

tric power plant companies, chemical producers, pulp makers, steel mills and fiber firms have become major users. There are now 1,810 flue-gas desulfurization plants in Japan, about 10% of the worldwide capacity for removing SO<sub>x</sub> from flue gas (Table 1). Another 379

denitrification plants are in service, with large-capacity units located in electric power stations. Other major users are steel makers, petroleum refiners and petrochemical producers (Table 2).

Appreciating that acid rain is a serious problem for the global environment, Ja-

pan is working on many fronts to meet this important challenge. ■

*Makoto Matsumura is manager of the Environmental Technology Dept., Technical Services and Coordination Division, at JGC Corporation.*

## Approach to Tropical Forest Restoration

By Satoru Shimazaki

The rapid and dramatic disappearance of large portions of the world's tropical forests has triggered a host of disruptive secondary catastrophes, such as floods and water shortages. These phenomena are now exacting a tragic toll on the lives of millions of people in developing countries. Equally as disturbing, tropical deforestation has begun to affect the global climate in potentially dangerous ways.

In response to these disturbing trends, many nations around the world are beginning to develop strategies to cope with both the local and potentially disastrous global impacts caused by tropical deforestation. Japan is one of the countries that is dealing most forcefully with these issues. At the request of many developing countries, it has undertaken a number of cooperative efforts, involving both technology transfer and financial aid.

In the area of technological cooperation, Japan has recently implemented 15 comprehensive projects with 12 developing nations that face deforestation crises. In the projects, Japanese forestry experts are sent to these countries to study the problem and to help devise strategies of response; equipment is offered on a grant basis; and foreign trainees are invited to Japan to learn sophisticated forest management techniques. The projects cover such wide areas as maintenance and creation of tropical forests, development or improvement of forestry management, and research into forest ecosystems.

Altogether, some 80 Japanese forestry specialists have received long-term assignments in developing countries that face deforestation problems, and 100 foreign trainees are being invited to Japan each year for higher training at a comprehensive forestry institute and other institutions affiliated with the Forestry Agency of the Ministry of Agriculture, Forestry and Fisheries.

As part of these cooperative projects, Japan also offers various forms of financial aid, including the donation of equipment and facilities needed for forestry training and study, together with cooperation in feasibility studies for establishing strong forest management programs in the host countries.

As the same time, Japan contributes funds to the Food and Agriculture Organization (FAO) and the International Tropical Timber Organization (ITTO) to help finance projects dealing with deforestation problems.

The Forestry Agency also conducts a variety of cooperative projects on its own, including surveys of tropical forests using the *LANDSAT* earth observation satellite; the implementation and diffusion of forestation (i.e., tree planting) technology in tropical areas; and research on how forestation technology might be used to combat "desertification," or the transformation of forests into deserts.

Tropical deforestation is a highly complex problem for which there probably

exists no simple, purely technological solution. Nor are Japan's aid programs aimed at finding such a quick "technofix." Instead, Japan is committed to understanding and approaching the problem at the level of the root cause, which involves not only scientific and technological problems but a web of political, economic, so-



Japanese experts check on newly planted trees in a tropical rain forest.



cial and cultural factors in each country.

One can easily point, for instance, to a number of obvious proximate causes of tropical deforestation: the burning of forests to make farmlands; use of increasing amounts of land for raising cattle; and the overcutting trees to obtain wood fuel. Just beneath the surface, however, lurks a tangle of difficult deeper causes: poverty, population growth, administrative failures and lack of expertise, technology and manpower.

With each passing year, the enormity of these problems is adding pressure on the developed world—where capital and technological expertise is concentrated—to help find a fresh and effective approach to avert massive tropical deforestation. Japan recognizes that until the root causes of deforestation are properly addressed, it will prove all the more difficult to find such a successful approach.

In May 1990, the director general of the Forestry Agency received an interim report from an advisory body that called on Japan to formulate a bold new initiative on the tropical forest issue. The report proposed that this initiative be based on the ideas of “sustainable development” and “keeping the earth green,” so that the present generation may pass on a healthy planet to the not-so-distant generations of the 21st century.

The specific recommendations of the report included proposals that Japan: (1) hold a conference of senior forestry officials from around the world; (2) promote forestry aimed at maintaining the earth’s environment; (3) promote proper utilization and control of existing tropical forests; (4) appeal to the world for the need to quickly establish a 10-year emergency international “Green Preservation” program to protect endangered plant and

animal species; (5) help to establish a system to promote this emergency program.

The Forestry Agency is taking the lead in implementing Japan’s international forestry cooperation programs, which are based on the interim report’s recommendations. The agency has many decades of experience through its 10 million hectares of domestic forestation, and also has long experience of cooperation in overseas forestry programs. It now faces the challenge of putting this expertise to good use in Japan’s international cooperative projects designed to help protect the world’s endangered tropical forests. ■

*Satoru Shimazaki is assistant director for Planning and Policy, International Forestry Cooperation Office, at the Forestry Agency.*

## Efforts to Cut CO<sub>2</sub>

By Hidefusa Miyama

The greenhouse effect. Scientists have spoken of it for years, but never before with such urgency. Today there is a growing consensus that global warming is a reality, with potentially traumatic effects on the global climate, ecosystems and human civilization itself.

The theory is straightforward. Suspended in the atmosphere, various gases and particulate matter form a huge barrier analogous to greenhouse glass, thus producing a global warming effect. The gases include carbon dioxide (CO<sub>2</sub>), methane, chlorofluorocarbons (CFCs) and nitrous oxide (N<sub>2</sub>O). CO<sub>2</sub> is believed to be the chief villain, blamed for some 55% of the warming effect. CFCs cause some 24% of the warming, but are also eroding the ozone layer that shields the earth from solar radiation. For this reason, the various CFCs now in commercial use are being phased out, with the final deadline set for the year 2000.

Resolving the global warming problem

will require efforts to reduce the far more widespread CO<sub>2</sub> emissions. The first practical measure is energy saving, including increasing the use of renewable natural energy sources. However, as long as humankind continues industrial activity, it will be difficult to substantially reduce CO<sub>2</sub> generation.

It therefore becomes necessary to capture and recover CO<sub>2</sub> after it has been generated, from exhaust gas. Today Japan, as with flue-gas desulfurization and denitrification in the recent past, has become one of the first countries to begin research for this new goal.

Most present research is being conducted by government-run institutions, such as the National Research Institute for Pollution and Resources, the National Chemical Laboratory for Industry and the Fermentation Research Institute—all controlled by the Agency of Industrial Science and Technology. Other public research institutions include the University

of Tokyo, the Tokyo Institute of Technology, Kyoto University, Osaka University and other schools. The Central Research Institute of the Electric Power Industry, the research arm of Japan’s electric power companies, is also engaged in research, as are other industries.

Particularly noteworthy projects are being promoted by a new nonprofit organization, the Research Institute of Innovative Technology for the Earth (RITE). RITE, only established in July 1990, launched several unique projects late last year, some of which make innovative use of biotechnology to fix CO<sub>2</sub>. These projects are described below:

### Fixing CO<sub>2</sub> with microorganisms:

RITE’s biotechnology-based CO<sub>2</sub> fixation scheme begins with a search for plant plankton or bacteria capable of active photosynthesis. Once such microorganisms are found, researchers will try breeding them to improve their capability, and