notes that outsiders from wealthy countries are often surprised to learn how optimistic many of the inhabitants of even the most grim Third World slums are. Destitution is relative. And who comes to the city? Not the dregs of society, but its most highly motivated members, said Janice Perlman of the Megacities Project at New York University.

In the 1970s, economists observed that productivity increased as cities grew, leading some to speculate that there might not be a limit to city size, and that the extra burdens of such phenomenal growth could be offset by the wealth and productivity of the megacity, said Harry Richardson of the University of Southern California in Los Angeles. But now Richardson believes that "the virtues of big city size were exaggerated."

Much of the early data on giant cities came from developed countries, particularly the United States. In the Third World, the "negative externalities" of pollution and congestion are more acute, said Richardson. Many megacities cannot provide even the most basic services. Only 11% of Manila has sewage pipes. Only 25% of Jakarta gets its garbage hauled away. The former planning director of São Paulo calculated that it would take the equivalent of 30 annual municipal budgets just to make up the current deficiencies in the city's water, sanitation, and road systems.

Perhaps more important to the economy of the megalopolis, the costs of housing and infrastructure are greater in the megacities than in smaller cities within the same country, said Richardson. These higher costs eat up the available investment capital.

But the continued growth of giant cities may be inevitable. "Efforts to limit size have failed," said Perlman. Nor is investment in rural development by agencies such as the World Bank keeping people on the farm.

Managing these giants will continue to be a daunting task, and perhaps greater than ability of present systems of urban management, said Duane Kissick of the Planning and Development Collaborative in Washington, D.C. There is some thought that the city should simply allocate its resources to dozens of neighborhood "governments," which could then spend the money on problems deemed most critical, be it sewage, overcrowding, or crime.

Kissick said one technological fix may involve the use of remote sensing technology to help cities plan, or at least monitor, their growth, since traditional mapping of the urban sprawl may be impossible. But then again, as a member of the audience asked, can a country afford to buy pretty pictures from space, when it can't afford to provide running water for its citizens?

■ WILLIAM BOOTH

Jet Propulsion Lab

The SP-100. *A reactor under development primarily to power SDI satellites.*

Space Reactors and Arms Control

A session on space nuclear power and arms control turned out to be especially timely. A week before the AAAS meeting, Soviet delegates to a conference in Albuquerque, New Mexico, announced that the Soviet Union has conducted two tests in space of a new reactor that is thought to be capable of powering radar reconnaissance satellites. Then, on the day of the AAAS session, the National Academy of Sciences released a long-awaited study on progress in developing nuclear systems to power satellites and weapons for the Strategic Defense Initiative (SDI).

The Soviet tests and the continuing development of reactors for SDI provide compelling reasons to negotiate a treaty banning nuclear-powered satellites in Earth orbit, argued Daniel Hirsch of the University of California at Santa Cruz. Hirsch, working under the auspices of the Federation of American Scientists, has put together a proposal with a group of Soviet physicists to prohibit orbiting reactors. "If we do not move forward with such a ban at this stage, we face the prospect of perhaps hundreds of reactors in space" early next century, said Hirsch.

The argument was supported by Joel Primack, an astrophysicist also at Santa Cruz, who pointed to the problems for astronomers that have already been caused by gamma rays emitted by reactors powering Soviet ocean reconnaissance satellites, or RORSATS (*Science*, 25 November 1988, p. 1119). These problems have intensified recently, apparently because of the new Soviet reactor tests, Primack said. The new Soviet reactor, some details of which were first reported in the *New York Times*, appears to be an improved version of the RORSAT reactors, Hirsch said.

Not surprisingly, the notion of prohibiting nuclear power systems in earth orbit was opposed by Colonel George Hess, deputy director of the SDI Organization. SDI, he said, should be debated on its merits and not be attacked indirectly by shutting off development of its power sources. Although nuclear power will not be required for any of the SDI systems planned for early deployment, satellites envisioned for later phases will require reactors to supply routine "housekeeping" power and to provide energy to place systems on alert when necessary. Some orbiting battle stations will also require several megawatts of "burst power" to drive weapons such as lasers.

The study released by the Academy indicates that technical problems in developing space reactors may, in fact, prove more troublesome for SDI than efforts to ban such systems. The report, prepared by a committee chaired by Joseph Gavin, former chief operating officer of the Grumman Corporation, concluded that major advances are required before nuclear systems will be available to meet SDI requirements, particularly for alert and burst power. Moreover, powerful reactors are expected to be so heavy that "the feasibility of space power systems needed for high-power SDI concepts appears impracticable from both cost and launch considerations."

The report noted that work has barely begun on high-power reactors and suggests that they may not be ready in time to meet SDI's needs. Consequently, "either major innovations in power systems and power system components will be required or SDI power requirements will have to be relaxed." Even the development of less powerful reactors for housekeeping duties is proceeding relatively slowly. The reactor currently under development, which is known as the SP-100, is also likely to have weight problems, according to Gavin, who spoke at the session.

The only uses of orbiting reactors currently planned are military ones, although thermal generators that use plutonium-238 are employed for some scientific deep-space missions (these would not be affected by the proposed ban). Gavin argued that the SP-100 program should be continued regardless of whether SDI goes forward because it may be useful for future military and civilian missions, such as providing power for radar reconnaissance satellites or a lunar base.

■ COLIN NORMAN

More AAAS meeting coverage next week: Topics will include the legal and scientific disputes over the 1990 census and the dismal state of public understanding of science.