Rainwater Harvesting Techniques Applied to Some Iraqi Zones

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Abstract

Iraq, the home of two great rivers, Euphrates and Tigris, has faced a sever shortage on its surface water resources on the years 1997-2002. The shortage due in part to the Turkish implementation of (GAP) project which includes number of dams and diversion tunnels which results in larger share of the two rivers water for Turkey on the expense of Iraq, and, in part to the recent drought that the middle east has experienced. Such situation calls for exploiting all the possible water resources of which rainwater constitute an important component.

This paper concentrate on evaluating the potentials of rainwater that can be harvested and distributed over different geographic zones of the country, and on the suitable techniques used to collect and store the harvested water. These techniques are site specific and designed to meet local people preference as well as geological, topographical, hydrological, and economical requirements…

الخلاصـــــة

العراق بلد الرافدين، دجلة والفرات، أصبح يواجه في السنوات الأخيرة شحة في موارده المائية لسببين رئيسيين، اولهما قيام تركيا بتنفيذ مشروع شرق الأناضول (GAP) المتضمن إنشاء عدد من السدود ومشاريع تحويل المياه (الأنفاق) مما يتطلب استغلال حصة اكبر من مياه النهرين على حساب حصة العراق، والثاني هو ما تعرضت له منطقة الشرق الأوسط عموماً من نوبة جفاف للسنوات ١٩٩٧ لغاية ٢٠٠٢ . لهذا فان الحاجة تدعو إلى استغلال كل البدائل الممكنة لتعزيز القدرة المائية للبلد ومن هذه البدائل تقنية حصاد مياه الأمطار.

يتضمن هذا البحث تقييم إمكانية حصاد مياه الأمطار وكمية المياه التي من الممكن حصادها واقتراح التقنيات اللازمة لتجميع وحصاد المياه.علما أنه قد روعي في اختيار هذه التقنيات الموقع الجغرافي، احتياجات السكان، ورغباتهم، إضافة إلى المتطلبات الجيولوجية والطبوغرافية والهيدرولوجية والاقتصادية.

1. Introduction

Iraq depends for its water supplied on Tigris and Euphrates. The two rivers are international, and shared by three countries, Turkey, Syria, and Iraq. Iraq is the largest user of the rivers water throughout the history. In recent years, Turkey has lunched a campaign to construct a series of dams, reservoirs, and diversion tunnels in what is called the, East Southern Anatolia Project (GAP). This project has diverted more water to Turkey than its traditional share, and caused a continuous diminishing on the Iraq share. In addition Iraq, as part of the middle east, has experienced several years of sever drought, for the years 1997 through 2002.

Consequently, the available water resources of Iraq dropped to record low. Alarmed by this water shortage, an effort has been lunched to augment and enhance the country water resources. Rainwater harvesting is one of these programs. The rainwater technique harvesting is meant to be implemented in west, east and the Jazziarah province zones of the country. Despite the fact that, Iraq climate is characterized by low rainfall (arid to semi arid climate), a proper techniques of rainwater harvesting could harvest a sizeable amount of water. This paper includes an evaluation of the Iraq rainwater resources and proposes the proper techniques to harvest and store such water.

2. Rainwater Resources of Iraq

Iraq climate is semi-arid to arid which is characterized by low rainfall and high evaporation rates. Rain falls on the months of October through May and the mean annual rainfall is about 150mm. **Fig.(1)**. Annual evaporation for Baghdad meteorological station based on class A pan evaporation measurement is about 3488 mm, **Table 1,** of coarse actual evaporation is less than this figure depending on the pan coefficient used. For the middle of Iraq represented by Baghdad, the coefficient is 0.7 [7].

Table (1) Monthly Evaporation at Baghdad in (mm)

Month	*Jan.*	*Feb.*	*March*	*April*	*May*	*June*	*July*	*August*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total*
Evaporation (mm)	74	99	184	261	403	522	600	533	370	274	134	61	3488

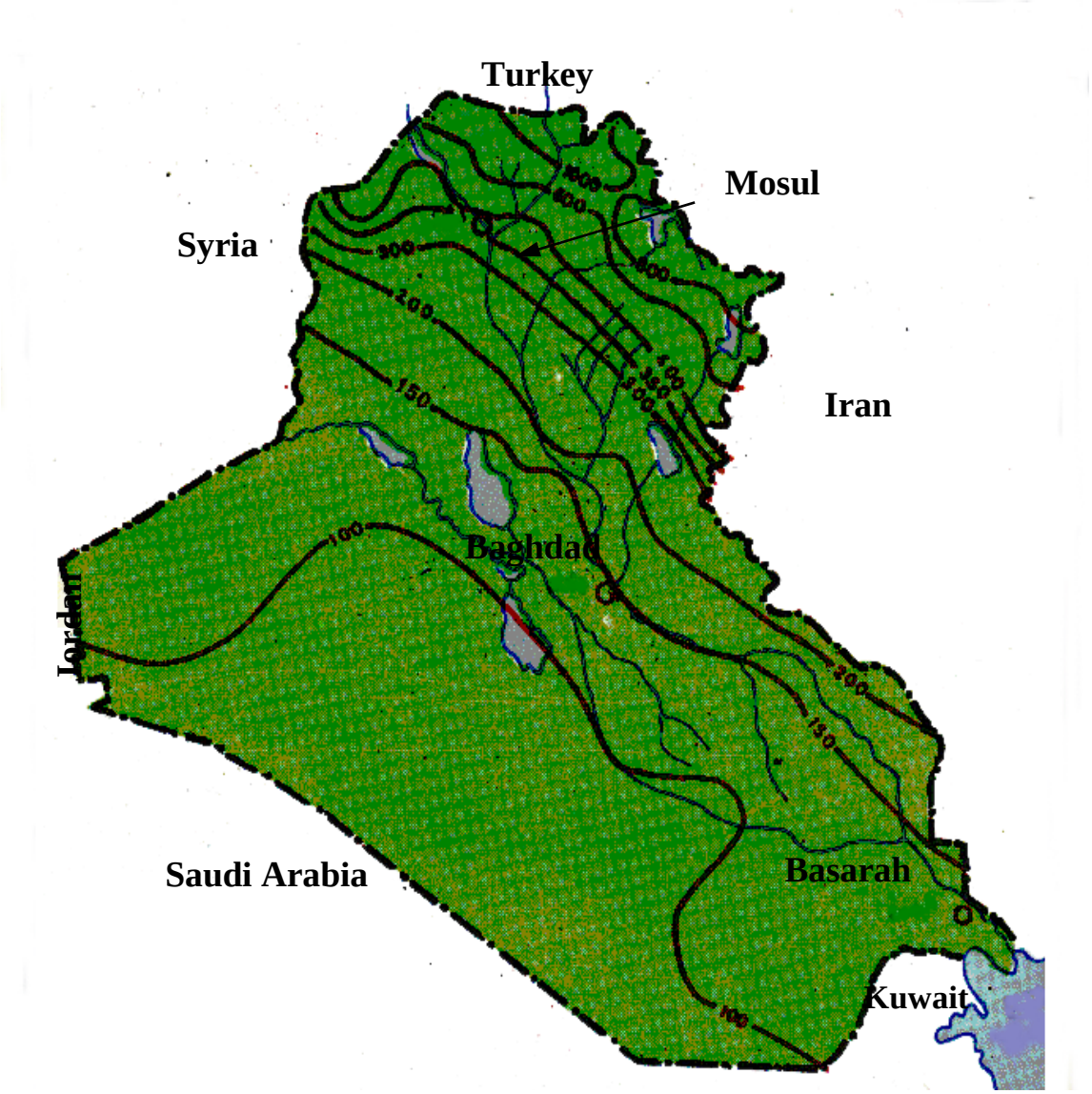


Figure (1) Isohyetal map of annual rainfall of Iraq

Surface area of Iraq is 435052Km^2 distributed as follows [8]:

1. 18.3% of the area is high mountain ranges with annual rain of 500-1200mm.

2. 9.6% of the area is foothills with annual rain of 300-500mm.

3. 6% is the Jazziarah province, located south and west of Mosul city, with annual rain of 150-400mm.

4. 23.6% is the Mesopotamia with mean annual rain of 150mm (started just North of Baghdad and extended south to the North of Basarah city).

5. 42.5% is the Western Desert with mean annual rain of 100mm or less.

Total gross rainwater resources of the country are evaluated, the following findings are outlined:

About 41.2% of the total rain falls on high flow mountainous area of high slopes and rough terrain. Most of water amount go to streams as surface flow, hence excluded from the

rainwater harvesting scheme. Another 15.5% of the total rain that falls on Mesopotamian plain which characterized by small slopes and deep soil of relatively high permeability. Which cause most of the falling rain to infiltrates and contributes to irrigation water?

The remaining 43.3% or about $42x10^9$ m^3 of water is distributed over the Western Desert ($18x10^9$ m^3) the foothills area ($16x10^9$ m^3) and the Jazziarah province ($8x10^9$ m^3) can be harvested. However, not all the water can be harvested as surface water. Since the harvested water needs to be stored and used as surface water, all other water that evaporate or infiltrate considered losses. To account for losses a runoff coefficient must be estimate. The runoff coefficient ranged from as high as 95% for impermeable slopping area to as low as 1% for permeable flat surfaces [4].

Studies of the runoff in West and East of Iraq showed that the runoff coefficient ranges from 2 to 20 percent [3,5]. Such low value of the runoff coefficient comes about as a result of low slopes and relatively high permeability of ground surface. An average value of 10% for the runoff coefficient is adopted for the purpose of this study. This means that the total water could be harvested is about $4.2x10^9$ m^3 distributed over the three main areas mentioned earlier. This amount is much less than previous estimates which put the number at $99x10^9$ m^3 [6]. However this water as low as it is forms important resources that must be not neglected.

The rainwater harvesting targets the upslope remote areas, mainly the Western Desert, the Jazziarah Provinces, and the Eastern border strip along the Iraq-Iranian border line. Selecting harvesting techniques that are suitable to each area is one of the subjects of this paper. An attempt is given below to select proper techniques that meet the climatilogical, economical, and social requirement of each zone.

3. The Proposed Rainwater Harvesting Techniques

Since the Iraqi climate is characterized by low rainfall and high evaporation rates, where the, average annual rainfall is 150mm while the average annual evaporation is about 2450 mm. Therefore, if rainwater is to be harvested it must be stored in structures that prevent or minimize evaporation losses. Historically, the harvested rainwater from a microcatchment diverted to large diameter wells (3-4 m diameter) of a depth between 40-50m. This technique is implementing, for the first time on the old pilgrimage road that connects the Holy Najaf City of Iraq with the Holy City of Makkah. Whereas Mrs. Zubiadah, the wife of the Fifth Abbassid Khalifa Haroon Alrasheed, ordered to construct wells and water points a long the mentioned road to serve the piligrams.

These wells and water point termed “Zubiadah wells”. A recent examination to the wells reveal that they were meant to be a water harvesting microcutchments connected to large diameter wells [6]. Apparently, water flows into wells from groundwater as well as surface water.

A similar structure to Zubiadah wells seems proper to be constructed in some locations with some improvement and modifications. A catchments area of low permeability and mild

slope is selected and modified in a way that the fallen rain is diverted to a well or group of wells of diameter of 3-4m and depth of about 50 meter, if geology allows. **Fig.(2)**.

However if the surface geology prevents the construction of large diameter deep wells, a shallow, narrow, and long trench may be implemented. The trench is of a depth of 5m, width of 3-4m, and length of 100m or more. The width of 3-4 m should comply with the working width of machines such as bulldozer and shovels, and in the same time minimize evaporation. Such trenches need to be built on the end slops of low hills. The rainwater is collected from slopes of the hill and diverted to the trench by leading dykes. **Fig.(3)**.

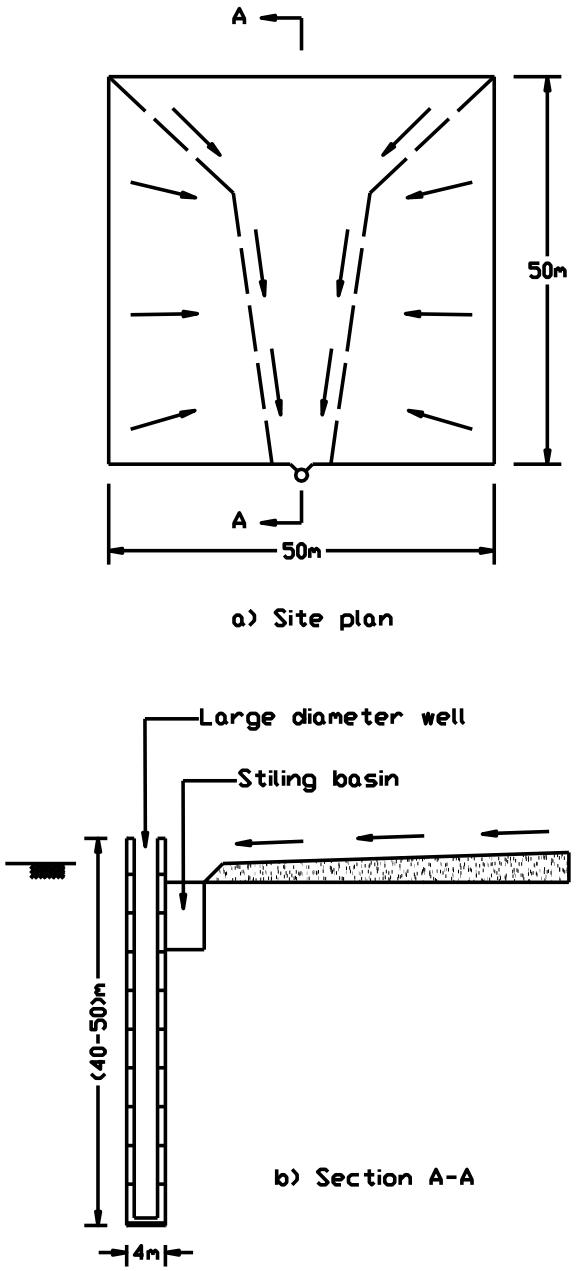
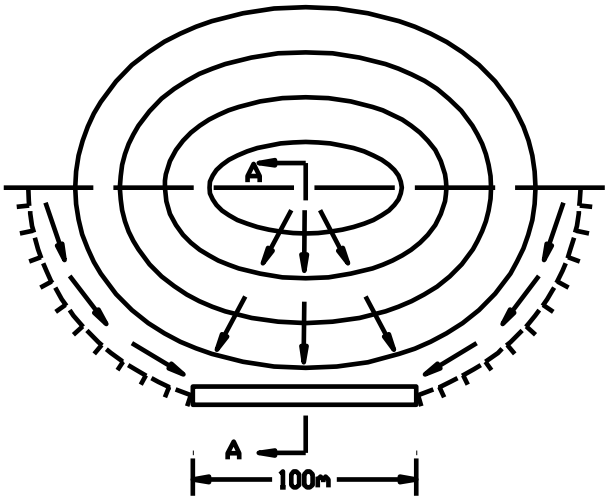
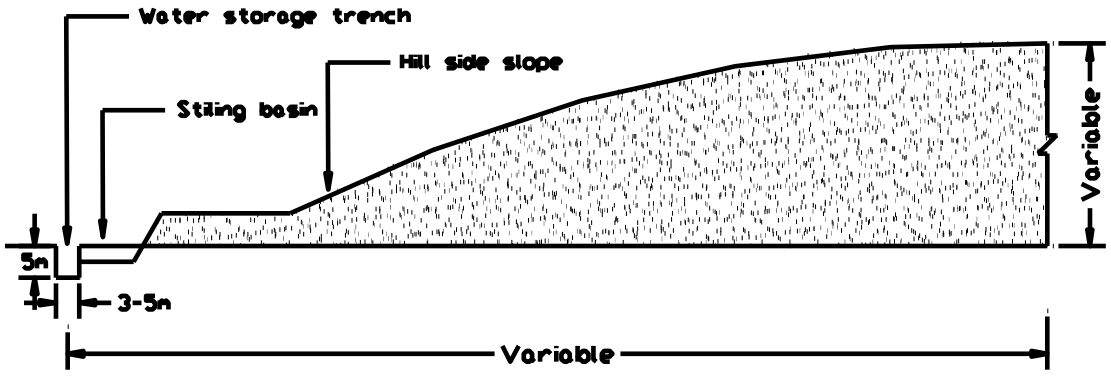


Figure (2) Details of Rainwater Harvesting Proposed Technique (Well Type)



a) Site plan (not to scale)



b) Section A-A

Figure (3) Details of Rainwater Harvesting Proposed Technique (Trench Type)

These two techniques may be used to insure drinking water for people and animals and are recommended to Western and Eastern areas of the country.

For pasture or agriculture purposes, a contour bunds [1] or dykes are built to spread flowing water of the wades to the banks where relatively deep soil existed. The water infiltrates and stored with in the upper soil profile, therefore enhance plant growth. **Fig.(4)**.

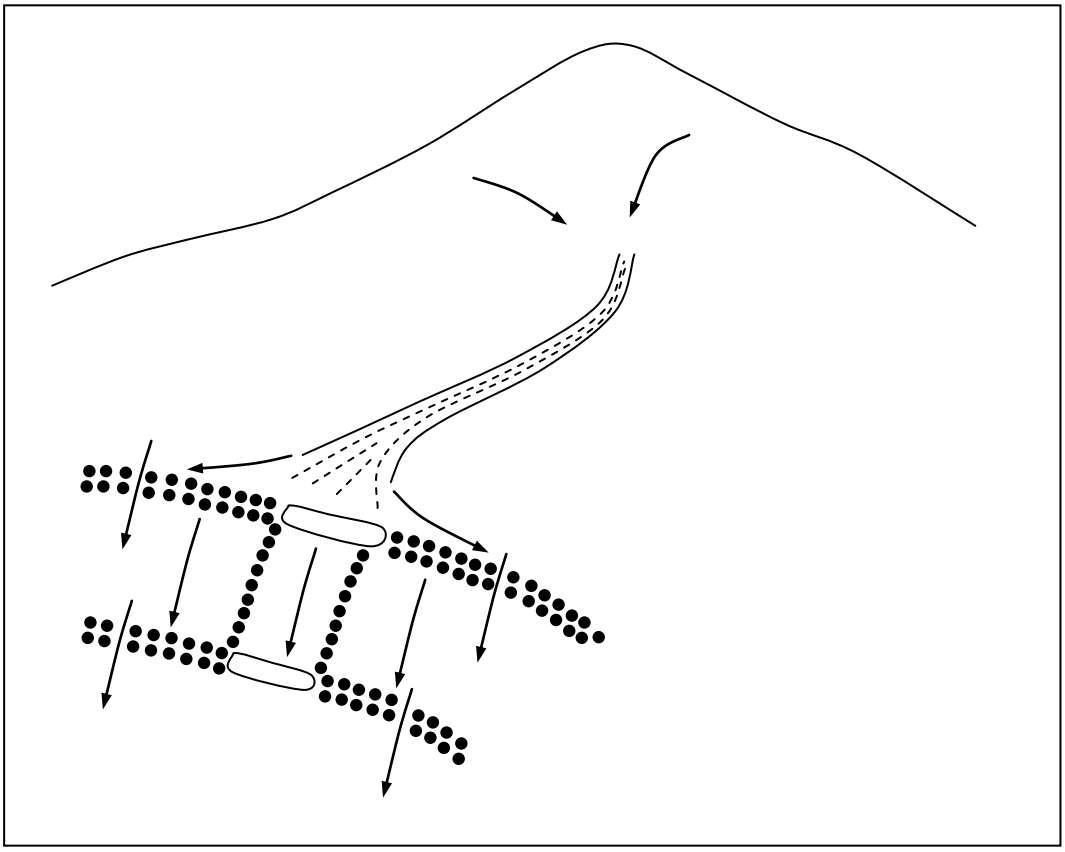


Figure (4) Spreading Flowing Water Technique

As far as urban areas such as the cities of Basarah, Rutbah, and Baghdad, which experience shortage of fresh water, a roof top water harvesting techniques are recommended. Several techniques are possible, however, the cheapest and easiest one, with no need to skilled labor or imported technologies, is the use of soil (clay) and tiben (remain out of cereal plants) as cover for the house roof. The harvested water is diverted through proper slopes and gullies (gutters) to stilling basins then to storage tanks. Minor water treatment may be needed before consuming the harvested water by human.

All the mentioned techniques are meant to be constructed by a single ruler family. The wells should be handdugged, and the trenches are excused by machines. Contour bands will be built by the available stones or boulders and are executed by labor. The techniques are cheep in terms of construction and need ordinary skills, and minimum maintenance.

4. Cost Consideration

Water is so vital to life and should not be subjected to cost evaluation, especially when no other alternatives are available. However, to the sake of argument, some cost considerations are discussed.

In the city of Ruttaba (West of Iraq) water is sold for about 1000.00 I.D per one cubic meter (based upon site visit by the authors). The cost at remote pasture areas may reach 2000.00 I.D for one cubic meter.

The volume of harvested water stored at the proposed trench, for example, is about 1050 m^3, and its value estimated as 2100000.00 I.D. The estimated cost of trench construction may be calculated as follows:

Assume the trench excavation by hydraulic poklain; its daily rate is about 500000.00 I.D and its total production about 400 m^3 of excavation. Then the average cost of the trench will be 1250 I.D for each cubic meter. The total cost is about 1300000.00 I.D, say 1500000.00 I.D. If this figure is compared to the value of collected water mentioned is very cost effective.

5. Discussion

The proposed techniques are techniques implemented in other parts of the world, which are similar to Iraq in term of geomorphology and meteorology (Syria and Sudan) [1]. As far as Zubiadah wells, they were constructed at the Western Desert, and prove to be a success [6]. Therefore, these techniques could be constructed at the mentioned location of Iraq and need not to be tested. Their usage elsewhere is proof of their success.

6. Summary and Conclusion

Iraq as part of Middle East will face, sooner or later, water shortage as it had experienced for the years 1997-2002. Rainwater harvesting should be considered to augment the water sources of the country.

Iraq weather is of arid to semiarid. The Low rainfall and high evaporation, of such weather make rainwater harvesting approach is not encouraging. However, with a proper technique, rain water may be harvested and stored to be used in latter times for municipal water supplies or agriculture. Several rainwater harvesting techniques are proposed through this study. The techniques are of low cost and easy to construct. They are meant to be implemented by an average ruler family. The cost should not by weighted heavily in the case of rain water harvesting, because the harvested water is so vital and should not evaluated as a commodity. All proposed techniques are technically and economically feasible and within the ability of a single family.

7. References

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