Negotiation-support toolkit for learning landscapes

Editors
MEINE VAN NOORDWIJK
BETHA LUSIANA
BERIA LEIMONA
SONYA DEWI
DIAH WULANDARI

WORLD AGROFORESTRY CENTRE
Southeast Asia Regional Program

Van Noordwijk M, Lusiana B and Leimona B. 2013. Rapid hydrological appraisal (RHA): watershed functions and management options. *In:* van Noordwijk M, Lusiana B, Leimona B, Dewi S, Wulandari D (eds). *Negotiation-support toolkit for learning landscapes*. Bogor, Indonesia. World Agroforestry Centre (ICRAF) Southeast Asia Regional Program. P.120-125.

20 | Rapid hydrological appraisal (RHA): watershed functions and management options

Meine van Noordwijk, Betha Lusiana and Beria Leimona

Rapid hydrological appraisal (RHA) diagnoses the hydrological situation of a landscape and perceptions and ecological knowledge of its important stakeholders: local, general public and scientific domains. These perceptions and knowledge include information concerning trade-offs between local decisions on land-use practices that influence watershed functions, types of local institutions that can increase effective management of the watershed, and social relationships among stakeholders. The RHA enables an appraisal of the opportunities for negotiating land-use agreements that include rewards for protecting and rehabilitating watershed functions.

Introduction: watershed functions under threat

Water supplies are increasingly unreliable and insufficient during dry seasons; water quality at sources is increasingly poor and damaging floods are becoming more frequent. Improved watershed functions to circulate and store freshwater is an essential solution for such pressing problems. A number of initiatives are working to protect the critical functions of watersheds, including through providing incentives for people in the uplands to modify their land-use practices.

Land use can significantly affect water quantity and quality, water flow regularity, and watershed capacity to prevent landslides and erosion and to stop sedimentation in downstream areas. However, developing an effective incentive system requires clarity of the relationship between land use and provision of environmental services that are of sufficient value to stakeholders to become the basis for rewards (see general introduction to this volume).

Moreover, there are often substantial differences in perceptions among stakeholders in identifying watershed problems and their causes and providing solutions for improved watershed functions. Downstream stakeholders may perceive that only natural forests with high tree density can guarantee provision of environmental services. Upland land-users may encourage more open land-cover types, such as agroforestry, or even open-field agriculture or pasture, to meet their need for livelihoods and watershed functions. On the other hand, a government's response to this situation can either improve the situation or even worsen it, triggering conflict among stakeholders.

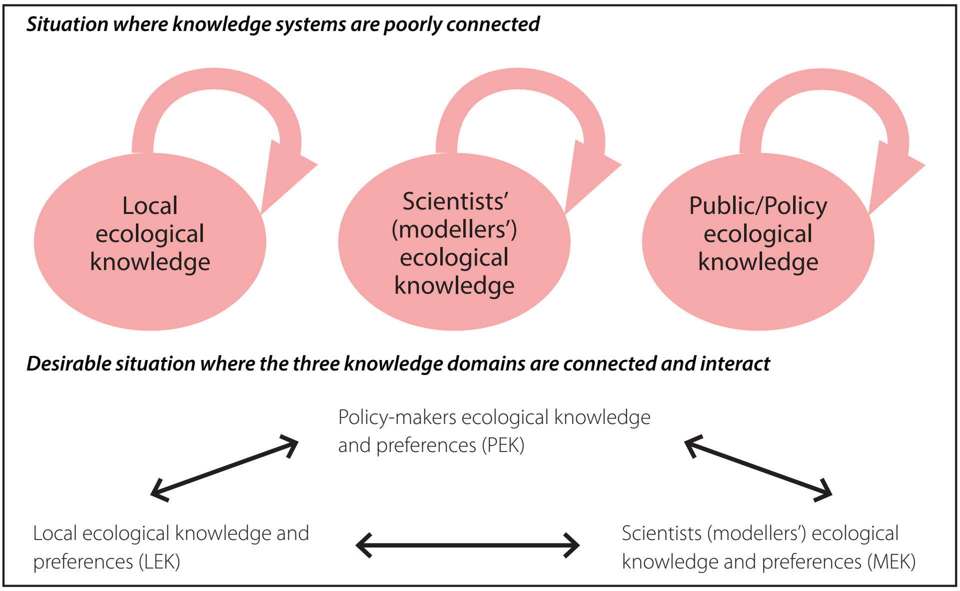

Figure 20.1. Disconnected and desirable interrelationships between three ecological knowledge systems
Note: compare with Figure 0.7

Developing a range of plausible scenarios for change may help negotiations among stakeholders. Appreciation of the various quantitative indicators probably varies by stakeholder group. Therefore, it's important to include the varying perspectives of 'local upland', 'local lowland', 'public policy' and 'ecological hydrology' in any negotiation process (Figure 20.1).

To understand the differing perceptions and their degree of similarity, we use RHA.

Objectives

RHA combines the participatory appraisal process and the use of computer-based, landscape-hydrological simulation models to:

- compare the overlap between stakeholders' perceptions of current and past patterns, process and impacts of land and water use;
- assess biophysical parameters of the watershed and its hydrological and environmental characteristics; and
- project forward the hydrological and environmental implications of current trends or future challenges in land- and water- use patterns through modelled land-use scenarios.

For negotiation purposes, the RHA contributes to a better knowledge system, thus, all stakeholders will be able to:

- understand local land-use patterns, the benefits they provide, alternative land-use options and the drivers of change;

- understand the impact of local land-use changes on watershed functions and the potential 'buyers' who are willing to provide incentives to maintain or enhance specific services; and
- evaluate the level of investment in future negotiations that can lead to a rewards mechanism that will deliver on stakeholders' expectations.

Steps

The approach includes the following activities, which can be carried out in less than 6 months.

1. Land cover/land-use change analysis (see ALUCT).
2. Exploration of the local knowledge of stakeholders about hydrological functions, water movement and the consequences of different land-use options for the landscape.
3. Exploration of the local knowledge of policy-makers about hydrological functions, water movement and the consequences of different land-use options for the landscape.
4. Compilation and analysis of existing hydrological data on the watershed, including a scenario analysis of plausible land-cover change and the likely impact on watershed functions. While watershed functions can include a range of hydrological functions, the RHA focuses on the subset that relates directly to surface water flows. These hydrological functions of watersheds include the capacity to 1) transmit water to freshwater stocks and flows; 2) buffer peak rain events; 3) release water gradually; 4) maintain water quality (sediment, nutrient, pollutants, bacteria leading oxygen demand); and 5) reduce mass wasting, such as landslides.

Table 20.1. Local, public/policy-makers', and modellers/hydrologists' ecological knowledge components

Local ecological knowledge	
Goal	Locally specific analysis of the problem and its causes and effects
Source of information	Key informants and village members
Documents needed	Base map as a foundation for participatory mapping
Questions asked and topics explored	Where are the 'hotspots' within the watershed that cause degradation? What are the existing land-use patterns in the watershed? Who contributes to the current land-use patterns? Why have these land-use patterns developed? What are examples of areas that decrease or buffer watershed degradation? Do good practices for solving watershed problems exist? What are those practices?
Public or policy-makers' ecological knowledge	
Goal	Analyse perceptions regarding watershed-level environmental and water resource problems and their causes and effects
Source of information	Government officers, community leaders and the general public, including downstream stakeholders
Documents needed	Base and thematic maps Environmental reports and watershed profiles
Questions and topics	What and where do watershed problems occur? Who caused the watershed problems? What are the reasons?
	What are the past and current 1) land-use; 2) forest-cover; 3) river-flow; 3) water quality and use; 4) lake; and 5) river problems?
	Are any development projects planned within the watershed? Will these projects cause environmental degradation?

Modellers or hydrologists' ecological knowledge	
Goal	Plausible land-use-change scenarios to analyse drivers and effects on watersheds
Source of information	Land-use modeller and hydrologist
Documents needed	Spatial data: topographic, landform, geology, soil, natural vegetation, land-use time-series and administrative maps Climatic data: daily rainfall Hydrological data: daily water level
Questions and topics	What changes have occurred in the watershed? What are the land-use-change drivers?
	How do land-use changes affect water balance and use within the watershed?
	What are the main indicators affecting watershed water quantity and quality?
	What are the land-cover effects on watershed water balance and river flow?

Case study: RHA at Lake Singkarak, West Sumatra, Indonesia

The first RHA was conducted at Lake Singkarak in West Sumatra, Indonesia, to assess the hydrological situation in the context of developing a payments for environmental services scheme aimed at rewarding the upland poor for protecting or rehabilitating watershed functions.

The study focused on the relationship between the operations of a local hydroelectricity company, fluctuations in the level of the lake, the water quality in the lake and the land cover in the catchment areas that contribute water to the lake. Payments made by the power company to the local government can, in part, be seen as rewards for maintaining or improving environmental services. Nevertheless, there was no shared understanding of the relationship between land cover and the environmental services provided.

The Singkarak Basin hosts rice fields (17%), agricultural crops (15%) and forests (15%). Rice fields occur in the lowland area, below 1000 masl and with slopes of less than 30%, commonly found in the southern part of the basin. Besides rice, other crops—mostly vegetables—are also found in the lowland plains up to 1000 masl. Mixed gardens, shrubs and grass are found in smaller patches all over the basin. In the higher elevations and where the slopes are steeper along the western range of the basin and on the upslopes of Mt Merapi, forest is the dominant land-cover type.

The study included consultations that found there was broad agreement on the need to maintain a clean lake and productive landscapes on hills and irrigated plains that met the food and livelihoods needs of the population and produced electricity for the provinces of West Sumatra and Riau. There was a widely held perception that the landscape was not currently meeting these expectations. The power company was not able to provide as much electricity as needed; fluctuations in water levels were of concern to the people living around the lake; water quality in the lake was poor; the population of the endemic fish, *ikan bilih*, was declining and two prior attempts to rehabilitate the *Imperata* grasslands in the area had not been very successful.

Stakeholders disagreed on the best approaches to watershed management, particularly with regard to reforestation and other means for achieving land rehabilitation. While policy-makers favoured reforestation, using either the local *Pinus merkusii* or another fast-growing tree species, villagers were convinced that reforestation with pine trees caused streams to dry up whereas natural forests provided regular stream flows during the dry season.

A water balance model confirmed a higher water use by pine trees owing to canopy interception and transpiration as compared to more open landscapes but no substantial differences between pine and natural forests. The model further suggested that the performance of the hydroelectric plant was only mildly influenced by land cover (Figure 20.2). Compared to the land-use mosaic at the time, an increase or decrease of 5% of the maximum electricity production could be expected, while the variation between wet and dry years of the 1991–2002 period was much larger. A change in the average annual rainfall owing to climate change would likely have a strong effect on the plant's performance. Declining water quality in the lake and weed infestation would offset any gains in water supply that could result from land degradation. Reforestation with fast-growing evergreen trees would slightly affect the plant's access to usable water. A basic assumption underlying payments for environmental services is that the supply of these services depends on the activities of those receiving the payments. For the power company, this assumption was not supported by evidence.

Payments made by the company could have various rationales.

1. Compensation for damage caused by the hydroelectricity company to the farmers along the Ombilin River whose waterwheel irrigation systems were disturbed and to farmers with rice fields surrounding the lake affected by increased flooding.
2. Shared responsibility for maintaining the quality of the water in the lake as the hydroelectricity company modified outflow rates and increased debris accumulation.
3. Tax payments to the local government.
4. Payments to enhance goodwill with the local community.
5. Payments for environmental services conditional on the delivery of these services.

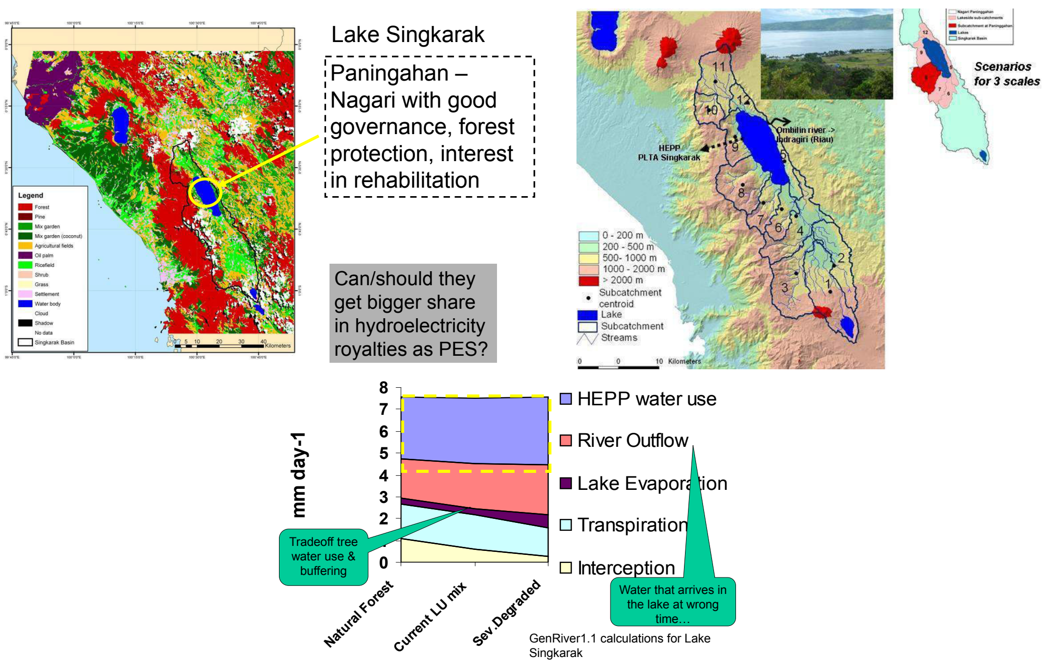

Figure 20.2. Summary of a rapid hydrological appraisal of Lake Singkarak

Table 20.2. State of knowledge before and after the RHA of Lake Singkarak

Before RHA Singkarak	After RHA and follow-up negotiations
▪ Deforestation seen as the main cause of all problems, including electricity blackouts ▪ Tree planting seen as major solution ▪ Belief that the village with most tree cover should get highest share of royalties ▪ Reduction in fish population linked to deforestation.	▪ Focus on lake and water quality ▪ More awareness of the impacts of climate variability ▪ Less blaming of upland deforestation for blackouts ▪ Less focus on tree planting as the principle solution to environmental problems ▪ *Ikan bilih* problem is understood to be caused by polluted breeding grounds and overfishing ▪ Adjust scale of institution in managing the watershed ▪ *Management implications from local perspectives* o Reforestation uses trees with low evapotranspiration. o Local wisdom maintains clean water stream in the upstream and conserving native *ikan bilih* ▪ *Management implication for watershed management and RWS* o Upstream village level: maintaining current intact environment, that is, biodiversity conservation such as organic coffee, voluntary carbon market scheme and watershed services o Villages surrounding the lake: improving water quality of the lake and river

Key references

Jeanes K, van Noordwijk M, Joshi L, Widayati A, Farida, Leimona B. 2006. *Rapid hydrological appraisal in the context of environmental service rewards.* Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

Lusiana B, Widodo R, Mulyoutami E, Adi DK, van Noordwijk M. 2008. *Assessing the hydrological situation of Talau Watershed, Belu Regency, East Nusa Tenggara*. Working Paper 57. Bogor, Indonesia: World Agroforestry Centre (ICRAF) Southeast Asia Regional Program.

The landscape scale is a meeting point for bottom–up local initiatives to secure and improve livelihoods from agriculture, agroforestry and forest management, and top–down concerns and incentives related to planetary boundaries to human resource use.

Sustainable development goals require a substantial change of direction from the past when economic growth was usually accompanied by environmental degradation, with the increase of atmospheric greenhouse gasses as a symptom, but also as an issue that needs to be managed as such.

In landscapes around the world, active learning takes place with experiments that involve changes in technology, farming systems, value chains, livelihoods' strategies and institutions. An overarching hypothesis that is being tested is:

> Investment in institutionalising rewards for the environmental services that are provided by multifunctional landscapes with trees is a cost-effective and fair way to reduce vulnerability of rural livelihoods to climate change and to avoid larger costs of specific 'adaptation' while enhancing carbon stocks in the landscape.

Such changes can't come overnight. A complex process of negotiations among stakeholders is usually needed. The divergence of knowledge and claims to knowledge is a major hurdle in the negotiation process.

The collection of tools—methods, approaches and computer models—presented here was shaped by over a decade of involvement in supporting such negotiations in landscapes where a lot is at stake. The tools are meant to support further learning and effectively sharing experience towards smarter landscape management.

World Agroforestry Centre
ASB Partnership for the Tropical Forest Margins
AARD
Federal Ministry for Economic Cooperation and Development
Norad
IFAD Enabling poor rural people to overcome poverty
CGIAR Research Program on Forests, Trees, and Agroforestry