

Forest futures



Often the role of forests and the forest sector is seen in a very traditional way: it is about timber, pulp and paper. The European Forest Institute has gathered together global examples of cutting-edge innovations in bioeconomy, agroforestry and ecosystem services, to demonstrate its full potential as a basis for a new economic model that prospers within our planetary boundaries.

Bioeconomy technology

Wood-based textiles

Biofuel for diesel and jet engines

Wood construction and technology advance in multi-storey wooden buildings

Forest operation technology

ZERO waste containment system

Agroforestry

Agroforestry in tropical climates

Farmer Managed Natural Regeneration

Agroforestry in temperate climates

Forest fires risk management with animal grazing

Other forest products and ecosystem services

Sustainable mushroom picking: rural revenue in Spain and Italy

Goat grazing for forest fire prevention in Andalusia

Public-private partnership for quality mineral water

Connecting private forest owners for collective biodiversity protection

Payments for watershed protection in Ecuador

Wood-based textiles

Location

Finland (Spinnova, Ioncell™) and Austria (Lyocell)

The innovation

There are several technologies which produce wood-based textiles: ioncell, spinnova and lyocell.

Briefing



Ioncell™ uses waste textiles, pulp or even old newspapers to create new textile fibres with ionic liquid as a solvent, which is environmentally friendly, can be recycled and isn't flammable. Spinnova turns cellulose and waste streams into textile fibre without dissolving chemicals, the process is based on mechanical treatment of the pulp, as well as fibre suspension flows and rheology. Lyocell fibre is made using a unique closed loop system which recovers and reuses the solvents used at a recovery rate of more than 99%, minimizing the environmental impact of production.

Many brands are moving into the market of wood-based clothing, both small and medium companies like Wijld (Germany), Allbirds (New Zealand), Textil Santanderina (Spain) and multinationals as Inditex or H&M, with a high impact both on the use of resources and at the end of the value-chain with a high consumers' share. The initiative 'Forests for Fashion' from PEFC, Programme for the Endorsement of Forest Certification, in partnership with the

Source: Ioncell™

UNECE and FAO, is linking forest-based materials from sustainably managed forests with the world of fashion.

Fibre innovation Ioncell™ gained widespread attention after Finland's First Lady Jenni Haukio wore an evening dress made of the wood-based fabric at the annual Independence Ball in December 2018.

In November 2019, Lenzing Group began construction on a 400 million euro lyocell production plant in Asia, with a capacity of 100,000 tons a year.

Weblinks

[Ioncell](#)

[Spinnova](#)

[Lyocell by Lenzing](#)

['Forest for fashion' showcase](#)

[PEFC and its 'Forest for fashion' initiative](#)

Biofuel for diesel and jet engines

Location

Finland and Sweden

The innovation

Bio-based fuels for aviation and ground-based transport

Briefing



In transport different types of fuel are used depending on the engine and mode of transport, such as diesel, gasoline or jet fuel. To replace fossil fuels is a major challenge to the bioeconomy in terms of providing the technological maturity, the possibility to admix with fossil and renewable fuels and the bulk volumes.

Currently several companies are developing market solutions: UPM BioVerno for diesel engines, Neste MY for diesel engines and jet fuel for aviation, Swedish Biofuels for jet fuel, gasoline and diesel. The feedstock for these fuels includes different bio-based sources ranging from vegetable-based oils, wood and pulping residues to waste animal fats and municipal solid waste.

Source: © Neste

UPM BioVerno is made from crude tall oil (CTO), a residue of pulp production. UPM has been producing renewable diesel from CTO in its Lappeenranta biorefinery since early 2015, and the plant has a capacity of 100,000 tonnes renewable diesel. According to studies, tailpipe emissions such as particle mass, hydrocarbon, carbon dioxide, nitrogen oxide and carbon monoxide emissions are reduced by up to 10% compared to conventional diesel fuel, and the greenhouse gas emissions (CO₂) over the entire production chain are as much as 80% lower than those of fossil diesel fuel.

Sustainable Aviation Fuel (SAF) from renewable waste and residues, with up to 80% less CO₂ emissions is being produced in Porvoo, Finland. It is compatible with the existing jet engine technology and fuel distribution infrastructure when blended with fossil jet (ASTM D1655).

Weblinks

[UPM Biofuels factsheet](#)

[Crude Tall Oil report](#)

[What is renewable jet fuel](#) (Neste My Jet)

[Neste MY products](#)

Wood construction and technology advance in multi-storey wooden buildings

Location

Austria and Sweden, global

The innovation

Wood construction and structural timber has and is evolving rapidly to allow for high-rise wooden buildings and hybrid-material constructions. Cross-laminated timber (CLT), glue-laminated timber (Glulam), laminated Veneer Lumber (LVL), and modular preconstruction of full house elements in factories allow timber to be competitive, versatile and economic compared with non-wood-based materials such as cement or steel.

Briefing



Source: HoHo

One example is the HoHo-Haus in Vienna, until recently the world's highest wooden building with 24 floors and 84 m height, and a gross floor area of 25,000 m². It is 74% wood. To follow Austrian fire protection requirements, the core (staircase and exits) are made from concrete, with the wooden structure (commercial spaces, offices, hotel) surrounding it. The floor system is a composite of CLT and cement in pre-fabricated elements. The self-supporting timber elements include also the exterior walls and columns.

In November 2019, Stora Enso launched a new building concept that makes it easier for architects, engineers and developers to design office buildings from wood. The flexible, modular wooden office concept enables office adaptation and demonstrates how the building products and applications can be used in a way that meets fire safety and acoustics regulations.

While innovative technologies for wood construction are coming into the spotlight, some companies already have a couple of years of manufacturing high quality modular apartment buildings with wood as a backbone. For example, Lindbacks produces and sells prefabricated 2-4 storey timber frame houses that accommodate students, families and elderly people. Based in Sweden, it produces sustainable cost-effective and custom-made housing with fixed furnishings and aims to show how prefab construction can scale.

Weblinks

[HoHo Vienna](#)

[Stora Enso massive wood construction](#)

[Swedish modular housing](#)

[Lindbacks](#)

Forest operation technology

Location

Finland and Austria

The innovation

Technological advances in hybrid machines (Finland) and winch-supported systems (Austria) for improved accessibility and mobilisation of timber from small assortments and steep terrain.

Briefing



Winch-supported harvester on a very steep slope in Austria. Source: Michael den Herder (EFI)

To provide timber for the bioeconomy, small-dimensioned timber and hard-to-reach places also need to be included in production in a safe, economic and environmentally friendly manner. While forest machinery for fully mechanised harvesting is well evolved, the latest cutting-edge improvements are in terms of hybrid engines (diesel and electric hybrids) and a shift from motorsaw felling to winch-supported harvesters and forwarders in steep terrain.

In precision forestry advancements, the next big leap in efficiency is in digitalisation for increased efficiency and more gentle harvesting. Digitalisation aims for increased value chain efficiency, such as improved communication and tracking of loads and information between several operators from forest to mill. Gentle harvesting can include wet area maps detailing low soil-bearing capacity and routes to avoid

during operations. Unmanned machines (remote control or fully automatic) are still in the future.

Weblinks

Winch-supported systems:

[Winch assisted forwarders on steep terrain under real working conditions](#)
[Forwarder on a steep slope](#) (video, Tech4Effect project)

Hybrid chipper:

[Electric hybrid chipper](#) (Kesla)
[Wood-chipping technology and comparing a new hybrid chipper to traditional chippers](#)

ZERO waste containment system

Location

Galicia, Spain

The innovation

The ZERO waste skip system is a clean response to the current model of plastics that prevails in urban waste management.

Briefing



ZERO is a refuse disposal system intended to replace plastics-based urban waste management. Starting from the imperative need to take care of the environment, Ocean Kube proposes the replacement of plastic containers with new, recyclable and biodegradable cardboard and aluminium ones.

The way it is manufactured and printed makes it easy to be reprocessed, encouraging a circular economy. The used paper is up to 91% recycled and supplied almost entirely by Saica Paper. This ensures high quality paper and a safe chain of custody since Saica Paper is certified according to FSC and PEFC standards.

This new model aims also at reducing noise pollution as much as possible, relevant in the future of biocities. The bins are designed to draw the attention of the user and society to their sustainability and efficiency. It is fully compostable and suitable for anaerobic digestion processes.

Source: OceanKube

Weblinks

[OceanKube](#)

[Launching campaign video](#)

[Saica-Paper](#)

Agroforestry in tropical climates

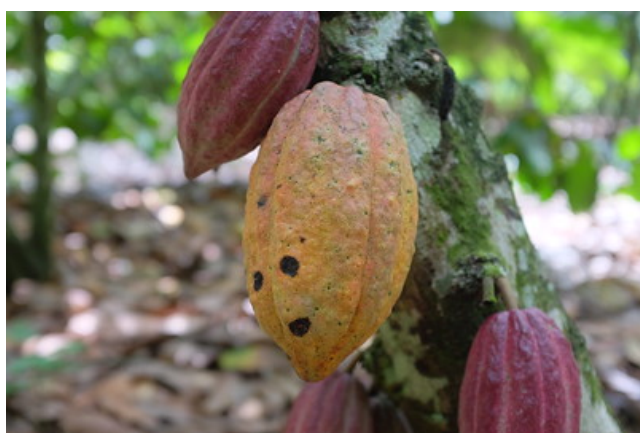
Location

Côte d'Ivoire

The innovation

Deforestation-free cocoa production

Briefing



Côte d'Ivoire's deforestation rate is one of the highest in the world. The national forest cover dropped from 50% (16 million hectares) of the total country area in 1960 to 10% (3.4 million hectares) in 2016. The expansion of cocoa production is the key direct driver for this rapid forest cover loss.

Côte d'Ivoire has taken ambitious commitments to decouple cocoa production from deforestation and restore forest cover to 20% of its territory by 2030. The challenge remains how to engage smallholder cocoa producers into sustainable practices, such as agroforestry or replantation. Smallholder farmers, most of whom live close to the

poverty line, lack the financial capacity to invest in input or seedlings that would provide them increased yields or alternative revenues. Land tenure insecurity and illegal logging practices also hinder the introduction of trees in cocoa plantations, or the reforestation of degraded areas.

To overcome these challenges, in 2016, Mondelēz International, Côte d'Ivoire's largest cocoa buyer, and the Government of Côte d'Ivoire entered into an innovative public-private partnership to test the practicalities of Payment for Ecosystem Services (PES) modalities. A local PES was introduced to contribute to forest cover restoration by promoting agroforestry, reforestation and conservation by mobilising and building support for local actors. The mechanism is based on voluntary contracts between local cocoa farmers or communities and the PES operator to implement zero-deforestation activities in exchange of technical and financial support.

As of October 2018, **156 agroforestry PES contracts** have been signed, thereby covering a total area of about 600 hectares. **Three nurseries**, run by local women cooperatives, with a total production capacity of 100 000 plants have been created to provide the necessary amount of seedlings for the project. **611 cocoa farmers** have received technical training on agroforestry practices, such as growing seedlings and caretaking of the trees. These trees give shade for the optimum growth of cocoa trees. By producing fruits or wood, they provide alternative sources of income for farmers.

Weblinks

[Deforestation-free supply chains: a PES pilot project in Côte d'Ivoire](#)

Farmer Managed Natural Regeneration

Location

Niger, Ethiopia, Zambia, Uganda, Kenia, Rwanda, Somalia, Mali and Senegal

The innovation

Restoration of degraded areas in sub-Saharan Africa through Farmer Managed Natural Regeneration (FMNR).

Briefing



In the late 1970's and early 1980's, vast areas in sub-Saharan Africa were heavily degraded because of long periods of drought, overgrazing and removal of trees for firewood and making space for large-scale intensive agriculture.

Tony Rinaudo and World Vision have pioneered Farmer Managed Natural Regeneration (FMNR). In heavily degraded areas, there still might be some naturally regenerating tree seedlings and living tree stumps hidden in the surviving and often very sparse understory vegetation. By protecting and careful pruning of these remaining seedlings and dwarf shrubs they can develop again into larger shrubs and eventually trees. By restoring shrub and tree cover, soil organic matter is slowly restored and through the tree roots and the shadow provided by the trees, the soil water holding capacity is also gradually restored. Eventually, crop cultivation and livestock husbandry can become possible again under tree cover. The trees also

It is estimated that in Niger 60 million trees were planted from nurseries over a 20 years period with less than 20% survival. However, there are millions of living tree stumps in farmlands, grazing lands and degraded forests across Africa and other countries with the potential to regrow into a tree if pruned and managed properly. Source: Tony Rinaudo (World Vision Australia).

provide a source of fuelwood which is important as most households rely on fuelwood for cooking.

Weblinks

[The benefits of FMNR](#) (video)

[Regreening Africa](#) is restoring ecosystems in 8 countries and improving the resilience of 500,000 households across sub-Saharan Africa

[\\$85 million initiative to scale up agroforestry in Africa announced](#)

Agroforestry in temperate climates

Location

Europe

The innovation

Agroforestry diversifies your farm, farm income and enhances the environment

Briefing



Pines and Vines at Restinclières, France. Source: AGFORWARD project

Alley cropping, or planting woody perennials in rows in arable or vegetable fields, is an innovative idea worthy of exploration by farmers seeking both an additional long term income, rather than income based solely on annual production, and to increase the environmental resilience of their system.

Large areas of farmland in Europe suffer from wind and water erosion, leaching of excess nutrients and nowadays with ongoing climate change, even drought damage in summer. Planting trees in farmland reduces evapotranspiration in crops creating an enhanced microclimate for crop production. In addition, the trees

provide a habitat for insects and birds. The insects provide pollination services enhancing crop production, and beneficial insects provide natural predator control. Therefore, this system fits very well in organic farming. When well-planned it is possible to use large-scale agricultural machinery creating a system that is profitable for the farmer and better for the environment.

Weblinks

[Series of factsheets helping farmers to get started](#)

[Agroforestry tutorial videos](#) (AFINET Project)

[Innovation leaflets](#) (AGFORWARD project)

[Agroforestry in the UK, video tutorial](#)

[Sheep as forest managers in Finland](#)

Forest fires risk management with animal grazing

Location

Catalonia, Spain

The innovation

The 'Ramats de Foc' label (Livestock against fires) promotes the continuity of livestock activity and helps to prevent wildfires.

Briefing



The sustainable management of forests and landscapes is important for reducing the risk of wildfires in the Mediterranean region.

Silvopastoralism, which integrates livestock, forage and trees, is a common practice with high benefits for society. These include landscape conservation, fire risk management, and the production of high quality meat and dairy products. But the presence of herds and shepherds is becoming increasingly uncommon, leading to the growth of fire prone forests.

In Catalonia, meat and dairy products are marketed under the label 'Ramats de Foc', fire flocks. The herds contribute to the risk management of fires through grazing in forest areas, and the label certifies the herds' fire risk management tasks and adds value to the farmers' products. The project strengthens the links between wildfire management services, farmers and local butchers and restaurants. Consumers contribute to creating and maintaining these fire-adapted landscapes by the simple action of consuming products from nearby herds. The project is promoted by the Regional Government.

Source: Ramats de Foc project

Weblinks

www.ramatsdefoc.org/en

Sustainable mushroom picking: rural revenue in Spain and Italy

Location

Navarre, Spain and Borgotaro, Italy

The innovation

Mushroom reserves and harvesting permits allow for a greater protection of mushrooms as an ecosystem service, generating rural income and boosting the area's tourism sector around this forest asset.

Briefing



Ultzama and Borgotar valleys, with Borgotaro's PGI logo top right

In Spain and Italy, regulating controlled mushroom picking and managing forests to increase productivity in mushroom reserves offer essential opportunities for rural revenue. Furthermore, wild fungi marketing and tourist services related to this valuable product are seen as key forest ecosystem services.

In Spain's [Ultzama Valley](#) in the region of Navarre, a dozen local entities have been teaming up to outsource the management of a mushroom reserve to a local company since 2006. Through this system, they issue around 2,500 harvesting permits a year which offers

greater control of social pressure on the forest and mushroom production. Thanks to this regulation, the valley's 6,000 hectares mycological park is a revitalising factor for the territorial marketing of the area, encouraging the activity of mushroom picking in a more sustainable way, which in turn promotes other activities such as ecotourism services or mushroom fairs.

In the case of Italy, three municipalities of the [Borgotaro](#) valley, with a long tradition of mushroom picking (specifically *Boletus edulis*), also decided to build an alliance around mushroom collection. Approximately 420,000 EUR have been obtained per year by selling mushroom collection permits and the area earns around 2.8 million EUR annually from tourism services. A consortium to promote the Protected Geographical Indication (PGI) of the Borgotaro mushroom controls the collection of fungi in their forests. The PGI gives the Borgotaro mushroom special recognition in the market and is an example of successful mycological regulation for the area, as it covers both commercial and recreational picking along with territorial marketing strategies.

Full information

Górriz-Mifsud, E., Marini Govigli, V., Antonio Bonet, J. (2017). What to do with mushroom pickers in my forest? Policy tools from the landowners' perspective. *Land Use Policy*. 63:450-460. doi.org/10.1016/j.landusepol.2017.02.003

Secco, L.; Pettenella, D.; Maso, D. (2009) 'Net-System' Models Versus Traditional Models in NWFP Marketing: The Case of Mushrooms. *Small-Scale For.* 8:349-365. <https://doi.org/10.1007/s11842-009-9088-0>

Weblinks

[What is mushroom picking worth?](#)

Goat grazing for forest fire prevention in Andalusia

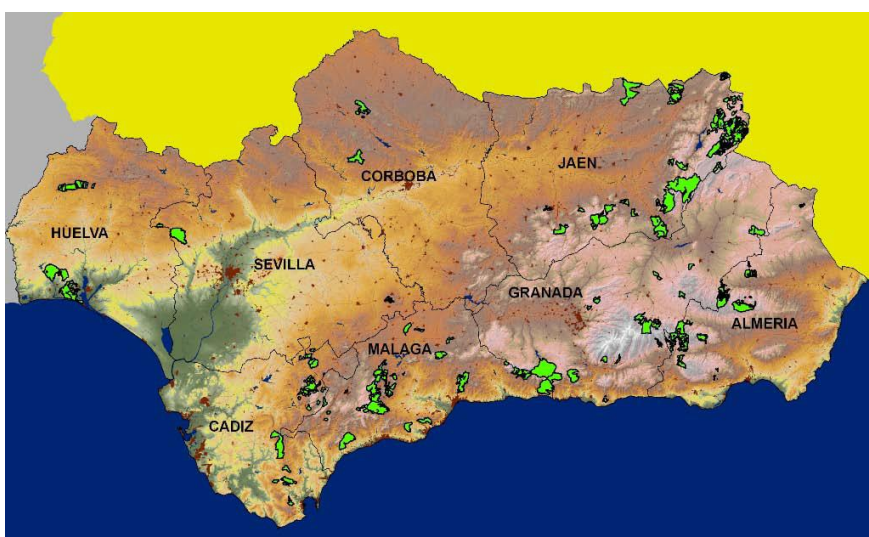
Location

Andalusia, Spain

The innovation

Agreements between shepherds and forest services provide efficient green technologies for reducing forest biomass and maintaining a fire-resilient landscape.

Briefing



Picture caption

Grazing activity has been widespread for millennia in the Mediterranean, playing an important role in shaping its landscapes. Today, innovative contracts are providing additional income and social recognition to shepherds working to reduce the risk of forest fires.

In 2005, the Andalusian Forest Service in Spain initiated a system of conditional payments to shepherds for bringing their herds to less productive forest areas identified as crucial for forest fire prevention. Shepherds receive instructions on how grazing should take place (exact location of firebreaks, intensities expected to reduce biomass) and, after a field control, they receive annual compensation payments.

This approach saves up to 75% of the mechanical cleaning costs that would otherwise be needed. Goats act as cheap, biological lawn mowers that prevent forest fires and are guided by shepherds for precision grazing. Shepherds are hired to maintain a clear fire break between urban spaces and the forest.

In 2016, 223 shepherds participated in this initiative carrying out grazing activity on 1200 hectares in the region of Andalusia. This meant that goat herds contributed to the protection of more than 6800 hectares of public forests through the implementation of natural firebreaks and the reduction of biomass.

Full information

Varela, E., Górriz-Mifsud, E., Ruiz-Mirazo, J. & López-i-Gelats, F. 2018. *Payment for targeted grazing: Integrating local shepherds into wildfire prevention*. Forests, 9(464). <https://doi.org/10.3390/f9080464>

Weblink

[Andalusian Network of Grazed Fuel Breaks](#)

Public-private partnership for quality mineral water

Location

Vittel, north-eastern France

Area

5100 ha catchment (mostly pastures)

The innovation

Payments to farmers to reconvert to extensive low-impact dairy farming have proven benefits on aquifer water quality and are shown to be profitable.

Briefing



Vittel – a reputation based on an enduring image of health and vitality (Photo: D. Perrot-Maître, from [The Vittel payments for ecosystem services: a “perfect” PES case](#))

In the 1990s, mineral water bottler Vittel (Nestlé Waters) started looking at solutions for the declining water quality in its main catchment at the foot of the Vosges Mountains. In 1993, they implemented a Payment for Ecosystem Services (PES) scheme in order to maintain the high quality of aquifer water. The scheme pays all 27 farmers in the watershed of the “Grande Source” to adopt best practices in dairy farming.

The scheme is implemented through Agrivair, an agricultural extension agency, which has a solid local base and is trusted by farmers. It has persuaded farmers to reconvert to extensive low-impact dairy farming, including abandoning agrochemicals, composting animal waste, and reducing animal stocks.

The scheme is fairly complex in design, combining conditional cash payments with technical assistance, reimbursement of incremental agricultural labour costs, and even arrangements to take over lands and provide usufruct rights of the farmland to the farmers. Contracts are long-term (18-30 years), payments are differentiated according to service provision costs on a farm-by-farm basis, and both land use and water quality are closely monitored over time.

Total costs (excluding the intermediary’s transaction costs) have been over €24.25 million from 1993-2000, or an estimated 980€/ha per year. This is equivalent to 1.52€/m³ of bottled water produced. Careful research shows a clear improvement of previously declining water quality, showing that the PES investments are profitable.

Full information

Perrot-Maître, D. (2006) [The Vittel payments for ecosystem services: a “perfect” PES case?](#) International Institute for Environment and Development, London, UK

FAO 2013. [The Vittel Case: A public-private partnership in the mineral water industry.](#)

Connecting private forest owners for collective biodiversity protection

Location

Central Jutland, Denmark

The innovation

Traditional government subsidies for biodiversity protection do not always effectively accommodate private forest owners. Reverse auction schemes can provide higher biodiversity impacts for the same amount of money.

Briefing



Denmark's private forest land hosts rich biodiversity

Most of Denmark's lush forests are on private land whose ownership is distributed among nearly 25,000 individuals, foundations and firms. As this large number of owners suggests, the parcels are mainly small patches of forest land, posing challenges to consistent forest management at a landscape scale. Nevertheless, Denmark's private forest land is home to some of the most unique and interesting populations of endangered animal and plant species locally, and fosters the highest overall forest biodiversity in Denmark, despite large regional variations. There is an urgent need to

bring privately-owned forest areas into broader forest management frameworks, connecting small forest parcels into a larger patchwork of ecosystems in order to connect suitable habitats and preserve biodiversity.

Research shows that private forest owners are ready to participate in biodiversity creation and protection if given appropriate incentives. This pilot project seeks to re-think existing public grant schemes for biodiversity protection on privately owned land. The innovative mechanism, implemented in this real-life case study, is a "reverse auction" whereby forest owners offer biodiversity conservation measures they are willing to implement on their land, which are bid on by public entities. In this way, rather than taking the form of prescriptive measures imposed or compensated by a government entity, this mechanism places emphasis on stakeholders' agency to offer their forest services, within limits set only by their own imagination and expected outcomes. This experience shows that a competitive bidding process can improve the coordination and cost-effectiveness of nature conservation efforts, as well as the engagement of landowners.

Full information

Thorsen, B. J., Strange, N., Jacobsen, J. B., Termansen, M., & Lundhede, T. (2018). [Auction mechanisms for setting aside forest for biodiversity](#). University of Copenhagen. IFRO Report, No. 267

Weblinks

[Reverse auctions for biodiversity protection](#)

Payments for watershed protection in Ecuador

Location

Northern Andes region, Ecuador

Forest area

638 ha micro catchment (focus forest protection)

The innovation

Improving a city's drinking water delivery through water bill surcharges paid by the city inhabitants which are used to stop upstream land being deforested for farming subsistence.

Briefing



Pimampiro PES case (650 ha)

Views from Pimampiro: from watershed to city

In 2000, after a long and severe drought and infective hydraulic infrastructure, the Municipality of Pimampiro in the Northern Andes of Ecuador needed new measures to improve the level of drinking water for its 12,951 inhabitants. Inspired by experience from Costa Rica, they established a local Payment for Ecosystem Services (PES) scheme, to protect native vegetation in the Palaurco River upper watershed which delivers the city's drinking water.

The NGO **CEDERENA** designed the PES as part of a forest management plan, including also ecotourism and *mise on valeur* of Non Timber Forest Products. Worried citizen and urban water users accepted to pay a surcharge on their

monthly water bill to improve watershed management and secure water. These funds are paid to seven indigenous upstream households that had been deforesting for pasture and potato crop expansion.

Payments per hectare were relatively small (6-12 USD), but applied to quite large remaining forest holdings by the resident families, providing a secure cash income for landowners. Hydrological modelling indicates that a hypothetical resumption of 'business as usual' deforestation (some 100 ha extra being cleared) would increase sediments by more than 50% and reduce dry-season flow by 0.5%, figures which underpin the economic rationale for the PES scheme.

Full information

Wunder S and Albán M. 2008. Decentralized payments for environmental services: the cases of Pimampiro and PROFAFOR in Ecuador. *Ecological Economics*; 65: 685-698. <https://doi.org/10.1016/j.ecolecon.2007.11.004>

Quintero M, Wunder S and Estrada R.D. 2009. For services rendered? Modeling hydrology and livelihoods in Andean payments for environmental services schemes. *Forest Ecology and Management*; 258: 1871-1880. <https://doi.org/10.1016/j.foreco.2009.04.032>

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