Gully plug (Mira Haddad)

# Gully plug (约旦)

السدات

## 描述

**Gully plugs aim at rehabilitating active gullies in dryland watersheds, which are prone to erosion through concentrated surface runoff. Multiple gullies plugged in succession dissipate runoff energy, foster local water retention and infiltration, encourage sedimentation, assist in the stabilization of gully bed and side banks, and stimulate revegetation of flow paths; the channel measures must be combined with proper SLM in the catchments upstream.**

Characteristics: Multiple gully plugs positioned sequentially within a gully system interrupt concentrated surface runoff and reduce its erosive power. The plugs are each made of multiple cobbles/stones mostly ranging between 10 and 30 cm diameter and constructed to ensure a stable structure. The plugs started at the head of the gully (upstream) and ranges from 1.5 - 3.7 m in width with an average of 2.5 m. For heavily eroded and very unstable sections, gabions can be used also. The structures are around 1.0 to 1.5-m high, anchored into the sidewalls, and around 0.20 to 0.35 m deep into the gully bed, built up to around 1/3 to max. 1/2 of the gully depth - ensuring the concentrated flow stays within the channel and does not overflow the side banks. The top of the plug is U-shaped, with the sides built higher than the centre. Upslope, the plugs are packed with soil to trap sediments (stopping it flowing through the structure), and downslope the plugs have an apron to dissipate the energy of overflowing water, into a micro stilling basin. The downslope side of the gully plug is sloped rather than vertical. The large stones add roughness to the slope, creating a rough spillway that dissipates erosive energy. In the direction of gully flow, several gully plugs are placed such that the upper gully apron is set at approximately the height of the following downstream gully crest.

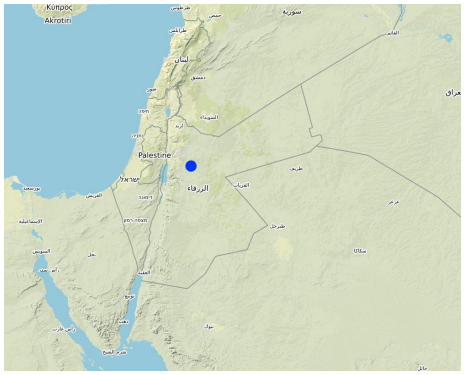
Environment: The technology is used in a watershed close to Al Majeddyeh village, located in the Middle Badia zone, approximately 30 km south-east of Amman. The climate is arid and warm (Palmer, 2013). The average annual rainfall is around 130 mm. The natural environment is labelled as steppe, "BSh" in the köppen classification. The human environment is characterized by agropastoralists. They are semi-nomadic and live in villages around the watershed, for example, Al Majeddyeh village.

Purpose: The measure interrupts the concentrated flow, reduces velocity, and dissipates energy. Multiple structures along the gully decrease the erosive power of runoff, retaining a fraction of the runoff, inducing sedimentation (upstream of the plug), thus protecting the gully bed from further deep-scouring, and strengthening the gully side banks, especially when this is linked with re-vegetation. Over time, the establishing vegetation (roots and surface cover) stabilizes the soil and protects it from concentrated flow erosion. To be effective, gully plug emplacement requires SLM in upland areas. These measures then jointly mitigate peak runoff generation and accordingly reduce downstream flooding.

Major activities: Upland SLM is essential. In the specific watershed rehabilitation context, upland SLM was achieved through micro water harvesting and re-vegetation through native shrubs (the "VALLERANI" method). Gully morphology assessment is required for gully plug design, and positioning and earthwork excavation is necessary for foundation preparation in the gully bed and wall anchors. Proper layering of various size stones and shaping of gully plugs is necessary as is the addition of a packed soil pack upstream of the stone structure, to semi-seal the surface and to pond water. Then gully walls are revegetated through native seedlings: these benefit from the water ponding upstream prior to sedimentation upstream of the gully and enhanced soil water storage in the sediments once the gully is filled.

Benefits: Stops ongoing land degradation and gully deepening, and achieves a certain degree of rehabilitation; retains a fraction of runoff water and sediments in the watershed – water mainly infiltrates and provides moisture to the gully vegetation; gully vegetation serves various purposes including livestock fodder, reduction of flow velocities in the gully, and retention of further sediment.

## 地点




**地点:** Amman governorate/Al Jizza/Al Majeddyeh village, 约旦

**分析的技术场所数量:** 单一场所

**选定地点的地理参考**
- 36.12826, 31.71933

**技术传播:** 适用于特定场所/集中在较小区域

**在永久保护区？:** 否

**实施日期:** 2017

**介绍类型**
- ☐ 通过土地使用者的创新
- ☐ 作为传统系统的一部分（> 50 年）
- ☑ 在实验/研究期间
- ☑ 通过项目/外部干预

Land user's opinion: Land users benefit from the vegetation (e.g. fruit trees can potentially be out-planted), as well as ponded water for livestock; however, the technology is labor-intensive, and therefore costly, and landowners (at the local target site) require incentives to carry out the work.

Gully plug construction (Mira Haddad)

Gully plugs during the first rainy season 2017/2018. Photo looking downstream at the top of a gully plug with water ponded and sediment trapped upstream. (Mira Haddad)

## 技术分类

### 主要目的

- [ ] 改良生产
- [x] 减少、预防、恢复土地退化
- [ ] 保护生态系统
- [ ] 结合其他技术保护流域/下游区域
- [x] 保持/提高生物多样性
- [x] 降低灾害风险
- [ ] 适应气候变化/极端天气及其影响
- [ ] 减缓气候变化及其影响
- [ ] 创造有益的经济影响
- [ ] 创造有益的社会影响

### 土地利用

同一土地单元内混合使用的土地： 是 - 农牧业（包括农牧结合）

**牧场**

- 半游牧畜牧业

**水道、水体、湿地** - 排水管道、水道
主要产品/服务: To convey and drain: Wd

### 供水

- [x] 雨养
- [ ] 混合雨水灌溉
- [ ] 充分灌溉

### 土地退化相关的目的

- [ ] 防止土地退化
- [x] 减少土地退化
- [x] 修复/恢复严重退化的土地
- [ ] 适应土地退化
- [ ] 不适用

### 解决的退化问题

**土壤水蚀** - Wg：冲沟侵蚀/沟蚀，Wo：场外劣化效应

**物理性土壤退化** - Pk：熟化和结壳, Pu：由于其他活动而导致生物生产功能的丧失

**水质恶化** - Hs：地表水良变化, Hw：湿地缓冲能力下降

### SLM组

- 改良的地面/植被覆盖
- 最小的土壤扰动
- 横坡措施
- water harvesting; surface water management (spring, river, lakes, sea, riparian zone, riverbanks, seashore, lakeshore, spring shed); ecosystem-based disaster risk reduction

### SLM措施

**植物措施** - V2：草和多年生草本植物

**结构措施** - S6：墙、障碍物、栅栏、围墙

**其它措施** - Specify tillage system: no tillage Specify residue management: grazed and retained

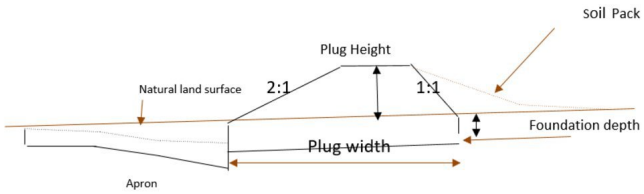
## 技术图纸

### 技术规范

Emplacement in gully morphological system and watershed context: Determine the downstream starting point for the gully plugs and then extend upstream. The basic design is to keep the structure height maximum half the gully depth regardless of structure type. The spacing between structures is set as a gully depth function, structure crest height above the gully bed, and slope of the gully bed between structures. Additionally, the structure's final location will be shifted either upstream or downstream of the calculated gully bed level to place the structure in a more stable point if required. Following this methodology ensures variable spacing between structures to cope with both slope and depth of gully to ensure the sediment filling in between these structures occurs. In the case of distinct gully morphology and side banks that are very unstable, gabion structures can also be used/instead of a single stone pack.

Design of the Structure: Gully plugs must be anchored strong enough to resist water flow and prevent bypass from the side banks. A foundation is also required for all structures, depending on their dimensions and the bed's nature. At the specific site, the foundation depth for the planned structures ranges between 0.2 to 0.35 meters. The anchoring of gully plugs ranges between 1 and 1.5 meters. This depends on the existing condition of the banks at each structure location. Gully plugs have a downstream apron with a length of around 3 to 4 times the height of structures. The apron starts from below the bottom level of the foundation and gradually level halfway down. All gully plugs were designed to have a height maximum of 0.5 the depth of the gully. So each structure will pass water flow downward but keeping it inside the gully. Gabion structures have a sort of spillway from the top but at the same time protecting the banks. The configuration slightly differs from the normal stone structure, but the idea is to protect the sides and a spillway in the middle. The upstream front of each gully plug has a side slope of 1:1, while the downstream front of the plug has a side slope of 2:1 (not counting the apron). The slopes at the two sides greatly increase the base width of the plug and improve their stability. The gully plugs are provided with an amount of soil resulting from the foundation to form a triangle of soil fill against the structure at the upstream side; this improves the function of the gully plugin holding more water and trapping sediments. On the other side of each structure, the downstream side's slope is meant to tackle the overflow of water along the drop to safely return to the gully bed level without causing additional erosion. The rock-filled apron catches the flow and acts to dissipate erosive energy.

The upstream front of each gully plug will have a side slope of 1:1, while the downstream front of the plug will have a side slope of 2:1 (not counting the apron). The slopes at the two sides will greatly increase the base width of the plug and improve their stability.




Author: Steve Evett

## 技术建立与维护：活动、投入和费用

**投入和成本的计算**

- 计算的成本为：每个技术单元 (单位：**Gully plug**)
- 成本计算使用的货币：**美元**
- 汇率（换算为美元）：1 美元 = 不适用
- 雇用劳工的每日平均工资成本：不适用

**影响成本的最重要因素**

The most distinct cost factor is labor – which is especially significant when using local (community) labor; some technical training is required.

**技术建立活动**

1. Implement upland watershed SLM (reference VALLERANI) (时间/频率: None)
2. Gully system/morphological assessment (时间/频率: None)
3. Determine plug design and implementation in the watershed (时间/频率: None)
4. Excavation earthworks for anchors and foundation (时间/频率: At least 2 months prior rainy season onset)
5. Stone made construction of gully plugs (occasionally with gabions) (时间/频率: At least 1 month prior rainy season onset)
6. Soil pack at upstream front (时间/频率: At least 1 month prior rainy season onset)
7. Revegetation of gully side banks (时间/频率: At the onset of the rainy season)

**技术建立的投入和成本 (per Gully plug)**

| 对投入进行具体说明 | 单位 | 数量 | 单位成本 (美元) | 每项投入的总成本 (美元) | 土地使用者承担的成本% |
|---|---|---|---|---|---|
| **劳动力** | | | | | |
| Field technician (design and oversight) | Labour Day (LD) per structure | 0.2 | 50.0 | 10.0 | |
| Workers (excavation/earthworks) | LD | 4.0 | 35.0 | 140.0 | |
| Workers (stone layering/construction) | LD | 4.0 | 35.0 | 140.0 | |
| Worker (out-planting of seedlings) | LD | 1.0 | 35.0 | 35.0 | |
| **设备** | | | | | |
| Shovel, Pickaxe, buckets, ruler | Lump sum | 1.0 | 10.0 | 10.0 | |
| **植物材料** | | | | | |
| Seedlings | per item | 10.0 | 0.5 | 5.0 | |
| **施工材料** | | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Stones | m3 | 4.0 | 10.0 | 40.0 | |
| **其它** | | | | | |
| Logistics (seedling transport, local stone transport) | lump sum | 1.0 | 10.0 | 10.0 | |
| **技术建立所需总成本** | | | | **390.0** | |
| *技术建立总成本，美元* | | | | *390.0* | |

**技术维护活动**

1. Inspect damage/status (时间/频率: After severe storms and runoff events)
2. Maintain/repair/improve (时间/频率: After inspection)

**技术维护的投入和成本 (per Gully plug)**

| 对投入进行具体说明 | 单位 | 数量 | 单位成本 (美元) | 每项投入的总成本 (美元) | 土地使用者承担的成本% |
|---|---|---|---|---|---|
| **劳动力** | | | | | |
| Expert (investigation) | LD | 0.1 | 50.0 | 5.0 | |
| | LD | 0.5 | 35.0 | 17.5 | |
| | LD | 1.0 | 35.0 | 35.0 | |
| **施工材料** | | | | | |
| stones | m3 | 0.5 | 10.0 | 5.0 | |
| **技术维护所需总成本** | | | | **62.5** | |
| *技术维护总成本，美元* | | | | *62.5* | |

## 自然环境

**年平均降雨量**

- [x] < 250毫米
- [ ] 251-500毫米
- [ ] 501-750毫米
- [ ] 751-1,000毫米
- [ ] 1,001-1,500毫米
- [ ] 1,501-2,000毫米
- [ ] 2,001-3,000毫米
- [ ] 3,001-4,000毫米
- [ ] > 4,000毫米

**农业气候带**

- [ ] 潮湿的
- [ ] 半湿润
- [ ] 半干旱
- [x] 干旱

**关于气候的规范**

以毫米为单位计算的年平均降雨量：130.0
Jordan has a rainy season from September to May – but locally, the effective rainy season sets on later (November or December) and lasts until April.
气象站名称：Queen Alia international airport reference station reports long term average annual rainfall of about 150 mm A rainfall tipping bucket installed in the site in 2016.

**斜坡**

- [ ] 水平（0-2%）
- [x] 缓降（3-5%）
- [x] 平缓（6-10%）
- [ ] 滚坡（11-15%）
- [ ] 崎岖（16-30%）
- [ ] 陡峭（31-60%）
- [ ] 非常陡峭（>60%）

**地形**

- [x] 高原/平原
- [ ] 山脊
- [ ] 山坡
- [x] 山地斜坡
- [ ] 麓坡
- [ ] 谷底

**海拔**

- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [x] 501-1,000 m a.s.l.
- [ ] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

**.....应用的技术**

- [ ] 凸形情况
- [x] 凹陷情况
- [ ] 不相关

**土壤深度**

- [ ] 非常浅（0-20厘米）
- [ ] 浅（21-50厘米）
- [ ] 中等深度（51-80厘米）
- [x] 深（81-120厘米）
- [x] 非常深（> 120厘米）

**土壤质地（表土）**

- [ ] 粗粒/轻（砂质）
- [x] 中粒（壤土、粉土）
- [x] 细粒/重质（粘土）

**土壤质地（地表以下>20厘米）**

- [ ] 粗粒/轻（砂质）
- [x] 中粒（壤土、粉土）
- [x] 细粒/重质（粘土）

**表土有机质含量**

- [ ] 高（>3%）
- [ ] 中（1-3%）
- [x] 低（<1%）

**地下水位**

- [ ] 表面上
- [ ] < 5米
- [ ] 5-50米
- [x] > 50米

**地表水的可用性**

- [ ] 过量
- [ ] 好
- [x] 中等
- [ ] 匮乏/没有

**水质（未处理）**

- [ ] 良好饮用水
- [ ] 不良饮用水（需要处理）
- [x] 仅供农业使用（灌溉）
- [ ] 不可用

*水质请参考： 地表水*

**盐度是个问题吗？**

- [ ] 是
- [x] 否

**洪水发生**

- [x] 是
- [ ] 否

**物种多样性**

- [x] 高
- [ ] 中等
- [ ] 低

**栖息地多样性**

- [ ] 高
- [x] 中等
- [ ] 低

## 应用该技术的土地使用者的特征

**市场定位**

- [ ] 生计（自给）
- [ ] 混合（生计/商业）
- [ ] 商业/市场

**非农收入**

- [x] 低于全部收入的10%
- [ ] 收入的10-50%
- [ ] > 收入的50%

**相对财富水平**

- [x] 非常贫瘠
- [x] 贫瘠
- [ ] 平均水平
- [ ] 丰富
- [ ] 非常丰富

**机械化水平**

- [x] 手工作业
- [ ] 畜力牵引
- [ ] 机械化/电动

**定栖或游牧**
- [x] 定栖的
- [x] 半游牧的
- [ ] 游牧的

**个人或集体**
- [x] 个人/家庭
- [x] 团体/社区
- [ ] 合作社
- [ ] 员工（公司、政府）

**性别**
- [ ] 女人
- [x] 男人

**年龄**
- [ ] 儿童
- [x] 青年人
- [x] 中年人
- [ ] 老年人

**每户使用面积**
- [ ] < 0.5 公顷
- [ ] 0.5-1 公顷
- [ ] 1-2 公顷
- [ ] 2-5公顷
- [ ] 5-15公顷
- [ ] 15-50公顷
- [ ] 50-100公顷
- [x] 100-500公顷
- [ ] 500-1,000公顷
- [ ] 1,000-10,000公顷
- [ ] > 10,000公顷

**规模**
- [ ] 小规模的
- [ ] 中等规模的
- [x] 大规模的

**土地所有权**
- [ ] 州
- [ ] 公司
- [ ] 社区/村庄
- [ ] 团体
- [ ] 个人，未命名
- [x] 个人，有命名

**土地使用权**
- [ ] 自由进入（无组织）
- [ ] 社区（有组织）
- [ ] 租赁
- [x] 个人

**用水权**
- [ ] 自由进入（无组织）
- [ ] 社区（有组织）
- [ ] 租赁
- [ ] 个人

**进入服务和基础设施的通道**

| | | |
|---|---|---|
| 健康 | 贫瘠 | 好 |
| 教育 | 贫瘠 | 好 |
| 技术援助 | 贫瘠 | 好 |
| 就业（例如非农） | 贫瘠 | 好 |
| 市场 | 贫瘠 | 好 |
| 能源 | 贫瘠 | 好 |
| 道路和交通 | 贫瘠 | 好 |
| 饮用水和卫生设施 | 贫瘠 | 好 |
| 金融服务 | 贫瘠 | 好 |

## 影响

**社会经济影响**

| | | |
|---|---|---|
| 饲料生产 | 降低 | 增加 |
| 饲料质量 | 降低 | 增加 |
| 家畜用水的可用性 | 降低 | 增加 |

**社会文化影响**

| | | | |
|---|---|---|---|
| 食品安全/自给自足 | 减少 | 改良 | Some herbs (and fruits (trees) in the future) |
| 娱乐机会 | 减少 | 改良 | enhanced biodiversity, shade and shelter |
| SLM/土地退化知识 | 减少 | 改良 | Through training/community participation |

**生态影响**

| | | | |
|---|---|---|---|
| 水质 | 降低 | 增加 | Certain degree purification through infiltration in the sediment accumulation zone |
| 水的回收/收集（径流、露水、雪等） | 减少 | 改良 | |
| 地表径流 | 增加 | 降低 | Effect on hydrology (distinctness of runoff peak) |
| 地下水位/含水层 | 下降 | 补水 | Certain deep-infiltration |
| 蒸发 | 增加 | 降低 | more open water ponding – but also deep-infiltration and beneficial use for vegetation (transpiration) |
| 土壤水分 | 降低 | 增加 | |
| 土壤覆盖层 | 减少 | 改良 | |
| 土壤流失 | 增加 | 降低 | Side banks stabilized |
| 土壤堆积 | 降低 | 增加 | sediments trapped |
| 土壤结壳/密封 | 增加 | 减少 | sediment crust increased in the ponding area – but better soil structure at the side banks (revegetation) – overall positive impact. |
| 植被覆盖层 | 降低 | 增加 | |
| 生物量/地上C | 降低 | 增加 | |
| 植物多样性 | 降低 | 增加 | |
| 动物多样性 | 降低 | 增加 | |

| | | | |
|---|---|---|---|
| 有益物种（捕食者、蚯蚓、传粉者） | 降低 | 增加 | |
| 洪水影响 | 增加 | 降低 | |
| 滑坡/泥石流 | 增加 | 降低 | Through side bank stabilization. |
| 微气候 | 恶化 | 改良 | |

**场外影响**

| | | | |
|---|---|---|---|
| 下游洪水（不希望） | 增加 | 减少 | |
| 下游淤积 | 增加 | 降低 | especially when combined with upland measure: reference VALLERANI |
| 对邻近农田的破坏 | 增加 | 减少 | Less tributary channel development (connectivity of upland areas); less downstream siltation |
| 对公共/私人基础设施的破坏 | 增加 | 减少 | less runoff peakiness and siltation |

## 成本效益分析

**与技术建立成本相比的效益**

| | | |
|---|---|---|
| 短期回报 | 非常消极 | 非常积极 |
| 长期回报 | 非常消极 | 非常积极 |

**与技术维护成本相比的效益**

| | | |
|---|---|---|
| 短期回报 | 非常消极 | 非常积极 |
| 长期回报 | 非常消极 | 非常积极 |

During the initial stage potential benefits through vegetation do not materialize; main effects are on water and sediment retention. Long-term, the technology fosters the rehabilitation nature-based retention functions (very limited long-term maintenance required).

## 气候变化

**渐变气候**

| | | |
|---|---|---|
| 年温度 增加 | 非常不好 | 非常好 |
| 年降雨量 减少 | 非常不好 | 非常好 |

**气候有关的极端情况（灾害）**

| | | |
|---|---|---|
| 局地暴雨 | 非常不好 | 非常好 |
| 山洪暴发 | 非常不好 | 非常好 |
| 流行病 | 非常不好 | 非常好 |

**其他气候相关的后果**

| | | |
|---|---|---|
| 延长生长期 | 非常不好 | 非常好 |

## 采用和适应

**采用该技术的地区内土地使用者的百分比**

- [x] 单例/实验
- [ ] 1-10%
- [ ] 11-50%
- [ ] > 50%

**在所有采用这种技术的人当中，有多少人在没有获得物质奖励的情况下采用了这种技术?**

- [x] 0-10%
- [ ] 11-50%
- [ ] 51-90%
- [ ] 91-100%

**户数和/或覆盖面积**

1

**最近是否对该技术进行了修改以适应不断变化的条件？**

- [ ] 是
- [x] 否

**什么样的变化条件？**

- [ ] 气候变化/极端气候
- [ ] 不断变化的市场
- [ ] 劳动力可用性（例如，由于迁移）

## 结论和吸取的教训

**长处: 土地使用者的观点**

- Gully side bank vegetation useable as (livestock) fodder source; some herbs (later fruit tree benefits) for human consumption.
- Gully is stable and does not expand e.g. tributaries. Uplands remain connected and productive.
- Ponded water for livestock watering (during the rainy season).
- Shelter and shade through vegetation.

**弱点/缺点/风险: 土地使用者的观点如何克服**

- implementation costs Incentives (e.g. governmental) for communities to implement SLM; regulations and enforcement on environmental management – especially connected with entitlements of natural resources facilitation
- Tensions between upstream and downstream watershed users (watershed hydrology) – especially affected through wrong design and failure (e.g. gully breakage) Community-based and holistic

**长处: 编制者或其他关键资源人员的观点**

- Sediments from the uplands are trapped; relatively fertile soil remains in the watershed.
- Increased local soil moisture and consequential vegetation quantity and bio-diversity enhancement; increase carbon storage and other ecosystem services such as pollination.
- Smoothened watershed hydrology is beneficial for downstream agriculture – especially when applied in a watershed context with downstream flood irrigation (MARAB)
- Protection of downstream infrastructure (flooding and sediments).

watershed management – the share of benefits and commitment for maintenance.
- Additional fodder supply might attract other foreign herders (overgrazing) Community-based and holistic watershed management – and protection.
- Technical skills needed for implementation Rural communities' capacity building programs

**弱点/缺点/风险: 编制者或其他关键资源人员的观点如何克服**

- Expert design and implementation support required Governmental and environmental organizations in control of design and support to local communities (training).
- Requires upland SLM Integrated watershed management and empowerment of local communities to manage and facilitate – provision of support (e.g. government and/or international projects).
- Increased vegetation in a fragile ecosystem can lead to local pressure Integrated watershed management and empowerment of local communities – especially sustainable grazing plans
- Risk of wrong lessons learned: large water harvesting in gully systems (dams) created by locals Capacity development programs; regulations and enforcement on environmental management.

## 参考文献

**编制者**
Mira Haddad

**Editors**

**审查者**
William Critchley
Rima Mekdaschi Studer

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**资源人**
Joren Verbist - co-compiler
Stefan Strohmeier - SLM专业人员
Mira Haddad - SLM专业人员
Steve Evett - SLM专业人员

**WOCAT数据库中的完整描述**
https://qcat.wocat.net/zh/wocat/technologies/view/technologies_5862/

**链接的SLM数据**
Approaches: From Tradition to Innovation: Restoring Arid Jordan Badia's Watershed with Indigenous-Science Synergy in Agriculture
https://qcat.wocat.net/zh/wocat/approaches/view/approaches_6736/

**文件编制者**

机构
- International Center for Agricultural Research in the Dry Areas (ICARDA) - 黎巴嫩

项目
- 不适用

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