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THE HYDROLOGICAL CYCLE OF WATER: AN INTERDISCIPLINARY STUDY OF PHILOSOPHY, SCIENCE, AND THE QURAN

Kitaran Hidrologi Air: Suatu Kajian Interdisiplin Falsafah, Sains dan al-Quran

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Abstract

This study investigates the evolution of human understanding of the natural water cycle (hydrological cycle) from early philosophical thought to modern scientific models, with a focus on the coherence of Quranic descriptions with contemporary knowledge. Using a qualitative content analysis of historical philosophical texts, scientific literature, and exegetical works on selected Quranic verses, the research applies a comparative approach to trace developments across different perspectives. The findings reveal that early Greek philosophers initiated conceptual speculation about the water cycle, which was further advanced through empirical methods during the Renaissance and Enlightenment. The 19th and 20th centuries, in turn, introduced transformative technological tools that shaped modern hydrological science. Significantly, Quranic verses revealed in the 7th century accurately describe key components of the water cycle, including evaporation, condensation, rainfall, and groundwater flow, in a manner consistent with contemporary scientific understanding. These findings affirm that the Quranic perspective remains scientifically valid across time, illustrating the text's enduring relevance and its intersection with later scientific discovery.

Keywords: *Quran, Greek, hydrology, philosophy, water.*

Abstrak

Kajian ini meneliti evolusi pemahaman manusia terhadap kitaran hidrologi, bermula daripada pemikiran falsafah awal sehinggalah kepada model saintifik moden, dengan memberi fokus kepada keselarasan deskripsi al-Quran dengan pengetahuan kontemporari. Melalui analisis kandungan kualitatif terhadap teks falsafah sejarah, literatur saintifik, dan tafsir ayat-ayat al-Quran terpilih, pendekatan perbandingan digunakan bagi menelusuri perkembangan pelbagai perspektif. Dapatan kajian mendapati ahli falsafah Yunani awal telah memulakan spekulasi konseptual mengenai kitaran air, yang kemudian diperkukuh melalui kaedah empirikal pada zaman Renaissance dan Pencerahan. Perkembangan pada abad ke-19 dan ke-20-pula dipacu oleh kemajuan teknologi yang membentuk asas sains hidrologi moden. Menariknya, al-Quran yang diturunkan pada abad ke-7 telah menggambarkan komponen utama kitaran air seperti penyejatan, pemeluwapan, hujan, dan aliran air bawah tanah dengan ketepatan yang seiring dengan kefahaman saintifik kontemporari. Hasil kajian ini menegaskan bahawa perspektif al-Quran kekal relevan secara saintifik merentas zaman, serta menunjukkan hubungan erat antara wahyu, falsafah, dan sains dalam memahami fenomena semula jadi.

Kata kunci: *Quran, Greek, hidrologi, falsafah, air.*

INTRODUCTION

Comprehension of the natural water cycle, also called the hydrological cycle, is not just an intellectual pursuit but also significant in examining water cycles and plays a pivotal role in water resource management, urban planning, and agriculture. This natural water cycle, with its processes of evaporation, condensation, precipitation (rainfall), and infiltration, collectively ensures the continuous distribution of water on Earth. The historical understanding of the natural water cycle mirrors the evolution of human thought, from early philosophical conjectures to modern scientific revelations. Understanding this cycle is crucial for managing and planning our water resources, urban environments, and agricultural systems, making it a topic of utmost relevance and importance in our modern world.

Exploring the hydrological cycle dates back to ancient Greek philosophers such as Plato and Aristotle, who engaged in dialogues about water movement based on their natural observations. However, progress in understanding the natural water cycle was impeded during the medieval period due to the predominant influence of the church, which restricted further studies. The Renaissance and Enlightenment eras heralded a more methodical scientific approach, leading to the establishment of modern hydrology. Technological progress in the 19th and 20th centuries significantly enhanced hydrological studies' depth, precision, and comprehensiveness.
The study aims to elucidate the historical progression of the natural water cycle from ancient philosophical periods to the present day while also establishing the consistency of Quranic content with contemporary scientific knowledge. Additionally, the study emphasizes the significance of integrating religious knowledge and scientific inquiry to comprehend the intricacies of natural phenomena.

METHODOLOGY

The methodology of this study encompasses a thorough literature review and historical examination of the hydrological cycle, an in-depth analysis of Quranic texts about the water cycle, and a juxtaposition with contemporary scientific theories and findings. By employing this approach, the study endeavors to amalgamate historical, religious, and scientific viewpoints into a unified framework to offer a comprehensive perspective on developing the understanding of the hydrological cycle.

FINDINGS AND DISCUSSION

The hydrological or natural water cycle is a foundational concept for comprehending the circulation and dispersion of water on Earth. Over time, our comprehension of this cycle has progressed from the speculative philosophies of early scholars such as Plato and Aristotle to the development of comprehensive, contemporary scientific frameworks.

WESTERN ANCIENT PHILOSOPHICAL SPECULATIONS

In ancient Greece, the earliest conceptions regarding the genesis of rivers centered on the hypothesis of immense subterranean caverns and reservoirs (Angelakis, 2012). These expansive underground passageways and reservoirs were thought to be the wellspring of the uninterrupted flow of rivers, even in times of drought. Such suppositions exerted significant influence during that era, as evidenced in the monumental works of Homer. He says, "There exists a colossal subterranean water vortex known as 'Oceanus,' from which all rivers and oceans, all springs and unfathomable pools emanate" (Homer, 1991, p. 319).

During the 5th century BC, several prominent Greek philosophers made significant contributions to the early study of natural water phenomena. Anaximenes (585–525 BC) extensively researched meteorological occurrences and proposed logical interpretations for the origins of wind, rainbows, cloud formation, rain, and snow (Kočandrle, 2019). During the same period, Hippo, a Pythagorean philosopher, postulated that the ultimate source of all water on Earth was the sea (Stewart & Howell, 2003). Concurrently, Anaxagoras (500-428 BC) and Plato (429-347 BC) speculated, drawing from Homer's poetic perspectives, that river water emanated from vast subterranean caverns, a theory later proven incorrect (Furley, 1987). Plato, in his work *Timaeus*, also introduced the notion of water traveling from the sea into extensive subterranean channels beneath the earth termed "Tartarus," then returning to the sea, representing a rudimentary comprehension of the water cycle, albeit inaccurately characterized by modern standards (Bucaille, 2015).

Aristotle (384-323 BC) astutely postulated that rainwater is a result of the evaporation of seawater. He proposed that seawater evaporating into the air renders it “sweet”, and when the vapor condenses, it does not revert to its salty state (Aristotle & Barnes, 2014). Aristotle was among the earliest to comprehend the imperative need for a continuous cycle to sustain river and sea water levels, preventing rivers from desiccation and seas from inundation. In his work *Meteorologica*, Aristotle disputed the concept of a substantial reservoir within the Earth's crust with a compelling argument:

> Suppose anyone can imagine a reservoir large enough to hold the water flowing every day and consider the volume of that water. In that case, it is clear that a container capable of holding all the water flowing in a year would be larger than the earth, or at least not much smaller. (Aristotle & Barnes, 2014, p. 230)

Aristotle laid the foundation for understanding the hydrological cycle by observing natural phenomena, particularly the interplay of water, air, and solar influence. In his work *Meteorologica*, he articulated a conceptual framework in which water vapor, induced by solar heating, ascends from the earth's surface, undergoes cooling and condensation processes, leading to precipitation, and eventually returns to the earth. Although lacking a comprehensive understanding of contemporary science, Aristotle's insights represented a pivotal step toward systematically comprehending the natural water cycle (Koutsoyiannis & Mamassis, 2021).

Notwithstanding his often-logical reasoning, Aristotle had difficulty accepting that rainfall alone was responsible for creating springs and rivers. He grappled with the mystery of how rivers could maintain their flow for prolonged periods, spanning weeks or even months, without rainfall. This riddle continued to perplex society during that time (Deming, 2005).

The philosopher Seneca (3 BC-65 AD) provided a succinct overview of the Roman era's understanding and perspectives on the natural water cycle. He argued that rainfall alone was insufficient to replenish the various river sources and springs adequately. Seneca contended that while rain could cause torrents, it could not sustain a consistent river flow. He emphasized the significance of the evaporation process. He posited that the coexistence of air and water played a pivotal role in the emergence and course of water flowing out of the soil, giving rise to springs and rivers (Duffy, 2017).

In his treatise *De Architectura*, Marcus Vitruvius, a prominent Roman author, scientist, and engineer of the 1st century BC, provided comprehensive insights into the phenomenon of rainfall and the factors contributing to the formation of mountain springs. He attributed these mechanisms primarily to evaporation and topographical influences. Vitruvius' explanations resemble the contemporary understanding of the hydrological cycle as acknowledged in current literature (Karterakis et al., 2007).

CONTRIBUTIONS OF THE MEDIEVAL PERIOD

During the Medieval Period, spanning from the first century AD to the 17th century AD, the field of science was characterized by a lack of significant progress, often referred to as a "dark age". The hydrological cycle received limited attention during this time, with prevalent adherence to ancient theories, such as the concept of giant underground water reservoirs from the Greek and Roman eras. The dominant influence on scientific thought during this period stemmed from Christian church teachings, with the Bible serving as the primary reference for scholars, shaping their observations and scientific studies. A notable reference from the book of Ecclesiastes in the Bible describes the sea as the source of all rivers and springs: “All the rivers run into the sea, yet the sea is not full; unto the place from whence the rivers come, thither they return” (Bible.com, 2024).

The interpretation of this verse by contemporary church scholars and followers of the era suggested that water from the sea would flow back to the rivers, potentially through channels or openings beneath the sea floor. While this conceptualization was consistent with the modern hydrological cycle, it mistakenly implied that the process involved openings in the sea floor (Adams, 1954). This implies that the Biblical interpretation aligned with outdated intellectual concepts that deviated from absolute truth. Given that most intellectuals during that era were associated with the church, this perspective gained traction and prevailed throughout the medieval period.

During the medieval period, Athanasius Kircher (1602-1680), a prominent German priest, contributed significantly to the field of hydrology with his 1664 publication *Mundus Subterraneus*. Kircher posited the theory of the hydrological cycle, proposing that the Earth's subsurface contained various conduits that transported water to extensive reservoirs within mountains, subsequently releasing it to the surface through springs. He likened this mechanism to the human body's blood circulation, though this analogy was widely disregarded then. *Mundus Subterraneus* sheds light on the challenges medieval society faced in comprehending the relationship between rainfall and river flow, particularly given that rain was not recognized as the primary source of river water during this era (Angelakis, 2012).

The challenge that confronted Kircher was akin to that of Aristotle: how to account for the continuous flow of rivers in the absence of rainfall? As a clergyman, Kircher's perspective was influenced by Ecclesiastes, which posited that seawater returned to rivers and land to sustain a cycle. This raised a secondary question: How does saline seawater transform into freshwater in springs and terrestrial rivers? Based on the analysis, Kircher did not answer the first query satisfactorily. However, he attempted to tackle the second question by suggesting that seawater seeped into the earth's subsurface and underwent a distillation process facilitated by the earth's internal heat (Rosbjerg & Rodda, 2019).

An alternative hypothesis, similar to Kircher's, was proposed for the hydrological cycle by the Alembic theory, initially presented in the book *Chemisches Laboratorium* by J. J. Becher (1635-1682). According to Becher's theory, the Earth resembled a vast distillation apparatus. When seawater seeped through the ocean floor and entered the Earth, it was heated by subterranean heat and vaporized. As the vapor descended, it permeated the cavernous interiors of mountains. The vapor condensed and turned into water upon encountering colder temperatures and snow on the mountains. This water gave rise to springs that cascaded down the mountainsides, eventually returning to the sea (Koutsoyiannis & Mamassis, 2021).

The concept comprises two significant incongruities:

> a) The assertion that water flows from sea level to mountain peaks contradicts fundamental laws of nature, as water predominantly descends from higher to lower elevations rather than the opposite.
>
> b) The linkage between the sea and the mountains would give rise to a notable inconsistency due to the disparity in salinity between seawater and freshwater from rivers and springs.

Efforts to reconcile these discrepancies were rooted in a combination of conjecture and Christian religious doctrines, which typically lacked robust scientific underpinnings and empirical substantiation. For instance, unconventional ideas emerged during that era, proposing that the ocean surface was elevated compared to the land, ostensibly accounting for the possibility of water flowing toward mountains. Alternatively, specific hypotheses proposed that water movement from lower to higher elevations was orchestrated by divine intervention, as documented by Karterakis et al. (2007). The historical understanding posited that the earth's internal heat caused subterranean water to evaporate and emerge at the earth's surface, including high-altitude mountain peaks (Bucaille, 2015). Contemporary scientific inquiry has since invalidated these beliefs.

RENAISSANCE AND ENLIGHTENMENT

During the Renaissance era in Europe, there was a notable resurgence in scientific research, driven by a renewed interest in empirical observation and experimentation. Notably, Leonardo da Vinci (1452–

1519) conducted detailed observations of cloud formation, rainfall, and river systems, emphasizing the interconnections among these natural elements. Da Vinci was the first to propose the existence of permeable, porous hydrogeological structures, particularly in sloped and hilly regions. He suggested rain and melting snow from mountain peaks could infiltrate these permeable layers, traveling deep underground before resurfacing as springs or flowing back to the sea (Rosbjerg & Rodda, 2019).

In his book *Admirable Discourses*, Bernard Palissy (1510–1590), a prominent figure of the Renaissance and Enlightenment, diverged from the prevailing belief of his time regarding the origins of rivers and streams (Kirsop, 1961). He posited that rainwater, rather than water from the sea, was the primary source of these water bodies. Palissy, a French Protestant known for his opposition to the limitations imposed by the church, presented a comprehensive scientific explanation of the hydrological cycle. In 1580, Palissy's work provided a definitive clarification, asserting that rivers and springs are exclusively derived from precipitation and snowmelt. His scholarly investigation of natural springs led him to conclude that their origins were tied solely to precipitation and snow. This departure from the established belief of the time significantly contributed to advancing scientific understanding of hydrology.

In his work, Palissy refuted the notion of seawater migrating to land through hidden subterranean passages to create springs. He contended that if springs stemmed from seawater infiltrating inland, they would carry a salty composition. Palissy also showcased astute observation by posing a fundamental query: If springs were indeed a result of seawater, why would they desiccate during the summer? (Palissy, 1957).
Another exciting thing about Palissy's work was that he correctly explained the time lag between rain and water flow, a perplexing issue for scholars from Aristotle to Kircher:

> Rainwater that falls on land, mountains, and any other inclined surface in the direction of rivers or springs does not rapidly reach them. It would cause every spring to shrivel up during the summer. Nevertheless, the water that precipitates on the ground during the winter months is unable to move swiftly; instead, it seeps gradually until it encounters an obstruction; upon encountering granite, it proceeds in the direction of the rivers. Based on this, it can be deduced that beneath these rivers are numerous continuous springs that flow slowly and alternate between winters. (Palissy, 1957, pp. 67-68)

The renowned ceramic artist Palissy met his demise in prison after being apprehended by royal forces and steadfastly refusing to renounce his Protestant faith in favor of Catholicism, which held sway in France during that era (Deming, 2005).

The research conducted by Edme Mariotte (1620–1684) and Pierre Perrault (1611-1680) in France and several modern scientists further substantiated and extended his findings. Their extensive quantitative studies of rainfall and river flow provided empirical evidence that contributed to the developing understanding of the hydrological cycle. Their emphasis on the significance of measurement and observation laid the groundwork for contemporary hydrology.

SCIENTIFIC UNDERSTANDING IN THE MODERN ERA

In the following years, as scientific knowledge progressed into the contemporary era, numerous researchers conducted thorough studies on this subject. Pierre Perrault illustrated his empirical efforts to measure the hydrological cycle in 1674. In his publication, *De l'Origine des Fontaines*, he designated a specific area for rainwater accumulation, calculated average precipitation using a rain gauge, and subsequently quantified the volume of water passing through a particular canal. His research revealed a rainfall-to-river flow ratio of 6 to 1, indicating that the quantity of rainfall exceeded the amount required to supply water to springs and rivers. Furthermore, an excess of water had not yet completed the hydrological cycle, suggesting that a portion of the water remained underground (Nace, 1974).

Subsequently, a French physicist and clergyman, Edme Mariotte (1620-1684), conducted a similar experiment, yielding a heightened ratio of approximately 8 to 1 (Deming, 2017).

Italian naturalist and medical scientist Antonio Vallisnieri (1661-1730) made a significant contribution by conducting an extensive study in the Alps on the natural formation of springs and rivers. A key finding of his research was the concept of infiltration. Vallisneria observed that despite the extensive Monte S. Pellegrino snowfield, the narrow rivers near Modena had low discharge. Detailed observations revealed that the water from the snowmelt atop the mountain traveled through imperceptible subterranean pathways for a considerable distance from Modena to Bologna, passing through small porous permeable strata. This discovery confirmed that subterranean routes, discussed in the Middle Ages, transported water naturally from mountain summits to depths rather than from oceans to mountains (Luzzini, 2014). This development led to humans' near-complete understanding of the hydrological cycle around 1715.

Recent findings in contemporary hydrology have elucidated that the hydrological cycle, also known as the natural water cycle, is an ongoing process encompassing the movement of groundwater, terrestrial water, and atmospheric water on Earth. Primarily driven by solar radiation, this cycle initiates with the conversion of liquid water from the Earth's seas, lakes, and rivers into gaseous water vapor. Additionally, plants contribute to this process through transpiration, releasing water vapor into the atmosphere. The water vapor ascends and cools, undergoing condensation to form clouds, resulting in precipitation in various forms, such as rain, snow, hail, or sleet. This natural process replenishes the Earth's surface water reservoir and concurrently seeps into the soil, augmenting groundwater reserves (Oki & Kanae, 2006).

Precipitation in the form of rain and snow can lead to surface runoff, where water flows over the land and enters rivers, lakes, and, ultimately, the oceans. Some of this water infiltrates the ground, replenishing aquifers and natural groundwater reservoirs, which can resurface through springs. Surface water supports human, plant, and animal life (Ibrahim & Ibrahim, 2024). The continuous movement of water is essential for sustaining life, regulating the climate, and preserving the natural balance of ecosystems (Yang et al., 2021). The hydrological cycle is directly responsible for ensuring the consistent distribution and availability of freshwater worldwide.

CONTRIBUTIONS OF MUSLIM SCHOLARS

Long before the European Renaissance, while the Western world was navigating the intellectual doldrums of the early Middle Ages, the Islamic world was experiencing a golden age of scientific discovery. In this vibrant atmosphere of learning, fueled by the Quranic injunction to seek knowledge, Muslim scholars made profound and pioneering contributions to the natural sciences. Among their most significant achievements was the formulation of a coherent and empirically-grounded theory of the hydrological cycle, the continuous process of evaporation, condensation, precipitation, and runoff that sustains life on Earth (Freely, 2010).

The hydrological cycle, the continuous movement of water on, above, and below the Earth’s surface, is a foundational concept in hydrology, meteorology, and earth sciences. While modern textbooks often credit 17th-century European scientists such as Pierre Perrault (1611-1680) and Edme Mariotte (1620-1684) for formulating the modern understanding of this cycle, historical evidence reveals that Muslim scholars of the Islamic Golden Age (8th–14th centuries AD) not only anticipated key elements of the cycle but also articulated them with striking clarity and empirical insight centuries earlier (Borroni, 2024). Through rigorous observation, logical deduction, and engagement with earlier traditions, while critically refining them, these scholars laid the intellectual groundwork for the science of hydrology.

Abū Yūsuf Yaʿqūb ibn Isḥāq al-Kindī (c. 801–873 AD), often regarded as the “Philosopher of the Arabs,” Al-Kindī was among the first to present a theory on tides, attempting to explain natural phenomena by reference to physical causes rather than purely on myth or speculation like Aristotle. In his treatise *Risāla fī al-ʾIllah al-Fāʿilīyah al-Madd wa-l-Fazr* (the Efficient Cause of the Flow and Ebb*)* he presented a somewhat clear description of what we now call evaporation and condensation

(Hamarneh, 1965). He explained that the heat of the sun draws up fine water vapour from the earth and the sea. This vapour rises, cools in the upper atmosphere, and condenses to form clouds. When these clouds encounter more cold air, they precipitate as rain. This was a critical departure from vague Aristotelian notions of water simply changing into air and back; Al-Kindi identified heat as the driving force and described a physical transformation of state (Prioreschi, 2002). Although his explanations were philosophical, they laid down early conceptual frameworks that later scholars refined. His work marked an early shift toward naturalistic explanations of rainfall and atmospheric behavior.

Al-Bīrūnī (973–1050 AD), one of the most distinguished polymaths of the medieval Islamic world, made foundational contributions to early hydrological thought through his integration of empirical observation and natural-philosophical analysis. In *Kitāb al-Tafhīm* (The Book of Instruction in the Elements of the Art of Astrology*)* and *Taḥqīq mā li-l-Hind* (Researches on India*)*, he presented systematic discussions of rivers, springs, and groundwater, grounded in observation rather than speculative cosmology (Borroni, 2024). Al-Bīrūnī argued that springs on mountain slopes originate from precipitation at higher elevations, which infiltrates the substrata and subsequently emerges downslope, an explanation consistent with contemporary concepts of lateral subsurface flow (Huff, 2017). His rejection of mythological claims regarding the origins of major rivers, including the Indus and the Ganges, further reflects his commitment to empirically grounded hydrological reasoning. Additionally, in works such as *Kitāb al-Jamāhir fī Maʿrifat al-Jawāhir* (The Book Most Comprehensive in Knowledge on Precious Stones) and al-*Āthār al-Bāqiya* (Vestiges of the Past Centuries*)*, his studies of material properties, climate, and phase changes illustrate an early recognition of the role of solar heat in driving vaporization processes (Borroni, 2024). His hydrological insights predate Bernard Palissy (1510–1590) and Pierre Perrault (1611-1680), who are often credited in Eurocentric narratives as “founding” the modern water cycle theory. Collectively, al-Bīrūnī’s interdisciplinary approach, linking geology, climatology, and fluid behaviour, anticipated several principles that later became central to the scientific study of hydrology.

Abū Bakr Muḥammad ibn al-Ḥasan al-Karajī (also spelled al-Karaji), a prominent Persian mathematician and engineer of the 10th–11th centuries (953-1029 AD), made significant contributions to hydrogeology, particularly in the context of groundwater extraction and water resource management in arid regions (Ataie-Ashtiani & Simmons, 2020). Though best known for his pioneering work in algebra and numerical analysis, al-Karajī applied his mathematical expertise to practical engineering problems, most notably in his treatise *Inbat al-miyah al-khafiya* (The Extraction of Hidden Waters). His book is a foundational text in medieval hydrogeology, offering detailed guidance on locating, accessing, and managing underground water resources (Bensi, 2020). In it, he synthesizes empirical observation, geological reasoning, and engineering design to explain how to identify aquifers, estimate water depth, determine optimal well locations, and construct *qanāts* (underground conduits), demonstrating an advanced understanding of hydrological principles such as water flow in porous media, recharge zones, and terrain-water relationships (Golzari & Rabb, 2023). Karaji's methods for calculating land slopes and extracting groundwater were influential, with some theories were eventually validated in Europe some 700 years later.

THE QURAN AND THE HYDROLOGICAL CYCLE

The Quran, revealed in the 7th century, contains verses that intricately depict the water cycle, aligning with modern scientific knowledge. Within various surahs (chapters) of the Quran, these descriptions eloquently portray fundamental processes of the natural water cycle, including evaporation, condensation, and the precise movements of water.

> Have you not seen that Allah sent down water from the sky, then made it penetrate into the earth (and gush forth) in the form of springs? Then He brings forth with it crops of different colors, and afterwards they wither, and you see them turned yellow, then He makes them chaff. Surely in that there is a lesson for the people of understanding. (The Noble Quran, Translation by T. Usmani, 2024, 39:21)

The mentioned verse alludes to rain descending from the sky and permeating the earth, ultimately giving rise to springs. During the 7th century, when the Quran was revealed in the Arabian Peninsula, the global understanding of the natural water cycle was in its infancy, leading to the proposal of various unconventional theories. These included the existence of vast subterranean reservoirs and the notion that seawater was being forced inland through specific underground channels, thereby creating springs on the earth's surface and even atop mountain peaks. In contrast, the Quran succinctly states that terrestrial springs originate from rain, a claim that has since garnered scientific validation (Kresic & Stevanovic, 2009).

> Do you not realize that Allah drives the clouds, then joins them together, then turns them into a heap? Then you see the rain coming out from their midst. He sends down from the sky mountains (of clouds) having hail in them, then He afflicts with it whomsoever He wills and turns it away from whomsoever He wills. The flash of its lightning seems to snatch away the eyes (The Noble Quran, Translation by T. Usmani, 2024, 24:43)

The passage delineates clouds' motion, aggregation, and stratification, elucidating the subsequent occurrence of precipitation, including hail. Additionally, it expounds on the generation of lightning as an offshoot of cloud movement, which has been empirically substantiated (National Geographic, 2009).

> Allah is the One who sends the winds, so they stir up a cloud, then He spreads it in the sky however He wills, and makes it (split) into pieces. Then you see the rain coming out from its midst. So, once He makes it reach those whom He wills from His slaves, they start rejoicing, (The Noble Quran, Translation by T. Usmani, 2024, 30:48)

The passage delineates the pivotal role of wind in orchestrating cloud movement and precipitation, along with the rain descending upon those deemed worthy by Allah. In contemporary society, technological advancements have provided the means to stimulate rainfall from previously non-responsive clouds through a method known as cloud seeding. Nevertheless, as expounded by French meteorologist M.A. Facy in the *Encyclopedia Universalis* within the section dedicated to precipitation.

> "It will never be possible to make rain fall from clouds that do not have the characteristics of rain clouds or have not reached the appropriate stage of evolution (maturity). Therefore, humans cannot accelerate the process of rain through technical means when the natural conditions for it do not exist. If humans could truly control rain, droughts would end - which clearly, they have not. Thus, having control over rain and good weather remains a dream." (M.A. Facy, as quoted in Bucaille, 2015, p. 177)

The observation mentioned validates the enduring relevance of the Quranic verse. It highlights the influence of natural factors, such as wind and other meteorological conditions, in dictating the distribution and occurrence of rainfall beyond human control.

> And We sent down water from the sky in due measure, then We lodged it in the earth, and of course, We are able to take it away. (The Noble Quran, Translation by T. Usmani, 2024, 23:18)

The following verse asserts that the quantity of rain and stored water on earth is predetermined. According to modern hydrological research, the total amount of water in the atmosphere and soil remains constant (Linton, 2008; Van der Ent & Tuinenburg, 2017). While the forms of water in circulation may vary, such as snow, dew, rain, or groundwater, the overall quantity of water within the hydrological cycle remains consistent (Jacob, 2001).

At any given time, the Earth's atmosphere contains approximately 12,900 cubic kilometers (km^3) of water particles. This quantity remains relatively stable, contributing to the overall balance of water on the Earth's surface. Should all the water particles in the atmosphere precipitate simultaneously, it would result in a global submersion of the Earth's surface by about one inch or approximately 2.5 cm (Schneider et al., 2011).

The verse highlights the constancy of water stored within the earth. Rainwater is typically absorbed into the ground through permeable layers and small pores in the soil. However, rapid urban development has led to ground surfaces being covered with impermeable materials such as cement and concrete, impeding rainwater from infiltrating the ground (Cheng et al., 2022).

The consistent quantity of water stored underground means that the hindrance of water infiltration disrupts the natural balance established by a higher power. Consequently, this disturbance contributes to frequent urban flash floods and sudden flooding. Human actions must align with the principles outlined in these Quranic verses. This requires modifications to urban constructions, which can enable rainwater to readily permeate the ground, thus mitigating the recurrence of flood disasters.

> How well We poured water, then how nicely We split the earth, then We grew in it grain, and grapes and greens, and olive and date-palms, and gardens, full of thick trees, and fruits and fodder, as a benefit for you and your cattle. (The Noble Quran, Translation by T. Usmani, 2024, 80:25-32)

The verse under scrutiny underscores the manifestation of rain on earth and Allah's precise division of the earth. Islamic exegetes such as Ibn Kathir have expounded upon this verse, interpreting it as indicative of Allah's placement of water within the earth, allowing it to permeate layers and percolate into the stored seeds, which subsequently germinate into lofty, rooted trees on the earth's surface (Kathir, 2021). Furthermore, the initial segment of the Quranic verse can be construed to signify that rainwater descending to the earth permeates the earth's crevices through porous spaces and fine apertures in the soil, facilitating subterranean storage of water (MyIslam.org, 2024; Islamic Foundation UK, 2024). This serves as an attestation to the veracity of the Quranic verses.

CONCLUSION

The comprehension of the natural water cycle has undergone significant evolution, ranging from ancient philosophical speculations in Greek and Roman antiquity to contemporary scientific models founded on advanced technology. Early thinkers such as Plato and Aristotle laid the groundwork for explaining the natural water cycle through philosophical observations, although their conclusions have since been disproven by modern knowledge. Scholars in the Middle Ages faced challenges refining their understanding and research within the confines of church influence. In contrast, Renaissance and Enlightenment scholars emancipated themselves from religious pressures, introducing empirical methods that could be experimented with and tested. This progression set the stage for the discovery and establishment of modern hydrology. Remarkably, the Quran, which was revealed over a millennium ago, contains remarkably accurate descriptions of the natural water cycle, aligning with contemporary scientific understanding. Its depictions of natural processes such as evaporation, condensation, and rain, emphasizing the interconnectedness and sustainability of the water cycle, attest to the veracity of the Quranic verses, which were remarkably progressive for their time. Continuous examination of the Quranic verses about natural phenomena remains imperative to explore further domains of knowledge that are not yet fully comprehended.

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