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, and almost absent for the scale level of avoided degradation in a single community (Nagari). Efforts of all lake-side nagari's will be needed to deal with the issues of lake water quality, while rehabilitating the other inflows to the lake need at least equal attention.

Before RHA Singkarak	After RHA + follow up discussions
▪ Deforestation seen as the main culprit of all problems, including blackouts ▪ Tree planting as main solution ▪ Village with most tree cover should get highest share in royalties ▪ Problems with the Ikan bilih fish linked to deforestation	▪ Focus on lake & its water quality; adjust scale of institution ▪ More awareness of climatic dependence ▪ Less blaming the upland deforestation for blackouts ▪ Less focus on 'tree planting' as the only or main solution ▪ More care in planning coffee re-intensification: Kopi Ulu ▪ Ikan bilih problem is about breeding grounds & overfishing

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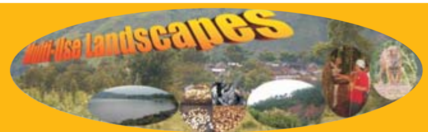

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RAPID HYDROLOGICAL APPRAISAL (RHA):

An Integrated Approach to Assess Watershed Functions and Management Options

Trees in Multi-Use Landscape in Southeast Asia (TUL-SEA)
A negotiation support toolbox for Integrated Natural Resource Management

Watershed functions as ecosystem service under threat

The circulation of water through rainfall, evapotranspiration, river and groundwater flows and its storage as clean, freshwater is essential for life. Protecting the cycling and storage is at the heart of 'watershed functions'. In practice, however, watershed management can mean different things in different situations, to different stakeholders. There is still a lack of clear criteria on the functions that can be expected from 'good' watersheds in a given climate and landscape, and of indicators of the hydrological functions that can be used to adjust management. In some interpretations 'watershed management' includes the totality of livelihood options and management of vegetation cover. We focus here on the 'hydrological' subset that relates directly to water flows.

The hydrological functions include the capacity to: (i) Transmit water to freshwater stocks and flows (total water yield), (ii) Buffer peak rain events, (iii) Release water gradually, (iv) Maintain water quality (sediment, nutrient, pollutants, bacterial leading oxygen demand) and (v) Reduce mass wasting , such as landslides.

With clean water becoming more scarce relative to a rising demand and damaging floods more frequent, there are various initiatives to protect critical functions of watersheds, including providing incentives for people in upper watershed areas to modify their land use to improve the watershed functions. Land use can significantly affect watershed functions such as water quantity, water quality, regularity of water flow, prevention of landslides and erosion, and prevention of sedimentation in sensitive downstream areas. However, to develop an effective reward mechanism requires clarity on the relations between the specific land use in a catchment and environmental services that are of sufficient value to downstream stakeholders to become the basis for reward mechanisms.

Environmental service rewards for **watershed function** need to deal with three important criteria:

Realistic - interventions need to be based on knowledge of the water balance and the way it depends on the landscape, land use and a changing climate; they also need to align with the tradeoffs between economic benefits from land use change and the consequences for measurable watershed functions;

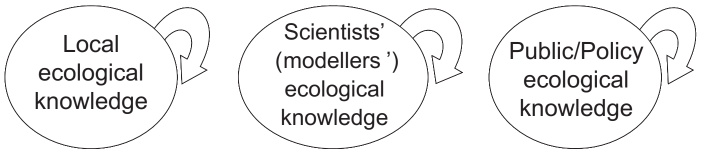
Voluntary - the mechanisms need to respect existing property and land use rights (compare the RATA or rapid tenure claim appraisal tool) and follow principles of Free and Prior Informed Consent (FPIC); agreements require a shared understanding of the issues and options to deal with them

Conditional - the economic incentives will be 'performance-based' and thus require systems of monitoring changes in the landscape that can be done locally and that relate to real stakeholder interests.

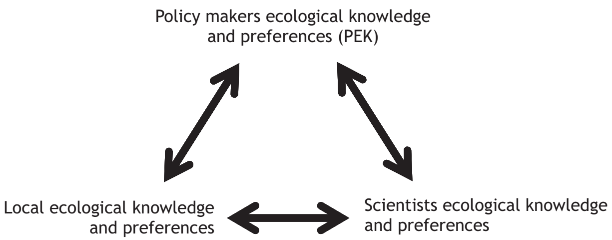
Objectives of RHA

Rapid Hydrological Appraisal (RHA) is a tool that aims to provide such clarity, providing answer on (i) how the watershed function is provided, (ii) who could be responsible for providing this service, (iii) how watershed function is being impacted upon at present, and (iv) how rewards can be channeled to effectively enhance or at least maintain the function. RHA can help to bridge the gaps of knowledge that may exist between the various watershed stakeholders. This approach hopefully lead to a situation where all knowledge systems are integrated and linked.

Situation where knowledge systems are poorly connected.



Desirable situation where the three knowledge domains are connected and interact



Steps in RHA

The approach is based on the following activities that can be carried out in less than 6 months:

(1) land cover/land use change analysis,

(2) exploration of stakeholders' local knowledge (LEK) and expectations on hydrological functions, water movement and consequences of land use options on the landscape,

(3) exploration of public and policymakers local knowledge (PEK) and expectations on hydrological functions, water movement and consequences of land use options on the landscape,

(4) compilation and analysis of existing hydrological data and modeling (e.g. using GenRiver) the water balance for the watershed including scenario analysis of plausible land cover change and its likely impact on watershed functions.

An example of RHA study

The first Rapid Hydrological Appraisal was conducted in the Singkarak Basin of West Sumatera (Indonesia) to assess the hydrological situation in the context of the development of payments for environmental services (ES), 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. Nevertheless, there was no full and shared understanding of the relationships between land cover and the 'environmental services' provided.

The major land cover types in the Singkarak Basin are rice fields (17%), agricultural crops (15%) and forest (15%). Rice fields occur in the lowland area, below 1000 m asl and with the slopes of < 30%, commonly found in the southern part of the basin. Besides rice, other types of agricultural crops are also found in the lowland plain up to > 1000 m asl. In this higher elevation area, the crops are mostly vegetables. Other land cover types like mixed gardens , coconut-based mixed garden, shrubs and grass are found in smaller patches all over the basin. In the higher elevation (> 1000m asl) and where slopes are steeper (>30%) along the western range of the basin and in the upslope of Mt Merapi, forest is the dominant land cover type. The main conclusions of the consultations are that there is broad agreement on 'objectives' such as the need to maintain a clean lake, productive landscapes on hills and irrigated plains that meet the expectations of the high population density as well as produce electricity for the provinces of West Sumatera and Riau, the nearby province.

There is a widely held perception 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 (alang alang) in the area have not been very successful.

Much of the debate is focused on proposed solutions and especially on the relative merits of 'reforestation' and the various alternative ways to achieve 'land rehabilitation'. While for many policy makers reforestation, either using the local *Pinus merkusii* or other fast growing tree species is the main approach, 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.

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. Compared to the current land use mosaic an increase of 5% or a decrease of 5% of the maximum electricity production can be expected, while the variation between 'wet' and 'dry' years of the 1991-2002 period is much larger. Details of PLTA lake management matter a lot. 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.

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