receive the lion's share of the money, although other states that are landlocked would benefit as well. The House of Representatives approved the bill in May with a two-thirds majority, but it faces a stiff floor fight in the Senate.

Coast 2050's staggering price tag alone is enough to raise a red flag for ecologist Pimm, who has been a vocal critic of the Everglades restoration. "Water projects in the U.S. have a reputation for embodying the worst excesses of pork-barrel spending," says Pimm, and Coast 2050 may be no exception. "What we'd really like for the Mississippi is to take out all the dams and levies and diversions and let the damned thing flow free."

Even if the big money doesn't arrive, the delta's defenders say they will not be deterred. They contend that the government will either spend billions now to save the marshes or many more billions later to bail out New Orleans, half of which already lies below sea level. "We'll do whatever we can," says DNR's Good. "Even if we have to fill sand bags and throw them into the breach." –JOEL BOURNE

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COMPUTER SCIENCE

Flushing Out Nasty Viruses In the Balkans

Bulgaria created a pioneering center to tackle the threat that its homegrown viruses pose to the world; now the lab is struggling to stave off obsolescence

SOFIA—Shortly before its corrupt Communist regime toppled a decade ago, Bulgaria was overrun by a spate of devastating infectious agents that went by names such as Dark Avenger, Anthrax, and Evil. Cooked up by shadowy figures in the besieged country, these plagues were not the errant concoctions of Soviet-era bioweapons labs. They were the scribbles of computer geeks.

How this mostly rural Balkan country with a frayed telecommunications infrastructure became a "virus factory" is a tale wrapped in Cold War intrigue. Just as compelling is how the Bulgarian Academy of Sciences responded to the crisis. The academy established a National Laboratory of Computer Virology, where antivirus hunters match wits with unseen virus creators. The laboratory has been a major force in reining in Bulgaria's viral threat, says Lars-Olof Stromberg, a virus expert with the Royal Institute of Technology in Stockholm.

While Bulgaria's significance as a computer virus reservoir has waned, the virology lab continues to serve as a training ground for antivirus experts, including a few who made major contributions during recent efforts to disarm high-profile scourges such as the ILOVEYOU virus. Despite a ludicrous budget—the government gives the lab roughly half of what a single Western whiz kid fresh out of college might earn in a year—the facility remains a force to be reckoned with. "They are certainly good at looking at emerging viruses and analyzing them quickly," says Fred Cohen, a researcher at Sandia National Laboratories in Livermore, California, who in 1983 coined the term "computer virus."

A Balkan Silicon Valley

No one knows where the first viral-type programs came from; they may have originated in instructions given to early computers to fill memory space by copying bits. In the late 1970s, some malignant codes infected Russia's Rijad mainframe computers. Then a few years later a virus known as the "Xerox worm" (so named because it made copies of itself) blighted a U.S. computer network.

It was not until the late 1980s that the public at large became acquainted with the destructive powers of viruses. That's when a rapidly proliferating virus from Israel dubbed Jerusalem bogged down computers around the world, and Brain—a "boot-sector infector" from Pakistan that hit MS-DOS systems—went on a rampage. Bulgaria then put itself on the map, unleashing a slew of globe-girdling viruses in the late '80s and early '90s. In the years since, the rogues' gallery has swelled to nearly 50,000 known viruses worldwide, with 10 to 15 new ones popping up every day. This proliferation has turned antivirus and computer security R&D into a multibillion-dollar business (see table).

Early antidote. Bulgaria tapped a young star named Veselin Bontchev to lead its antiviral campaign.

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Bulgaria's contributions to this global scourge trace their roots to the 1970s, when Soviet planners designated the loyal satellite as the lead East Bloc country for producing computers and software. Implementing that decision, Bulgarian Communist Party leader Todor Zhivkov decreed that personal computers would be manufactured in his hometown of Pravetz, which lent its name to two generations of PCs. Unable to import user-friendly Western software, a cadre of computer-literate Bulgarians soon became intimately familiar with the code that runs computer programs—knowledge that helped them understand how viruses operate, says Klaus Brunnstein, who founded the University of Hamburg's pioneering "Virus Test Center" in 1988.

Several theories have been put forward to finger who among the Bulgarian population turned their hands to virus writing. Some say the culprits were a handful of talented but frustrated young computer experts who were looking for an escape from the economic and social turmoil of the late 1980s and early '90s. Others see more insidious forces at play. Stromberg, for one, asserts that Bulgaria was a center of the once top-secret "InfoWar" effort, initiated by the KGB in the late 1970s to develop software and viruses that could be sicced upon the West. After the Soviet Union dissolved, he contends, some of those highly trained experts left the government "to freelance and to hack Western computer systems"—sometimes for organized crime rings.

Bulgarian experts contacted by *Science* demur, insisting that viruses sprang from the brows of amateurs, not spies. Thousands of computer-savvy teens cut their teeth in neighborhood "computer clubs" set up by the government in the 1980s. Although most of their activities were benign, some learned how to pirate Western software, and a few dallied in viruses. "The first viruses created here in Bulgaria were innocent things—just kids who experimented," claims computer scientist Eugene Nickolov, who runs the Sofia lab.

If that's true, it didn't take long for some computer jocks to lose their innocence. By the late 1980s, Bulgarians "certainly displayed more aggressive virus examples than many of their contemporaries" in viral hot zones elsewhere, Cohen says. Notorious

Talent agent. Eugene Nickolov's lab churns out antiviral stars.

Bulgarian viruses included Yankee Doodle and Dark Avenger—perhaps the first "fast infector" virus, it ripped through the industrialized world. Viruses like Dark Avenger infect files not only when the user executes them, but also any time the computer accesses them for other reasons. "This was a novel idea that permitted the virus to spread very fast," says Vesselin Bontchev, the founding director of Sofia's virology lab and author of the first analysis of the Bulgarian virus factory. Also around that time, the first highly publicized "virus exchange"—a venue in which hackers swap viruses—began operating in Sofia, a development that put the Bulgarian threat under a harsher international spotlight.

The academy founded the virology lab in late 1990 to combat the country's mushrooming virus problem. To lead the facility, the academy's president tapped Bontchev, then a young hot shot at the Institute of Industrial Cybernetics and Robotics. He had made a mark for antivirus research done in his spare time, including devising a way to neutralize "Vienna 648"—an early virus that damaged *.com files—by writing a program to locate the infected files and purge the virus.

"I became director of the laboratory before I even had an office, equipment, or personnel," recalls Bontchev, who soon left the lab for Hamburg to write his dissertation under Brunnstein. Bontchev is now an antivirus expert at FRISK Software International in Iceland. "One of my strongest motivations then and now," he says, "is to counter the public image of Bulgaria as a place that makes viruses."

The antiviral diaspora

Virus creators and antivirus researchers are constantly at war, with both sides in an arms race to launch increasingly sophisticated attacks and counterattacks. Although some viruses evade detection long enough to inflict global economic losses, Nickolov argues that he and his colleagues benefit from the thrust and parry. "From this race emerge better operating systems, applications, and technologies" that are more resistant to viral infection, he says, thanks to the development of "bloodhound" technologies capable of lightning-fast virus detection.

Devising such technologies is a lucrative pursuit, although you wouldn't know it from touring the Sofia lab. On a summer day the facility, tucked in a corner of the academy's Institute of Mathematics and Informatics, is hot and cramped, a far cry from sleek, air-conditioned Western centers. All the Sofia lab has to work with are 15 personal computers, upgraded occasionally thanks to European Union grants. The government gives Nickolov, who took over from Bontchev shortly after the lab was up and running, a budget of less than $50,000 a year. Most of the lab's 10 computer scientists must take second jobs, says Nickolov, who himself moonlights as a lecturer at three universities.

CREDIT: (TOP) R. KOENIG

Unable to pay competitive wages, Nickolov says it's "virtually impossible" to hold onto young experts. Although the lab has produced some world-class antivirus researchers, most of Bulgaria's domestic computer industry disintegrated after Communism fell, and the Bulgarian software companies that remain can't match the salaries paid by their Western counterparts. Bulgaria's loss is the world's gain, as the lab's far-flung progeny have established themselves as leaders in antivirus efforts. Bulgarian luminaries include Bontchev and Katrin Tocheva, a senior researcher at F-Secure Corp. in Finland. Tocheva, who got hooked on computer programming when she was 15, joined the virology lab in 1991 and stayed for 6 years until taking a higher paying job at F-Secure.

A SAMPLING OF ANTIVIRUS R&D SHOPS

Center	Location
Universities	
Virus Test Center, Univ. of Hamburg	Hamburg, Germany
Virus Research Unit, Univ. of Tampere	Tampere, Finland
Carnegie Mellon University	Pittsburgh, PA
Massachusetts Institute of Technology	Cambridge, MA
Royal Institute of Technology	Stockholm, Sweden
Industry	
Symantec	Cupertino, CA
IBM Research (computer security labs)	Hawthorne, NY
Network Associates	Santa Clara, CA
Computer Associates	Islandia, NY
Kaspersky Lab	Moscow, Russia
Government/Academy of Science	
National Infrastructure Protection Center (FBI)	Washington, D.C.
FAPSI (communications research center)	Moscow, Russia
National Laboratory of Computer Virology	Sofia, Bulgaria
Computer Emergency Response Team (at Carnegie Mellon U., Pentagon-funded)	Pittsburgh, PA

One of Tocheva's crowning moments, she says, was fighting the ILOVEYOU virus, which inflicted billions of dollars of damage on computer and information systems last spring. "When a copy of ILOVEYOU arrived from one of our distributors, I realized that the case was really big," she says. "I informed all my colleagues, called Vesselin [Bontchev], and dragged him out of bed."

After taking a few minutes to figure out how the virus functions—it's a "worm" that infects computer networks via Microsoft Outlook and uses a separate code to steal passwords—Tocheva set to work analyzing the script that forms the main body of the virus, while a colleague tackled the password-grabbing code. "When there is a new virus, the first and main part of the job is to analyze it. The next step is to give users a solution," she says. F-Secure was among the first security firms to alert the computer world about the virus, and it and other companies soon ginned up antidotes.

Bontchev, who has disarmed hundreds of viruses, along with Brunnstein is a founding member of the world's most exclusive club of antivirus researchers, the Computer Anti-Virus Researchers' Organization. The group's 25 members, most of whom work for competing computer security companies, ship viruses to each other for analysis. "We often exchange information," Bontchev says. One major concern among today's virus fighters is that as more communications functions are merged—such as WAP cell phones that can access the Internet, or cable television systems that double as Internet service providers—clever virus programs will propagate faster and become more destructive. This phenomenon, called "convergence," is "a major potential threat," notes Stromberg.

Nickolov looks forward to the possibility that his lab, freshly infused with grant money from the Swedish government, will be able to help defang any convergence threat. But he also casts a wary eye toward the past. In a hallway near the virology lab sits a display case containing the dusty metal skeletons of antiquated Bulgarian and Russian computers. "They are relics now," says Nickolov, running his fingers along a 1960s Bulgarian keyboard that resembles an antique cash register. Unless Nickolov can somehow lure new equipment and a decent budget, his lab could become just as obsolete. –ROBERT KOENIG