

1 Introduction

The present book deals with water-related knowledge in two works by the Sabian mathematician and scientist Ṭābit b. Qurra (211-288/826-901), at the beginning of the so-called golden age of the *dār al-islām*. The two treatises are the *Qawl fī al-sabab al-laḡī ju‘ilat lahu miyāh al-biḥār māliha* (Discourse on the Reason Why Seawater Was Made Salty), and the *Risāla fī manāfi‘ al-jibāl* (Treatise on the Benefits of the Mountains), a similar work about mountains and their role in nature. The two treatises read together give us an insight into Ṭābit’s view of the environment. When I say environment, I am referring to what our author calls ‘creation’. He consistently uses the term (ar. *ḥalq*) to denote the broad sphere of beings that encompasses humans and non-humans, animals and elements, phenomena and material properties both sub-lunar and supra-lunar – essentially everything except God. As will become evident, this notion of the environment as creation is primarily viewed as a system. This system is both self-balancing and divinely ordained, with water playing a pivotal role in its inner workings.

During my research for the Network of Science and Water project at the Centro di Ricerca Marco Polo – Centre for Global Europe-Asia Connections, I examined these two treatises, focusing on water-related science in al-Bīrūnī’s (362-c. 440/973-c. 1048) thought in collaboration with Vladimiro Boselli, at the time an environmental engineer at Brescia University. Despite their lack of direct relevance to hydraulics and environmental engineering, it became apparent that these treatises have received relatively little attention compared to their significance within the broader history of environmental thought. Previous research on these texts has tended to approach them from a purely philosophical perspective, specifically in relation

to the doctrine of the best possible world. The following pages present an attempt to contextualise Tābit's work within its historical and cultural milieu, and to identify innovative aspects or insights that played a significant role in contributing to the understanding of the environment and the role of water within the Arabo-Islamic scientific, and thus philosophical, tradition.

Water is one of the few geographical features that may justify, to some extent, the adoption of categories such as Middle East or Middle East and North Africa at any level other than the geopolitical.¹ The diverse regions identified by these terms usually span from North Africa and the Atlantic to Central Asia and the Hindu Kush. These lands are, for the most part, arid; at the same time, they often rest upon considerable subterranean water reservoirs, also known as fossil water. Aridity does not mean a complete lack of water, but rather a scarcity of precipitation. In fact, a significant portion of the lands of premodern *dār al-islām*, meaning the territories subject to Muslim authority, enjoys a steady supply of water through its rivers, such as the Nile, the Tigris and Euphrates, and the Amu Darya or Oxus. The Indus river would join this group at a later date.²

These four rivers have their sources either outside the territories of the caliphal *dār al-islām* or at its fringes. Nevertheless, they appear prominently on the stylised map produced by premodern Muslim geographers, such as the world map contained in the manuscripts of the early geographical work by Ibn Ḥawqal (d. after 362/973) *Kitāb ṣūrat al-arḍ* (The Image of the Earth).³ It is not surprising that al-Bīrūnī chose the Nile, the Tigris, the Euphrates, and the Amu Darya to discuss fluvial regimes and the physical principles governing them in conjunction with geographical contingencies.⁴

The scholars responsible for the high-cultural production that is the Arabo-Islamic scientific tradition lived and worked in these environments and landscapes, especially in the early corpus of this tradition. Tābit was one of these individuals, and he occupies the centre stage in this book. He was neither Arab nor Muslim, but he shares with other key representatives of this learned tradition a place in the global history of scientific thought and the landscapes that informed their experience of the world.

As we will see, there is a fascinating assonance between what Tābit, the historian and philosopher Miskawayh (c. 320-421/c. 932-1030), al-Bīrūnī, and, to some extent, even an engineer and mathematician like al-Karāḡī (d. after 410-420) and the esoteric philosophers of the anonymous fraternity known as Iḥwān al-Ṣafā' (tenth century) had to say about what we would today call the water cycle and the environmental realities of the "eastern lands of the Caliphate". I here reference the seminal work by Guy Le

1 Bonine, *Is There a Middle East?*.

2 C.E. Bosworth mentions a "considerable confusion over the precise nomenclature of the Indus and its constituents", despite Muslim presence in the Indus valley dating back at least to the early eighth century, signalling a lack of information or attention regarding this river before Ghaznavid expansion in the Indian subcontinent. Perhaps, this may simply be a consequence of the initial imprint of Greek traditions on Arabo-Islamic geographers. However, a comprehensive analysis of how Islamic authors from the eighth to the eleventh centuries perceived the Indus has yet to be undertaken. Bosworth, "Mihrān"; Siddiqi, "Muslim Geographic Thought". For a general summary of the notions held by geographers at this time about the Indus and its valley see Le Strange, *The Lands of the Eastern Caliphate*, 330-3.

3 Ibn Ḥawqal al-Naṣībī, *Ibn Ḥawwqal's Kitāb Ṣūrat al-arḍ*.

4 See infra and Borroni, Boselli, "Hydraulics and Hydrology".

Strange⁵ because its title encapsulates two crucial elements: the geographical coordinates of the environments where these thinkers lived, and the political order governing the societies that nurtured them.

Ṭābit was and remains primarily known as a mathematician and astronomer, both as a translator and as an original author. Of his original works, the most significant are those dedicated to astronomy. Of the thirty to forty titles on astronomy attributed to him, we currently have access to only eight. These are primarily focused on resolving discrepancies between mathematical astronomy and observational astronomy, specifically the observable behaviour of celestial bodies. His interest in mathematics extends beyond its application to astronomy, with his most noteworthy contributions found in calculus and the study of amicable numbers. Furthermore, as R. Rashed rightly points out, our author produced works “in all the practical sciences of his age”, as demonstrated by the texts we will discuss.⁶

The socio-political context that nurtured Ṭābit matters the most when we consider in what terms his scientific and philosophical production should be understood in the broader Arabo-Islamic scientific tradition. The nodal question rests on the definition of Islamic, and, henceforth, on the definition of Islam. The topic has a very long history with historiographical and theoretical trappings, that will not be described in full here. I will just discuss the definitions adopted in the following pages. We owe to Shahab Ahmed a new, clever, and evidence-based definition of Islam and Islamic; this is the one I will rely on in this book. Ahmed understands Islam “as meaning-making for the self in terms of hermeneutical engagement with Revelation to Muḥammad as Pre-Text, Text, and Con-Text”.⁷ Here the Pre-Text amounts to the ultimate Truth, which lies *before* the Revelation on a logic or conceptual level. The Con-Text is the entirety of the hermeneutical projects engaging with these three elements, be they religious sciences, history and memory, art, etc.

The matter is far from settled, of course, and Ṭābit’s contribution to water-related sciences in Islam only provides one specific case of this broader issue. That being said, Ahmed’s understanding of Islam is meaningful and productive when applied to the question posed here, namely in what terms we can describe Ṭābit’s scientific contributions as Islamic. In a sense, just as the concepts of high and low lose their meaningfulness in outer space, or as the all-important concept of time loses its validity in the infinitely small, so any definition of Islam and Islamic may prove less than functional in some research contexts, for instance if we consider Islam as a large scale historical, cultural, and religious phenomenon. This is a question of fields of applicability, that may be more or less suited to different definitions. For what concerns us here, Ahmed’s understanding of Islam allows to approach the Islamic character of the Arabo-Islamic scientific tradition in a meaningful and rigorous way.

According to Ahmed, we should consider Islamic what engages hermeneutically with the Text, Con-Text, and Pre-Text of the Revelation to Muhammad. Crucially, Ahmed argues that “obviously” Non-Muslims can produce meanings

5 Le Strange, *The Lands of the Eastern Caliphate*.

6 Rashed, “Ṭhābit b. Ḳurra”.

7 Ahmed, *What Is Islam?*, 405; for a critique of Ahmed’s approach see Hughes, “New Methods, Old Methods”.

that come to be incorporated in the Con-Text of the Revelation. Thus, these meanings can and should be considered Islamic in the fullest sense of the term. In this frame, natural sciences occupy a special place. Ahmed himself draws on the work of previous scholars about the intellectual history of natural sciences in Islam to fold this topic in his broader argument. The overall picture that he details shows that natural sciences in premodern and early modern Islam are linked with several other Islamic meaning-making projects, such as fine arts or poetry; moreover, they were intended as a “rational project of knowing the rational Pre-Text of the Revelation”. In light of this, he continues, Aristotle is surely Islamic as a philosopher whose thought is well incorporated into the Con-Text of the Revelation and geared towards the knowledge of its Pre-Text, although perhaps under the Arabic name of Ariṣṭū.

Ahmed finely conceptualises the process more currently called Islamisation or, sometimes, ‘Islamicisation’. It is a theory that works very well for the incorporation of pre-Islamic philosophers and scientist. When we apply it to Ṭābit’s thought, and to the *Treatise on Why Seawater was Made Salty*, there are some further considerations to be made.

First, Ṭābit discusses the purpose of natural sciences explicitly. In his view, the study of the created world leads to the rewarding, albeit never fully attainable, comprehension of (snippets of) divine wisdom. This is a description in premodern terms of a rational project of knowing the rational Pre-Text of divine Revelation. Perhaps conveniently and surely for basic intellectual politeness, Ṭābit does not say *which* revelation. Nevertheless, he was clearly referring to something not too different from the rational Pre-Text of subsequent Islamic tradition. He was clearly aware of the fact that a large part of his audience was and would have been Muslim. It does not seem too much of a stretch to say that the knowledge project of natural sciences in Ṭābit is the same as the later Arabo-Islamic scientific tradition.

Second, we cannot make a comfortable distinction between Islamic and non-Islamic Ṭābit. We can formulate this distinction in the case of Aristotle because he was chronologically and culturally apart from his Islamic alter-ego, Ariṣṭū. On the contrary, Ṭābit worked and, at least in part, acquainted himself with natural sciences in an already Islamic social setting. His work was simultaneous with the beginning of its own incorporation in the Con-Text of the Revelation and this renders moot any attempt at a clear-cut distinction between the two.

Third, he is a foundational figure for mathematical and natural sciences. Therefore, his work has undergone a thorough process of incorporation in the Con-Text of the Revelation that lasted centuries. Since some of his works are lost and their content is known to us only in later summaries, it is impossible to differentiate between aspects of his thought that became Islamic by later incorporation and elements that already had the aforementioned hermeneutical engagement.

Lastly, and returning to Ṭābit’s awareness of his audience, we cannot say if and to what extent the fact that he was talking to an audience of Muslims, at least in substantial part, influenced his presentation of scientific theses that easily border on the theological. I am not referring here to what we may today call self-censorship, of course, but this does not exclude other forms of argument-tailoring intended to make his words more persuasive for the audience.

In conclusion, this treatise on the salinity of the sea and the lost treatise *On the Benefits of the Mountains* can be considered Islamic in the sense outlined by Shahab Ahmed, i.e. in the same way that Aristotle/Ariṣṭū can be

considered Islamic. It is less clear whether these works should be considered Islamic in the sense that they actively engage with the Con-Text and Pre-Text of the Revelation to Muhammad. If we apply the distinction between Islamic and Islamicate, as proposed by Marshall Hodgson, we may say that Tābit's work on water-related sciences was, if not Islamicate, certainly 'Islamicable' from its inception.⁸

I have so far relied on the concept of water-related sciences. The two treatises that form the core subject of this book, written by Tābit, discuss a range of topics that are primarily within the scope of modern hydrology. However, it should be noted that neither hydrology nor hydraulics had a clearly defined place in the premodern Islamic natural sciences. Today, hydrology is understood to be the branch of science that studies the movements, distributions, and qualities of water on Earth.⁹ Meanwhile, hydraulics is a branch of continuum mechanics that examines the mechanical properties of liquids, and is commonly applied to engineering problems such as pipe flows, dams, pumps, and channel behaviour. This distinction and the delimitations of knowledge that it implies are applicable to the premodern Arabo-Islamic scientific tradition only to a limited extent.

The discipline of hydraulics, or at least applied hydraulics, has its closest analogue in the Islamic concept of *handasat al-mā'*, which is commonly translated as 'irrigation', 'water engineering', or 'hydraulics'. However, it is worth noting that in the early centuries of the caliphate, the term *handasa* was typically used exclusively to refer to *handasat al-mā'*. For instance, the founding of new cities often involved significant planning and the participation of engineers, in Arabic *muhandisūn*. These individuals were responsible for developing the water supply infrastructure for the city, while the construction of residential areas was left to the inhabitants.¹⁰

Furthermore, throughout the vast irrigated regions of the Mesopotamian caliph provinces, engineers would primarily focus on irrigation infrastructure. This was also the career of Muḥammad b. al-Ḥasan al-Karaḡī, whose treatise on hidden waters constitutes the only known work on the subject. Despite the limited availability of technical primary sources, the topic of water-related sciences has received a considerable amount of scholarly attention. The rich archaeological evidence for premodern Islamic water supply infrastructure compensates for the lack of technical information that has been preserved. In fact, *handasat al-mā'* is likely the first thing that comes to mind to many people when thinking about water and premodern Islam.¹¹

Knowledge about water extended far beyond the field of *handasa*, though. For instance, *fiqh* (jurisprudence) intervenes wherever water is subject to

⁸ According to Marshall G.S. Hodgson, the concept of the 'Islamicate' serves as an alternative to the commonly used term 'Islamic', in order to address the ambiguity present in the usage of the word 'Islam' within scholarship. While acknowledging the interconnectedness of religious faith and the various aspects of daily life, Hodgson argues that "the society and culture called Islamic in the second sense are not necessarily Islamic in the first". The term 'Islamicate' is intended to encompass all aspects that are influenced by Islam, but are not necessarily directly related to religious faith. This includes behaviours and ideas that may be present among non-Muslims, but are still clearly linked to Islam. Hodgson, *The Venture of Islam*, 1: 57.

⁹ Hydrology covers also other water on planets other than Earth, of course, but this does not concern us here.

¹⁰ Kennedy, "How to Found an Islamic City".

¹¹ See, for instance, the abundant space devoted to water-related engineering in Hill, *A History of Engineering*.

human use. As a hermeneutic project set to understand its various subjects in meaningful relation with the Con-Text, Text, and Pre-Text of the Revelation, *fiqh*, that is Islamic shariatic jurisprudence, deals with the water of canals, rivers, marshes and seas.

Saints and Sufis also had a keen interest in water. For example, North African Sufis were called upon to perform rituals to combat drought, which is obviously a hydrological challenge. Their work, which is recorded in bibliographical literature, has been considered as a potential source to compensate for the lack of climatological data from the ‘archives of nature’ about premodern Maghrib. It is scarcely relevant that the knowledge expressed by jurists or Sufis does not fall under the categories of either hydraulics or hydrology. Sufi rituals against drought described in biographical literature were an Islamic practice of water-management and part of Islamic water-related knowledge.

Most of the notions we understand today as hydrology were comprised in the general field of natural sciences, *‘ulūm ṭabī‘iyya* in Arabic. As such, they are most commonly found in scientific-philosophical works. Knowledge about the origins of sweet water, the role of precipitation, the salinity of the sea and similar subjects appear, for instance, in the *‘Ulwiyyāt* by Ibn Sīnā (370-428/980-1037), but also in al-Tawḥīdī’s (d. 414/1023) collection of the philosophical answers which he received from Miskawayh on several diverse topics. Nevertheless, even works that are not programmatically devoted to philosophy or natural sciences may devote some space to water-related knowledge. This is the case of al-Bīrūnī’s digression on water in the astronomical-chronological treatise titled *Kitāb al-āṭār al-bāqīya* (usually translated as *The Remaining Signs of the Past Centuries* or *Chronology of the Ancient Nations*). Even a treatise on *qanāt* construction, al-Karaḡī’s *Kitāb inbāṭ al-miyāh al-ḥāfiyya* (On the Discovery of Hidden Waters), is introduced by a lengthy discussion of theoretical hydrological notions.¹² The *Kitāb Inbāṭ* is a highly technical treatise composed by a successful engineer who had earned his living by practicing his craft. In other words, al-Karaḡī was someone who would have been included in what al-Tawḥīdī (d. 414/1023) wrote about engineers:

The engineers, when they use their knowledge as a craft become like the canal diggers, or like those who dig streams in a valley, like those who build public baths.¹³

Notwithstanding al-Tawḥīdī’s disdain for applied science or the practical use of knowledge of any kind, al-Karaḡī’s theoretical introduction shows that knowledge about water formed a continuum of interrelated meanings and applications. We can surely treat this continuum separately as hydrology or hydraulics for convenience’s sake, but without forgetting that it is not a classification and delimitation shared by our authors or by engineers.

Ṭābit contributions to the development of Islamic knowledge about water are fundamental, first of all for chronological reasons. Ṭābit worked in a formative early period, when some of the earliest activities of knowledge production and Islamicisation took place. Moreover, thanks to the

¹² The *qanāt* is a traditional technology for harnessing groundwater in areas characterised by uneven terrain and slopes. Sajjadi, *Qanat, kārīz*; Yazdī, *Ḥānikī, Qanat Knowledge*.

¹³ Abū Ḥayyān al-Tawḥīdī, *Risālatān*, 206. Cited in Beg, “Agricultural and Irrigation Labourers”, 27.

prestigious social context in which he could operate, his work holds a lasting influence on later scholars. As I argue in the following pages, the concepts expressed in the two treatises on the sea and the mountains informed a strain of thought about the place of water in the created environment that lasted centuries. This school of thought was not disconnected from the mainstream, overwhelmingly Aristotelian, view of the water cycle, and the last chapter of the book will discuss how this coexistence influenced al-Karāǧī's introduction in the *Kitāb inbāṭ al-miyyāh al-ḥafīyya*.

The relevance of Ṭābit's thought may extend also to some ongoing debates on Islamic environmental ethics. This debate is clearly too ample for this book to do it justice, but it may be useful to remark on a few key points. Scholars, both Muslim and non-Muslim, who work on Islamic environmental ethics and Islamic eco-theology usually rely first and foremost on the text of the Revelation to Muhammad. This has not always been the case. Most prominently, for instance, Seyyed Hossein Nasr, who is regarded as the initiator of scholarly reflection on the subject, was mostly interested in philosophical, scientific, and mystical thought about the environment within Islamic traditions.¹⁴ Nevertheless, in recent years, many argued that Islam may give a special contributions to the global effort against the ecological and climatic crisis through shariatic measures, which may be received as more legitimate among Muslim populations and connect the legislative effort to the cultural and spiritual dimensions of the crisis.¹⁵ Thus, Islamic environmental ethics may be flowing into Islamic ecological law, which entails that the evidence for the assumed environmental character of Islam as a religion is to be found in the most authoritative sources of Islamic jurisprudence: the text of the Revelation. On the one hand, this approach has some practical benefits in terms of environmental protection. It allows to produce actual environmental legislation that is Islamically mandated. On the other hand, it is detrimental to a broader understanding of the plurality of Islamic views on the environment, something that was crucial in Seyyed Hossein Nasr's effort, among others. This plurality is a richness very much worth investigating and it comprises sources of environmental thought beyond the text of the Revelation.

In Ṭābit we find an author of the formative age of Islamic views about nature with influential ideas. The theses on human-animal relationships and on the water cycle espoused by the Iḥwān al-Ṣafā' (fourth/tenth century), which are often mentioned as Islamic precursors to today's environmentalisms and hydrology, are in continuity with Ṭābit's world view, which could be a component of the efforts to understand and foster contemporary environmental ethics.

14 Nasr, *An Introduction to Islamic Cosmological Doctrines; The Encounter of Man and Nature*.

15 The shariatic turn is not entirely new. For instance, the S.W.A. Husaini's textbook on Islamic environmental system engineering published in 1980 opens with a discussion of Quranic environmental themes, and moves to actual engineering only after a chapter devoted to "Islamic Jurisprudence: revealed law (*shari'a*), and derived or substantive law (*fiqh*)". That being said, S. Idlallène has rightly noted that the pressure posed by the environmental crisis, the strong religious influence, and the overall weak implementation of secular environmental laws create a strong incentive toward the elaboration and adoption of measures falling under shariatic discourses on environmental protection. Moreover, as noted by A.M. Gade, the more theological and philosophical approach to Islam and the environmental question often appears to re-construct traditional Islamic concepts in ways that do not echo contemporary Muslim understanding of those concepts and vocabularies. Husaini, *Islamic Environmental Systems Engineering*; Idlallène, *Rediscovery and Revival*, 12-19; Gade, *Muslim Environmentalisms*, 37-77.

