Green Artificial Water Basins

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Abstract:

Drought is one of the greatest challenges facing humanity. It manifests in two forms: one in which rainfall is completely absent, and another in which rainfall is scarce and, when it does occur, falls intensely over a short period. This does not give mountains and soil sufficient time to absorb and store water within fractures and underground aquifers. Regardless of the permeability of the soil, rainfall in such cases does not allow adequate time for water storage due to the rapid runoff and the slope gradient of the terrain. Through this study, we aim to propose theoretical solutions that are believed to be practical in addressing such crises.
Keywords: drought, water basins, water storage, groundwater, rainfall.

Introduction:

Water is an essential element in all aspects of life, without which life cannot exist. This is affirmed by the Almighty's saying: "And We made from water every living thing." Accordingly, it is necessary to preserve and manage water optimally, whether during periods of scarcity such as drought years, or during periods of excess such as flood seasons, which can cause natural and human disasters that are difficult or impossible to manage at the moment they occur. Therefore, it is essential to develop water management mechanisms to maximize its benefits while maintaining control over it.

Such efforts can also reduce the costs associated with providing potable desalinated water, especially for regions far from dams or seawater desalination plants. Since ancient times, water has been the foundation for human settlement, the establishment of cities, and the development of civilizations, whether surface water such as springs, rivers, and valleys, or groundwater such as wells.

If we examine present-day Algerian villages, we find that they were all built near water sources, where water could be easily transported to homes either by animals or through channels. Moreover, Muslim societies, historically and culturally, have had a particularly high demand for water due to their emphasis on cleanliness and ritual purity.

The idea of green artificial water basins is proposed as a means to help communities benefit from rainwater as much as possible. To support this concept theoretically, we have drawn upon verses from the Holy Qur'an and evidence from hydrology, a branch of physical geography concerned with the study of water properties, distribution, movement, and characteristics.

The central question addressed in this research is:

Can green artificial basins successfully store rainwater?

To answer this question and contribute potential solutions that may assist communities during such crises, this theoretical study is structured as follows: First, we argue that mountains serve as the primary reservoirs for water storage, supported by general Qur'anic texts. Although there are no explicit texts on this matter, by compiling and interpreting relevant verses with the assistance of established exegeses, we support our perspective. We then reinforce this claim through hydrological

science. Finally, we present the proposed solution: the construction of green artificial water basins, explaining their method of construction, utilization, and their importance across various fields.

Section One: Mountains as Water Reservoirs

In this section, we attempt to support the idea that mountains constitute the primary foundation and initial storage system for rainwater. We will demonstrate this through a collection of general texts from the Qur'an and the Prophetic tradition, accompanied by commentary based on recognized and authoritative interpretations.

First: Mountains in the Holy Qur'an

Allah تعالى says in Surah Al-Hijr:

﴿وَإِنْ مِنْ شَيْءٍ إِلَّا عِنْدَنَا خَزَائِنُهُ وَمَا نُنَزِّلُهُ إِلَّا بِقَدَرٍ مَعْلُومٍ (21) وَأَرْسَلْنَا الرِّيَاحَ لَوَاقِحَ فَأَنْزَلْنَا مِنَ السَّمَاءِ مَاءً فَأَسْقَيْنَاكُمُوهُ وَمَا أَنْتُمْ لَهُ بِخَازِنِينَ) (22)

{"And there is not a thing but that with Us are its treasures, and We do not send it down except in a known measure."} That is, everything has its stores with Allah, meaning the keys to its treasures. It has also been said that this refers to rain.

[1]

{"And We do not send it down except in a known measure"} meaning that each land has a determined share. It is also said that not a single drop descends from the sky except accompanied by an angel directing it wherever Allah wills. It is narrated from Ja'far ibn Muhammad, from his father, from his grandfather, that on the Throne there is a representation of all that Allah created on land and sea.

{"And We sent the winds as fertilizing agents"} meaning carriers, as they carry water to the clouds. The term is the plural of lāqiḥah (fertilizing), just as a she-camel is called lāqiḥah when pregnant. Ibn Mas'ud said: Allah sends the wind, which carries water, and it passes over the clouds, causing them to yield rain as a milking camel yields milk. Abu 'Ubaydah said that lawāqiḥ refers to fertilizing winds that pollinate trees.

'Ubayd ibn 'Umayr said: Allah sends the heralding wind, which sweeps the earth; then He sends the stirring wind, which raises the clouds; then He sends the combining wind, which gathers the clouds together into masses; then He sends the fertilizing winds, which pollinate the trees.

Abu Bakr ibn 'Ayyash said: Not a drop falls from the clouds except after the four winds act upon it: the easterly stirs it, the northerly gathers it, the southerly disperses it, and the westerly separates it. It is also reported that the fertilizing winds are the southern winds.

{"So We sent down water from the sky and gave it to you to drink"} meaning We made rain a source of water for you. In Arabic, asqā (to provide water) differs from saqā (to give a drink). The Arabs say: "I gave him water and milk" when directly giving him to drink, but if one provides water for his land and livestock, they say: "I supplied him with water."

{"And you are not its keepers"} meaning that rain is stored in Our treasures , not in yours. Sufyan said: meaning you are not able to prevent it.

Al-Zamakhshari said: {"And you are not its keepers"} negates for them what He affirmed for Himself in {"And there is not a thing but that with Us are its treasures"}, meaning: We are the keepers of water, i.e., We are capable of creating it in the sky and sending it down, while you are not capable of that demonstrating His great power and their inability.[2]

From these verses, we understand that the water sent down from the sky descends only in a measured quantity. If it exceeded its limit, the world would be flooded and disasters would occur; conversely, if it decreased, drought, scarcity, and thirst would prevail.

Allah Almighty also says:

﴿أَلَمْ تَرَ أَنَّ اللَّهَ أَنْزَلَ مِنَ السَّمَاءِ مَاءً فَسَلَكَهُ يَنَابِيعَ فِي الْأَرْضِ ثُمَّ يُخْرِجُ بِهِ زَرْعًا مُخْتَلِفًا أَلْوَانُهُ ثُمَّ يَهِيجُ فَتَرَاهُ مُصْفَرًّا ثُمَّ يَجْعَلُهُ حُطَامًا إِنَّ فِي ذَٰلِكَ لَذِكْرَى لِأُولِي الْأَلْبَابِ﴾(Az-Zumar: 21)

Al-Zamakhshari explained that all water on Earth originates from the sky, descending to rock layers, after which Allah distributes it: "He channels it into springs within the earth" that is, He causes it to enter and flow through pathways, veins, and channels like blood vessels in the body. "Producing vegetation of different colors" refers to its varied forms green, red, yellow, white, and others.[3]

From these verses, it is understood that the earth is responsible for absorbing water through the soil, after which it emerges in the form of springs. In reality, this occurs as follows: when rain falls, mountains absorb it especially gentle rainfall and snowfall, which are the best types for gradual and effective absorption, unlike heavy rains that fall rapidly.

Mountains vary in their ability to store water:

One type does not absorb water at all due to a predominantly rocky surface or impermeable soil.

Another type absorbs water, but it is lost in its depths and not utilized.

A third type absorbs water but does not retain it for long due to the absence of storage pockets.

A fourth type combines the advantages of the previous types, forming underground reservoirs that feed springs it absorbs and retains water effectively.

As water passes through layers of sand, soil, and gravel, it is naturally filtered from impurities and microbes, becoming pure and pleasant to drink.

During its passage through the earth layers, water dissolves some salts and minerals found in the soil. If it flows over salty rocks, it becomes saline; if over sulfuric rocks, it becomes sulfurous.

We may also benefit from the (statement of Allah Almighty):

{﴿وَجَعَلْنَا فِيهَا رَوَاسِيَ شَامِخَاتٍ وَأَسْقَيْنَاكُمْ مَاءً فُرَاتًا﴾} (Al-Mursalat: 27)

From the association between mountains and water in these verses, scholars have concluded that mountains are responsible for storing water that feeds springs and wells. In other words, mountains are the origin of springs, and this association appears in multiple places in the Qur'an.

Groundwater is also the result of rainfall falling on the earth, where water infiltrates through soil pores and gaps between rocks, and is stored for thousands of years in underground cavities and reservoirs. For this reason, modern scientists pay increasing attention to subsurface water as vast natural storage systems such as those found beneath the Algerian Sahara as potential resources for the future. This understanding is supported by the (statement of Allah Almighty):

﴿وَأَنْزَلْنَا مِنَ السَّمَاءِ مَاءً بِقَدَرٍ فَأَسْكَنَّاهُ فِي الْأَرْضِ وَإِنَّا عَلَى ذَهَابٍ بِهِ لَقَادِرُونَ﴾ [Al-Mu'minun: 18]

A careful reflection on the word (We settled it) indicates prolonged residence within the الأرض, which corresponds to groundwater that remains underground for long periods without deterioration or disappearance.

After establishing that mountains serve as reservoirs for water, and in order to preserve underground water storage for future generations while maximizing the benefit from rainfall, the idea of this research emerged. In years of abundance when snow and steady rainfall fall over long periods on mountain peaks this idea may not be necessary, as mountains naturally absorb, store, and gradually release water through springs or wells.

However, the challenge arises in years when snowfall is insufficient and gentle, sustained rainfall is absent. In such cases, mountains cannot absorb or store adequate amounts of water, especially since most rainfall during these periods is intense and rapid, giving little time for infiltration and instead causing floods due to fast runoff. Here emerges the concept of green artificial water basins as a

potential solution. By constructing such basins on mountain tops, even rapid and heavy rainfall can be temporarily stored, allowing the mountains to gradually absorb and retain the water over time.

Second: In the Prophetic Sunnah

From the Sunnah, this concept can be inferred from the hadith of the Prophet (peace be upon him), narrated by Abu Musa:

"The example of the guidance and knowledge with which Allah has sent me is like abundant rain falling on land. Some of it is fertile soil that absorbs water and produces abundant vegetation and grass. Some of it is hard land that retains water, benefiting people who drink from it, give water to others, and use it for cultivation. And some of it is barren land that neither holds water nor produces vegetation. This is like the one who understands the religion of Allah and benefits from what Allah has sent me with, so he learns and teaches, and the example of one who does not care for it and does not accept the guidance with which I was sent." [4]

From this hadith, we indirectly understand that soils are of different types: some absorb, store, and retain water, while others neither absorb nor store it.

Third: Mountains in Hydrology

Mountains store rainwater through a process known in hydrology as infiltration and percolation, which is the movement of water from the soil surface into its interior layers. This process is influenced by several factors, including surface runoff, vegetation cover, soil moisture, evaporation, and agricultural and environmental conditions.

Other influencing factors include surface permeability, internal soil transport, soil water storage capacity (field capacity), the characteristics of permeable layers, and the properties of the infiltrating fluid.[5] Additionally, the slope of the mountain plays a crucial role the steeper the slope, the lower the soil's capacity to absorb rainfall.

Infiltration capacity represents the maximum rate at which water can penetrate the soil surface over a specific time, usually measured in centimeters per hour or similar units. Generally, infiltration begins at a high rate in sandy soils, then decreases over time to a stable rate.

The rate of infiltration capacity is highly significant in agriculture, soil conservation, groundwater preservation, flood control, and the maintenance of surface water resources.[6] This applies under natural conditions; however, with the use of green basins, this rate can be increased to its maximum potential.

To support our theory, we relied on hydrology, a branch of physical geography concerned with water on Earth its existence, distribution, and properties (physical, chemical, biological, and microbiological). Hydrology also studies the environmental impacts of water on both living and non-living entities. Among its key areas of focus are:[7]

Measurement, collection, and publication of basic data.

Data analysis, derivation of fundamental theories, and their development.

Application of derived theories and data across various practical domains.

1. The Hydrological Cycle (Natural Water Cycle):

Water is in a constant state of movement and transformation from one form to another in a continuous cycle through the atmosphere, the subsurface, and the Earth's surface as a result of climatic and natural factors. This cycle is known as the hydrological (natural water) cycle.

In this cycle, condensed water falls to the Earth's surface in the form of precipitation such as rain, ice, frost, snow, hail, and other types. This precipitation then flows over the soil surface and infiltrates it. When the soil becomes highly saturated, another portion of the water percolates deeper

into the earth to form groundwater reservoirs. When precipitation exceeds infiltration, evaporation, and transpiration, water accumulates in low-lying areas, forming natural storage zones.

When these depressions and ponds fill up, excess water overflows across the surface, representing retained storage. The surplus beyond this storage becomes surface runoff, forming lakes, ponds, seas, rivers, streams, and other surface water channels.[8]

Section Two: Utilization and Management of Green Artificial Basins

Introduction:

Before constructing green artificial basins, it is essential to consult experts and specialists in geology and topography for several reasons:

Determining the actual recharge areas of the mountain under study: These are the zones through which rainwater infiltrates into the mountain's interior. Mountains typically consist of two types of areas: recharge zones and non-recharge zones. To avoid wasting effort and resources, expert analysis is necessary to accurately identify these areas.

Determining the thickness of the groundwater reservoir within the mountain: This stage is considered one of the most difficult tasks for geologists and topographers, as it requires time and advanced geophysical studies known only to specialists. It involves identifying the depth of layers, the type of rocks, and the percentage of pores, fractures, and storage capacities in the area where basins are to be constructed.

Estimating storage capacity and the volume of water that can be stored: This is done using mathematical models specific to this process, which depend on constants such as soil permeability in recharge zones and the porosity of rocks in the groundwater reservoir.

Under normal conditions, when rainfall is gentle and regular especially when accompanied by snow mountains are capable of storing water efficiently. However, during drought years, snowfall is absent and rainfall is scarce. When rain does occur, it is often intense and rapid, preventing the mountain from absorbing it and instead causing floods. Here lies the importance of green artificial basins in capturing and regulating such rainfall.

The reason for naming them "green basins" is as follows:

They are described as green because they must be planted with evergreen trees suited to the mountain's climate, along with evergreen grass. This vegetation plays a crucial role in slowing down rainfall especially heavy summer rain with large droplets by reducing its speed and breaking the droplet size. As water drips from the trees, it is further slowed and diffused by the grass, allowing it to reach the basin surface gently. This ensures that the water remains clean and does not mix with the basin's soil.

They are called basins because they take the form of large reservoirs constructed on mountain peaks and within forested areas using natural soil only. No cement or impermeable materials are used, so as not to prevent water from infiltrating into the mountain. The preparation relies solely on locally available soil.

First: Construction and Management

These basins are constructed on mountain peaks and within forested areas.

Their dimensions consist of three aspects:

The depth should not exceed two meters and should be sloped in a way that does not trap living organisms. As for length and width, they depend on the nature of the site, provided that no side is less than 50 meters.

Construction within these basins is strictly prohibited under any circumstances.

The disposal of animal or human waste in them is strictly forbidden, and forest guards are responsible for their protection.

The Ministry of Agriculture, Rural Development, and Fisheries represented by the Rural Engineering Authority oversees their construction, preparation, maintenance, and afforestation using local, resilient, long-living, renewable evergreen trees.

Evergreen grasses are planted inside the basin and along its edges to prevent erosion and collapse, thus avoiding the need for repeated reconstruction.

They are equipped with outlets that can be opened when necessary to drain water, especially in years of abundant rainfall and snow. Since excess can become harmful, it is recommended to close these outlets in summer and open them in winter when precipitation is abundant.

Legal penalties are enacted against anyone who pollutes, damages, builds within, or otherwise violates these basins, whether directly or indirectly.

Camping and the lighting of cooking fires by tourists and visitors are prohibited within these basins.

Forest guards are granted authority to initiate and pursue legal action against anyone who damages, pollutes, or builds on these basins.

Forest guards should be equipped with drones to monitor and protect these basins.

Grazing within the basins is prohibited, and penalties are imposed on anyone who grazes livestock or cuts grass without authorization.

Private landowners may allow their mountain-top lands to be developed into green basins by the Rural Engineering Authority and planted with fruit trees, from which the landowner may benefit. However, construction within these areas remains prohibited.

Forest guards may, at specific times, permit some citizens to harvest grass growing inside these basins, provided that cutting does not reduce plant height below 10 cm, and that this occurs only once per year even if the basins are located on private land.

Second: Their Importance

Green artificial water basins offer a range of social, economic, and environmental benefits, summarized as follows:

A source for replenishing groundwater and surface water:

The presence of water in springs and underground reservoirs is primarily due to rainfall, especially snow. Evidence of this is that regions with reduced rainfall and snowfall experience drying of springs and depletion of groundwater, rivers, and valleys.

Preservation of plant and animal resources:

Continuous flow of springs, rivers, and wells supports traditional agriculture and livestock farming. This increases the economic well-being of citizens, as livestock breeders achieve self-sufficiency in meat and can supply markets, lowering prices due to increased availability too, farmers enhance market competition by offering local produce such as fruits and vegetables.

Reduction of floods:

These basins act as small natural dams that capture heavy rainfall, preventing sudden flooding. They retain large quantities of water, allowing gradual absorption by the soil, which in turn feeds springs and groundwater.

Protection of dams:

The basins reduce sediment accumulation in dams. Heavy rains especially in mountainous areas carry mud, soil, and small stones that settle in dam reservoirs and reduce their storage capacity. By

capturing and slowing runoff, these basins either retain water completely or regulate its flow before it reaches dams.

Sustaining dams and preventing drought:

Green basins help maintain dams by supplying them with clean, fresh water throughout the year.

Reducing rural migration:

Drought is a major cause of rural migration. Historically, people settled in areas where water was available and abandoned arid regions where springs, rivers, and wells dried up. Many migrated to cities where water is more consistently available, often leading to informal settlements. Green basins can reduce rural migration by ensuring water availability.

Reducing government costs:

These basins require neither cement nor steel, as they are formed simply by shaping soil into basin structures. Costs are mainly limited to labor and tree planting preferably using government nurseries to reduce expenses. Additionally, the state would not need to repeatedly search for new water sources; instead, it could rely on sustained natural springs and distribute water through existing networks without extensive treatment or desalination.

Combating desertification:

Or more precisely, confronting desertification and the expansion of arid regions. Green artificial basins can be established in areas classified as “green belts” to counter desertification, as follows:

Planting trees in the center and along the edges of the basins.

Utilizing large green artificial basins as small artificial lakes to irrigate newly planted shrubs nearby, within the framework of anti-desertification efforts, until they grow strong enough to sustain themselves.

Encouraging residents of these regions to plant local, resilient, renewable fruit trees, relying on springs that flow beneath these mountains.

Conclusion:

Based on the above, we conclude the following:

Effective recharge of mountainous groundwater depends not only on the quantity of rainfall but also on the duration of its fall. Gentle, prolonged rainfall is more effective than heavy, rapid rain.

Winter rainfall is the best source for recharging mountainous groundwater because it is steady and long-lasting, second only to heavy snowfall.

Summer rainfall is typically stormy, intense, and rapid, often occurring as runoff, and is therefore not effectively stored by mountains.

Green artificial basins are based on the principle of distributing water across the mountain surface to enhance absorption, unlike dams which rely on water accumulation; over time, fine sediments in dams clog soil pores and reduce infiltration.

The grasses planted on the surfaces and edges of green artificial basins prevent fine sediments from blocking the soil pores responsible for water absorption.

Trees planted within and around these basins help moderate heavy summer storm rainfall.

To avoid wasting effort and time, implementation should begin with mountains that serve as primary water sources for rural communities.

Even basins constructed in areas where the underlying layer is initially impermeable can be modified to become permeable by drilling holes and filling them with gravel. In addition, such areas can still be utilized for afforestation and the creation of green spaces.

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[2] Abu al-Qasim Mahmud ibn ‘Amr ibn Ahmad Al-Zamakhshari (d. 538 AH), Al-Kashshaf ‘an Haqa’iq Ghawamid al-Tanzil, Dar al-Kitab al-‘Arabi, Beirut, 3rd edition, 1407 AH, Vol. 2, p. 575.

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[4] Muhammad[4] ibn Isma‘il Abu ‘Abdullah Al-Bukhari Al-Ju‘fi, Al-Jami‘ al-Musnad al-Sahih al-Mukhtasar min Umur Rasul Allah ﷺ wa Sunanihi wa Ayyamihi (Sahih al-Bukhari), edited by Muhammad Zuhayr ibn Nasir al-Nasir, Dar Tawq al-
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[5] ‘Issam Muhammad ‘Abd al-Majid Ahmad and ‘Abbas ‘Abdullah Ibrahim, Hydrology, Dar al-Wadan for Publishing, Printing, and Distribution, Khartoum, Sudan, n.d., n.ed., p. 30.

[6] ‘Issam Muhammad ‘Abd al-Majid Ahmad and ‘Abbas ‘Abdullah Ibrahim, same reference, p. 33.

[7] ‘Issam Muhammad ‘Abd al-Majid Ahmad and ‘Abbas ‘Abdullah Ibrahim, same reference, p. 10.

[8] ‘Issam Muhammad ‘Abd al-Majid Ahmad and ‘Abbas ‘Abdullah Ibrahim, same reference, p. 10.