Integrated Watershed Management Using Vallerani and Marab Rain Water Harvesting (RWH) Systems in Jordan

Descriptive Summary

The arid landscapes of Jordan confront substantial difficulties, such as pronounced land degradation, water scarcity, and diminishing agricultural production, jeopardizing local ecosystems and livelihoods. The Integrated Watershed Management Using Vallerani and Marab Rain Water Harvesting (RWH) Systems in Jordan intervention employed an integrated watershed approach, utilizing Vallerani and Marab water harvesting technologies to manage resources both upstream and downstream efficiently.

The Vallerani technique, applied upstream, employs a tractor-mounted plow to form intermittent pits along the contours of the ground. These pits collect precipitation and runoff, enhance soil moisture, and facilitate the establishment of indigenous shrubs, averaging two seedlings per pit. Over time, vegetation rehabilitates soil health and provides forage for cattle. The Marab system redirects and distributes surplus runoff across extensive deep-soil floodplains. This procedure encompasses gully-filling, seedbed leveling, and the construction of bunds and spillways to facilitate flood-irrigated agriculture, hence supporting high-yield crops such as barley.

The intervention yielded significant outcomes, such as augmented soil fertility, enhanced vegetation cover, elevated agricultural and livestock productivity, and better biodiversity. Through the integration of upstream and downstream technology, the project offered a scalable and sustainable solution for tackling water, energy, food, and ecosystem concerns in arid regions.

Background

Numerous issues that impact the ecology and local inhabitants' means of subsistence are present in the Jordan Badia. The challenges encompass:

- **Agro-environmental Concerns:** The region's arid terrains have significantly deteriorated, exhibiting issues such as soil erosion, vegetation depletion, and diminishing soil fertility. This deterioration directly affects agricultural output,

diminishes grazing land for cattle, and harms ecosystems vital for water filtering and biodiversity support.
- **Climatic Conditions:** The Jordan Badia has a severe climate with significant rates of evaporation, prolonged dry spells, and little to no rainfall. Because of these factors, there is a persistent lack of water, which makes it challenging to support vegetation and agriculture. Effective water collection and storage are essential for facilitating plant growth and agricultural practices in such an environment.
- **Hydrological Issues:** Water resources in the Jordan Badia are few, and a significant portion of rainfall is lost as runoff during intense storms, failing to be collected for future utilization. This runoff exacerbates soil erosion and flooding, hence deteriorating the land and diminishing agricultural viability. The objective is to collect rainwater and store it for utilization during arid conditions, so supporting the sustenance of flora and agriculture.
- **Socio-economic Challenges:** Local populations, especially those dependent on agro-pastoralism, experience economic difficulties due to land degradation and diminishing agricultural output. As grazing land for cattle diminishes and agricultural yields decline, these communities face challenges in sustaining themselves and their families.

These interrelated difficulties illustrate the necessity for a holistic solution. The Integrated Watershed Management employing Vallerani and Marab Rain Water Harvesting Systems in Jordan Badia tackles these challenges by emphasizing land restoration, enhancing water retention, and increasing agricultural productivity. The initiative seeks to restore land health, enhance agricultural practices, and bolster the resilience of the environment and local populations through the application of water harvesting technologies.

Aims and Goals

The main objective of the Integrated Watershed Management Using Vallerani and Marab Rain Water Harvesting (RWH) Systems in Jordan Badia was to tackle significant challenges such as land degradation, water scarcity, and restricted agricultural productivity through the implementation of ecosystem restoration techniques, rather than emphasizing energy solutions or extensive irrigation systems. The project aims to enhance land health and agricultural productivity by implementing sustainable water harvesting techniques and rehabilitating ecosystems.

1. WEFE Objectives

The project focused on the water, food, and ecosystem dimensions of the WEFE nexus, although it did not directly address energy.

- **Water**: The project aimed to improve water retention; the Vallerani system, implemented in upstream areas, effectively captured rainfall and runoff, enhancing soil moisture and promoting vegetation growth without reliance on irrigation. The Marab system, utilized in specific floodplain regions, captures surplus runoff, temporarily storing water to mitigate erosion and facilitate agricultural practices.
- **Food**: The Marab system was developed to facilitate crop cultivation, including barley, via flood irrigation. This method eliminates the necessity for extensive groundwater extraction and expensive irrigation systems. The project sought to enhance food security and livestock fodder availability through the augmentation of soil moisture and fertility in arid environments.

- **Ecosystems**: The Vallerani system was primarily implemented for ecosystem restoration, emphasizing the planting of native species in degraded rangelands. This technique improved soil health, restored vegetation cover, and enhanced biodiversity. Restoring native vegetation offers essential ecosystem services, including carbon sequestration and wildlife habitat, while mitigating soil erosion.

Stakeholder consultation involves engaging relevant parties to gather insights and perspectives on specific issues or projects. This process is essential for informed decision-making and fostering collaboration among stakeholders. Consultations were conducted with local stakeholders, including communities, NGOs, and government agencies, to ensure alignment of project objectives with local needs and conditions. The discussions were essential for tailoring the intervention to the unique challenges of the Jordan Badia, including the area's limited rainfall and groundwater extraction restrictions.

2. Chronology and Objectives:

- **Short-term objectives** aim to restore soil health, establish native vegetation via the Vallerani technique, and enhance floodplain productivity through the Marab system.
- **Long-term objectives** encompassed the establishment of a sustainable, integrated watershed management system aimed at the restoration of degraded land and the enhancement of local community livelihoods through improved agricultural productivity and ecosystem resilience.

The intervention sought to establish a sustainable and scalable approach to ecosystem restoration and agricultural productivity in the Jordan Badia, emphasizing water management, food security, and environmental restoration.

Actions taken

The initiative aimed to tackle the issues of land degradation, water scarcity, and limited agricultural productivity in the Jordan Badia by implementing water harvesting technology and restoring ecosystems. In addition to two major water harvesting systems, the Vallerani and Marab, the intervention also included "soft" interventions to increase capacity and involve stakeholders, including the former to restore vegetation upstream and the latter to cultivate floodplains downstream.

1. Installation of Water Harvesting Systems

The Vallerani System, which is located upstream, was constructed mainly to collect and retain runoff from rainfall in the higher parts of the watershed. Pits were cut at irregular intervals following the terrain's contours by means of a Vallerani plow that was mounted to a tractor. The holes facilitate the collection of surface runoff, the enhancement of soil moisture, and the subsequent planting of seedlings of native shrubs. Planting two native shrub seedlings in each hole helped replenish depleted vegetation and increase biodiversity. By improving soil quality and creating a sustainable habitat for animals including cattle, the Vallerani method sought to restore portions of damaged rangelands.

The Marab system was implemented in the floodplains of the watershed to temporarily store and redirect surplus runoff. This system allowed for flood irrigation of different areas by filling gullies, levelling seedbeds, and building bunds and spillways. Livestock in this dry area had better access to fodder thanks to the Marab system's ability to collect and store water, which allowed for the development of high-yield crops like barley.

2. Soft Interventions

Several "soft" interventions were carried out in order to ensure the project's success over the long term. These include the following:

- **Stakeholder Engagement**: Community consultations and workshops were conducted with local farmers, NGOs, and government agencies to ensure project alignment with local needs, these ensured that the interventions are suitable for the area socio-economic context and received local support.
- **The capacity building** involved training local farmers and community members in the maintenance and management of the Vallerani and Marab systems. The training aimed to provide the community with the essential knowledge and skills to maintain the systems after the project's completion.

3. Engagement and Labor Force

The initiative encompassed a diverse array of participants:

- **Local Communities:** More than 200 community members engaged directly in the installation, maintenance, and monitoring of the water harvesting systems (30 people from 6 households in Majdiyya watershed and seasonal jobs created at the watershed (10-15 people)/year). Local farmers significantly contributed to the planting of native plants and the cultivation of crops within the Marab system. Additionally, awareness and skills were enhanced through training on sustainable land management, creating long-term capacity in these communities.
- **Technical and Scientific Experts:** The project received support from technical experts at ICARDA, local NGOs, and governmental organizations that offered advice on the execution of water harvesting systems and ecosystem restoration initiatives.

4. Sequence of Actions

The project implementation followed a systematic and integrated methodology:

- **Phase 1 (Water Harvesting Installation):** With primary objective was to implement the Vallerani system to enhance soil moisture and facilitate vegetation restoration in damaged rangelands. This phase was crucial for tackling the upstream issues of water retention and ecosystem restoration.
- **Phase 2 (Floodplain agricultural with Marab):** Following the establishment of the Vallerani system, focus transitioned downstream to the deployment of the Marab system for floodplain agricultural. The objective was to collect and regulate surplus runoff to facilitate the growing of crops, especially barley, for cattle feed.
- **Phase 3 (Biodiversity Restoration):** Simultaneously with the Marab system, initiatives were undertaken to restore biodiversity, emphasizing the cultivation of indigenous shrub species and enhancing overall vegetation coverage. The implementation of native species via the Vallerani system enhanced ecosystem services, including carbon sequestration, habitat provision, and soil fertility.

Main Achievement to date

The latest research on watershed restoration in the Jordanian Badia highlights several significant achievements driven by innovative water harvesting techniques. The restoration project successfully reduced annual surface runoff from 23.5 mm to 19.1 mm and soil erosion by over 60%, from 3.3 tons/ha to 1.3 tons/ha. These improvements have brought the hydrological dynamics closer to historical conditions, ensuring long-term sustainability.

The use of the Marab water harvesting system led to a remarkable increase in barley production, rising from 0.34 tons/ha to 8.37 tons/ha. This breakthrough shows how effective the technique is in enhancing agricultural yields under challenging climatic conditions. Silty soils proved to be the most productive, reaching up to 9.25 tons/ha. However, the success of the Marab system heavily depends on the timely occurrence of flood events, underlining the importance of precise environmental management.

Additionally, mechanized micro water harvesting methods significantly boosted soil moisture retention, encouraging the growth of native vegetation. The planted shrubs exhibited substantial growth, with notable increases in both stem diameter and height, particularly in dry spells. These results reaffirm the potential of water harvesting techniques

to combat land degradation and foster agro-pastoral development in arid environments.

A comprehensive mapping effort identified areas most suitable for micro and meso-scale rainwater harvesting, providing a framework for large-scale restoration and sustainable

land management in Jordan’s arid landscapes. The research offers invaluable insights into restoring vegetation cover and improving land productivity, marking a major step towards ecological recovery in the region.

On the institutional engagement and policy influence, the demonstrator facilitated substantial knowledge exchange across scales. Highlights include:

- Training of over 60 individuals from government agencies, NGOs, and academia in Jordan, Lebanon, and Palestine on water harvesting techniques and monitoring technologies.
- Specific capacity-building sessions were held with municipal staff, community nurseries, university students, and technical experts from NARC, LARI, and ARIJ.

These efforts have informed broader land restoration strategies and fed into discussions with national institutions on policy and planning for rangeland rehabilitation and climate adaptation. Moreover, ICARDA published several policy briefs that are shared with NARC-MOA.

Partners
ICARDA WADI - NGO NARC-JORDAN USFS Utrecht University Florance University

Lessons, replicability and scalability potential

- **Integrated Approaches Yield Greater Impact:** Combining biophysical interventions (Vallerani and Marab systems) with community engagement and capacity building created a holistic model that addressed environmental, agricultural, and socio-economic challenges simultaneously.
- **Adaptation to Local Conditions is Critical**: Tailoring water harvesting technologies to suit specific landscape features (e.g., upstream vs. floodplain) and soil types significantly enhanced effectiveness. The success of the Marab system in silty soils highlights the importance of site-specific planning.
- **Community Ownership Drives Sustainability**: Active involvement of over 200 community members in installation, monitoring, and maintenance fostered local ownership, which is vital for long-term success and system upkeep beyond the project’s lifespan.
- **Nature-Based Solutions Enhance Climate Resilience**: The restoration of native vegetation and improved soil moisture through mechanized water harvesting strengthened the ecosystem’s ability to withstand climatic extremes, offering a replicable nature-based solution for arid and semi-arid regions.
- **Scalability Requires Strategic Mapping and Timing**: The project's geospatial analysis for identifying suitable sites and the dependency of flood-based systems on seasonal timing underscore the need for strategic planning and adaptive management to ensure scalability and replicability in similar dryland contexts.

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