Annex PN 46: Small Reservoirs Toolkit overview of tools

I. Intervention Planning

Participatory Impact Pathways Analysis

This tool will assist those planning research on or interventions for small reservoirs systems to use Impact Pathways Analysis to develop a plan to better bring about desired outputs, outcomes and impacts. By helping make explicit the links between project activities or program interventions on the one hand, and partner roles and inter-relationships on the other. The likelihood of achieving greater better impacts may be improved. How the Impact Pathway Analysis was found useful in the Small Reservoirs Project is presented.

Stakeholder and Conflict Analysis

This tool assists in the analysis of the stakeholders' goals, aims, and interest in the project's envisioned outcomes; it also assists in identifying their relationships with other stakeholders and assesses their relative power and capacities. The conflict analysis tool allows the user to assess the degree to which identified interests and goals, conflict with or complement each other, related to the specific goals of the development project, are influenced by relationships among stakeholders, and will likely determine future relationships between the stakeholders.

Understanding each other: Creating Common Ground for Dialogue

This tool uses drawing as a means of fostering better communication, and improved mutual stakeholder understanding of the aims, views and goals of a proposed activity. The drawing approach helps water-users take a larger role in the design and implementation of small reservoir improvements. It introduces the water users' perspectives into problem identification and the design process. By clarifying messages and focusing the discussion this tool can facilitate the development of improved reservoir design strategies.

Monitoring Change and Adoption – Outcome Mapping

The outcome mapping tool presents an approach to assist planners to monitor the implementation, adoption, and changes in attitude and behaviour of the stakeholders. Outcome Mapping is a participatory planning, monitoring and evaluation methodology which focuses on the contribution of a program to changes in the actions and behaviours of the 'boundary partners'. Applied to knowledge and learning strategies, Outcome Mapping facilitates communication and has a number of potential other benefits.

II. Storage and Hydrology

a. Reservoir ensembles measurements

Reservoirs Inventory Mapping

In most semi-arid areas of the developing world, the number, size, and location of small reservoirs is generally unknown. To facilitate planning activities, an inventory of existing

dams is necessary. This tool outlines the steps required to obtain a regional reservoir inventory using satellite imagery.

Towards an Atlas of Lakes and Reservoirs in Burkina Faso

To facilitate planning activities, an inventory of existing dams is necessary. This tool outlines the steps required to obtain a regional reservoir inventory using secondary data. It demonstrates how databases provided by official sources may be merging and interconnected to create a “homogenized” metadata base. And how subsequently a customized GIS may be used with the data to generate maps.

Small Reservoir Capacity Estimation - Measuring storage - Developing Area Volume relations

Measuring the storage capacity of large numbers of small reservoirs by conventional means is labor-intensive, costly, and time-consuming. This tool explains the estimation of reservoir storage capacity as a function of remotely-sensed surface area.

Near-Real-Time Monitoring of Small Reservoirs with Remote Sensing

This tool describes use of radar satellite imagery to monitor changes in small reservoir surface area and therefore storage volumes. Because radar is not affected by clouds, a near-real time record of water stored in small reservoirs can be produced every two to four weeks. Such records are of interest to hydrologists and are useful in drought monitoring.

Hydrological Impact Assessment of Ensembles of Small Reservoirs

This tool illustrates methods to assess the hydrological impact of an ensemble of small reservoirs, particularly evaporative losses, spillage, water used for irrigation, and excess irrigation drainage. The tool uses stochastic simulation and assumes that the main statistical properties of the ensemble do not change when new reservoirs are added. This tool is an analytical framework or algorithm, not a globally ready-to-run model. Tools based on this model could be used to predict what may happen when the number of reservoirs is increased without defining the location of each new reservoir as it is added.

b. Hydrology and physical measures of performance

Calibration of Runoff Models with Remotely Sensed Small Reservoirs

In most semi-arid areas, small reservoirs are located in upland watersheds. To understand the filling process of reservoirs, and to determine their impact on flow, hydrological models are needed. Most existing runoff models are, however, geared towards temperate climates and may not capture the relevant hydrological processes and runoff production in semi-arid areas. This tool presents a method to develop simple hydrological models for dammed upland watersheds based on monitoring reservoir surface areas with radar remote sensing.

Rainfall-discharge Relationships for Monsoonal Climates

Methods for estimating runoff that have been developed for temperate climates may not be suitable for use in the monsoonal climates of Africa, where there is a distinct dry season in which soils dry out to a considerable depth. Water balance models have been shown to better predict river discharge in regions with monsoonal climates than alternative methods based on rainfall intensity, or on the USDA-SCS curve number. This tool can be used to develop a simple water balance model for predicting river discharge.

Deep Seepage Assessment in Small Reservoirs

Evaporation and seepage are the principle non-productive reservoir losses. Seepage is sometimes ignored when reservoir water balance calculations are made because it is considered so difficult to estimate or measure. However, a large number of small reservoirs exhibit significant seepage losses and it is therefore important to understand their seepage behavior. This tool provides a simple methodology to estimate seepage losses through the bottoms of small reservoirs.

Evaporation Losses from Small Reservoirs

Because water that evaporates directly from the reservoirs is unused water, it is called an unproductive loss. Many planners and decision makers feel that small reservoirs are unsuitable for rural water supply because they assume that evaporation losses are extremely high. In a detailed study in the Upper East Region of Ghana we measured evaporation from water bodies using various methods. This tool demonstrates that observed evaporative losses were moderate.

Water Quantity Assessment of Silted Up Small Reservoirs

There many small reservoirs in the Limpopo Basin that are filled with silt. This creates difficulties for local communities as there are often no other nearby sources of water (especially in the dry season). This tool may be used to estimate the quantity of water stored in silted-up reservoirs, and to estimate how much of it can be abstracted for community use.

137Cs Radionuclide Tracer Method to Quantify Soil Erosion and Sedimentation at Hillslope and Reservoir Scale from GLOWA PhD

Quantifying soil erosion and soil deposition processes is often important in understanding their dimensions in semi-arid environments and in identifying land management methods to reduce their effects. This tool presents an innovative method using measurements of 137Cs concentrations in soil samples collected in the watershed to estimate the amount of sediment eroded from fields, redistributed downstream, and accumulated in reservoirs.

Soil Erosion Modeling at Small Reservoir Scale by WaTEM/SEDEM from GLOWA PhD

Reservoir siltation is an important “off-site” consequence of soil erosion. When fertile topsoil is eroded from hill-slopes, it is transported downstream and ultimately accumulates in valleys and reservoirs. The loss of nutrient-rich topsoil can reduce the productivity of hillside agricultural systems, while siltation of small reservoirs lessens reduces their storage capacity. This tool uses soil erosion models to simulate soil erosion and sedimentation rates at the catchment scale and to produce soil erosion hazard maps. These maps can help identify suitable locations for implementing soil conservation techniques.

Bathymetric Survey by Depth-sonar and Lake Sediment Coring by Beeker Sampler to Identify Sediment Budges and Siltation Rates of Small Reservoirs from GLOWA PhD

Accumulating soil particles can lead to changes in reservoir morphology, which may reduce their water storage capacity. Small reservoirs may be particularly vulnerable because the maximum water depth is often only a few meters and an accumulated sediment layer of a few decimeters at the bottom of the reservoir may cause a comparatively large reduction in water volume. This tool presesnts methods using bathymetric surveys and lake sediment retrievals to monitor changes in reservoir morphology, to measure the thickness of accumulated soil particles, and to calculate siltation rates.

III. Ecosystems and Health

Participatory Health Impact Assessment

This tool contains guidelines intended to reduce the health risks and increase the health benefits from small reservoirs. Guidelines are structured in a step-wise manner, beginning with the identification of relevant health issues and concluding with small reservoir design and operation for improved human health. The guidelines focus on: major water-related diseases associated with small reservoirs in Africa, the added value of community participation in health impact assessment, opportunities to mitigate risks and improve human health through better planning and operation of small reservoirs, and improved planning, design, and management options.

Health Questionnaires

This tool describes the use of school surveys, an important tool that supports both participatory and biomedical research. When epidemiological studies are carried out at the same time, a local quantitative relationship between measured and reported infection rates can be established and the questionnaire can be applied in a larger area to assess prevalence at the level of the reservoir cluster or river basin. Such questionnaires can be adapted for other diseases and to fit varying local circumstances.

Epidemiological Survey

This tool uses standard biomedical methodologies to determine infection rates for key water-related (or “reservoir-related”) diseases including schistosomiasis and other intestinal parasites, and malaria. In any particular locale there may be a completely different set of priorities with regard to reservoir-related health issues. Therefore, it is always wise to check with local health personnel about priorities, and to sample local communities’ perceptions with respect to reservoir-related problems. For diseases and infections not described in this tool, local health professionals, literature, and the internet provide good starting points.

Vector Studies

One of the health risks of small reservoirs is the potential for increased transmission of water-related diseases, in particular, parasitic infections dependent on water-based “vectors”. The design, use, and management of reservoirs all influence their suitability as breeding grounds for disease vectors. This tool describes the use of selected methods to help stakeholders understand the ecological preferences of vector organisms in relation to small reservoirs. This is an important step in identifying management options for environmental disease control.

Water Quality Assessment

Some rural populations are dependent on small reservoirs for their water supply and are concerned about the quality of this water for direct consumption and other uses. Chemical and biological water quality measurements can be made to ascertain the suitability of water for different uses. Water “suitability” of course, depends on the use for which it is intended. This tool describes selected methods for assessing the suitability of reservoir water quality.

Cyanobacteria, cyanotoxins and potential health hazards in tropical small reservoirs

Cyanobacteria, photosynthetic prokaryotes, also called blue-green algae, may be a source of considerable nuisance, particularly when proliferating as the ultimate state of the eutrophication process in water masses. The building of dams and regulation of rivers may create more habitats suitable for cyanobacteria. There is growing concern related to the development of toxic cyanobacterial populations. Cyanobacterial growth is constrained by low levels of light, temperature, and nutrients. In tropical areas, the first two of these are

rarely limiting so nutrient availability is usually the key determinant of their proliferation. This tool documents the situation as recently observed in Burkina Faso. It aims to contribute to a better understanding of this issue in less developed countries in tropical basins.

Agricultural Intensification and Ecological Threats around Small Reservoirs

Small reservoirs have the potential to improve the lives of people who irrigate crops and fish, water livestock, and use water in their households. This positive statement needs to be revised, however, when farming practices near reservoirs generate deleterious by-products that degrade water quality in aquatic ecosystems, and reduce the level of goods and services that reservoirs produce. Agricultural intensification and urban expansion both lead to increased levels of anthropogenic inputs into reservoirs. Ultimately, these human activities may undermine reservoirs' integrity and sustainability. This tool demonstrates how to begin the process of analyzing the impact of mans activities on the reservoirs.

Small Reservoirs Water Quality Monitoring using Plankton Abundance and Diversity

Rural populations often are very dependent on small reservoirs for their water supply, and it is widely accepted that land use impacts on water quality in these reservoirs. Therefore stakeholders are often concerned with assessing the reservoirs water quality. Approaches that look at ecosystem integrity can be used to assess water quality. This tool uses plankton (zooplankton and phytoplankton) abundance and diversity to measure water quality. Changes in abundance and diversity of these organisms represent direct and profound responses to pollution entering reservoirs.

Indicators

Using mutually agreed indicators facilitates communication among the key stakeholders and is helpful when planning new small reservoirs. Indicator definitions chosen from the literature should be tailored to local conditions to take into account of the field experience of local experts. Planners should pay special attention to the development and use of impact indicators, including those defined together with the community as being most efficient in measuring change. This tool based on a case study conducted in Morocco demonstrates how this may be done.

Environmental Flows in Small Reservoir Systems from IWMI PhD

This tool is expected to be available in 2010.

Fisheries from GLOWA PhD

This tool is expected to be available in 2010.

IV. Institutions and Economics

a. Water Allocation

Water Evaluation and Planning (WEAP) (incl. PEST – Parameter Estimation Tool)

WEAP is a modeling tool for water planning and allocation that can be applied at multiple scales, from community to catchment to basin. WEAP uses scenarios as a way to evaluate different water allocation schemes, given water demand and associated priorities. It includes a hydrological model and links to the groundwater model MODFLOW and the water quality model QUAL2K. WEAP has also been linked to socio-economic models, some of which can track changes over time in livelihood assets given changes in water allocation. It

has a global user base, and is available in Arabic, Chinese, English, Farsi, French, Korean, Portuguese, Korean, Spanish, and Thai.

Financial Accounting Model

The purpose of the tool is to convert the outputs of a water planning model like WEAP into variables useful for decision-making by planners and farmers. The tool can also be used in a stand-alone fashion, without links to such models. It can be used in “direct mode” where calculations are performed only once, or in “Monte Carlo mode”, where calculations are carried out multiple times and summary statistics are generated. It is meant to be applied to a small number of farmers located in the same watershed. The tool is designed for the following purposes: to estimate the initial and recurring farm-level costs of water-related infrastructure, including capital investment and amortization, and operational expenses and to estimate the price and income consequences for farmers of increased production (higher yields, increased planted area) of particular crops.

Water-Limited Yield Model

This tool is designed for the following purposes: to estimate the effect on yields of climate and weather (deviations from average rainfall patterns such as drought; climate change) and to estimate the effect on yields and water consumption of improved irrigation practices. It is intended for use at the field level and it allows for multiple cropping systems. In essence, this tool implements the WEAP two-bucket soil moisture model. The upper bucket is represented by a loss term to the lower bucket or to interflow through percolation losses. Soil moisture in the lower bucket is not tracked. It also provides two new features not present in the WEAP soil moisture model. It models crop yields under water-limited conditions and irrigation efficiency for different irrigation techniques.

Small Reservoir Water Allocation Strategy Water Productivity Based Water Allocation

Water is a limited resource, with many users and uses. Water allocation strategies need to recognize this. This tool uses estimates of water productivity and social values to inform decisions on the allocation of scarce water resources. The tool shows how estimates of water productivity can help in the evaluation of the socio-economic contributions of small multiple-use reservoirs.

b. Institutions and Governance

Institutions and Governance of Small Reservoir Water Resources from PN47

Before indigenous practices and institutions can be evaluated, they first have to be identified, described and characterized. This tool describes the methods used to answer a specific question: “Which indigenous practices, legal frameworks and institutions are most conducive to equitable, win-win, and pro-poor investments within sub-Saharan African transboundary basins”? It describes case studies on transboundary issues and local water governance institutions from the Volta & Limpopo Basins.

Net-Map (Influence Network Mapping) from PN40

Net-Map is an interview-based mapping tool that helps stakeholders understand, visualize, discuss, monitor, evaluate and improve situations in which many different actors influence outcomes. By creating Influence Network Maps, individuals and groups can clarify their own views of a situation, foster discussion, and develop a strategic approach to networking activities. For a specific situation, Net-Map helps stakeholders define: the kinds of influence that exist, the actors that are involved in a given network, how and why different actors are linked, the degree to which different actors have influence, and the respective goals of

different actors. It helps users answer such as questions: “Should we strengthen our links to influential supporters who share our goals? Which influential actors do not share our goals? Can increased networking help empower otherwise powerless stakeholders? Which actors typically cause conflicts? Which actors are parties to a conflict? Where are the bottle-necks that prevent a free flow of information? Two case studies one on Organizational learning in multi-stakeholder water governance, and the other one on Research on Fisheries Management in Small Multipurpose Reservoirs

Social Capital

The sustainability of technological interventions in rural settings often depends on socio-environmental interactions among local stakeholders. In principle, the concept of “social capital” makes it possible for relationships and networks to be quantitatively and qualitatively measured. This tool describes a method to assess and analyze social networks within a community to determine how cooperation in that community influences “who participates, and how” in the development of a collective good such as a small reservoir.