Social monitoring of water resources

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1 Towards social self-regulation of hydrological systems

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1.1 Introduction

Participation is one of the key elements of common pool natural resources management and is a prerequisite for integrated water resources management. A review of various possible means of stakeholder involvement in integrated water resources management reveals that monitoring is not among the most prominent areas of participation. This is a surprising negligence for a number of reasons: Monitoring provides sensors for the systems state. Hydrological systems are often very heterogeneous regarding the spatial and temporal distribution of water resources and require a dense monitoring. In mountain areas and in areas with a high variability of small scale land-use patterns as well as in densely populated and urban areas common monitoring approaches do not provide sufficiently fine-grained information. Is it obvious that the spatial network density and of the temporal resolution also depends on the variability of the observed state parameters: Tropical regions and drylands having highly variable hydrological processes in space and in time require another distribution and stance of monitoring than humid and mid-latitude areas. However, often, this is not the case: Humid and mid-latitude regions are often well equipped and densely monitored, drylands and tropical regions often have sparse networks.

The activity of monitoring hydrological system state is economically expensive and time consuming. Today, developing countries are often struggling to maintain and run monitoring networks developed in the 1960ies and 1970ies during the International Hydrological Decade at a desired optimal density as required by recommendations of WMO (2002). Monitoring networks often also fall short of the recommended density and required set of meteorological, hydrological and ecological parameters. At the same time, dimensions of natural systems to be monitored increase. Instead of just monitoring rainfall, stream gauges and groundwater levels, integrated and complex information is required such as biodiversity, state of ecosystem services, water and resources quality and sustainability indices. It is difficult to translate classic monitoring data to such complex indicators. Models are needed to translate 19th-century-type monitoring data to such aggregated indicators: The price for such a transformation is error propagation.

Still, it is often quite simple for local residents (farmers, water users) to directly evalute these integrated indicators on the ground: Is drinking water of sufficient quality, does it smell or taste bad, are there water-related diseases in the community? How is the state of grazing land, are there signs of agricultural drought? Did erosion occur, was there surface runoff with localized erosion? How is the turbidity of rivers and springs? In some cases local residents observe ecosystem parameters that we rarely pay attention to: Which type of fauna (e.g. birds) can be observed, do they indicate scarcity of surface water resources (this is a parameter Bushmen communities were used to observe to find and identify the proximity to water pools in the Kalahari). When do plants grow or bloom, how is their state? This talk addresses methods and possibilities to collect, aggregate and process these informations in a social-hydrological monitoring network.

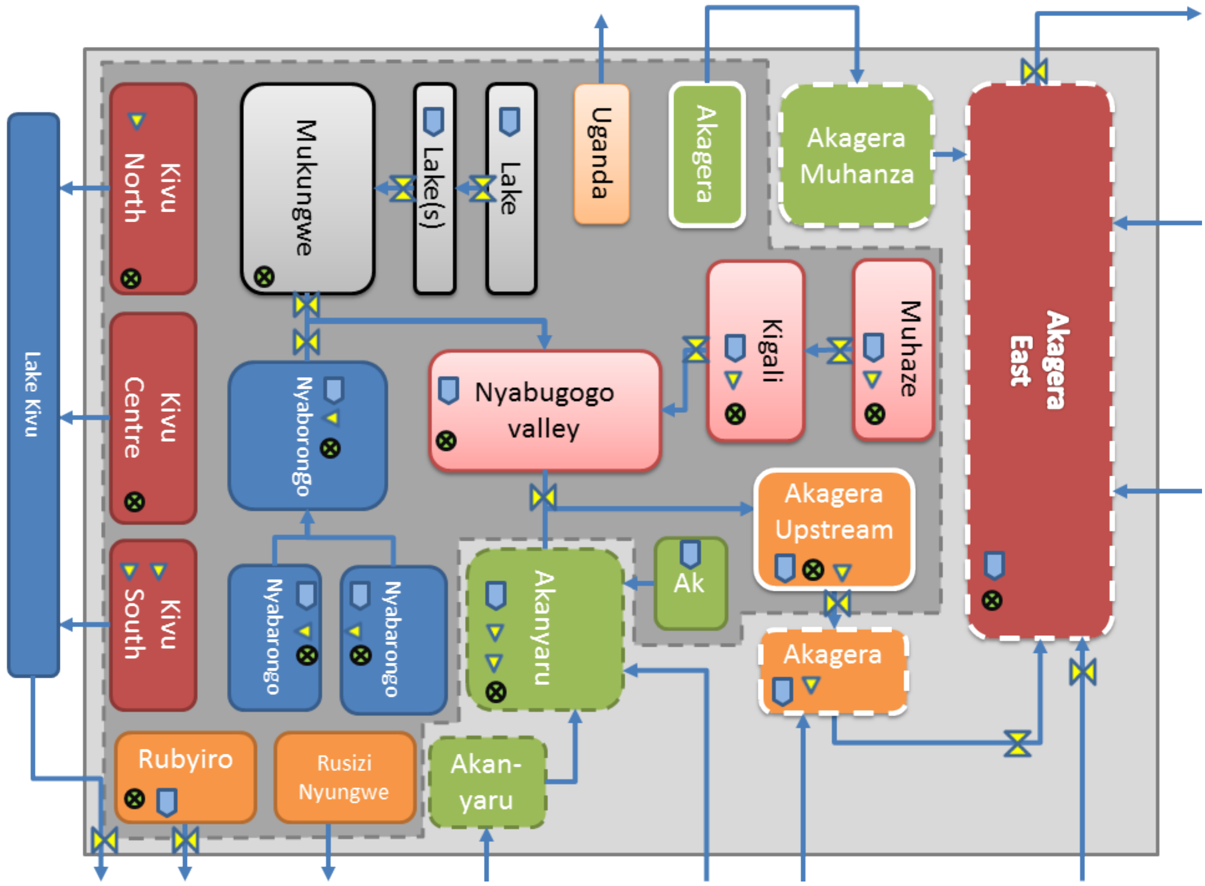

Figure 1: Hydrological System of Rwanda and monitoring points

Information technology provides networks through which communication at second and minute intervals is possible among social groups. This technology is available in many developing countries in Africa and Asia also in rural areas at affordable costs. Data on the functioning of monitoring services during civil wars and crises in Burundi and Rwanda showed that community based monitoring networks were by far more robust and reliable than high-technology systems (dataloggers, monitoring stations). A network of local residents reading and writing down water levels and being linked by several sentinels provided most of the data even during years of civil wars in Central and Eastern Africa. This was the only active source of information on the distribution of water resources.

Therefore, in a project for a National Master Plan for Water Resources of Rwanda, a resident-based monitoring strategy is being developed. The working group on Social Hydrology at the IHF has launched training of locals that monitor hydrological system state and report to a processing unit by sending information through a ShMS (a Short hydrological Messaging Service). The regular monitoring system provides central processing of data and re-distributes results back to all monitors and to regional and national agencies and stakeholders.

Methods to evolve this approach towards self-regulating systems are being investigated. The role of the social hydrologist is to simulate and recommend on behavioural rules using resident-based monitoring data. During preliminary studies, patterns of behaviour have been observed, analysed and translated to agent behaviour. Agent behaviour has then been simulated and modeled figuring observed rainfall distribution, runoff in tributaries, and modelled recharge and storage in aquifers based on physical process models. This approach requires a more complex physical simulation. The current approach is based on simultaneous monitoring of actions, behaviour and observed environmental data by independent monitor groups (social and hydrological). The identification of best practice as a set of rules relies on correlation analysis and multiple regression joining resident actions and environmental impact. Results indicate that resident-based monitoring can lead to improved and inherent sustainability and higher resilience.