IWMI International Water Management Institute
BRIEF SERIES

WATER ISSUE BRIEF

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Putting Research Knowledge into Action

1 Water quality: Why land management matters

The key to effective management of water resources and their quality is understanding that the water cycle and land management are intimately linked.

Every land-use decision is a water-use decision. Improving water management in agriculture and the livelihoods of the rural poor requires mitigating or preventing land degradation which can include erosion, agrochemical pollution, nutrient depletion, salinity, reduced plant cover, loss of soil organic matter and other forms of land degradation resulting in inappropriate soil management.

Key messages

- Declining water quality and soil degradation are growing problems as the world's uplands continue to be cleared while lowlands are intensively farmed in response to population pressures, government policies and market demands.
- Sustainable land use practices in the whole watershed are a key requirement to improving water quality conditions in downstream communities.
- Uptake of sustainable practices has not been that high globally because there are insufficient or inappropriate incentives for farmers to change their habits or encourage them to engage in more sustainable practices. This might change now.

The context

Agricultural activities influence water quality in two main ways. First, unsustainable farming practices in upland areas usually cause soil erosion. The rain washes the loosened soil downstream causing lakes, rivers and other water bodies to silt up. Heavily silted water bodies can cause flooding and prevent dams from working effectively. Over time, the upland soil structure is damaged and depleted of nutrients. The land becomes less productive and more soil washes away in a vicious cycle. If the cycle continues, the soil eventually becomes unusable. This is a growing problem as the world's uplands continue to be cleared and intensively farmed in response to population needs, government policies, market demands and the spiral of land degradation. On the other hand, some of the fertility lost in uplands is deposited in lowland areas where it supports intensive crop production such as in paddy fields.

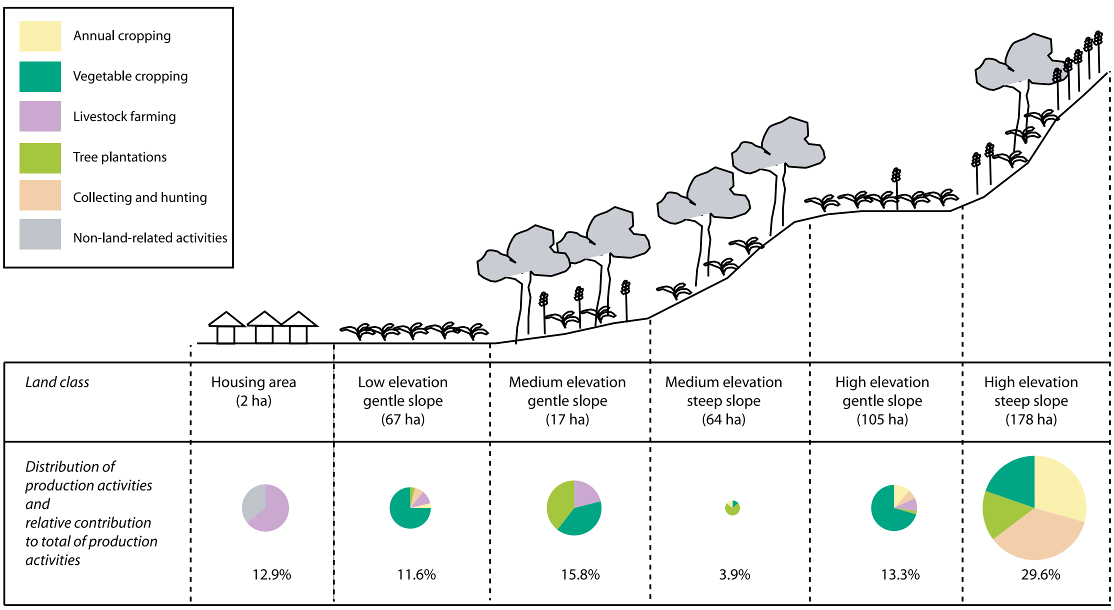
Second, too much use of fertilizer and pesticides has another impact on water quality. Chemicals are also included in runoff with rainwater and end up in rivers, lakes and the sea. In regions such as Africa, where fertilizer use is relatively light, the additional nutrients are sometimes beneficial to farmers downstream. However, in Asia, where agrochemicals are often subsidized, rivers can become overloaded with nutrients. This can lead to eutrophication, where algae or other plants grow excessively. Eutrophication disrupts ecosystem functions by depleting oxygen, and killing fish. If fertilizers and pesticides enter groundwater that is used for drinking, this can also result in human health problems.

IWMI's position on land management in rural areas of Southeast Asia

A considerable amount of research has been undertaken to find ways to prevent soil eroding from upland areas and prevent the inappropriate use of agrochemicals. The Management of Soil Erosion Consortium (MSEC), of which IWMI has been a member for ten years, focused on the common lack of data on river catchments across Southeast Asia. The Consortium comprises institutions in Indonesia, Lao PDR, the Philippines, Thailand and Vietnam, and IWMI and the Institut de Recherche pour le Développment (IRD) in France. Over several years, scientists of MSEC assessed runoff and sediment yields of different farming practices in 27 catchments and subcatchments in the participating countries. Their findings verified sediment loads and showed that implementing sustainable land use practices can help improve water quality conditions in downstream communities.

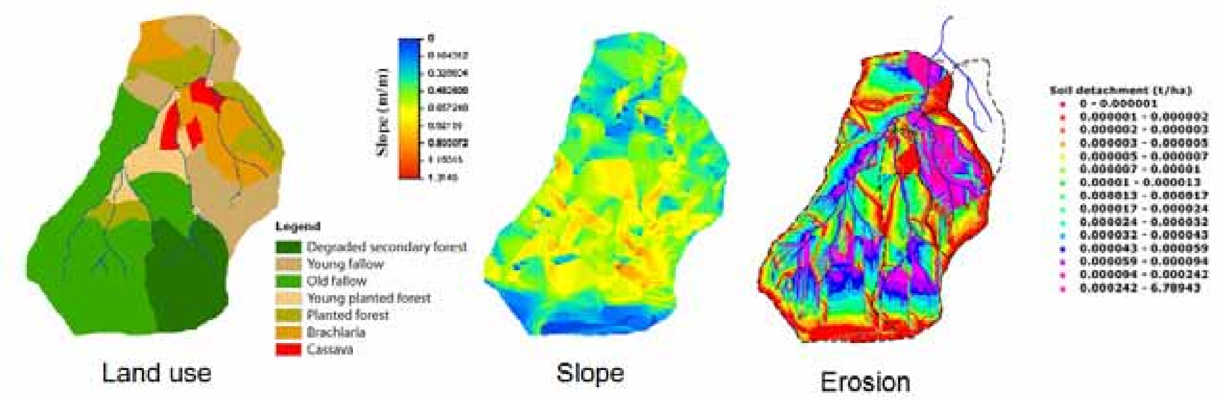
MSEC researchers gathered data on topography, soils, land use, rainfall, hydrology and erosion on long-term observation sites, and then carried out statistical analyses to find relationships between the different soil, climate and agronomic attributes. All sites showed that land use changes were having an impact at the catchment scale. For example, when farmers sought to earn more by intercropping rambutan plantations with cassava in one Indonesian catchment, the total sediment yield increased from 2.9 to 13.1 Mg (Mg = Megagram or tonne) per hectare (ha) per year. The scientists first identified farming practices that were causing erosion (for example, increasing cropping intensity or growing maize instead of rice). They then observed alternative practices that could help prevent erosion (such as planting fruit trees or sowing strips of native grasses along land contours) and measured erosion rates and sediment yields under the different land-use systems.

There were notable improvements in sediment yields when farmers adopted some of these conservation practices. A reduction in erosion rates was also observed when farmers extended the fallow periods; however, this is an increasingly rare option these days. A key result was that extreme rainfall events could completely overshadow any normally observed erosion, especially where it caused landslides. This is of significant concern in view of the increase of extreme events under all common climate change scenarios.



Typical distribution of production activities by altitude and slope characteristic in Lao PDR, Southeast Asia. *Source*: Lesterlin et al. 2005[1]. *Note*: the colored pie charts represent the distribution of production activities within an elevation/slope class. Their sizes are proportional to the contributions of a particular elevation/slope class to total of production activities.

[1] Lesterlin, G.; Giordano, M.; Keohavong, G. 2005. *When "conservation" leads to land degradation: lessons from Ban Lak Sip, Laos*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 30p. (IWMI Research Report 091)



Analyzing the relationships between land use, topography and erosion in Northern Vietnam. ***Source*****: Modified after Phai et al. 2007[2].**

Actions needed and how IWMI can help

Although the results suggest that changing farming patterns could considerably influence runoff and the associated downstream problems, uptake of sustainable practices has not been that high globally. IWMI scientists believe that this is because there is a lack of sufficient or appropriate incentives for farmers to change their habits or encourage them to engage in less sustainable practices. Scientists are now embarking on a project that will assess a benefit-sharing scheme between upland farmers and hydropower companies operating dams downstream. The idea is that hydropower companies, who have a vested interest in maintaining silt-free reservoirs, would directly or indirectly pay farmers to employ practices that cause minimal soil erosion. "We are exploring this possibility with a new project based in Lao PDR and Vietnam," explains Andrew Noble, IWMI's Director for Southeast Asia. "This region is undergoing rapid economic growth and development and has an insatiable demand for energy. Dozens of dams are being planned or are under construction to meet this need."

IWMI believes that the same principle, of using financial incentives to change farmer behavior, could help reduce pollution from fertilizers and pesticides. You cannot pay farmers to use less agrochemicals, but you could remove subsidies from those that are particularly problematic. For example, if phosphorus is dissolved in quantities liable to damage the environment or threaten human health, then it would make sense to remove subsidies on phosphorus-containing agrochemicals. This would encourage farmers to use damaging chemicals more sparingly. IWMI plans to investigate this possibility in future initiatives as it strives to support farmers' efforts to use more sustainable land management practices.

Finally, hydropower providers might particularly target conservation measures that reduce the fragility of slopes under heavy rainfall. This concerns agricultural practices and requires the support of reforestration measures, and the reduction of possible damage in areas of mining and road construction. However, as the MSEC results verified, not every tree stops erosion. The popular teak tree with its dense canopy, for example, does not support understory in the rainy season, and when the first rains begin it leaves the soil unprotected because it sheds its leaves in the dry season.

[2] Phai, D. D.; Orange, D.; Migraine, J. B.; Toan, T. D.; Vinh, N. C. 2007. Applying GIS-assisted modelling to predict soil erosion for a small agricultural watershed within sloping lands in Northern Vietnam. In: Gebbie, L.; Glendinning, A.; Lefroy-Braun, R.; Victor, M. (Eds.). *Proceedings of the International Conference on Sustainable Sloping Lands and Watershed Management: Linking Research to Strengthen Upland Policies and Practices, National Agriculture and Forestry Research Institute (NAFRI), Vientiane, Lao PDR, 2007.* Vientiane, Lao PDR: National Agriculture and Forestry Research Institute (NAFRI). pp. 212-228.

Source

This Water Issue Brief is based on:

(a) the discussions and presentations of the Inaugural Workshop on Relevance and Feasibility of PES to Combat Soil Erosion and Solve Catchment Management Issues at the 2nd International Symposium on Water and Food, November 10-14, 2008, Addis Ababa, Ethiopia;

and

(b) the following publications:

IWMI (International Water Management Institute). 2010. *Land and water resources management for upland farms in Southeast Asia: some lessons learned*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 4p. (IWMI Water Policy Brief 33)

Valentin, C.; Agus, F.; Alamban, R.; Boosaner, A.; Bricquet, J. P.; Chaplot, V.; de Guzman, T.; de Rouw, A.; Janeau, J. L.; Orange, D.; Phachomphonh, K.; Do Duy Phai; Podwojewski, P.; Ribolzi, O.; Silvera, N.; Subagyono, K.; Thiébaux, J. P.; Tran Duc Toan; Vadari, T. 2008. Runoff and sediment losses from 27 upland catchments in Southeast Asia: Impact of rapid land use changes and conservation practices. *Agriculture, Ecosystems and Environment* 128: 225–238.

Related IWMI Publications

Open access (electronic version freely accessible via the internet)

George, A.; Pierret, A.; Boonsaner, A.; Valentin, C.; Orange, D.; Planchon, O. 2009. *Potential and limitations of Payments for Environmental Services (PES) as a means to manage watershed services in mainland Southeast Asia. International Journal of the Commons* 3(1):16-40.

Molle, F.; Hoanh, C. T. 2009. *Implementing integrated river basin management: lessons from the Red River Basin, Vietnam*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 25p. (IWMI Research Report 131).

Noble, A.; Bossio, D.; Penning de Vries, F. W. T.; Pretty, J.; Thiyagarajan, T. M. 2006. *Intensifying agricultural sustainability: an analysis of impacts and drivers in the development of bright spots*. Colombo, Sri Lanka: International Water Management Institute (IWMI). 35p. (Comprehensive Assessment of Water Management in Agriculture Research Report 013).

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