



Water and
Environment Centre

Evaluating the potential of road rain water harvesting in Yemen

*A case study of the Maghrabah Manakah Bab
Bahil Road,
Sana'a Governorate*

By

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Problem Background

In Yemen the water affect the road infrastructure and the environment also affected by road construction especially in rural area's as a result of neglecting the effect of water to the roads and consequently the effect of construct and maintenance of roads to the nearby environment.

Road surfaces may act as a great catchment area in rainy seasons especially in rural areas thus we can established harvesting structures along the alignment of the road near to the right of the road and at the same time prevent the road body from deterioration by the accumulated water throw the road surface and side ditches, and also protect the entire environment and the degradation of soil because of the water at the outlets of the culverts and spillways in term of an integrated approach relate the whom will be the beneficiaries of this structures (local communities, specialist roads engineers and road authority) who have direct interface to the overall landscape along the pathway.

Study Area

a large part of the main proposed asphalted roads in this area required protection and culverts works to protect the road from water problems (scour?).

The local people living near the road already practice road water harvesting using several techniques.

There are also other road surfaces used in this area, like tertiary (stone paved?) roads and rural stone paved feeder roads.

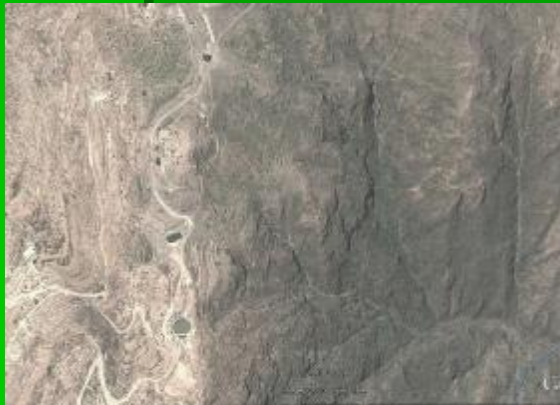




Maghrabah Manakah Bab Bahil Road (Bani Al-Gail)



Jabal Awi – Hasaban Road



Examples of Water Harvesting Maghrabah Manakah Bab Bahil Road & Jabal Awi Road

Objectives

Main objectives

Optimize the benefits of water from roads for the local communities in socio-economic development and for the environment protection focusing on the road of Maghrabah Manakah Bab Bahil Road and the linked rural road Jabal Ekbari and Jabal Awi Road Sana'a Governorate

Other objectives

Suggest alternative strategies in geometric road designs to manage water from roads due to **Integrated Water & Roads Management**

Check the awareness of roads engineers (designers and executioners) and decision makers and donors and contractors on the importance of **Integrated Water & Roads Management**.

Develop Geometric & Environmental guidelines for road construction and maintenance.

Research question

Main research question

What is the water harvesting potential of the road (Maghrabah Manakah Bab Bahil Road and the linked rural road Jabal Ekbari and Jabal Awi Road) in water storage volume and the beneficial reuse of additional captured water?

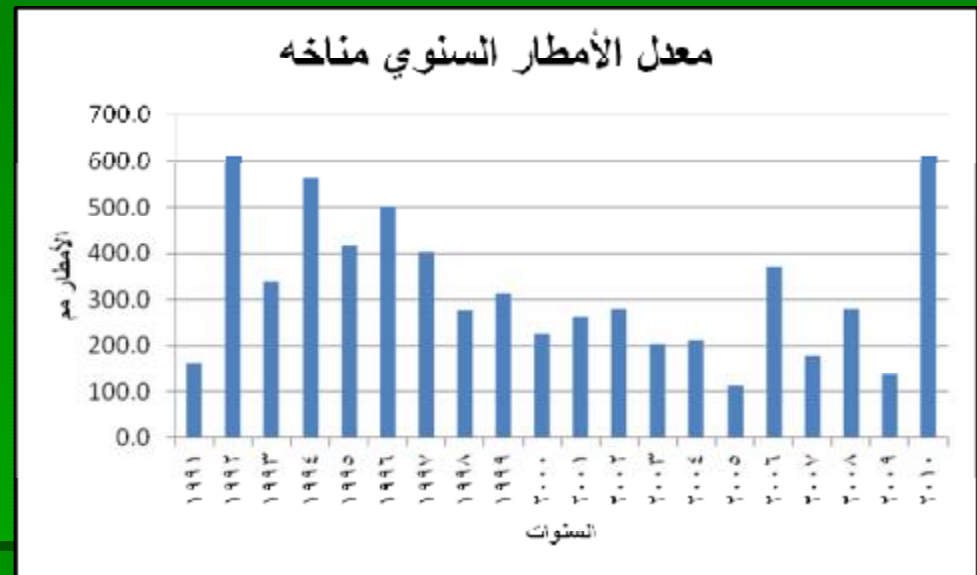
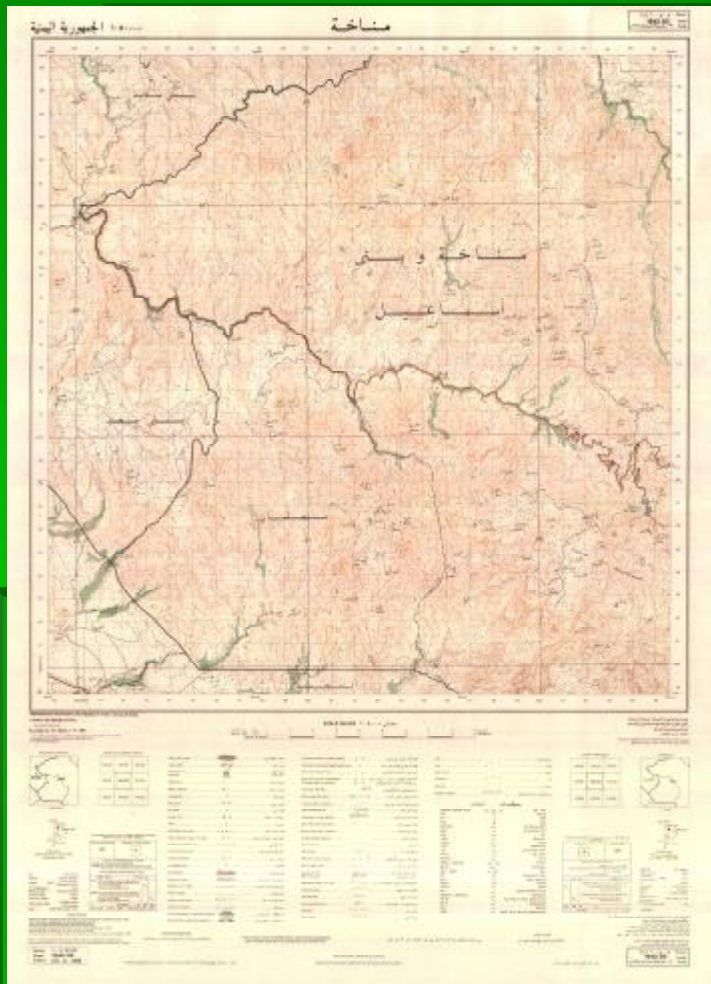
Sub questions

What is the role of geometric design of the road to enhance the water harvesting from the road

What is the knowledge and awareness of roads engineer to the subject of harvesting water from roads.

Methodology Research Plan

1 - Literature review and Base line data collection



شكل () : معدل التساقط السنوي لمحطة مناخه (1991-2010) م.

Methodology *Research Plan*

2. Design of Questionnaires

The questionnaire will be designed to find out the following:

- Water harvesting from roads and how to benefit from it.
- Water effects to the roads under construction and after construction.
- Solution to the effect of water to the roads and vise-versa.
- Roads construction effect to the environment.
- The study will take a questionnaire to the specialist's engineers who are responsible for the design, supervision and maintenance of roads.
- The study will take a questionnaire to the beneficiaries.

Technical Questionnaire for the Engineering of the Water Supply in Trinidad Water Finance Manager

Yohan Singh, Chairman of the Board of Directors, Trinidad Water Finance Manager

Code	Question	Answer
100	What is the main objective of the water supply system?	to provide a safe and adequate supply of water for all the people of Trinidad and Tobago
101	How do you measure the performance of the water supply system?	through the use of various indicators such as water quality, quantity, reliability, and cost-effectiveness
102	What are the main components of the water supply system?	the water source, treatment plant, distribution network, and retail supply
103	How do you determine the water demand in the country?	through the use of various methods such as population growth, economic development, and climate change
104	What are the main challenges facing the water supply system in Trinidad?	the ageing of infrastructure, climate change, and population growth
105	How do you manage the financial aspects of the water supply system?	through the use of various financial instruments such as bonds, loans, and equity
106	What are the main risks facing the water supply system?	the risk of drought, flooding, and contamination
107	How do you ensure the sustainability of the water supply system?	through the use of various strategies such as water conservation, recycling, and desalination

The above information was obtained from the various sources mentioned in the questionnaire and is for informational purposes only.

Yohan Singh, Chairman of the Board of Directors, Trinidad Water Finance Manager

Code	Question	Answer
108	What are the main sources of water in Trinidad?	the natural rainfall and the imported water from other countries
109	How do you ensure the quality of the water supply?	through the use of various quality control measures such as regular testing and monitoring
110	What are the main factors affecting the water supply in Trinidad?	the climate change, population growth, and economic development
111	How do you manage the water supply during the dry season?	through the use of various water conservation measures and the importation of water from other countries
112	What are the main challenges facing the water supply system in Trinidad during the wet season?	the risk of flooding and the contamination of water sources
113	How do you ensure the sustainability of the water supply system during the wet season?	through the use of various strategies such as water conservation, recycling, and desalination

Code	Question	Answer
114	What are the main components of the water supply system?	A. The water source, B. The water treatment plant, C. The distribution network, D. The retail supply
115	How do you determine the water demand in the country?	A. Through the use of various methods such as population growth, economic development, and climate change, B. Through the use of various methods such as population growth, economic development, and climate change, C. Through the use of various methods such as population growth, economic development, and climate change, D. Through the use of various methods such as population growth, economic development, and climate change
116	What are the main challenges facing the water supply system in Trinidad?	A. The ageing of infrastructure, B. Climate change, C. Population growth, D. Economic development
117	How do you manage the financial aspects of the water supply system?	A. Through the use of various financial instruments such as bonds, loans, and equity, B. Through the use of various financial instruments such as bonds, loans, and equity, C. Through the use of various financial instruments such as bonds, loans, and equity, D. Through the use of various financial instruments such as bonds, loans, and equity
118	What are the main risks facing the water supply system?	A. The risk of drought, B. Flooding, C. Contamination, D. Economic development
119	How do you ensure the sustainability of the water supply system?	A. Through the use of various strategies such as water conservation, recycling, and desalination, B. Through the use of various strategies such as water conservation, recycling, and desalination, C. Through the use of various strategies such as water conservation, recycling, and desalination, D. Through the use of various strategies such as water conservation, recycling, and desalination

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Questionnaire for MSU Inland rain water harvesting

Q1	Name of the respondent
District - _____ Area - _____	
Q2	Sex
Q3	Age
Q4	NAME SURVEYED HOUSEHOLD - DISTRICT - VILLAGE
Q5	House construction year سنة البناء
Q6	Household size عدد أفراد العائلة
Q7	Household income per year الدخل السنوي للعائلة
Q8	Education level المستوى التعليمي

Questionnaire for MSU Inland rain water harvesting

Demographic information

Q1	Q2	Q3	Q4
Q1	Q2	Q3	Q4
Q5	Q6	Q7	Q8
Q9	Q10	Q11	Q12
Q13	Q14	Q15	Q16
Q17	Q18	Q19	Q20
Q21	Q22	Q23	Q24
Q25	Q26	Q27	Q28
Q29	Q30	Q31	Q32
Q33	Q34	Q35	Q36
Q37	Q38	Q39	Q40
Q41	Q42	Q43	Q44
Q45	Q46	Q47	Q48
Q49	Q50	Q51	Q52
Q53	Q54	Q55	Q56
Q57	Q58	Q59	Q60
Q61	Q62	Q63	Q64
Q65	Q66	Q67	Q68
Q69	Q70	Q71	Q72
Q73	Q74	Q75	Q76
Q77	Q78	Q79	Q80
Q81	Q82	Q83	Q84
Q85	Q86	Q87	Q88
Q89	Q90	Q91	Q92
Q93	Q94	Q95	Q96
Q97	Q98	Q99	Q100

Questionnaire for MSU Inland rain water harvesting

Q1	Q2	Q3	Q4
Q5	Q6	Q7	Q8
Q9	Q10	Q11	Q12
Q13	Q14	Q15	Q16

Methodology *Research Plan*

3. Field research

Oriented experience exchange sharing of road engineers, watershed specialists, contractors and water harvester's from roads.

Detailed interviews and discussions with some examples of harvesting water from some selected areas.

Development of and testing of basic integrated package, for calculation of road impact on local water harvesting , location of roads in watershed; road material; road length, width/bends; height road ridge; type of embankment; location of culverts; ditch infiltration; locating Irish bridges and length of longitudinal slope .

Sampling of road water quality.

Methodology *Research Plan*

4. Data analysis and interpretation

- Questionnaire data will be analyzed using Statistical Package for Social Science (SPSS) Program and the results will be discussed to evaluate the situation and prepare the proposed sustainable strategies to be implemented.
- Discussion and technical review of standard designs and suggestions for modification to existing manuals for best integrated design
- Scientific paper summarizing the research findings

Methodology *Research Plan*

5. Report Preparation

- The final report will be prepared containing a broad view in current water and roads management and the main recommendation to implement the best strategy to WR in an integrated way, the report will include tables and figures which obtained from the study.
- Scientific paper summarizing the research findings.

Thank you for your Attention