



Flows

News on Payments for Watershed Services

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Review: Science in the Mist and the Mysteries of Cloud Forests

In theory, cloud forests have high value because they capture water from clouds in addition to that provided by normal rainfall, which can be particularly important during dry seasons. Given that they are generally wet and inhospitable, and cover relatively small areas of tropical forests, they should also be easy to protect. In practice, the amount of water intercepted from clouds is notoriously difficult to actually measure. It is also not clear how much of this additional water comes from clouds or from wind-driven rain, and how much of the additional water captured enters streams, and is therefore available for human use. There are also many people who have no options other than to clear them for pasture, and, by the way, the climate is changing.

These questions were among many addressed at the recent international symposium on *Mountains in the Mist: Science for Conserving and Managing Tropical Montane Cloud Forests*. Cloud forests are characterized by unique and diverse levels and combinations of some common characteristics. These include: frequent cloud cover, high rainfall, high winds, high altitude, wet and often waterlogged peaty and acid soils, low temperatures and, at higher elevations, dwarfed and gnarled trees along with a greater abundance of mosses and *epiphytes*. These are plants that grow attached to other vegetation, such as ferns, bromeliads, and orchids. Not having roots in the soil, they have become particularly efficient at capturing and storing water from the air, and have driven the design of elaborate experiments and measuring devices intended to find out what they do with it.

Estimates of the amount of water added by cloud interception reported in the literature range between 19% and 79% a year for upper montane cloud forests (Bruijnzeel, 2001). This percentage can be even greater in just the dry seasons, when even small amounts of water can be significant for insuring a steady supply. In the case of Mt. Kilimanjaro, the loss of 15,000 ha of cloud forest that have been destroyed by fire since 1976 due to climate change alone may have resulted in an annual loss of 20 million m³ of water intercepted by fog-stripping, according to estimates presented by Andreas Hemp. This amount of water may be quite significant for the water supply and ecosystems of Northern Tanzania. However, as Bruijnzeel cautions, these are estimates rather than direct measurements. Even if correct, questions remain of how much of the intercepted water actually enters streamflow, and how much is trapped by epiphytes and never reaches the ground.

Given the variety of conditions that are found, perhaps the most pronounced characteristic of cloud forests is that they are highly variable, and dynamic mountain ecosystems. Like clouds, treelines also move in response to both climatic changes and human uses of land, which have a long history. So, while more direct measurements are crucial, science cannot be expected to completely eliminate the uncertainties. Given the imperiled status of cloud forests, failure to take action would simply seal their fate.

The challenge to scientists is to translate research findings into protocols and rules of thumb that can be used as guidance for establishing priorities in areas where there are high rates of land use change. Ultimately, the value of protecting cloud forests needs to be considered in the context of a basin-wide landscape approach, and options for sustainable uses of mountainous areas. Payments are one of many tools, and provision of water one of many different reasons to save a

cloud forest, such as the beauty of an orchid. Like other forests, they may have more value for protecting water quality than for increasing the supply of water.

References and sources of further information

The content of this bulletin generally reflects presentations from participants in the symposium: [Mountains in the Mist: Science for conserving and managing Tropical Montane Cloud Forest](#). 2nd International Symposium – TCMF 2004. July 27-August 1, 2004, Hawai'i Preparatory Academy, Waimea-Kohala, Hawai'i

Subsequent follow-up comments were provided by Sampurno Bruijnzeel, Andreas Hemp, and Ina Porras via personal electronic communication.

General background information on cloud forests can be found in the following reports:

Bubb P., May I., Miles, L. and Sayer, J. [Cloud Forest Agenda](#) (pdf) UNEP WCMC IUCN UNESCO

Bruijnzeel, L.A. and L.S. Hamilton. 2000. [Decision Time for Cloud Forests](#). UNESCO, WWF, IUCN IHP Humid Tropics Programme Series No. 13

More specialized reports and research papers related to cloud forests:

Aylward B. & Echeverría J. (2001) Synergies between Livestock Production and Hydrological Function in Arenal, Costa Rica. *Environment and Development Economics*, 6, 39-382.

The above is among the most comprehensive economic valuation study done to determine the value of cloud forest areas for water supply. On-line papers and reports, freely available, and based on the same study are:

Aylward B., Echeverría J., Allen, K., Mejías R. & Porras I. T. (1999) [Market and Policy Incentives for Livestock Production and Watershed Protection in Arenal, Costa Rica](#).(pdf) CREED Working Paper 25, International Institute for Environment and Development, London

Aylward B. & Fernández González A. (1998) [Institutional Arrangements for Watershed Management: A Case Study of Arenal, Costa Rica](#).(pdf) CREED Working Paper No. 21 International Institute for Environment and Development, London

Aylward B. & Tognetti S. (2002) [Valuation of hydrological externalities of land use change: Lake Arenal case study, Costa Rica](#).(pdf) Land and Water Linkages in Rural Watersheds Case Study Series FAO, Rome

Becker, C. D. & Ghimire, K. (2003) Synergy between traditional ecological knowledge and conservation science supports forest preservation in Ecuador. *Conservation Ecology*, 8, 1. [online] <http://www.consecol.org/vol8/iss1/art1>

Becker, C.D. 1999. [Protecting a Garúa Forest in Ecuador: the Role of Institutions and Ecosystem Valuation](#). *Ambio*, 28:2, pp. 156-161

Bruijnzeel, L. A. (2001) [Hydrology of Tropical Montane Cloud Forests: A Reassessment](#). *Land Use and Water Resources Research*, 1, 1.1-1.18.

Bruijnzeel, L. A. (2004) [Hydrological functions of tropical forests: not seeing the soil for the trees?](#) *Agriculture Ecosystems and Environment*, 104.

Sarmiento, F. 2002. [Impulsores de Cambio del Paisaje: Dinamica de las Lineas de Arboles en la Montologia Neotropical](#). Human Drivers of Landscape Change: Treelines Dynamics in Neotropical Montology. *Ecotropicos* 15(2). (In Spanish, abstract provided also in English)

Sarmiento, F.O. and Frolich, L.M. (2002) Andean Cloud Forest Tree Lines: Naturalness, Agriculture and the Human Dimension. *Mountain Research & Development*, 22, 278-287. [Abstract](#)

Other links:

IUCN, UNEP, WCMC, [Mountain cloud forest initiative](#)

Documentary film: Decision Time for Cloud Forests. [Ordering information](#)

[Cloud Forest Alive](#) – Weekly nature lessons, photos and information about the Cloud Forests of Central America and the MesoAmerican Biological Corridor

Feedback and Commentary

If you have a good rule-of-thumb, or other comments, please send them to comments@flowsonline.net

Resources

FAO/Netherlands International [Conference on Water for Food and Ecosystems](#) - 31 January – 4 February 2005, The Hague, The Netherlands. [Conference bulletin](#) (by IISD)

CONDESAN (Consortio para el Desarrollo Sostenible de la Ecorregion Andina). Experiencias y métodos de manejo de cuencas y su contribución al desarrollo rural en los Andes: Desafíos y oportunidades para lograr mayores impactos. Seminar, Bogotá Colombia, 8-10 November 2004. [Conference presentations](#) (Spanish)

Red Latinoamericana de Cooperación Técnica en Manejo de Cuencas Hidrográficas (REDLACH), [Revista Electrónica](#) – Número 1, Año2 (2005). (Spanish)

Hacia una Estrategia Nacional Para el Manejo Sostenible de los Recursos Naturales, [Resultados y Conclusiones del 1er Foro Nacional Pago Por Servicios Ambientales](#). Tegucigalpa, Honduras, 12-14 Noviembre del 2003.