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WASH Field Note FN/25/2023

Harvesting the Sky: Rainwater as an Answer to Water Scarcity Challenges in Iraq

SUMMARY

Key drivers of water scarcity in Iraq are: limited available water resources (average precipitations 216 mm of water annually); increasing water demands by all users, largely above available water resources; high population growth; high dependence on transboundary waters; destruction of vital infrastructure, as a consequence of conflict and a lack of capital investments; Extremely highly subsidized domestic water tariffs, resulting in one of the lowest water tariffs globally – one of the lowest globally; unaccounted water; deteriorating water quality due to pollution; and low efficiency and effectiveness of water management due to underperforming governance and institutional capacities.

Rainwater harvesting is one of the most common methods that have been used widely to collect and store rainfall to be used at a later stage. It is defined as a method for inducing, collecting, storing, and conserving local surface runoff in arid and semi-arid regions for various applications. For rainwater collection and storage, small and large hydraulic structures can be used including dams, reservoirs, basins, and water tanks. The collected and stored harvested rainwater can be used for agricultural irrigation, livestock, environmental restoration, and groundwater recharge. In addition, rainwater harvesting structures are usually used as detention and/or retention basins that successfully mitigate high rainfall intensities while minimizing or preventing the impacts of destructive storms and flash floods on downstream communities. Meanwhile, naturally and artificially harvested rainfalls help in supporting the local biodiversity and water systems while providing a sustainable water resource to sustain lives and livelihoods.

UNICEF Iraq Country Office, in coordination and collaboration with the Ministry of Water Resources in the Kurdistan Region, introduced raw models of water area ponds in Erbil and Dohuk governorates to be adapted, replicated and scaled by decision-makers in other governorates. Although high permeability soil of those ponds with small watershed, satellite photos collected in Sep. 2022, show however that Ponds still retain water, indicating that the ponds meet the water needs of the neighboring village, such as for their crops and cattle. Also, water tests have shown the presence of good quality water; therefore, chlorination systems only are required to provide clean drinking water.

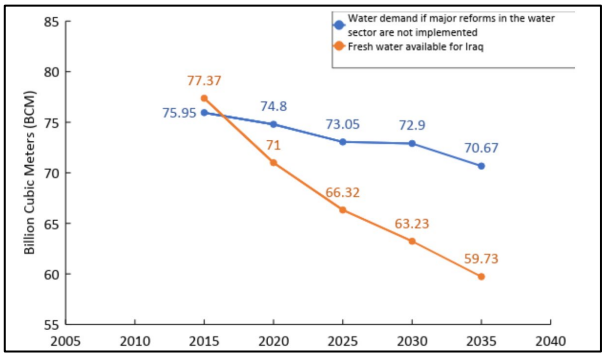
Introduction

Globally, water scarcity is one of the root causes of migration and is predicted to remain a primary cause of displacement in the future, as population growth and lifestyle changes increase water

demand.[1] Where water resources are already scarce[2], competition can elevate tensions and lead to conflict and migration. Tensions can be further exacerbated as large influxes of displaced people move into host communities and create increased demands on existing water resources.[3]

Kurdistan Region of Iraq (KRI) is blessed with a relative wealth and diversification of water resources, such as tributaries of the Tigris River, numerous small springs and an annual rainfall between 300 and 1000 mm per year. Despite this, external and internal factors endanger water security in the region – changing rainfall and snowmelt patterns, unregulated over-consumption, and often short-sighted management of public resources. Figure 1 below from the Iraq Energy Institute shows the projected potential discrepancy between source and demand, if major reforms in the water sector are not implemented.

Figure 1: Projected freshwater supply vs. water demand



Source: Iraq Energy Institute

According to local news reports, climate change affecting rainfall has been a significant factor in reservoir water levels being reduced below 50 per cent of capacity in three large dams in KRI – Dukan, Darbandikhan and Duhok Dams. This has prompted the federal Minister of Environment to announce that seven million people in the country are at risk of losing access to drinking water in the coming years.[4]

UNICEF is concerned that, in such situations, the basic human right of access to safe drinking water is compromised due to the prioritization of other water demands, such as for large-scale industrial and agricultural processes. A basic amount of water required for drinking, sanitation and hygiene needs to be safeguarded and guaranteed, wherever governance around water resource management lies, from national to community levels.

In some governorates, as aquifers are projected to be exhausted by largely uncontrolled overexploitation, integrated water resources plans have recently focused more significantly on rainwater harvesting and on implementing a managed aquifer recharge technique.

The complexity of all these factors has prompted the Kurdistan Regional Government (KRG) to devise a "long-term comprehensive planning process to ensure self-sufficiency and sustainable development"[5]. **This Field Note hopes to provide an evidence base for rainwater harvesting as part of this planning.**

At the same time, and in line with UNICEF's risk-informed global WASH Climate Shift, UNICEF Iraq Country Office has committed to integrating risk-informed climate resilience components into programming, with an intended output of building community resilience to adapt to the impacts of climate change, focusing especially on groups that are vulnerable to climate threats.[6]

Under this remit, UNICEF provides technical WASH infrastructure solutions to sector partners to address the impact of climate change. One of the

[1] World Bank Group (2021) *Ebb and Flow: Volume 2. Water in the Shadow of Conflict in the Middle East and North Africa*
[2] UNICEF Iraq Climate Landscape Analysis for Children Report
[3] Water Security for All
[4] Water levels decreasing in Kurdistan Region dams (kurdistan24.net)

[5] Tinti, A. (2017) *Water Resources Management in the Kurdistan Region of Iraq: A Policy Report*, Yousuf M.A., Rapantova, N. and Younis, J.H. (2018) *Sustainable Water Management in Iraq (Kurdistan) as a Challenge for Governmental Responsibility*
[6] UNICEF (2020) *How UNICEF Regional and Country Offices can Shift to Climate Resilient WASH Programming*

main mitigation measures is the implementation of pilot, small-scale, decentralized projects which are a cost-effective and represent a high-reward solution that can be adopted even during times of fiscal austerity. Rain harvesting ponds are a prime example.

Description of Intervention

In KRI, the main objective of rainwater harvesting is to support more sustained water resources. Conceptually, through deliberate infiltration and recharge, rainwater harvesting contributes to sustainably raising precariously low groundwater levels.

A secondary objective is to create detention and/or retention basins to mitigate high rainfall density and minimize or prevent the impacts of destructive storms and flash floods on downstream communities.

At the same time naturally and artificially harvested rainfalls help support local biodiversity and water systems while providing a sustainable water resource to sustain lives and livelihoods. Moreover, the accessibility to surface water and vegetation promotes a healthy environment and may make the nearby region a popular recreational area. Additionally, it can create a stable watering place for sheep and goat herds, helping to improve biodiversity in the area.

Rainwater harvesting also reduces the potential for energy consumption because it helps to maintain or reduce groundwater levels while minimizing shallow groundwater pumping throughout the targeted region, in addition to the consequent reduction in CO_2 emission.

Periodic deterioration of water quality may occur mainly during the higher rainfall season, when high-intensity rainfalls cause flash floods that reach the harvesting ponds and reservoirs and quickly accumulate, thus infiltrating into the ground layers and causing water turbidity and contamination.

Between September and December 2022, UNICEF conducted a study on the role of ponds in water harvesting. The main objective of the study was to generate evidence on the potential role of the ponds in climate resilience, but also to identify gaps, challenges, opportunities in the design to mainstream climate resilient programming and more specifically in implementing a rainwater harvesting concept. Additionally, the study was carried out to assess to what extent rainwater harvesting ponds contribute to combating water scarcity and their impact on climate action (in compliance with UNICEF 2020-2024 strategy for Climate Resilient WASH), providing recommendations on how to improve drinking and domestic water availability and accessibility.

More precisely, the specific objectives were to:

- Conduct a comprehensive evaluation (hydrological, hydraulic, geological, and hydrogeological studies) for Bamerene and Dwin ponds (in KRI) and conduct flood analyses for the two ponds.
- Determine the capacity of the pond to retain water, with recommendations for potential improvements and better utilization of the pond.
- Assess the appropriateness of Bamarene pond in terms of efficiency of harvesting rainwater and recharging groundwater, recommending site selection criteria.
- Provide technical recommendations of scalability to increase/improve the soil infiltration and decrease the sedimentation.
- Assess the impact of the pond on the surrounding environment.

The study identified institutional gaps in government technical capacity and provides guidance/recommendations on how to best overcome these gaps through system strengthening and capacity building of the relevant government technical departments. The study also included environmental and social impact assessment of those interventions on the hosting communities and gave recommendations to overcome challenges and reduce any existing and potential risks.

Outcomes

Environmental and Social Sustainability

In the Kurdistan Region, precipitation is variable and fluctuates from one region to another, both in its temporal occurrence and intensity. In general, the average annual precipitation in the Kurdistan Region ranges between 700 and 1,000 millimeters (27 and 40 inches) and occurs between October and April. This is the only area of Iraq which receives substantial rainfall. If this amount of rainfall is collected correctly, especially in flat and semi-flat areas, it can provide an efficient source for surface water and groundwater recharge while minimizing the risk of flash floods.

Bamerne Pond

Bamerne pond is located in Bamerne district (Ninewa). It is surrounded by many villages (Aradin, Shayakh mama, and Kanica) with an estimated population of 6,400 individuals, and the retained water can be utilized to meet their domestic and livestock watering needs. The pond is an estimated 26,100 cubic meter in volume.

Figure 2: Bamerene Pond location

Source: Imagery-Zoom into the Bamarene Pond

Bamerne pond rests on a large impermeable layer of claystone and siltstone, and to reach permeable rechargeable layers, mainly of limestone, drilling to 500 metres deep would be necessary. On site permeability tests confirmed that the Bamerne pond can be considered as a storage pond (Retention Reservoir), rather than an aquifer recharge pond.

It is worth highlighting that the construction of the small check dam is considered part of adaptation to climate change due to current water scarcity and drought situation. It also represented an alternative safe source of water during drought seasons with minimum treatment methodologies, through recharging of underground water, generating new jobs for villagers, increasing their livelihood and protecting biodiversity in the area. It is intended to recharge the downstream groundwater aquifer and not to supply potable water needs, it should be necessary to release a daily volume of 500 m3 during the dry period into the downstream watercourse.

Bamerne pond catchment area is relatively large, and the flood analysis revealed that flooding is probable. Therefore, the spillway capacity is recommended to be increased to 85 m^3/s (spillway width must be enlarged from 5 meters to 15 meters).

Bamerne pond capacity has the potential to be increased; therefore, constructing a concrete retaining wall of 2 m height over the crest at the upper side of the reservoir is strongly recommended. This will also absorb the overtopping during flood extreme cases.

Dwin Pond

Dwin pond is located near the towns of western flank of Safeen Mountain in the district of Erbil, slightly north of Erbil city with an estimated population of 1,600 individuals. It has an estimated volume of 26,400 cubic meter.

Dwin pond is considered to have a small watershed of about 1.3 km^2. The soil underneath it is highly permeable and there is a high rate of evaporation (see Table 1 below). The average annual runoff volume at Dwin pond is three times the pond capacity, therefore, it is expected that Dwin pond will not suffer water filling problems.

Figure 4: Yearly water losses by evaporation and infiltration from Dwin pond

Year	Surface evaporation (m^3)	Reservoir infiltration (m^3)	Dam found. Infiltration (m^3)	Total water losses (m^3)
2010-2011	19,941	4,255	1,095	25,292
2011-2012	15,828	2,436	1,098	19,362
2012-2013	16,981	3,684	1,095	21,760
2013-2014	14,959	3,037	1,095	19,091
2014-2015	15,636	3,753	1,095	20,484
2015-2016	17,046	3,848	1,098	21,992
2016-2017	10,862	1,929	1,095	13,886
2017-2018	11,963	2,020	1,095	15,078
2018-2019	15,771	2,895	1,095	19,762
2019-2020	13,958	1,907	1,098	16,963
Average	**15,295**	**2,977**	**1,096**	**19,367**

Source: Water Resources Management in the Kurdistan Region of Iraq | Alessandro Tinti - Academia.edu 2017

Despite the small catchment, high soil permeability and high rates of evaporation, satellite imagery and photographs (such as in Figure 3 below) collected in September 2022 show that Dwin Pond still retains water at the end of summer, thus meeting the water needs of the neighboring village, including their crops and cattle.

Figure 3: Dwin pond in September 2022

Source: UNICEF-Erbil Staff

Because of this high permeability, Dwin pond is classified as a recharge pond.

The study recognizes the utility of Dwin pond to meet domestic needs as well as livestock needs. Refill of the pond does not seem to be at risk and water quality testing shows no evidence of contamination or pollution. Therefore, it is recommended to install a traditional water treatment unit (with multi-media filters and disinfection system)[7] at Dwin pond to enable affected people in the surrounding areas to use the pond water.

Lessons learned

A pond with a capacity of less than 100,000 m^3 is not recommended in Iraq, as the evaporation loss will constitute a considerable portion of the runoff volume and reduce the volume of the retained water.

To make ponds more effective and efficient both as recharge points and for local use, a decrease in sedimentation coming from the erosion of the catchment's slopes must be achieved. Options include:

- Construction of weirs or sediment traps on the main tributaries to the pond to decrease the velocity of flood water. They must be easily accessible to be able to carry out the necessary annual cleaning and sediment removal. They must be also protected against the surge of floods over the 10 years period.

- Re-vegetation of the catchment area immediately in the vicinity of the pond is another method to reduce sedimentation.

Planting shrubs, broad-leaved trees and medium to tall evergreen trees at the boundary of the pond is recommended to serve as wind breakers and reduce the rate of evaporation from the surface of pond.

[7] BIODOS - COMPACT UNIT RIVER WATER TREATMENT SYSTEM

KEY POINTS

- *Emphasize strengthening the enabling environment, public financial management systems and private sector strengthening, to develop and implement appropriate service delivery models that can get services closer to the population.*
- *Develop improved water sources, aiming to achieve the highest possible level of service that will ensure sustained access, and which is resilient to the impacts of climate change or other shocks and stresses.*
- *UNICEF's approach to water programming must be built on strong national and sub national analyses that lead to the implementation of the right solutions to the local context and consider the underlying causes (economic, social, political, and environmental) that prevent progress.*

Next Steps

More efforts, resources, and investments need to be provided and allocated while developing the designs and calculations of the pond structures (basin capacity, retaining dam, spillway capacity, upstream and downstream riprap's thickness of the retaining dam etc.), which needs to be conducted, for instance, through academia, consultancy firms/entities/personnel, etc.).

UNICEF continues to provide support through strengthening national monitoring systems, ensuring services levels beyond any programme implementation. This might include support to national monitoring systems that set up an effective way to monitor real-time service delivery and water quality, sustainability factors, including catchment and water resources protection, or affordability.

As an outcome of advocacy with sector partners to find more resilient solutions against water scarcity and on increasing the level of contaminants in water bodies, the presidency of Kurdistan Region has formed a high-level flood committee in Erbil governorate which is chaired by the President of the Kurdistan Region and co-chaired by the Ministry of Municipalities and Tourism, the Ministry of Agriculture and Water Resources, Erbil Province Office and the Joint Crisis Coordination Center. The committee has worked with the academia and a consultancy firm to analyze the situation, identify reasons, and design mitigation measures. A two-day conference was held in November 2022 to present the findings and recommendations of the joint work. One of the highly prioritized solutions is adopting rainwater harvesting techniques, ponds in particular.

The evaluation also identified locations for prioritized large-scale strategic ponds that would significantly mitigate flash floods but also store water. The sum of 12 small dams, ponds and weirs of different capacities have been proposed in seven catchment areas that generated floods north and northeast of the city, with total storage of 13,000,000 m^3 for the purpose of reducing the effects of the flood' These can be used for the purpose of irrigation, soil conservation and groundwater recharging, as well as of improving the environment of the city through the formation of these water bodies.

UNICEF will consider, particularly in the lead-up to the new Country Programme Document, developing evaluations and lessons learned for these pilots, focusing on impact and scalability. This would lay the groundwork for prioritizing the WASH pilots that should be conducted in the new programme cycle.

UNICEF will be holding a launching conference for the evaluation findings and recommendations with the main stakeholders including the government represented by the Ministry of Agriculture and Water Resources in the Kurdistan Region, the General Directorate of Irrigation, the relevant Directorates of irrigation in Erbil, Duhok, and Sulaymaniyah. In addition to the academia, Other UN agencies (WFP, FAO), NGOs, and donor community.

UNICEF continues to advocate for more investment in these interventions across KRI considering the impact to the climate action (water scarcity and flash floods). UNICEF will also continue supporting the Government efforts in the implementation of the strategic plan through supporting the scalability of rainwater harvesting inside KRI and in other scarce governorates in the center and south of country.

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Evaluation of two selected ponds in Erbil and Dohuk, 2023.

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