Rapid Hydrological Appraisal: an integrated rapid approach to assess watershed function

World Agroforestry Centre (ICRAF)

Watershed function: why do we want to assess it?

Hydrological functions of watersheds are very much influenced by the amount of rainfall that the watershed area receives and its underlying geology and land form. The functions include the capacity to:

- ✓ Buffer peak rain events,
- ✓ Release water gradually,
- ✓ Transmit water,
- ✓ Maintain water quality and
- ✓ Reduce mass wasting (such as landslides).

The relation between land use and the flows of water to downstream areas is important, because human demand on water for agricultural production, industries and domestic use are globally increasing, while supply is stable. Fears that the quality, quantity and regularity of flow of water from uplands is affected by 'deforestation'are the basis of land use regulation, restricting opportunities of upland people to make a living the way they want and see fit.

Land use mosaics in upland areas provide important parts of environmental service functions. Communities gain income/direct benefits from what they harvest, grow or extract from these upland landscapes. Yet, there is no income for maintaining the landscape in order to produce environmental service functions for off-site and downstream beneficiaries. Maintaining or enhancing these functions thus remains an 'externality' to their decision making.

The current perception in watershed management is that forest is the land use that can 'best' maintain watershed functions and changing landscape mosaics from forest into other form of land use will reduce the ability of the watershed to maintain its functions. This perception is debatable. How good or bad actually are non-forest land uses in maintaining the watershed function? Can tree-based systems provide similar service as forest in maintaing the watershed function? The answer to these questions are of interest and of importance to the policy makers in developing the watershed management policy. These answers are also of interest for the development of reward mechanism for the upland people for the environmental services they provide.

What is Rapid Hydrological Appraisal?

The Rapid Hydrological Appraisal (RHA) approach was developed to provide a rapid, inexpensive and integrated tool to assess hydrological functions of a watershed and help to bridge the often constrained communication gaps between three types of knowledge on watershed function (Figure 1). RHA approach can provide clarity concerning criteria and indicators of hydrological function and thus provide clarity on: (i) how the watershed function is provided, (ii) who can be responsible for providing this service, (ii) how it is being impacted upon at present, and (iv) how rewards can be channelled to effectively enhance or at least maintain the function. This approach hopefully lead to a situation where all knowledge are integrated and linked (Figure 2).

Figure 1. *Current situation: three poorly connected knowledge systems*

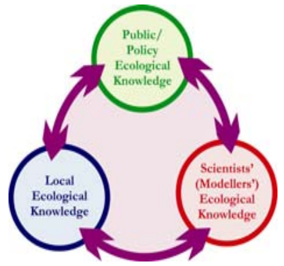


Figure 2. *Desirable situation where the three knowledge domains are connected and interact*

The main objectives of the RHA are:

- ✓ to understand local land use patterns, the benefits it provides to actors in the landscape, the alternative land use options that exist and the current drivers of change.
- ✓ to understand the impacts of local land use change on environmental services, and thus on potential 'buyers' that are willing to provide incentives to maintain or enhance specific services

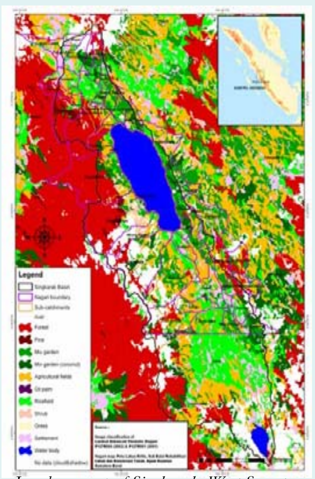
Thus, RHA is very important in the initial phase of Environmental Service Rewards (ESR) development in getting sellers and buyers to communicate with each other.

The main activities carried out within RHA are:

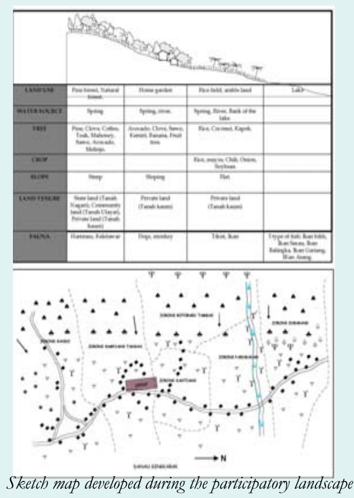
1. *Stakeholder analysis*
2. *Local ecological knowledge (LEK) documentation and analysis*
3. *Public and policy-shapers ecological knowledge (PEK) documentation and analysis*
4. *Spatial analysis*
5. *Modeler/Scientist ecological knowledge (MEK) documentation and analysis*
6. *Synthesis*

An examples of Rapid Hydrological Appraisal study

A Rapid Hydrological Appraisal was conducted in the Singkarak Basin of West Sumatra (Indonesia) to assess the hydrological situation in the context of the development of payments for environmental services (ES) that are aimed at rewarding the upland poor for protection and/or rehabilitation of watershed functions. The main 'issue' that became the focus of the study is the relationship between the hydroelectricity project (HEPP, PLTA Singkarak), the fluctuations in the level of the lake, the water quality in the lake and the land cover of the catchment areas that contribute water to the lake. Payments made by the PLTA to the local government can, in part, be seen as rewards for maintaining or improving environmental services.



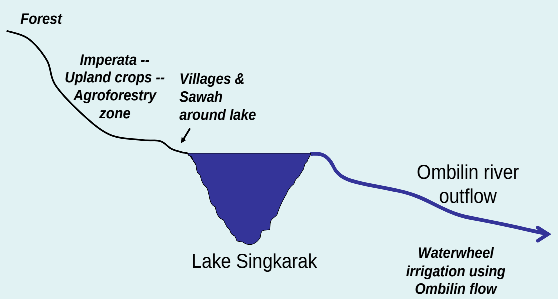
Landcover map of Singkarak, West Sumatra



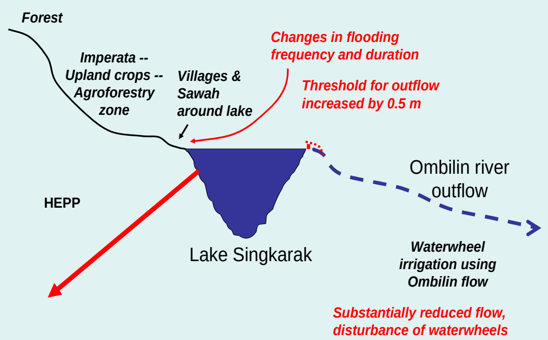
Sketch map developed during the participatory landscape analysis

There is a broad agreement on 'the need to maintain a clean lake, productive landscapes on hills and irrigated plains as well as to produce electricity for the provinces of West Sumatra and Riau. A widely held perception is that the current landscape is **not** meeting all these expectations: the PLTA is not able to provide as much electricity as was expected, the fluctuations in the level of the lake are a concern to the people surrounding the lake, the water quality of the lake is a concern, the population of the endemic fish (ikan bilih) is declining and two previous efforts to rehabilitate the *Imperata* grassland in the area have not been very successful.

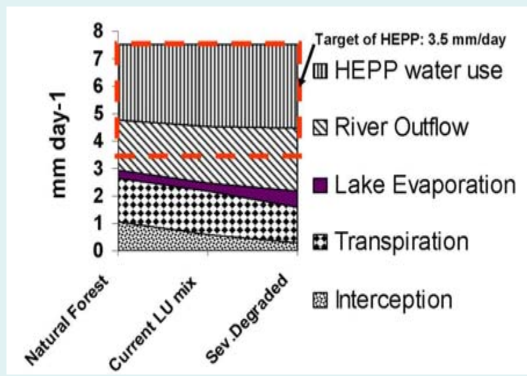
Situation before Hydro-Electric Power Plant (HEPP)



Situation after Hydro-Electric Power Plant (HEPP)



For policy makers reforestation, either using the local *Pinus merkusii* or other fast growing tree species is the main approach. But villagers in Paninggahan are convinced that streams dry up in the dry season after reforestation with pine trees, while the natural forest is providing regular stream flows. The water balance model with the default parameter values for Pine tree confirmed a higher water use by canopy interception and transpiration compared to more open landscapes, but no substantial difference with natural forest. Impacts of land cover via soil properties may need to be further tested. Further hydrological distinctions between the limestone and granite parts of the landscape are needed as well.



Average daily water balance for the simulations over the 1991-2002 period under the assumption that HEPP is operational, for a range of land cover scenarios

Overall the **water balance model** suggested that the possible performance of the PLTA is only mildly influenced by land cover within the range of scenarios tested. A change in mean annual rainfall under the influence of global climate change will have a strong effect on PLTA performance. Declining water quality in the lake leading to weed infestation will offset any gains in water supply that could result from 'land degradation'. Reforestation with fast growing evergreen trees will have a mildly negative effect on water usable by the PLTA. A basic assumption for 'payments for environmental services' is that the supply of these services does depend on activities of those 'rewarded'. For the PLTA this assumption is not supported by much evidence.

Conclusion

Payments made by the PLTA may have various types of rationale:

- ✓ Compensation for damage caused by the HEPP project, to the farmers along the Ombilin river whose waterwheel irrigation systems are disturbed and to farmers with rice fields surrounding the lake affected by increased flooding
- ✓ Shared responsibility for maintaining the water quality in the lake as the HEPP project modified outflow rates and increases debris accumulation
- ✓ Payments of tax to local government
- ✓ Goodwill enhancing payments to the local community
- ✓ Payments for environmental services conditional to the delivery of these services

At this stage the evidence for the last component is relatively weak. Efforts of all lake-side nagari's will be needed to deal with the issues of lake water quality as well as rehabilitating the other inflows to the lake.

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