



**Glimmers of hope.** At a landmark meeting in Pyongyang, experts mulled ideas for restoring North Korea's degraded ecosystems and strengthening research at test beds like this tree nursery near the capital.

## ECOLOGICAL RESTORATION

# Seeking Cures for North Korea's Environmental Ills

Margaret Palmer got a firsthand look earlier this month at a looming ecological catastrophe that few other scientists have witnessed. On a rare foray into North Korea's countryside, Palmer, director of the University of Maryland's National Socio-Environmental Synthesis Center in Annapolis, saw a landscape of wasted soil and rivers choked with silt from erosion. "Farmers were working the land right down to the water's edge," she says. Draped with camouflage netting, apparently reflecting their deep distrust of South Korea-U.S. military exercises, the farmers would trudge in and out of waterways with ox-pulled carts and plows; some scooped sediments from streambeds to use as fertilizer for nutrient-depleted fields. "The situation is very, very bleak," Palmer says.

Her sobering glimpse of an environment under siege came during a field trip following a landmark seminar on ecological restoration in Pyongyang, capital of the Democratic People's Republic of Korea (DPRK). The conference, held from 7 to 9 March and sponsored by the American Association for the Advancement of Science (AAAS, *Science's* publisher), brought together 85 North Koreans and 14 experts from eight other countries to take stock of DPRK's ecological misery, share ideas on how to restore its ecosystems, and improve the country's food security. "It

was an utterly remarkable, unprecedentedly real and substantive seminar," says Norman Neureiter, director of AAAS's Center for Science, Technology and Security Policy, who led the foreign delegation. In a boost for Korean scientists, it was the first international conference in DPRK since Kim Jong Un took power in December.

Bringing North Korea's environment back into equilibrium will be a monumental challenge. And securing help from outside could become more difficult, thanks to growing political tensions. Last week, DPRK announced that it will launch an Earth-observation satellite in mid-April to celebrate the 100th anniversary of the birth of the nation's founder, Kim Il Sung. Analysts assert that the launch is a long-range ballistic missile test in defiance of U.N. sanctions. If DPRK follows through, nascent attempts to cooperate in science and other areas could be derailed for months, a U.S. State Department official told *Science*.

There's no question North Korea needs assistance. Wide swaths of land have been stripped of biomass, says Richard Hardiman, an expert on natural resource management at the Hebrew University of Jerusalem, who attended the Pyongyang meeting. "The soil in many areas is in terrible shape. There's no organic matter left."

Many other aspects of DPRK's ecological degradation are sketchy, with the true extent of deforestation and pollution loads unknown. "It was impossible for us to get solid data on the scale and magnitude of the problem," says Palle Madsen, a forest ecologist at the University of Copenhagen. Although many North Korean presentations were enlightening, "a lot of analysis was superficial and qualitative," says Junguo Liu, a water specialist at Beijing Forestry University. Informal interactions between the two sides were also limited and chaperoned, frustrating attempts by the visiting researchers to get a more nuanced picture and size up North Korean expertise.

Despite the obstacles, several of the foreign meeting participants are forging ahead with proposals for restoration projects within North Korea. DPRK scientists, they say, are eager to collaborate. At the seminar, organized by Pyongyang International Information Center on New Technology and Economy in Pyongyang and the Environmental Education Media Project in Beijing, "we met some very smart people with an absolute thirst for knowledge," Hardiman says.

North Koreans "recognize that they need to do something, and do something fast," says ecologist Keith Bowers, president of Biohabitats Inc., an ecological restoration company in North America. "They also recognize that their livelihoods and food security depend on a restored and healthy ecosystem."

DPRK's environment took a turn for the worse during the Korean War, which ignited forest fires that razed vast tracts of its hilly terrain. After the 1953 armistice, some

areas, including picturesque Mount Myohyang Biodiversity Reserve, were restored through tree-planting campaigns. By 1990, about two-thirds of the country was forested. Conditions deteriorated again in the 1990s, when the nation endured droughts and floods that ruined harvests, touching off a famine that claimed hundreds of thousands of lives. Desperate villagers scoured forests for food and fuel. During this “arduous time,” forest cover shrank from 8.2 million to 7.6 million hectares, says Hoh Man Suk, director of the Institute of Forest Management in Pyongyang. (Satellite imagery suggests steeper losses in recent years.) At the seminar, Ryo Song Hwa, director of the Central Forestry Design Institute in Pyongyang, described how the deforestation led to desertification, spawned pest outbreaks, and perturbed local climate regimes.

As a step toward healing its ecosystems, DPRK passed a law in 2009 to protect specific areas. Since then it has set aside more than 2 million hectares as forest reserves. North Korean scientists also recently completed a national land-cover assessment that will serve as a basis for a 10-year reforestation plan. Bowers estimates that reforesting half the country could run as high as \$46 billion; for comparison, restoring the Florida Everglades will cost roughly \$30 billion.

Another top priority for DPRK is agroforestry. Varieties slated for mass planting include Japanese larch for timber, chestnuts, which tolerate poor soils, and aronia shrubs, which help stabilize slopes and yield chokeberries, a source of vitamin C. Other cash crops include pine nuts, mushrooms, and medicinal plants such as ginseng. Model farms now also practice intercropping: planting maize and wheat between stands of acacia grown for firewood. “They had a fine understanding of agroforestry principles and were applying them in a very understanding way to reforestation,” says Peter Raven, president emeritus of Missouri Botanical Garden in St. Louis.

Bedeveling these efforts are poor survival rates of seedlings in the wild and pervasive problems with soil fertility and water, Korean scientists say. The struggle highlights the urgent need to regenerate North Korea’s ailing soil. “They’ve virtually destroyed it by overfertilization with urea,” Hardiman says. The simplest remedy, he says, would be to apply gypsum or calcium carbonate to neutralize pH, then spread compost to infuse nutrients. “They could probably deal with the problem in 10 or 15 years,” he says.

A major concern in DPRK is how to adapt to climate change. In one of the more sophis-

ticated Korean presentations, Pak Chol Jun of the Ministry of Land and Environmental Protection described how he modeled shifts in vegetation patterns on the Korean Peninsula in response to climate change over the next 30 to 50 years. Pak’s analysis relied on satellite data he gathered as a visiting researcher at the China Agro-Forestry Research Institution in Kunming. Anticipating that climate change could take a toll on native species, DPRK intends to create a seed bank for endangered or threatened varieties.

More training stints like Pak’s in China and similar capacity-building exercises should not be too difficult to arrange, says Liu, who has offered to host visitors and postdocs in his lab. Bowers is exploring the idea of setting up an Asia chapter of the Society for Ecological Restoration in China that could bring DPRK into the organization. And in Pyongyang, Palmer extended an offer from the University of Maryland to invite DPRK scientists to environmental workshops at her center. She is keen to help North Korean scientists come to grips with their watersheds.

At present, she says, “there appears to be little or no focus on restoration of aquatic ecosystems despite extensive degradation of the water resources.” Obtaining U.S. visas for DPRK scientists, however, may depend on the fallout from next month’s rocket launch.

Even if the mood on the Korean Peninsula becomes more strained, participants say they are willing to give collaboration a shot. “There was a greater openness and potential for fruitful engagement than I had expected,” says Dennis Ojima, an ecologist at Colorado State University, Fort Collins. The International Union for Conservation of Nature has expressed an interest in helping to catalyze landscape-restoration initiatives. One possible donor is the European Union, which has allotted €6 million for capacity building in food security and other areas in DPRK this year. If the offered money and scientific expertise aren’t thwarted by politics, there may still be hope for the countryside. As Bowers notes, the nation has “the ability to mobilize thousands, possibly millions, of people to the task at hand.” —RICHARD STONE

#### NEWSMAKER INTERVIEW: CHRISTOF KOCH

## A Vision of How Mouse Vision Can Reveal Consciousness’ Secrets

Neuroscientist Christof Koch has spent the past 25 years puzzling over the mystery of consciousness. A professor at the California Institute of Technology since 1986, Koch worked closely for years with the legendary Francis Crick exploring how the firing of neurons gives rise to perception, the experience of pleasure and pain, and other manifestations of conscious awareness.

Now, Koch is embarking on a seemingly narrower quest at the Allen Institute for Brain Science in Seattle, Washington, one that he nonetheless hopes will ultimately lead to breakthroughs in understanding consciousness. It’s a 10-year project to study vision in the mouse brain, funded by a new donation of \$300 million from Microsoft co-founder Paul Allen, who had already financed the start-up of the 9-year-old Seattle research center. The project, announced publicly this week, will build on the institute’s foundational work of mapping the mouse

brain to study how information flows through the mouse cortex—a millimeter-thick layer of tissue—to help the animal see. Although the specific goal is to understand vision, Koch says he and his colleagues also intend to study higher-order brain functions such as perception, decision-making, and conscious awareness.

And that, for Koch, is the bridge between the project and his grander desire to understand consciousness. “Once neuroscientists know the basic mechanisms [of vision] in the mouse, they may start to understand more complex forms of perceptions in other animals, including humans,” Koch and fellow neuroscientist

R. Clay Reid write in a *Nature* commentary this week about the initiative.

Koch, who now spends three-quarters of his time at the Seattle institute as the project’s chief scientific officer, has over the past several months described the project’s vision to neuroscience labs around the country. The



Koch