GREEN WATER HARVESTING RESTORES ARID ECOSYSTEMS IN JORDAN

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Country: **JORDAN** | *Principal Organisation:* **National Agricultural Research Center (NARC Jordan)**

ABSTRACT

Arid environments, such as Al-Badia, Jordan, suffer from water shortages and land degradation. This good practice evaluates the impact of selected rainwater harvesting interventions on crop production and the prevention of soil erosion.

Two small sub-watersheds were selected to measure sediment yields using a geotextile trap. The water harvesting (WH) interventions increased available rainwater, doubled crop biomass production, and decreased soil erosion.

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NARC JORDAN

المركـز الوطنـي للبحـوث الزراعيـة
National Agricultural Research Center

COMPETENCIES

AREAS	SKILLS
PEOPLE-CENTRED LAND GOVERNANCE FOR EQUITABLE AND JUST SOCIETIES	PROJECT DESIGN AND IMPLEMENTATION SUPPORT
SUSTAINABLE FOOD SYSTEMS	RESEARCH AND TRAINING

BACKGROUND

In many countries, accelerated soil erosion and water scarcity are widespread problems that affect agricultural productivity, food security, and environmental quality. Jordan suffers from water shortage, land degradation and ecosystem deterioration. Arid environments, such as Al-Badia, Jordan, are characterised by sporadic, low annual rainfall and very high rainfall intensities that cause runoff and erosion. Runoff causes erosion of the fertile topsoil, which results in land degradation and an increased risk of flooding. Sustainable management of natural resources such as soil and water optimises the benefits of rainwater for enhanced crop production and soil fertility, decreased soil erosion, and supporting inhabitants' livelihoods.

THE CHALLENGE

Jordan suffers from water shortage and land degradation. Arid environments like Al-Badia are characterised by sporadic but intense rainfall. Al-Majidyya village is characterised by a low vegetative cover, soils with high silt content, hard surface crust, weak aggregation and localised thunderstorms. Additionally, the Al-Majidyya area is covered by erosion, such as sheets, rills and gullies.

The traditional farming practices adopted by farmers in planting and managing winter barley usually contribute to soil erosion. Additionally, there is little available data on the crops farmed in the arid areas. As such, implementing the Soil and Water Assessment Tool (SWAT) in arid regions requires modifications of the existing SWAT databases and parameters. The current land cover parameters are unsuitable for dry environments like Al-Badia.

OVERCOMING THE CHALLENGE

In overcoming this challenge, the National Agricultural Research Center (NARC) designed and implemented WH interventions using the Soil and Water Assessment Tool (SWAT) model for crop production and soil erosion management under the Badia Benchmark project. Different water harvesting techniques (WHT) were developed and implemented to secure runoff water, recharge aquifers for irrigation, increase crop production, and decrease soil erosion.

The SWAT model simulates the water harvesting process at a watershed scale and has become a crucial tool for estimating runoff and sediment yield. However, no study has sought to quantify the impacts of water harvesting interventions at various spatial and temporal scales.

In this respect, SWAT measures the spatial and temporal variations of runoff, sediments, productivity in arid watersheds and the impact of the implemented WH interventions.

The parameters of the crop databases, such as the harvest index (HVI) and leaf area index (LAI), were modified to suit the arid conditions for each class of crops planted under the project. Additionally, existing land use and soil conservation management practices optimised the benefits of rainwater by increasing plant productivity and reducing soil erosion. These parameters were considered in both model setup and simulation processes.

MOVING TOWARDS PEOPLE-CENTRED LAND GOVERNANCE

SWAT was adapted to simulate sediment transport characteristics of hillslope watersheds in the arid region of Al-Badia. Implementing SWAT enabled the NARC to reliably predict the positive impacts of the WH interventions (contour ridges) on soil erosion. As a result, the WH interventions increased available rainwater and crop biomass production. They also decreased soil erosion as no sediments were observed in the WH contour ridges compared to deposits in the barley site where farmers practised traditional farming. Crop biomass productions were about double the control barley site.

THE GOOD PRACTICE IN FIVE SIMPLE STEPS

1

STUDY AREA SELECTION AND DESCRIPTION

Two sites representing small sub-watersheds (hillslopes) were selected in Al-Majidyya village, 40 km southeast of Amman, representing an arid area of Jordan. Al-Badia receives an annual rainfall of less than 150 mm. The sub-watersheds were selected to measure sediment yield using a geotextile trap (silt fences), a low-cost technique to measure onsite hillslope erosion. Such a technique is easy to install by making the sediment trap face the upslope. One of these paired swales contained continuous contour ridges as a WH measure and was planted with the Atriplex halimus shrubs over an area of 1.1ha. The other sub-watershed remained as a control site without intervention – it remained planted with barley (Hordeum vulgare) using traditional farming practices and covering an area of 0.9 ha.

2

MODEL SELECTION AND DATA PREPARATION

ArcGIS 10.0 is an extension and interface for the Soil and Water Assessment Tool (SWAT 2012) (Di Luzio et al., 2002). The primary data required to develop the model input parameters were topography, soil, land use and climatic data. The unique portion of the watershed was determined by the hydrological response units (HRU) based on soil, land use, slope, physical processes, crop operations and management (irrigation, tillage, harvesting, and fertiliser). Geographic Information Systems (GIS) and Remote Sensing (RS) were used for derivative layers and interpretive and analysis databases.

3

FIELD SEDIMENT DATA MEASUREMENTS AND BIOMASS ESTIMATION

The geotextile sediment trap or silt fence was installed at each outlet of paired swales to measure hillslope erosion (Dissmeyer, 1982). Another geotextile sediment trap was established in the contour ridges and barley sites to prevent overtopping. The deposits collected in the sediment traps were removed and cleaned periodically. The eroded sediment yields on the geotextile trap were estimated by manually recording the quantities of accumulated sediment after each significant rainfall event in the field and a subsample stored for water content determination.

4

CAPACITY BUILDING AND PRACTICAL TRAINING

NARC provided practical training and capacity-building activities for the community and youth during the implementation and monitoring stages of the project. The training emphasised adopting and disseminating the WH concept, providing agricultural labour, and improving incomes.

5

MODEL SIMULATION, CALIBRATION, AND SENSITIVITY ANALYSIS

The SWAT Calibration and Uncertainty Program (SWAT-CUP) was used to calibrate and test the model output of the study watershed (Abbaspour, 2005). The SWAT model was simulated on the site using continuous contour ridges, while the control site was without WH interventions. The model outputs determined sediment yields (kg/ha) based on modifications to suit the existing arid conditions on both sites. The Nash-Sutcliffe Model Efficiency Coefficient Calculator (NSE), a software used to assess the predictive power of hydrological discharge models, found that the contour ridges and barley sites were a perfect fit.

KEY FACTORS OF SUCCESS FOR REPLICABILITY AND ADAPTABILITY PURPOSES

- Water harvesting interventions assist in combatting land degradation by decreasing soil erosion and restoring arid ecosystems.
- Water harvesting enables the optimisation of the benefits of rainwater, especially in arid areas. Securing runoff water and recharging aquifers for irrigation ensures increased agricultural productivity and crop survival for water harvesting farmers.
- Community participation through capacity building and practical training enhances community uptake of the project.

LESSONS LEARNED

- The SWAT model can be applied in similar arid regions by adapting it to the unique dry characteristics of the area, such as surface soil crust formation, rainfall patterns and intensity.
- The SWAT model allows the user to reliably predict the positive effects of the water harvesting interventions on soil erosion where the ponds simulate the contour ridges.
- The outcomes can be significant for the decision-makers and farmers to adopt water harvesting interventions to maximise productivity and protect the environment.

MORE INFO

JOURNAL ARTICLE

Robichaud, Peter R.; Brown, Robert E. 2002. ***Silt fences: an economical technique for measuring hillslope soil erosion.*** Gen. Tech. Rep. RMRS-GTR-94. 24 p.

DISSERTATION OR THESIS

Ziadat, F. (1995). ***Effect of management practices on soil losses in arid to semi-arid areas in Jordan.*** Unpublished Ms Dissertation. University of Jordan.

Al-Mahasneh, L. (2014). ***Adapting SWAT model to assess the impact of water harvesting intervention on soil erosion and runoff in an arid environment: a case from Jordan.*** Unpublished Ms Dissertation. University of Jordan.

CONFERENCE PAPER

Al-Mahasneh L., Ziadata F., Srinivasn R., Shatnawi K.2013. ***Adapting SWAT model for the evaluation of water harvesting systems in an arid environment: a case from Jordan***, International SWAT conference, France.

SOFTWARES

Geographic information systems and remote sensing (GIS and RS)/ Microsoft office (excel)

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