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Home > User Resources > Sensing Our Planet > Fish in the Trees

Fish in the Trees [1]

by Rachel Hauser
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Only in the Amazon do fish live where birds fly. Six months of the year, from December to May, the Amazon River floods the surrounding rainforest, allowing fish increased habitat during the rainy season.

Because of the difficulty of gaining access to the Amazon rainforest interior, however, little is known about flooding extent. In addition to obtaining a clear picture of Amazon flood patterns, scientists are interested in determining the amount of water stored on floodplains during the wet season, and the proportion of herbaceous versus woody vegetation that are important unknown parameters in regional biogeochemical and hydrologic models.

> An international collaboration may lead to accurate assessments of water storage on Amazonian floodplains during rainy seasons.
> - About Alaska SAR Facility (ASF) [2]

Historically, obtaining any satellite data from the Amazon basin has been as difficult as gaining physical access; radar images have provided the only reliable source. Since the 1970s, the Brazilian government has acquired enough radar data to issue a series of maps outlining the basin, constituting a basis for many pioneering Amazon studies.

Recently, the Japanese, with help from the Brazilians and Americans, have begun a new mapping effort using satellite remote sensing that offers several advantages over earlier projects. Since mid-1995, a synthetic aperture radar (SAR) aboard the Japanese Earth Resources Satellite-1 (JERS-1), has been collecting data from the world's tropical forests. The first data acquisitions of this project were of the Amazon rainforest during the low flood season of 1995.

It took 62 days to map the Amazon from coast to coast. Longer radar wavelengths, provided by the SAR, penetrated both clouds and forest. The return signal reveals the state of flooding beneath the forest canopy, simultaneously allowing remote sensing scientists to distinguish between woody and herbaceous plants.

Once collected, data were downloaded to the Alaska SAR Facility (ASF) for processing into high resolution images (12.5 meters), which were then sent to the Jet Propulsion Lab (JPL) in California, where they were converted to 100-meter resolution images. The images were also converted to a graphical file format and provided to the public via the World Wide Web. Finally, the images were sent to the National Space Development Agency (NASDA) Earth Observation Research Center in Japan, where individual images could be mosaicked to form large, geocoded images of geographic regions.

With the high resolution data, scientists are able to determine the extent of flooding by comparing water extent for the dry and wet seasons. Knowledge of flood extent and land cover distributions will offer new insight into the Amazon's contribution to global methane emissions, said researcher Laura Hess, of the University of California, Santa Barbara. "There are no current estimates on the relative proportions of woody versus herbaceous vegetation in the Amazon floodplain," said Hess. "This becomes important because the methane generation for flood macrophyte beds is generally much higher than for flooded forests."

"Floating meadows are very productive, floating masses of grass. The stems elongate as the water rises and a canopy develops at the top of the water. Grasses can reach several meters in length and float at the top of the water. As water levels recede, the stems begin to decay. This causes a bubbling of methane and high methane emissions," said Hess. "The proportion of floating meadows increases as you go toward the mouth of the Amazon and the river channel geomorphology changes."

In addition to enhancing biogeochemical models, the Amazon data sets will be important for evaluating the health of fisheries that are essential to the physical and economic welfare of the people inhabiting the Amazon

basin, said Hess.

Fish from the Amazon are a popular export to Asian countries, especially Japan. They are also a key element in the diet of people living along the Amazon River. Because of the high protein content of their diet, inhabitants along the river are much less likely to be malnourished than rural people in regions without fisheries, said Hess.

As the Amazon River rises, fish move through river channels into the floodplains. Some fish, such as the tambaqui, are specially adapted to the flooded forest environment. A keen sense of smell leads the tambaqui to fruit which has fallen from the tree tops to the water. The tambaqui are genetically adapted with powerful jaws and teeth that enable them to consume fruit. Not only do they gain and store fat to last them through the dry season but in the process they propagate the tree species by providing a dispersing mechanism for the seeds.

Over the past 15 years, naturalist Michael Goulding has noticed a steady decline in the size of many of the fish. This, together with increasing agriculture, raises concern about over-fishing and habitat depletion especially in the lower Amazon where extensive agricultural production already exists and continues to expand.

The satellite mapping has many applications. These include enhancing scientific knowledge of river habitat, improving the existing geomorphologic information base on the Amazon basin, and providing functional data sets for geochemical modeling. The availability of this data set will offer scientists a greater understanding of the role of floodplains in the basin's hydrology and ecology, said Hess.

The international effort to map global rainforests is not limited to the Amazon nor is it limited to SAR data exclusively. Since radar can image day or night, cloudy or clear, SAR data make it possible to study seasonal changes. Mapping of floodplain vegetation and sediment concentrations of river channels and lakes is also being carried out by Brazilian and American scientists using Landsat Thematic Mapper data. Landsat data offer a much longer data record, dating from the 1970s, offering researchers more detailed information on land use changes, but the optical instrument can take years to acquire cloud-free coverage over the entire basin.

Rather than abandoning Landsat data for new technology, scientists are using SAR to continue the available record. The regions with the best images, that is those with the least cloud cover, are archived in three blocks of time, the early-1970s, mid-1980s, and early 1990s. The desired outcome of fine-tuning the Landsat data is two-fold. The first outcome is to ensure that past data collection efforts are not lost, the second is to facilitate global change research. Data acquisition and processing are currently underway in Southeast Asia and Africa, and archived Landsat data are being used to facilitate global research.

New Mapping Effort

The Global Rainforest Mapping Project (GRFM) is an international effort, involving space agency players from Japan (NASDA), the United States (NASA), and Italy. The Joint Research Center (JRC), in Isra, Italy is the lead center for African data, said Bruce Chapman, a researcher at JPL. The JRC will be processing SAR data collected over Africa, just as the Jet Propulsion Lab does for South American SAR data, he said.

SAR images of Central and West Africa were taken in the first months of 1996, and Central Africa was imaged again between October and November 1996. Southeast Asia (including New Guinea, the Phillipines, Indochina, Sumatra, Borneo, Java, and Sulawesi) were imaged in late 1996.

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