WEBINARS SERIES
ON RAINWATER HARVESTING
21st June 2022

Module n°2: RWH processes
Linking Watershed Management with Local Water Harvesting and SLM

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Water Harvesting (WH) – Guidelines to Good Practice

Mekdaschi Studer, R. and Liniger, H. 2013

https://www.wocat.net/library/media/25/
Also available in French: La collecte de l'eau - Directive pour de bonne pratiques

See: Webinar Module 1: Introduction to Rainwater Harvesting  (Mekdaschi Studer, Oweis)

On- and offsite Benefits of SLM

**Principle of WH**

- **composed of:**
  - **Catchment or collection area:** high runoff coefficients (e.g. clay or shallow soils, compacted soils, roads)
  - **Conveyance system**
  - **Storage component**
  - **Application area or target:** e.g. deep soils with high water infiltration and storage capacity

- catchment to application area ratio (C:A) degree of concentration of rainfall / runoff
- upstream-downstream dependency
- onsite – offsite dependency

Source: Mekdaschi Studer, Liniger 2013
4 Groups of Water Harvesting

1. Floodwater Harvesting
2. Macrocatchment
3. Microcatchments
4. Rooftop/Courtyard WH

1 & 2 are at watershed level
3 & 4 are at local / field level

Source: Mekdaschi Studer, Liniger 2013; On- and offsite Benefits of SLM
Water harvesting / LM practices and impacts in the watershed (catchment, basin)

How to estimate surface runoff from daily rainfall in small catchments / watersheds?
What is the influence of:
- Land Cover and Management
- Soil / Slope / Relief
- Amount and Intensity of Daily Rainfall

Source: Hanspeter Liniger
Watershed Approach to combine interactions of local Land Management (LM) /WH practices

- Current land management (LM1) determines the runoff generated from each area
Watershed Approach to combine interactions of local Land Management (LM) /WH practices

- Current land management (LM1) determines the runoff generated from each area
- This adds up to the total runoff/discharge generated at the outlet of the catchment ...
- ...and influences the desing of a WH technology
- Any land management change (LM1 → LM2) results in a different catchment discharge and potential for Macro-/Floodwater Harvesting
- Tool to develop scenarios is needed for watershed planning and management: Facilitating interactive and participatory identification of WH practices

Source: Mekdaschi Studer, Liniger 2013;
An easy to use Watershed Tool?

• A number of watershed models exit: SWAT, STEPS, However, few are used for practical use, planning, development of SLM / WH projects
• According to practitioners they are too demanding and thus almost only applied by researchers in selected areas
• WOCAT with SLM / WH partners have been developing and testing a Watershed Tool to assess hydrological processes that are sensitive to land management (first as a DRR tool to identify LM solutions to reduce floods in Central Asia))
• Which land management areas generate most runoff?
• What happens if land use / management changes?
• WOCAT Watershed Tool: How does it work?
  • Based on single / daily rainfall events
  • QGIS-based, open source
  • Almost no GIS knowledge needed
  • Simple compared to other hydrological models (e.g. SWAT)
  • Prototype version: under further development

Not enough rainfall ...
... but increased floods followed by droughts → tragedy of drylands
Assessing runoff sensitive to different mgt practices

Inputs needed
- Identify watershed
- Map Hydrological response units:
  - LULC, land management practices
  - Soil Group (A, B, C, D)
  - Slope
  - Soil moisture condition (dry, average, wet)

SCS Runoff Curve Number Model (SCS 1972)
- Empirical parameter (used tested adapted worldwide)
- Adjusted to slope (Sharpley and Williams 1990)

Source: SCS, 1992, 2004
Key is the water balance at local level and its impact at watershed level.

Water Balance

Local: \( P = RO + \Delta Sw + \Delta Gw + T + E \)
Regional: \( Fo = Ei + RO + GW \)

without SLWM rainy season

Flow out \( \rightarrow \) Flood

with SLWM rainy season

Flow out \( \rightarrow \) Flood along river

Source: Hanspeter Liniger: Lecture notes
Example Haiti: runoff, and groundwater recharge, spring flow,…

Total watershed runoff:
% of rainfall:
A: 18%
B: 41%

Total groundwater / Springshed recharge: % of rainfall:
A: 19.3%
B: 7.5%

Source: Eichenberger J., Liniger HP. 2020

See Video and Policy Brief Case Study Haiti:

Rainwater Harvesting Linking Watershed – Local: HP Liniger

Photos: HP Liniger
Example India:
Drying up springs in the Himalayas
Potential for WH and groundwater recharge

Key message
- Of the estimated 3 million springs in the Indian Himalayan Region (IHR), roughly 60% have dried up or become seasonal.

villages depend on spring water...

Why drying up???

... due to climate change or land use change?

Source: Bandy 2020, Liniger et al. 2020
**Example India:** Changing Forests: *Pine vs. Broadleaf, Gorang Valley*

**Banj Oak Soil:**
SOC increased, high water holding capacity, visible root development, habitat for diverse species, liveable temperature

**Pine Soil:**
Pine needle cover, compact, rocky impermeable, no root development, organism/microbe deficit, “deadly” temp., ...

Source: Bandy 2020, Liniger et al. 2020
Example India: Infiltration in Pine forests is dramatically reduced

**Soil Infiltration in Pine Forest**
Topsoil baked by high temperature and frequent fire

**Soil Infiltration in Oak Forest**
Healthy topsoil protected from extreme temperature

**Water**
Water is lost as runoff.
Water goes down in the ground.

Photos: H.P. Liniger
India: Runoff, Recharge ponds, groundwater / spring recharge

Figure 6. A recharge pond serves as a water harvesting technology, collecting runoff water from a nearby pine forest. It serves as a point of infiltration and groundwater recharge for their local spring. (Photo: HP Liniger)

Figure 7. Water Balance: Rainwater divided into runoff, groundwater recharge and evapotranspiration in mm for different land use types. The calculation assumes a total rainfall of 957 mm (between May and September 2018) using daily local rainfall records. (Source: Bandy and Liniger 2020)\textsuperscript{15}.


Source: Bandy 2020, Liniger et al. 2020
Experiences Haiti, India, Colombia, Central Asia, Kenya
Runoff/ Floods, WH, groundwater recharge, spring flow,…

Watershed tool used for:
• Assessing current situation: Estimation of areas with highest runoff, total outflow volume
• Identifying areas for local interventions and Exploring different scenarios for:
  • WH with microcatchments or other SLM practices and their impacts downstream
  • WH with macrocatchments, depending on upstream interventions and impacts downstream

Needed for:
• Watershed planners, decision makers to better understand, negotiate, optimize up- and downstream interaction.
• Implementers: For local communities / planners / decision makers and water user associations: reduce conflicts, reduce water loss, reduce flood flows and water demand for irrigation
• Link to WOCAT SLM / WH documentation

Source: Watershed Tool:
Source: WOCAT SLM Practices:
https://qcat.wocat.net/en/wocat/
In the WOCAT SLM Database the impacts of different sustainable land management practices including WH are assessed and documented:

- **Onsite impacts**: on production, runoff, ...
- **Offsite impacts**: on floods, droughts, drying up of rivers and springs, ...

Source: https://qcat.wocat.net/en/wocat/
From problems to solutions: locally and in the watershed

→ key challenge

**Part I – Identification:**
Problems and possible solutions:
- Land management practices: «bad» and «good»
- Their spread and impact

**Part II – Assessment:**
- Document & evaluate existing solutions (WOCAT database)
- Mapping watershed, land management & assess impact, building scenarios

**Part III – Selection:**
- Select most promising SLM technologies and approaches
- Select, what, where and how large and assess the impact

10 min video made for Tajik TV:
https://www.wocat.net/library/media/136/
On-site water balance triggers ...
large and divers offsite costs or benefits

Cover and land management of the topsoil are key for onsite (local) as well offsite (watershed) management:

- Determining...
  - water harvesting potential;
  - peak flow and the sediment load

“Deadly” surface temperatures of unprotected soil affecting water cycle
Outlook: Water Harvesting Explorer

A decision support webtool for small scale water storage intervention planning in the Western Sahel, available in EN and FR; https://sahel.acaciadata.com/

The WOCAT cases show successful implementation at precise locations (geo-referenced)
SLM, WH, Watershed Approaches: WOCAT SLM Database

Water user associations / groups (WUA / WUG)
Participatory Land Use Planning (PLUP)
Integrated watershed management (IWM)
Integrated watershed management (IWM)
Payment for Ecosystem Services (PES)

→ **Strengthen the link Local- Watershed! Need for a tool!**
→ **Multi-level, multi-stakeholder, multi-age, multi-cultural, ...**
→ **Capacity building: education (next generation → students), extension, advisory service, planning and decision makers: Local and regional / watershed**

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**Water Harvesting – Guidelines to Good Practice (E/F):** [https://www.wocat.net/library/media/25/](https://www.wocat.net/library/media/25/)


Thank you for your attention

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