ERTS: An Earthwatch from Orbit

The Earth Resources Technology Satellite is giving scientists a window from space to see the middle view between tedious, earthbound measurements and planet-wide theories that overshoot local and national concerns

by Jonathan Eberhart

Despite all the probing, sampling and analyzing of our planet by scientists around the globe, earth is in a way still a sphere of mystery, confronting researchers with much the same problem as that facing an ant trying to understand a mountain by crawling laboriously over every inch of its surface.

Localized observations are easy enough, and when it has enough of them the ant can try to meld them into theories about the whole mountain. But there's a hole in the middle: area surveys. Any given patch on the mountainside may be too small to fit the ant's broad theories but still big enough to take a lot of study time. Some of those middle-sized features, in fact, just get lost completely.

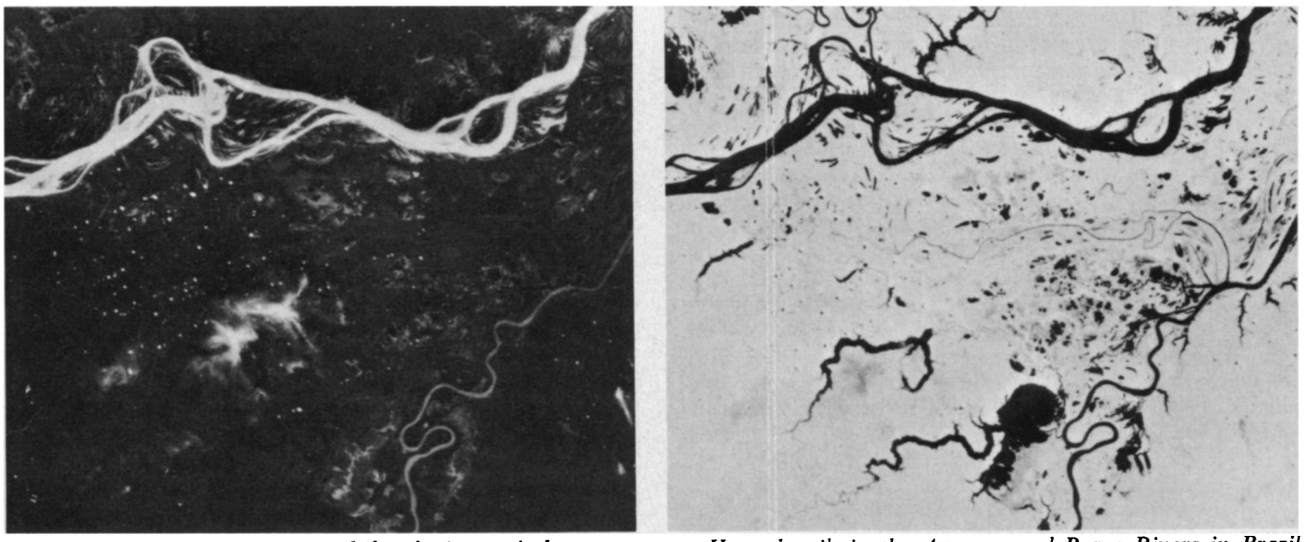
Into this hole, for the human scientists at least, comes the Earth Resources Technology Satellite. Often condemned in its planning stages as an overpriced and unnecessary substitute for land and airborne studies, ERTS-1 was launched last July 23 and has already shown the middle view to hundreds of researchers around the world. Two weeks ago those scientists met to describe their findings. Most felt the satellite had fulfilled or exceeded their expectations.

By mixing images from the four wave bands of the satellite's spectral photometer, watchers through the ERTS window have seen and charted crops, fires, ice floes, water and air pollution, geological features and rich potential mineral deposits.

And it's cheap. Including a second satellite which hasn't even been launched yet (and won't be until 1976, due to even tighter budgets), as well as a huge data-handling complex at the Goddard Space Flight Center in Maryland and financing for more than 300 scientist window-watchers, the ERTS program is costing about $172 million.

One key uncertainty was how well the satellite would be able to distinguish separate features on the earth, about 570 miles below. A good answer came from a 3,200-square-mile site in Arizona, where ERTS photos were able to discriminate among 29 separate types of vegetation. In California's Imperial Valley, investigators found that they could separate fields that were fallow, freshly plowed, newly sown (detectable by recent irrigation) or bearing crops. In Maryland, the sediment of the Anacostia River clearly stood out from that of the Potomac, as well as from organic mud flats and those of mineral origin. One researcher compared summer and winter photos of the Canadian Arctic and found that if he waited until a light snow cover was on the ground, thereby masking the varying reflectivity of soil, rocks, water and vegetation, it became much easier to detect dikes, sills, bedding, folds, faults, incised valleys, glacially caused flattenings and other features.

Most of the ERTS studies, in fact, have been largely devoted to learning the ways of the scientists' new tool, but many also produced immediate practical results. A possible new copper deposit turned up in Pakistan ("One of those could pay for the whole satellite if we owned it," observed a NASA official). Photos of the lower Mekong Delta in Laos, Thailand and Vietnam provided a vital flooding and drainage



Key to ERTS' success is its multiband views of the same area. Here the silt in the Amazon and Purus Rivers in Brazil shows by red light (left), while infrared (right), useful for crop studies, reflects from the dense vegetation of the jungle.

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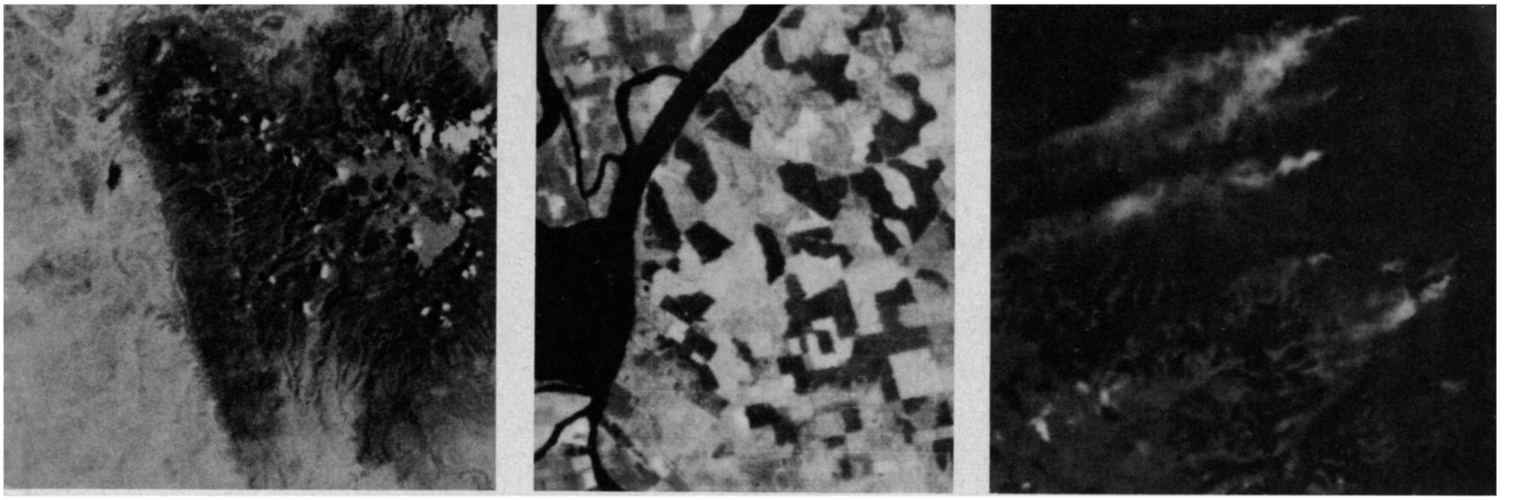


Photos: NASA

Geological fault and alluvial fans in New Mexico, crop conditions in central California, forest fires in Alaska.

survey that had been unavailable for years because of security restrictions on access to conventional methods. The Managua, Nicaragua, site of last December's tragic earthquake produced a virtual graph of the lines along which the earth movement could have taken place.

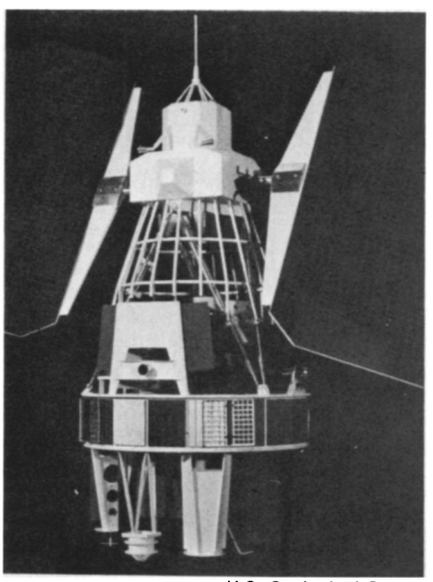
The ready availability of the ERTS data in usable form—sometimes just a few minutes of computer time away instead of days, weeks or months—makes it particularly useful as a disaster monitor. Grass fires, for example, were tracked in much of southern Africa, where they are an ever-present threat during the dry season, including one in Botswana that successive satellite passes revealed to have spread over 70 square miles in 24 hours. A tense fire watch is also being kept through the ERTS window over the Oakland-Berkeley area in California, where unexpectedly frost-killed trees and a record growth of grass and wild oats is producing what has been described as "the greatest fire hazard of the century." A 200,000-acre plague of spruce beetles in Alaska, difficult to keep up with from the ground, has been not only mapped but also divided into areas of killed spruce, living spruce and spruce-hardwood mixture.

A prime example of ERTS time-saving is a map of Los Angeles County, in which ordinary photointerpretation of the satellite pictures revealed 177 selected topographic features, 250 streams, 26 parks, 51 golf courses, 60 grading sites, 24 cemeteries and several hundred other details. Even when the photos were enlarged more than 40 times, even a more rapid automatic multispectral analysis system was able to produce adequate detail for routine use in county and regional planning.

Man made pollution is a key ERTS target. Smoke plumes have been spotted, along with their dispersal patterns, over much of Virginia. Ocean dumping and surface pollutant films have been plotted around New York, including acid-iron wastes, sewage sludge and suspended solids. Other photos showed underwater effluents being piped into the Niagara River feeding Lake Ontario, a 15-mile patch of iron oxides and sulfuric acid dumped at sea off Corsica, strip mine and acid mine damage in the United States and elsewhere, tide-washed sewage confronting beaches in New Jersey and numerous other debacles.

In the Andes, ERTS mapped 500 volcanoes (13 of them active) and easily picked out the former shorelines of some Pleistocene lakes. A meandering river was followed in Spain; shifting desert sands charted in Africa, Asia and Australia; chlorophyll and plankton detected in the Atlantic and ice floes monitored in the Arctic.

ERTS will get a boost this summer from an elaborate instrument package aboard the manned Skylab space station, now scheduled for a mid-May launch. The Earth Resources Experiment Package, EREP, will carry a spectrometer similar to the satellite's, but with 13 separate wave bands instead of four. There will also be half a dozen cameras with different combinations of filters and black and white, color and infrared film. An earth terrain camera will provide straight visual topographic photos, while microwave and L-band radiometers will measure reflectivity, thermal radiation and brightness temperature of the land and water below.



U.S. Geological Survey

ERTS: *Beyond all expectations.*

Another plan is to use ERTS in conjunction with the Smithsonian Astrophysical Observatory's Center for the Study of Short-Lived Phenomena. The Center receives reports from investigators all over the world about events and discoveries in danger of changing significantly before scientists can study them, and relays them out along its network of contacts as an alerting system. The ERTS plan is for the Center to report out observations by the satellite, and also to offer its own reports as targets for observation from space.

Even as scientists are excitedly poring over the satellite's data, others are already working out ways to improve it. Researchers are developing ways to compensate for solar effects, atmospheric disturbances, geometric distortions and even the individual variations between components in the ERTS instrumentation. Other programs are under way to correct parts of the photos that are not taken from directly overhead as well as to improve the picture quality by computer processing of the direct data from the satellite.

The hope is that ERTS-1 will last a full year, but project officials say there are no telemetry deteriorations to suggest that it won't go on even longer. "The ERTS system has performed exceptionally well," says Stanley C. Freden, its acting project scientist, "meeting or exceeding its specifications. Analyses of the data," he says, "are proving more fruitful and valuable than even our most optimistic projections had predicted." □