kit Larsen was talking with two young Russian associates, geographer Alexei Naumov and biologist Elena Boukvareva, who sat at tandem computer screens, debugging the project software. Its centerpiece was macGIS, a program Hulse and Larsen co-authored, which crammed the power and graphics of a mainframe GIS into a portable Apple Macintosh. Naumov had translated macGIS into Russian and now was squeezing the character-rich Cyrillic alphabet into Macintosh menu screens that could be toggled between both languages. Boukvareva was test-driving the program's multimedia introduction: a computerized show with sound and

movement, designed to charm any computer illiterate. The goal was a program that could be grasped after one demonstration. In the target area they had chosen, the 250-square-mile Novozybkov district of western Russia's Bryansk region, near the border with Ukraine, economic conditions had deteriorated so much that citizens would sometimes burn radioactive peat when they knew that government monitors were coming, to ensure they'd keep receiving compensation funds.

Boukvareva's screen filled with scenes of Novozybkov. High-resolution images showed ponds and gingerbread-trimmed cottages surrounded by green pastures and golden fields, which segued into animations of children walking to school and men on horseback driving cows down village lanes. A click, and a map of Europe appeared, with a brown stain spreading outward from Chernobyl—one dark lobe engulfing western Russia. We zoomed in: clouds of radiation migrated through the soil and streams, up the food chain from grass to cow to hamburger. Another click and a second stain seeped through a woman's body, followed by a brief descent into microdetail, as single cells and DNA chromosomes were barraged by radioactive ions. Yet another click opened an optional level for science students, replete with equations and chemical formulas.

The introduction ended with a display of the greatly increased risk of radiation combined with such other hazards as smoking (an almost universal obsession among Russian men). An aerial view of the tainted Novozybkov landscape now appeared on the screen, digitally scanned from the topographic maps Gennady Yagodin had somehow coaxed from the Soviet Defense Ministry. With the push of a button, the map could be rotated horizontally to reveal the terrain's texture, or it could be superimposed with as many as twenty-three colored layers of data. As Boukvareva clicked away, outlines of the district's six collective farms appeared. Next they subdivided into 577 cultivated fields; then a single farm was isolated. Further layers added forests, soil, roads and bridges, settlements, slope, elevation, water bodies, peat deposits, crop-rotation sequences, and crops themselves. The all-important final layer displayed radiation levels.

"NOT A PLACE FOR CHILDREN," LINNIK SAID AS OUR GEIGER COUNTERS CLICKED. BUT NEARBY STOOD A BAREFOOT GIRL IN A FLOWERED SKIRT AND A BLONDE WOMAN HOLDING A LITTLE BOY

That afternoon, Vitaly Linnik, the man who had measured, field by field, the Novozybkov radioactivity data used in this project, was due to stop by at the lab. He was late, and there was no assurance that he'd appear at all. In whispers, I was told that Linnik suffers bouts of irrational behavior, the result of prolonged radiation exposure stemming from surveys he had conducted at Chernobyl right after the explosion. Linnik was a genuine hero, his colleagues told me, but they feared he might have leukemia, a matter he refused to discuss. As we waited for him, I met the remaining team members, nuclear physicists Olga Scotnikova and Mikhail Panin. Until recently, their work had involved mostly military secrets; the matronly Scotnikova had spent part of her career in the Urals at Chelyabinsk, a military plutonium-production reactor 700 miles east of Moscow, where an enormous explosion in 1957 had caused thousands of deaths. For the Chernobyl assignment the two physicists had written a program called the Dose Forecast Model, which when grafted onto macGIS calculated the radiation a human would absorb from various combinations of foods, soil types, and crop-rotation schemes. The Dose Forecast Model was the key to the entire project, the tool that presumably would allow each of the 70,000 residents of Novozybkov to focus all the data on his or her own circumstances.

Humans absorb radiation three ways: directly, through exposure to a radioactive source; by inhaling radioactive particles; and by ingesting food contaminated by fallout. Ever since the initial explosion subsided, 95 percent of Chernobyl's ongoing threat has come from the third. The Dose Forecast Model took into account the fact that plants tend to deposit radioactivity in their leaves. Leafy vegetables such as lettuce have levels many times higher than grains, which store more radioactivity in non-edible parts like their stalks. But people need leafy vegetables, and importing enough to contaminated regions would cost more than people or governments can pay these days. One way to reduce lettuce's uptake of cesium 137, Panin said, is to rotate crops: plant a field in wheat, barley, or a cover crop like lupine to suck radiation from the surface, then follow with greens.

This strategy, of course, raises another problem: how to dispose of the radioactive wheat chaff or barley stalks. Burning them would return radioactivity to the environment, so land must be set aside for organic toxic-waste dumps. A long-term solution, especially for highly contaminated areas, is planting orchards. Apple and peach trees store more radiation in their trunks than in their fruit; conceivably, in two centuries, when the cesium has decayed, the trees could be harvested for wood, and the land would again be safe for vegetables.

The evening before we caught a train for Bryansk, the most contaminated region in western Russia, we were relaxing in a dormitory room at International University when we were joined by Dima Litvinov. The son of an exiled dissident

mathematician, Litvinov directed campaigns for Greenpeace-Russia. He believed that another nuclear catastrophe was all but inevitable because Russia's infrastructure was deteriorating and the workforce was demoralized. Besides the fifteen remaining Chernobyl-type graphite-controlled reactors, the former Soviet bloc has forty-one pressurized-water nuclear stations. From his briefcase Litvinov extracted diagrams of pressure cracks in reactor vessels. In western Europe, he said, cracked pressurized-water reactors had been shut down, but in the former U.S.S.R. they were still commonplace. He shuffled through more papers: a cheerless World Bank memo about Russia's nuclear-safety conditions, reports of an alleged cover-up regarding a recent spill at the Tomsk-7 plutonium factory, an admission by Russia's environmental minister that spent reactors and fuel from nuclear submarines were still being dumped at sea.

Baldwin asked about Chelyabinsk, site of the 1957 explosion, where his team had been asked to take its GIS project next. Litvinov described a second accident in that region, a partial meltdown in the mid-1970s at the Beloyarsk military breeder reactor, whose unprocessed fuel still sits in a cooling pond, leaking into the environment. Ten minutes at the water's edge could kill a man. "Lovely," said Hulse. "When can we go?"

"You want worse?" Lately, Litvinov had been investigating black-market sales in Moscow of uranium and plutonium, not in quantities sufficient to produce an explosion but by the gram. "There are enough neutron emitters in one gram for a very dirty radiological bomb," he said. "Imagine terrorists dropping one into London's water supply."

"How do you sleep at night?" Larsen asked.

"Could you pass me that?" Litvinov replied, reaching for a bottle of Stolichnaya.

Two days later, Vitaly Linnik and I stood in a Novozybkov potato field overlooking a peat bog. Dairy cows lolled along the winding brook that marked the field's border with Belarus, where 70 percent of Chernobyl's radiation fell. One goal of the joint Russian-American project was to provide a guide for making informed choices quickly in future disasters by using GIS's power to mesh data with topography. Soon after the Chernobyl explosion, the Soviet authorities made one of their more fateful decisions—one that helped explain why this region was so heavily doused: rain clouds heading east were secretly seeded by pilots from the Soviet Committee of Hydrometeorology so that contaminated rainfall would not reach Moscow. As a result, the green, undulating landscape, planted in rye, feed corn, root crops, and apple trees, was filled with invisible poison. Linnik's Geiger counter indicated that we were receiving between 200 to 300 micro-roentgens per hour here, ten to fifteen times more radiation than is normal. "Not a place for young children," Linnik said. But we could hear some. At a nearby white brick house, we saw a barefoot girl in a flowered skirt and a blonde woman in sweatpants holding a little boy. As we approached, the father joined them, shirtless and sweating from digging potatoes.

RESIDENTS NEAR CHERNOBYL ARE MONITORED FOR RADIOACTIVITY

Anatoly and Irina Bynya, it turned out, had moved here just two years ago. We asked if they understood that this part of Novozybkov was considered so toxic that it had been evacuated. They did. I glanced at the children.

"We didn't have much choice," Anatoly sighed. The house had belonged to his own father, who during the 1950s was sent to Kazakhstan as part of a five-year plan to open new agricultural land. Anatoly was born and raised there. But with the breakup of the Soviet Union, Kazakhstan became an independent Islamic nation, and ethnic Russians were no longer welcome. So the couple returned to Novozybkov.

"But it's radioactive here," I repeated.

Photograph by Ivleva / Magnum Photos

"It was there, too."

Kazakhstan was the site of Soviet nuclear-weapons testing, Linnik reminded me. "Hugely contaminated. No one knows how much. Top secret."

Vitaly Linnik knew many secrets. Not long before Chernobyl, he had defended his dissertation on the migration of heavy-metal pollution in the soil around Moscow. Because of the sensitivity of his subject, his superiors ruled that his thesis could not be published. But after the explosion, he was called to Chernobyl. The reactor fire had finally been extinguished by bombing it from helicopters with thousands of tons of sand and dolomite. Ecologists now needed to know how the buried radionuclides would begin migrating through the ground and watershed. Linnik was at the site a day later, having stayed up all night on the train from Moscow, reading about radioactivity. By morning he knew enough to be frightened.

AN ABANDONED HOUSE SEVEN MILES SOUTHEAST OF CHERNOBYL

For eight months he sampled water and soil cores. He was compelled to sign an agreement pledging absolute secrecy about his findings, including from his own relatives, and was prohibited from all contact with foreigners. Soon thereafter, he was told that a blood analysis had revealed that he had received a large dose of radiation, but he was given no details. That spring he returned to Moscow. A former student athlete, Linnik felt fine until he tried to play soccer and vomited from the exertion.

Two years later, Linnik was in Russia, taking readings in forests, bogs, and leaf litter and sampling soil at depths of two and five centimeters in the center and every corner of every field in Novozybkov. These fine collective farms, he realized, were now the most contaminated places in the republic. When he was asked to suggest a pilot area for the joint Russian-American Chernobyl project, Linnik knew exactly where.

We drove to Svyatsk, an abandoned village in western Novozybkov. A sign that proudly charted each year's potato harvest had stopped abruptly in 1989, when everyone fled. Near a store window that displayed canned goods bearing four years' accumulation of radioactive dust, we encountered an old woman in a white babushka who told us she was the only one left in the village. She had refused to leave. We poked inside cottages, built centuries ago from stout, hewn timbers, whose painted doors and shutters now flapped uselessly. Their interiors attested to rapid evacuation: a plank floor strewn with crayoned pages from a child's geography lesson; a skeletal Christmas tree, tipped on its side; a barrel of apples, left to shrivel. The Geiger counter chattered in stove ashes, where radioactive kindling had been burned, and around drainspouts where rainwater laden with cesium 137 had poured off the eaves. In a former truck garden, feral, irradiated house cats lurked among rhubarb plants. Just outside town we saw two men in a pasture, sharing a bottle. One of them fell. Alcoholism is a major secondary effect of Chernobyl, partly because people here believe that vodka insulates them from radiation. "I'd rather die early here than grow old in the housing project where they put us," shouted the man who was still standing.

I couldn't blame him. The land was so fertile, and the danger so insidious. We entered a woodland of fragrant red pines and white birch, bordered by clumps of blueberry and raspberry. Because forests act as windbreaks, catching and holding moisture, they are particularly tainted—a sorrowful irony in the Russian countryside, where picking forest mushrooms and berries is a favorite pastime and a principal source of vitamins. Gathering them from this sweet-smelling glade, or anywhere in Novozybkov, was now strictly forbidden.

Linnik set the Geiger counter on a piece of

Photograph by Fabienne Bouville

moss. It clicked wildly. "I wonder if it will hit 400," he mused. It went to 500. He whistled. It kept going, and he quietly stared at it. I heard a woodpecker. The Geiger counter finally held at 857 micro-roentgens per hour. It was the highest reading Linnik had ever seen here. "We should go," he said.

Figuring that it was better for many people to receive a little radiation than to expose residents from contaminated zones to even higher concentrations through their diet, the U.S.S.R. decided after Chernobyl to distribute foods from its radioactive farm belt to markets throughout the country. Plans were made to disburse thousands of kilos of irradiated beef in sausage made up of one part infected meat per nine parts clean. Then the Soviet Union broke apart; today, contaminated crops remain in the country where they're grown. Given the forbidding cost of imports, people have no alternative but to eat them.

With the nuclear genie out of the bottle for centuries to come, the residue of the explosion at Chernobyl poses two as yet unanswerable questions. First, there is the matter of how Ukraine will pay for the ongoing cleanup and compensation to victims, which are currently devouring about 13 percent of the country's annual budget. As in Russia, the recent flurry of World Bank and International Monetary Fund advisers in Kiev indicates the desperate hope that in the long run, a market economy will prevail and prosper. Meanwhile, I saw fishermen in their shallow skiffs back on the Dnieper, catching and eating radioactive pike and carp, and selling them in the streets. Legally, this was prohibited, but in practice no one tried to stop them. People were hungry.

Second, how harmful will chronic radiation prove to be? There are many indications that steady low-level doses of increased radiation have a cumulative effect on cells and chromosomes. Only time—and generations—will reveal what damage Chernobyl really caused. Officials at the Ukrainian Ministry of Health's Radiation Hygiene Laboratory told me that the numbers of unexpected thyroid cancers and chronic diseases were already multiplying in contaminated areas. One study indicated that toxic heavy metals throughout Ukraine—a legacy of Soviet military manufacturing—were intensifying the radiation's destructiveness.

"Life itself will be the evidence," said Dr. Alexander Urinan, a surgeon I visited at Kiev's Children's Hospital Number 14. "Seven years after the accident, we're now starting to observe the effects we feared." Urinan confirmed that thyroid cancers in Ukraine and Belarus, especially among children who received a dose of radioactive iodine from the initial blast, have far surpassed the numbers predicted. It is also clear that the immune systems of many children of Chernobyl, even those born far from the reactor, have become so depressed that old diseases like diphtheria are now reappearing. "We're seeing newborn children with liver and stomach cancers," Urinan said. The hospital has also reported record numbers of babies born with cleft palates, deformed limbs, and missing rectums. "We can't tell what to expect when affected children who are now adolescents begin to give birth," he added.

With hematologist Svetlana Kireeva, I walked through the hospital's white-tiled cancer ward. A quarter of the 100 children here were dying from lymphoblastic leukosis, a form of leukemia that usually occurs at much lower rates. "Something similar happened in the years after Hiroshima," she noted.

I paused at the bed of a boy named Taras. Like the others, he was bald, puffy, and hooked to an IV. His lips were painted with aqua balm to soothe the ulcerations from the leukemia. On the wall were decals of mushrooms, fruit, and Scrooge McDuck. Taras lay propped on his mattress, playing a board game with his mother. She moved the pieces for him. She was a geography teacher who had lived in a rural region east of Chernobyl. She was pregnant with him when the reactor blew.

No one told them that the village had been hit by fallout. "But we all knew." I asked if they talk about Chernobyl in geography classes. "It's too painful," she said. She and her neighbors had sent their healthy children away to live with relatives. "It's the only hope we have for them. This is all poisoned."

"What can be done?" I asked.

She looked at her son, who had been lying in the hospital for a year.

"Nothing," she said.

A week earlier in western Russia, I had watched the Oregon and Moscow State scientists demonstrate their risk-reduction program to the somber citizens of Bryansk and Novozybkov. In the discussion period that followed, several confessed their doubts that they could ever give up eating their beloved berries. I asked myself if these people—or their governments—would be able to summon the will to accept the profound changes demanded by their radioactive environment.

"It will be up to the young," Baldwin had said in Bryansk. "The old men in power today are still in denial about the poison that surrounds them. But the coming generation has been raised on computers, environmental awareness, and the wrenching metamorphosis from communism to capitalism. I hope they will understand what needs to be done. And when that generation is making Russia's and Ukraine's decisions," he added, "the radiation will still be around." ■