some cases they die, leaving the reefs vulnerable to erosion. During a massive bleaching episode in the tropical eastern Pacific, which has been closely linked with the near-record warm waters of the 1982–83 El Niño Southern Oscillation, Peter Glynn, a marine biologist at the University of Miami, found not only widespread mortality—up to 85% on the Panamanian reefs—but also the apparent extinction of two coral species, he told the group in Miami. (Also see *Science,* 5 July, p. 69.)

But while the culprit was fairly easy to discern in the eastern Pacific—the waters were unusually hot—that is not the case for the recent episodes in the Caribbean. They do appear to be linked to high temperatures, but the temperature anomalies are smaller and the connection more nebulous, says Glynn. Mark Eakin, NOAA's representative at the meeting, agrees: "The data are suggestive but far from statistically convincing." Good in-situ temperature records exist for only a few sites around the Caribbean, Eakin explains. "For most areas, the best we can do are satellite observations, which just give you the 'skin' temperature, and that is not necessarily what the corals feel." The rest of the data come from ships, which do take deeper measurements, but typically far from the reefs.

Using these admittedly crude measurements, various investigators, including Goreau and Hayes, have discerned a correlation between elevated water temperatures and recent episodes of bleaching in the Caribbean. But as intriguing as those findings are, says Robert Buddemeier, a reef expert at the Kansas Geological Survey, it is "extremely difficult to argue from a local scale to a regional scale to a global scale with any logic or conviction." He suspects, as do many of his colleagues at the meeting, that local high temperatures may be acting synergistically with other stresses to trigger bleaching. One possibility, he says, is that elevated nutrient levels may lower the threshold for bleaching, so that temperatures that did not bother corals 30 years ago might do so now, since waters are more polluted.

Indeed, the group concluded that the biggest threat to reef health worldwide is not global warming or transient high temperatures but rather "the cumulative effect of local perturbations" from population growth, land use, and resource exploitation, says Christopher D'Elia, director of the University of Maryland Sea Grant College and the principal organizer of the meeting. "We are quick to worry about climate change but not so quick to worry about local effects," he adds.

The reefs of Southeast Asia are especially vulnerable, said the group. Not only is rainfall high, which leads to freshwater runoff and sedimentation, but population pressures and environmental problems are rife. At this stage, however, next to nothing is known about the status of those reefs. "It is a major area of ignorance," says Buddemeier. "Finding out what is going on there ought to be a high priority."

To figure out what is happening to the world's reefs, the group recommended monitoring not just seawater temperature but such physical and chemical parameters as light, wave energy, and water quality. The more challenging problem, says Buddemeier, "is to develop the biological and ecological monitoring techniques that could be related to physical environment and could be compared among sites and over time." Such monitoring could cost millions of dollars a year, but most of it could come from redirecting and coordinating ongoing efforts, says Buddemeier, "with just a modest amount of new funds."

Collecting enough data to confirm or deny the link to global warming could take 10 to 15 years, the group estimated. In the interim, they called for "retrospective monitoring," by which they mean an attempt to discern past environmental variations and coral response from coral growth bands.

The group also urged the federal agencies to fund more research in coral physiology and adaptation, in order to predict how corals might respond to greenhouse warming. On the climate modeling side, too, improvements are needed to predict accurately just how high seawater temperatures might rise. Based on runs with two existing atmospheric models, which are still quite crude, Linda Mearns, a climatologist at the National Center for Atmospheric Research, predicted daily temperature excursions of up to 3° to 4°C, if atmospheric levels of carbon dioxide double—clearly enough to trigger bleaching. Lab experiments have shown that an increase above warm summertime temperatures of just 1° or 2°C for several weeks, or 3° or 4°C for a day or two, can induce bleaching. But how quickly the reefs might recover from such temperature-related stress, or what their ultimate fate might be, remains unknown. ■ LESLIE ROBERTS

Geographic Fission on Fusion

Cooperation in large international scientific projects often comes with a political price, and the International Thermonuclear Experimental Reactor (ITER), an ambitious attempt to build a working fusion reactor, is no exception. ITER's four international partners—the United States, Japan, Europe, and the Soviet Union—agreed last week to proceed with the reactor's 6-year, $1-billion engineering design phase. The political price was a complex arrangement to spread the work over three continents.

The design phase was scheduled to start at the beginning of this year, but bickering over the site for the work brought negotiations to a standstill. "For roughly 6 months, Japan, Europe, and the U.S. have gone to the negotiations with their own home site as their first choice, and no second choice," says a U.S. fusion physicist who spoke on condition of anonymity. That deadlock was finally broken last week when the partners accepted a plan to establish ITER centers in San Diego; Garching, Germany; and Naka, Japan (*Science*, 31 May, p. 1241).

Billed as a "compromise" between siting the activity in one country and splitting it equally between three, the new plan places most management and coordinating responsibility in San Diego. The centers in Garching and Naka will take charge of designing and building reactor component prototypes.

Attempts to internationalize the project as much as possible don't end with the site selections. While none of the site directors has yet been named, their countries of origin have been decided—and the whole scheme resembles a game of musical chairs. The director of the San Diego site will be a Soviet; the director in Garching will be an American; and the Naka director will be a European. (A Japanese will serve as chief deputy at the European site.) The partners have also set up an ITER Council—resembling a corporate board of directors—in Moscow, to be chaired by a Soviet. Sources within the fusion community say the director of the entire project, although not yet named officially, will be Paul Rebut, a Frenchman who is currently director of the Joint European Torus.

Some critics have charged that splitting the project among three sites would create serious management difficulties. "Absent any other considerations, when you're building a large project, you'd do it in one place," acknowledges Alexander Glass, leader of the U.S. engineering team. "[H]ere, we had other considerations."

■ DAVID P. HAMILTON