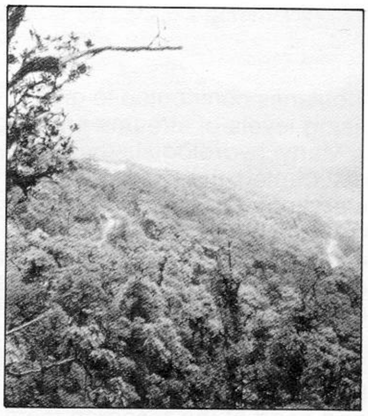
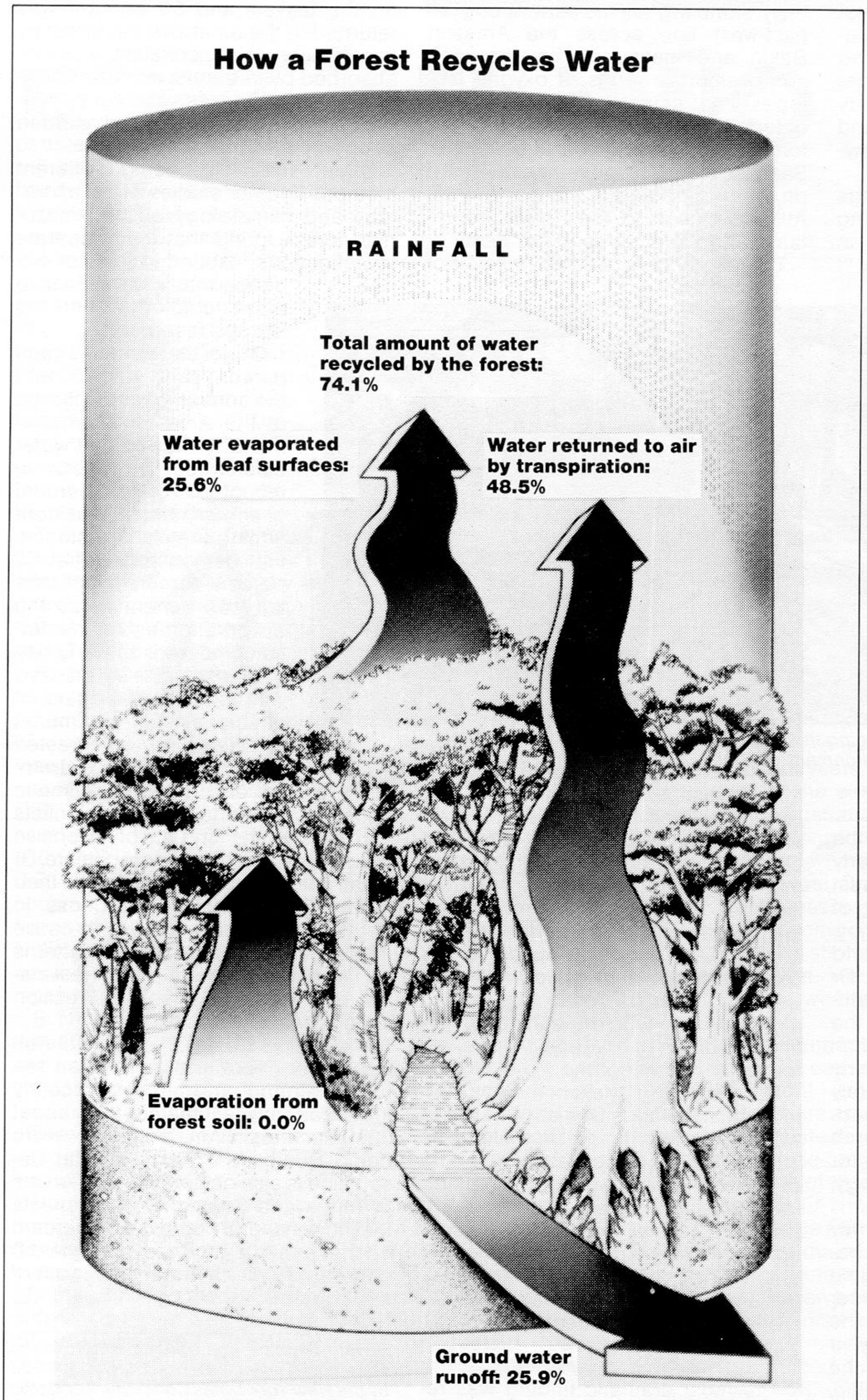
FOREST WEATHER

BAYARD WEBSTER

THE ROLE OF FORESTS IN GENERATING WEATHER





Researchers studying the dynamics of South America's tropical forest have produced scientific evidence showing with precision for the first time that a forest can return as much as 75 percent of the moisture it receives to the atmosphere. The finding indicates that the forest plays a much more important role in weather generation than had been previously believed.

The pioneering study, conducted in the world's largest forest in the Amazon River Basin, is also the first to show that the amount of water a forest gathers can be returned to the air in large enough amounts to form new rain clouds. Naturalists had long thought there was some relationship between forests and rainfall, but evidence for such a connection had largely been circumstantial or anecdotal.

The new research also indicated that land covered by trees collected and returned to the air at least 10 times as much moisture as bare, deforested land, and twice as much as land where grasses or plants other than trees predominated.

Other data gave evidence that water runoff is greatly increased without the heavy mass of vegetation to break the fall of rain, and that the rate at which water infiltrated the soil was considerably lower in compacted pasture soils than in other types. These two findings mean that most of the runoff from precipitation travels relatively far from the site and is not easily returned to the atmosphere. And the study also showed that removal of trees adjacent to rivers or their tributaries contributed to greater runoff, rising levels of streams and flooding.

Many hydrologists had previously discounted the possibility that forest clearance or replacement by pasture or crops would have any major impact on amounts of rainfall, water balance, and flooding. The new findings were reported in a paper submitted to the American journal *Science* by Dr Eneas Salati, a professor of meteorology at the University of Sao Paulo in Brazil and head of the research team.

The study group, made up of forest ecologists, hydrologists, oceanographers, and others from South and North America, is credited with developing the most sophisticated study so far of the role played by forests and the atmosphere in relation to the hydrological and nutrient cycles.

Dr Salati believes that the findings could be helpful in land-use planning and forest protection programs in temperate and tropical forest zones. "I think we have shown that the water and energy balance — the life support system — of a land area depends on the kind of cover you have on the land," he said.

It is not yet known how the basic finding of the study, that a large forest can generate its own weather patterns, may be applied to forests in the temperate zone. Forests in varying geographical areas with different wind patterns, temperatures, soil composition and terrain, and affected by differing external forces, have correspondingly different internal water and nutrient dynamics.

GLOBAL IMPLICATIONS

"The implications of this study for the rest of the world are that it clearly shows that natural vegetation must play an important role in the forming of weather patterns," Thomas E. Lovejoy, vice-president for science of the World Wildlife Fund, said in an interview. Dr Lovejoy is conducting a study of different kinds of ecosystems in the Amazon River Basin.

As tropical forests make up nearly one-half of the world's approximately 124 million square kilometres of wooded land, the results of the new research are expected to have significance for all scientists studying forest ecology, hydrology and energy balance.

"In other forests, the conditions may be different, but the underlying mechanisms shown in this study are the same all over and the implications for proper land use are not confined to the Amazon," said Dr Jeffrey Richey, a member of Dr Salati's team from the University of Washington in Seattle, U.S.A.

And although the study does not show that a large forest may influence weather and climate patterns far from the forest, many scientists think its ability to create clouds and rainfall may significantly affect global weather patterns. Such an effect could occur from changes in solar heat reflection caused by the formation of clouds above a forest. When clouds form, the temperature of the earth below them changes, a major factor in generating winds and weather.

By sampling air moisture along an east-west line across the Amazon Basin and measuring its changing composition in terms of oxygen isotopes, the scientists were able to determine how much moisture the forest recycled into the atmosphere. Samples of water vapour were collected on the ground and in the air from the Atlantic Ocean to the Andes mountains, 3200 kilometres to the west.

The researchers used as the basis of their investigation the fact that the isotope oxygen 18 is found in known amounts in water vapour and rain clouds from the Atlantic. They knew that oxygen 18, one of the heaviest isotopes in water vapour molecules, falls preferentially to earth when it rains. Thus, in theory, as the prevailing winds from the east moved moist air westwards across Amazonia, rainfall along the way would greatly diminish the proportion of oxygen 18 as well as the water content of the moist air.

But they found by examination of the molecular composition of the air and water vapour at many sites along its 3200-kilometre route that the amounts of moisture and oxygen 18 remained fairly constant, indicating that the forest was recycling rain back into the atmosphere in large quantities. Over the entire range of the Amazonian forest, the amount of recycled rainwater averaged about 50 percent.

Photo: Jack Redden

Logging in Peru. Extensive destruction of the forest environment will undoubtedly cause major changes in climate.

RECYCLING MOISTURE

The most dramatic finding was reported by the team leader, Dr Salati, who is also director of the Center for Nuclear Energy and Agriculture in Sao Paulo. He cited studies that showed that the forest near Manaus in Brazil recycled 75 percent of rain back into the atmosphere by evaporation and transpiration.

In that area, approximately 25 percent of the rain was diverted into stream runoff that transported the water far from the site. But another 25 percent was evaporated back into the atmosphere from raindrops that stayed on the leaves, and 50 percent was returned to the air above the forest by transpiration. In transpiration, moisture absorbed by tree roots from the soil is carried by the plant's vascular system back up to the leaves and exuded through their pores.

Other scientists, using different methods in other studies of the hydrology and climatology of the Amazonian forest, found that their separate investigations resulted in lines of evidence that were similar to those obtained from the isotope research.

One of these studies compared yearly rainfall with the annual water discharge of the Amazon and other rivers. It showed that water discharged by rivers amounted to only 44 percent of annual rainfall, thus confirming the isotope studies that demonstrated that 50 percent or more of the rainfall was generated by the evaporation and transpiration processes of the forest.

These studies are credited with focusing the attention of scientists on the impact forested and nonforested land can have on hydrological cycles and regional climatic patterns. And although few scientists can predict the impact of extensive forest destruction on global climate, Dr Salati and his colleagues state in their report that extensive forest loss in South America will undoubtedly cause major changes in weather patterns and agricultural practices in the Amazon Basin, an area of some 4.2 million square kilometres.

The United States Office of Technology Assessment and a Brazilian forest-monitoring program have recently independently estimated that about 6000 hectares of Amazonian forest are being leveled every day. Similar destruction is also occurring in the forests of Africa and Southeast Asia, forests that have hitherto occupied 50 percent of the existing land area in the 10 degrees of latitude north and south of the Equator. □

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