Constructability criteria to reclaim farmland by making use of micro-dam sediments in Tigray, Ethiopia

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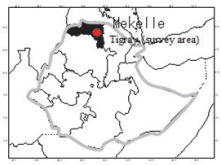
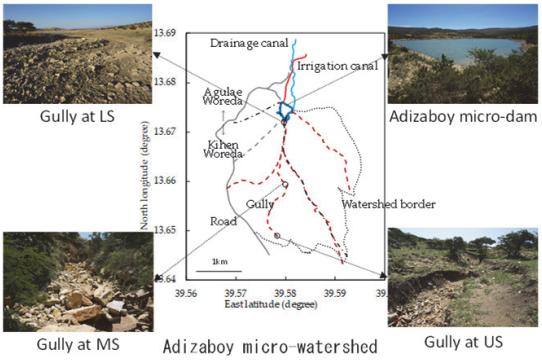
Introduction



Location map of project site in Ethiopia

Latitude:13.64-13.68°
Longitude:39.56-39.60°
Altitude:2050-2275m
Average slope:8.8%
Rainfall:300-1000mm



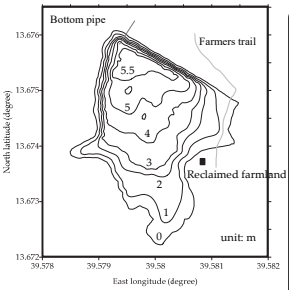
- ✓ Ethiopian highland: about 45% of Ethiopian land is located greater than 1500 m.
- ✓ Ethiopia's main industry is agriculture: 65% of employment (2018).
- ✓ Soil erosion is severe due to the sparse vegetation cover: 130 tons/ha/year.
- ✓ Micro-dams have been constructed to mitigate water shortages water as most farming areas are rain-fed and poor water resources affect crop yield.
- ✓ 50% of micro-dams in northern Ethiopia have suffered from sedimentation problem.
- ✓ Sediments in micro-dams with a high nutrient accumulation are left unused.
- ✓ Demand for higher-yield farmland to produce food for the growing population is increasing.

Objective

To demonstrate the utility of constructability criteria for reclaimed farmland to mitigate the sediment accumulation in micro-dams

Materials and Methods

1. Micro-dam sediment



Sediment Survey Results at Adizaboy Micro-dam

2. Constructability Concepts

Conceptual planning phase

1-A: The constructability program should be made an integral part of the project execution plan.
1-B: Special emphasis should be placed on maintaining an effective project team.
1-C: Early project planning should actively involve individuals with current construction knowledge and experience.
1-D: This early construction involvement should be a consideration in developing the contracting strategy.
1-E: The master project schedule should be start-up and construction-sensitive.
1-F: Major construction methods should be analyzed in-depth early on and should be facilitated through proper facility design.
1-G: Site layouts should promote efficient construction, operation, and maintenance.

Design and procurement phase

2-A: Design and procurement schedules should be construction-driven.
2-B: The capabilities and benefits of advanced information technology should be exploited.
2-C: Designs should be configured to enable efficient construction.
2-D: Design elements should be standardized.
2-E: Technical specifications should promote construction efficiency.
2-F: Detailed designs of modules and preassemblies should be prepared to facilitate efficient fabrication, transport, and installation.
2-G: Project designs should promote accessibility to materials and equipment by construction personnel.
2-H: Designs should allow for and enable construction under adverse weather conditions.

Field operation phase

3-A: Special effort should be applied toward developing innovative construction methods.

Results

1. Constructability Criteria

Conceptual Planning Phase

1) Building an effective project team
Criteria: 1-B, 1-C and 1-D
Attribute: training program for specific craft, daily allowances for on-site jobs
on-site communication with construction expertise
availability of delivery systems
availability of special craftmen and equipment for metal welding
2) Facilitating proper designs and layouts
Criteria: 1-E, 1-F and 1-G
Attribute: storage water in micro-dam for irrigation
availability of standard design for farm pond, tank and drip irrigation

Design and Procurement Phase

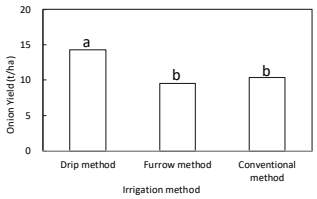
1) Design efficient construction elements
Criteria: 2-B, 2-C, 2-D and 2-E
Attribute: minimize design details complexity, reduce detailed specifications need
use results of past survey and water balance analysis
use standard dimensions and sizes for farmland
2) Planning, design, and procurement schedules and flexibility
Criteria: 2-A
Attribute: land permit processes to obtain the reclaimed land
adaptability to withstand unexpected field conditions
potential delays due to unavailability of equipment, material, and labor
3) Preparing for preassemblies and logistics
Criteria: 2-F and 2-G
Attribute: maximum use of on-site equipment and minimum labor
off-site preassembly (prefabrication and cutting/welding) by skilled labor
maximize use of same transportation system for delivery
facilitation of customs inspection for equipment made abroad
4) Preparing for adverse weather conditions
Criteria: 2-H
Attribute: reclamation work (sediment transportation and concrete) and foundation work (fixing poles) under rain
site access through submerged farming roads during rainy season
temporary storage for weather-sensitive equipment and materials

Field Operation Phase

Criteria: 2-B and 3-A
Attribute: maximize the use of advanced materials (solar light)
maximize innovative survey equipment (GPS, note PCs, cameras, weather observation devices, and echo-sounders)

2. Onion Cultivation Trial

Onion yield on reclaimed farmland for different irrigation methods



Letters above onion yields show significant differences ($p < 0.01$) among treatments.

Conclusion

1) Mapped constructability criteria to solve micro-dam sedimentation problem through the farmland reclamation by using micro-dam sediments in Tigray.
2) Participants' experience, knowledge, teamwork, communication, and leadership decided performance of farmland reclamation.
3) Constructability criteria will produce an optimum reclaimed farmland model to make the most of benefits, to reduce costs and to increase the agricultural productivity and incomes.

Acknowledgement

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Reference

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