

Irrigation in the Medieval Islamic Fayyum: Local Control in a Large-Scale Hydraulic System

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Abstract

Because of the unique set of sources available, the Fayyum in Middle Egypt offers a unique case study of large-scale irrigation from antiquity to the Islamic period. A close reading of a cadastral survey of the province from 641/1243-4 shows that the distinctive aspect of the Islamic period was the local control of water supply and management. Drawing on the engineering experience of the villagers, water allocation and management in the gravity-fed canals of the Fayyum were in the hands of *iqṭā'* holders and tribal groups along the main canals, a pattern similar to that which pertained in mediaeval al-Andalus.

Grâce à une série de sources exceptionnelles, le vaste système d'irrigation du Fayoum, en Moyenne-Égypte, peut être reconstitué depuis l'Antiquité jusqu'à l'ère islamique. L'examen approfondi d'un relevé cadastral de cette province, datant de 641/1243-4, montre que l'époque islamique se caractérise par une gestion locale de l'approvisionnement en eau. S'appuyant sur l'expérience technique des villageois, les détenteurs d'*iqṭā'*s et les groupes tribaux implantés le long des principaux canaux du Fayoum contrôlaient la répartition de l'eau et la gestion des canaux alimentés par gravitation. Ce modèle de gestion de l'eau rappelle à bien des égards les pratiques en usage au Moyen Âge en al-Andalus.

Keywords

Fayyum, Egypt, Nile, irrigation, *iqṭā'*, al-Nābulusī, al-Andalus, al-Lāhūn, tribes

Few places on earth have been as dependent on irrigation works as the region of the Fayyum, in Middle Egypt. The Fayyum lies in a large depression of

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the Libyan Desert, 25 kilometres west of the Nile, to which it is linked by a long canal known as the Baḥr Yūsuf. Because of its topography and location, agriculture in the Fayyum relied entirely on a system of embankments and canals that allowed the water of the Nile to reach the depression in sufficient quantities, but without flooding the cultivated areas. The agricultural exploitation of the Fayyum began in the Middle Kingdom, when the pharaohs of the Twelfth Dynasty transformed the Fayyum into a giant holding basin for excess water during the annual Nile floods and a reservoir of Nile water for irrigation. Under the Ptolemaic dynasty, in the fourth and third centuries BCE, the reservoir was drained, and a large-scale reclamation project tripled the area of cultivated land.

The principal elements of the Ptolemaic irrigation system were an embankment at the entrance to the depression to regulate the amount of water entering it, the construction of main and subsidiary irrigation supply canals, and the drainage of excess water into Lake Qarun, in the northern part of the depression. Once drained and put into cultivation, the Fayyum became one of the most fertile and prosperous provinces of Egypt, a position it has maintained up to the present.¹

In this millennia-long history of irrigation, the mediaeval Islamic period is generally perceived as a period in which the Ptolemaic achievements were eroded. A process of decline is seen as setting in during the third and fourth centuries CE, when many villages around the edge of the Fayyum ceased to receive adequate water supplies and were partially or wholly abandoned. More than a century of excavations of sites in the northeastern, northwestern, and southern edges of the Fayyum unearthed a series of large and rich settlements, which were, by and large, deserted by the time of the Arab conquest. The desertion of these sites, a result of the failure of the canals running along the foot of the mountains surrounding the province, is often viewed as part of a general decline. The shrinking of the cul-

¹ For recent accessible summaries of the history of the Fayyum in antiquity, see Roger S. Bagnall and Dominic W. Rathbone, *Egypt: From Alexander to the Copts: An Archaeological and Historical Guide* (London: British Museum Press, 2004): 157ff.; R. Neil Hewison, *The Fayyum: History and Guide* (Cairo: The American University of Cairo Press, 2001); Willy Clarysse, "The Fayum: A First Introduction," in *The Fayum Project* (<http://www.trismegistos.org/fayum/index.php>) [accessed 22 July 2011]. For a survey based on pollen records, see P. Mehringer et al., "A Pollen Record from Birket Qarun and the Recent History of the Fayum," *Quaternary Research* 11 (1979): 238-56.

tivable area persisted through the subsequent Islamic period, until irrigation was revived in the nineteenth century.²

As evidence for decline during the Islamic period, scholars have relied on the unique tax register of Abū ʿUthmān al-Nābulusī, an Ayyubid official who visited the province during the winter of 641/1244-5. The work has been known to scholars since the end of the nineteenth century, when it was published under the title *Tāʾrikh al-Fayyūm wa-bilādihī* (“History of the Fayyum and its Villages”).³ As noted by John Ball, in his classic study of the history of irrigation in the Fayyum, al-Nābulusī formulated his work as an attempt to revive agriculture in the Fayyum, whose affairs, he claimed, had deteriorated through negligence. One of the chapters of the work is, in fact, entitled “An account of the deterioration (*taghayyur*) of its canal and the reason for that, and of the villages that have so fallen into ruin that their reconstruction could be achieved only by [the investment of] generous sums of money over a long period of time.” Al-Nābulusī specifically reports that the central government in Cairo recorded no expenditure on the irrigation system in the Fayyum for more than a century.⁴

Not all assessments of irrigation as reflected by al-Nābulusī’s survey have been so negative. Ali Shafei Bey, the irrigation inspector of the Fayyum during the 1930s and 1940s and an amateur historian, was impressed with the achievements of mediaeval irrigation, particularly with the amount of land under extensive perennial cultivation. For him, under the Ayyubids the “Fayoum Province had an irrigation system very similar to, if not better, than present.”⁵ More recently, Sato’s work on mediaeval rural society highlights the extent of investment in irrigation under the Mamluk sultans, especially in the seventh/thirteenth and eighth/fourteenth centuries. His work uses details of irrigation works from al-Nābulusī’s survey to illustrate the complexity and dynamic nature of the management of irrigation

² This view is most clearly articulated in A. E. R. Boak, “Irrigation and Population in the Faiyum, the Garden of Egypt,” *The Geographical Review* 16/3 (1926): 353-64. This is also the view of John Ball, *Contributions to the Geography of Egypt* (Cairo [Bulaq]: Government Press, Survey and Mines Dept, 1939), 199-220; and, more recently, David H. Price, “The Evolution of Irrigation in Egypt’s Fayoum Oasis: State, Village and Conveyance Loss,” PhD diss., University of Florida, 1993.

³ Abū ʿUthmān al-Nābulusī, *Tāʾrikh al-Fayyūm wa-bilādihī*, ed. B. Moritz (Cairo: Publications de la Bibliothèque Khédiviale, 1898).

⁴ Ball, *Contributions*: 220; see also Price, “Evolution,” 185-94, al-Nābulusī, *Tāʾrikh*: 6.

⁵ Ali Shafei, “Fayoum Irrigation as Described by Nabulsi in 1245 A.D.,” *Bulletin de la Société Géographique Royal d’Égypte* 20 (1940): 283-327, at 285.

in mediaeval Egypt.⁶ Sato's conclusions are accepted by Stuart Borsch, who views the rule of the Ayyubid and early Mamluk sultans as a zenith in investment in irrigation, before a subsequent collapse brought about by the Black Death.⁷

In recent years, impetus to revisiting the history of irrigation in Islamic Fayyum and al-Nābulusī's work in particular has come from scholars of late antiquity. In trying to explain the desertion of sites on the edges of the province in the third and fourth centuries CE, these scholars prefer to see a process of adjustment rather than a failure of irrigation works. In a survey of the south-western edges of the Fayyum, Kirby and Rathbone note the great variability in the history of the sites, suggesting that the villages in the area were deserted gradually, over many centuries. Such a pattern does not fit the traditional account of a sudden catastrophic collapse of the irrigation system.⁸ Keenan goes further: he points out that all the deserted villages are found on the edges of the province, while we know little about the history of Greco-Roman settlements in the centre of the depression. Evidence from a handful of deserted villages located on the outskirts may thus not be typical of the province as a whole.⁹ Keenan, in particular, has called for a sustained study of al-Nābulusī's rich text in order to gain a fuller understanding of the development of the Fayyūm and its water regime.¹⁰

This essay aims to provide a systematic and critical account of the irrigation system of the Fayyum in the seventh/thirteenth century, as described by al-Nābulusī. Rather than taking al-Nābulusī's various statements in isolation, the aim here is to explore the totality of the rich text—the most

⁶ Tsugikata Sato, *State and Rural Society in Medieval Islam* (Leiden: Brill, 1997): 227-8.

⁷ S. Borsch, "Environment and Population: The Collapse of Large Irrigation Systems Reconsidered," *Comparative Studies in Society & History*, 46/3 (2004): 451-68; *The Black Death in Egypt and England: A Comparative Study* (Austin: University of Texas Press, 2005): 38.

⁸ C. Kirby and D. Rathbone, "Kom Talit: The Rise and Fall of a Greek Town in the Fayyum," *Egyptian Archeology* 8 (1996): 29-31.

⁹ J. Keenan "Deserted Villages: From the Ancient to the Medieval Fayyum," *Bulletin of American Studies in Papyrology* 40 (2003): 119-40; See also B. Kraemer, "The Meandering Identity of a Fayum Canal: The Henet of Moeris / Dioryx Kleonos / Bahr Wardan / Abdul Wahbi," *American Studies in Papyrology* (2010): 365-76.

¹⁰ J. Keenan, "Fayyum Agriculture at the End of the Ayyubid Era: Nabulsi's Survey," in Alan K. Bowman and Eugene Rogan (eds.), *Agriculture in Egypt from Pharaonic to Modern Times* (Oxford: Oxford University Press, 1999): 287-99; J. Keenan, "Landscape and Memory: Al-Nabulsi's Ta'rikh al-Fayyum," *Bulletin of the American Society of Papyrologists* 42 (2005): 203-12.

detailed cadastral survey to have survived for any region of the mediaeval Islamic world—in its historical context, using both qualitative and quantitative research methods. This work is based on a close reading of the treatise and on an analysis of the terminology and fiscal data provided by al-Nābulusī. It is also based on the fiscal data contained in the work, which is now publicly available on a dedicated website.¹¹ We complement al-Nābulusī's survey with a fifth/eleventh-century account of the Fayyum irrigation system, written by a certain Ja'far Abū Ishāq and preserved by al-Maqrīzī (d. 845/1442).¹² Another account of the irrigation of the Fayyum in the mediaeval period, found in the administrative manual of Ibn Mammātī (d. 606/1209), relies largely on that of Abū Ishāq.¹³ References to the Fayyum in the works of earlier Muslim scholars, such as Ibn 'Abd al-Ḥakam (d. 257/871) and al-Mas'ūdī (d. 345/956), are especially useful for their glimpses of the transition from late antiquity to the Islamic era.

This study of the irrigation of the Fayyum in the Islamic period relates to two larger questions that have dominated the study of irrigation in the mediaeval Islamic period. One question has been whether irrigation systems improved or declined under Islamic rule. Andrew Watson has viewed the transfer of irrigation technologies from Iran and India as part of the “mediaeval green revolution” brought about by the spread of Islam, and, in detailed studies of irrigation in al-Andalus, it has been shown that Muslims greatly extended the network of irrigation canals they found in place.¹⁴ Peter Christiansen, on the other hand, has chronicled the decline of large-scale irrigation in Iran, while other archaeological studies have found that Islam brought no change at all or failed to stem the late-antique collapse of irrigation infrastructure in the Near East.¹⁵

¹¹ Y. Rapoport and I. Shahar, “Rural Society in Medieval Islam,” (<http://www.history.qmul.ac.uk/ruralsocietyislam>) [accessed 22 July 2011].

¹² Al-Maqrīzī, *al-Mawā'iz wa-l-ītibār fī dhikr al-khīṭaṭ wa-l-āthār*, ed. A. F. Sayyid (London: Mu'assasat al-Furqān li-l-Turāth al-Islāmī, 2002-4), 1:669-74.

¹³ Ibn Mammātī, *Qawānīn al-dawāwīn* (Cairo: al-Jam'iyya al-Zirā'iyya al-Malikiyya, 1943): 229-32; translation in R. S. Cooper, “Ibn Mammātī's Rules for the Ministries,” PhD diss., University of California, Berkeley, 1973): 74-7.

¹⁴ T. Glick, “Hydraulic Technology in al-Andalus,” in *The Legacy of Muslim Spain*, ed. S. K. Jayyusi (Leiden: Brill, 1992): 974-86.

¹⁵ P. Christiansen, *The Decline of Iranshahr: Irrigation and Environment in the History of the Middle East 500 B.C. to A.D. 1500* (Copenhagen: Museum Tusulanum Press, 1993); M. Decker, “Plants and Progress: Rethinking the Islamic Agricultural Revolution,” *Journal of World History* 20/2 (2009): 187-206.

A second question has been the degree of centralization required to control large-scale irrigation systems. Egypt in particular has been the focus of the debate over Wittfogel's *Oriental Despotism*, in which a link has been posited between strong state structures and the demands of centralized control of the Nile annual flooding.¹⁶ In contrast, a dominant theme of the study of rural society in mediaeval al-Andalus has been the predominance of local control. Thomas Glick, building on previous studies by Barcelo, Guichard, and Bazzana, argues that, in almost all irrigation systems, except for the large-scale macro-systems, tribal organization has been particularly suitable for managing rights to water and resolving conflicts between upstream and downstream communities.¹⁷

In relation to these two questions of continuity and centralization, and in light of the unique topography of the Fayyum, this paper looks at the methods of water supply, allocation, and management in mediaeval Islamic Fayyum. It argues for a significant degree of continuity with pre-Islamic infrastructure, yet also shows that, at least up to the middle of the seventh/thirteenth century, the trend has been one of decentralization and localization of knowledge and control. With practically no irrigation bureaucracy, few direct irrigation taxes, and minimal direct interference, the management of the irrigation system appears to have been very much in the hands of local communities, which were, as in al-Andalus, organized in tribal groups. The decentralization and localization of control and knowledge may have limited the scope of large-scale irrigation projects that required heavy investment and professional engineers, but decentralization did not necessarily mean decline. Mediaeval Islamic Fayyum had a fully functioning irrigation system, one which supported a thriving economy and which continued to develop.

The al-Lāhūn Dam

The dam at al-Lāhūn is an enormous earthen dyke that can still be seen, from al-Lāhūn to the mortuary pyramid at the entrance to the Fayyum. It

¹⁶ K. Wittfogel, *Oriental Despotism: A Comparative Study of Total Power* (New Haven: Yale University, 1957).

¹⁷ T. Glick, *From Muslim Fortress to Christian Castle: Social and Cultural Change in Medieval Spain* (Manchester: Manchester University Press, 1995): 69-76; D. M. Varisco, "Sāyl and Ghayl: The Ecology of Water Allocation in Yemen," *Human Ecology* 11 (1983), 365-83 (esp. 378-9), reprinted in his *Medieval Folk Astronomy and Agriculture in Arabia and the Yemen* (London: Ashgate, 1997).

awaits an archaeological study, but its relation to the pyramid suggests it was first constructed in the Middle Kingdom to divert the Baḥr Yūsuf into the depression.¹⁸ There are several descriptions of the al-Lāhūn dam in geographical texts from the Islamic period, and they all assert that the purpose of the dam was to divert the water of the Baḥr Yūsuf into the Fayyum, while allowing high Nile floods to escape back to the Nile. Al-Mas'ūdī, the first Muslim scholar to give a technical account of the operation of the al-Lāhūn dam, reports that the biblical-Qur'anic Yūsuf (Joseph) built the barrage at al-Lāhūn in order to allow the appropriate amount of water to enter the depression. Openings within weirs (*qanāṭir*) allowed the water to go through them rather than over the dam.¹⁹ The next account of the barrage, by al-Muqaddasī (fl. 375/985), suggests that the weir mechanism has gone out of service, to be replaced by a simpler method of regulation. Al-Muqaddasī describes a simple spillway dam, in which water goes over the crest of the embankment when the Nile waters are high, which also allows boats to sail in and out of the Fayyum, albeit with difficulty. At the bottom of the barrage there were glass pipes, which served as outlets (*manāfis*). When the Fayyum has received enough water, these pipes are opened, so that the level of the water behind the barrage drops.²⁰

The most detailed technical account of the dam in the Islamic period, by Abū Iṣḥāq in 422/1031, confirms the abandonment of the weirs and sluice-gate system, which was still visible.²¹ The area in front of this section was paved, and in the embankment one can still see ten ancient stone weirs (*qanāṭir*), with sluice gates (*abwāb*). These pre-Islamic weirs at the end of the embankment formerly diverted the water to the Fayyum through an old canal, which, he says, was no longer used. Like al-Muqaddasī, he mentions glass outlets (*manāfis*) in the embankment, through which water escapes.

The level of water entering the Fayyum was controlled by two openings, which allowed excess water to cross the embankment when the Nile waters were high. Abū Iṣḥāq describes in detail a large opening, in the southern section of the embankment, which was 120 cubits wide. The two banks of

¹⁸) Bagnall and Rathbone, *Egypt*: 152; cf. an earlier view in Ball, *Contributions*, 213-22.

¹⁹) Al-Mas'ūdī, *Murūj al-dhahab wa-mā'ādin al-jawhar*, ed. Ch. Pellat (Beirut: al-Jamī'a al-Lubnāniyya, 1965-79), 2:72 [no. 784], 2:80 [nos. 797-8].

²⁰) Al-Muqaddasī, *Kitāb aḥsan al-taqāsīm fī mā' rifat al-āqālīm* (Leiden: Brill, 1906): 208.

²¹) Al-Maqrīzī, *al-Mawā'iz*, 1:670-1; see also Shafei, "Lake Moeris and Lahun Mi-wer and Ro-hun: The Great Nile Control Project Executed by the Ancient Egyptians," *Société d'Égypte Bulletin* 33 (1960): 187-215, esp. 210-3.

this opening sloped towards each other until they reached a depth of four cubits, which allowed boats to pass through it during the Nile flood. At other times of the year this opening was closed by a dyke (of grass) called *Lamsh*, which was forty cubits wide and covered the lowest part of the opening. A smaller opening, in the northern section of the embankment, was twenty cubits wide and two cubits deep. This opening is also blocked by a dyke of grass, called *Lknd*.

By al-Nābulusī's time, in the seventh/thirteenth century, the memory of the ancient pre-Islamic structure at al-Lāhūn had become blurred. He no longer mentions sluice gates or weirs, which suggests that these structures were no longer visible. He does, however, assert, on the authority of local "wise men," the existence of culverts and paving in the section of the embankment closest to al-Lāhūn; this ancient apparatus, which prevented the silting of the canal, were, by his time, obsolete.

Like Abū Iṣḥāq, al-Nābulusī describes in detail an opening in the embankment that allowed boats to sail into and out of the Fayyum during high Nile floods. This must be the same four-cubit-deep opening in the southern section of the embankment that is called *lamsh* by Abū Iṣḥāq. Al-Nābulusī says that water escapes through this opening during the Nile floods, and boats pass through it, as they do not want to risk passing over the dam itself.²²

Given that the sluice gates were no longer used, the main annual maintenance work on the al-Lāhūn dam was the annual blocking of the shipping opening in the embankment. When the Nile flood had peaked and begun to recede, it was necessary to block the opening in order to divert into the Fayyum whatever water still flowed in the Baḥr Yūsuf. Al-Nābulusī provides a lively account of this process, peppered with uncharacteristic hints of Egyptian dialect:

when the Nile recedes... the piece (*qiṭ'a*) is installed at al-Lāhūn... The "piece" is a long palm log to which straw and rags are fixed. These are tied up with ropes, so that it becomes very thick. The strong ropes are at its edge, and the ends of the ropes are in the hands of a large group of men on the bank adjacent to the small village (*ḍay'a*) called al-Lāhūn, and on the opposite bank. They release the ropes little by little, while the water carries the piece and pulls it toward the opening... releasing it little by little, until it comes to the mouth of the opening and blocks it and thereby prevents the water from escaping. Then the men pile soil and clay on it so that it resembles the bank

²²) The second, smaller opening to the north, which is called *lknd* by Abū Iṣḥāq, is not mentioned by al-Nābulusī (*Tā'rikh*: 12). He does, however, mention the term *lknd* as a name for the barrage as a whole, or a section of it (*Tā'rikh*: 101).

adjacent to the structure, so much so that a person may cross over the dam from al-Lāhūn to the bank of Qāy,²³ just as he would proceed on the same bank.²⁴

The account exemplifies clearly the way the upkeep and regulation of the al-Lāhūn dam had changed in the Islamic period. The process was simple, and based on local knowledge and materials. Moreover, although the blocking of the opening in the embankment was essential for the water supply of the Fayyum as a whole, there is no evidence of hierarchical or centralized control. No state official is mentioned, nor any order issued by the governor of the province, nor *corvée* labour; rather, al-Nābulusī simply describes “a large group of men from the villages of al-Fayyum, as well as engineers, [who] gather together.”²⁵ The local, simple, decentralized upkeep of the dam kept it functioning, and the irrigation system of the Fayyum did not collapse. Yet, the local and decentralized maintenance work on the al-Lāhūn dam corresponds with the way the dam itself has changed in the Islamic period, as the sluice gates and weirs, whose maintenance must have been labour-intensive, were abandoned. Perhaps for that reason, during the seventh/thirteenth century the Fayyum did face an increasing problem of water supply. The local and government responses to these problems provide an excellent case-study of the management of the Fayyum irrigation system.

Water Shortage and Local Investment

The key problem facing the agriculture of seventh/thirteenth-century Fayyum was a shortage of water, a shortage caused partly by the decreasing flow from the Nile, through the head of the Baḥr Yūsuf canal, 300 kilometres south of the Fayyum. In the past, says al-Nābulusī, the head of Baḥr Yūsuf had flowing water for eight months of a year and was dry for only four months. In his time, however, the situation is reversed, and water flows into it only four months in a year, and it is dry during the remaining eight months. The Fayyum still contained some water in the other eight months of the year, because seepage from underground sources (*nab'*) continued to feed the canal after the Nile inundation ended. But, without a constant flow from the Nile, water became scarce. Moreover, many waterwheels on the banks of the Baḥr Yūsuf in the upstream provinces of al-Ashmūnayn

²³ Qāy is a village located several miles southwest of al-Lāhūn.

²⁴ Al-Nābulusī, *Tā'rikh*: 12; see also Shafei, “Fayoum,” 307.

²⁵ Al-Nābulusī, *Tā'rikh*: 12.

and al-Bahnasā drew off water for irrigation, at the expense of the Fayyum. Al-Nābulusī suggests closing off these upstream waterwheels when the Nile recedes.²⁶

According to al-Nābulusī, the water shortage in the Fayyum was not a result only of diminished supply from the Nile but also of problems at the al-Lāhūn dam itself, where silting caused the shoaling of the canal. Al-Nābulusī attributes the silting of the canal to the blocking of the ancient, pre-Islamic culverts, which allowed silt to pass through. Whether this was indeed the cause of the silting is impossible to say. At any rate, he reports that soil and clay had accumulated in front of the embankment, so that the height (*irtifāʿ*) of the al-Lāhūn embankment above the bed of the canal was reduced from fifteen cubits to seven cubits or less. This meant that more water escaped back to the Nile, and less water was available for agriculture in the Fayyum.²⁷

Al-Nābulusī links the water shortage in the Fayyum to the abandonment of villages at the edges of the province, along the two major canals that branch out soon after the water enters the Fayyum.²⁸ Al-Nābulusī is describing here the culmination of a long-term process that started, as we know from excavations, by the third century CE, or even earlier. Abū Iṣḥāq, writing in the fifth/eleventh century, also notes that there are abandoned villages along the Tanabṭawiya canal and the easternmost canal, which he calls the al-Awāsī canal.²⁹ Although the immediate reason given for the desertion of the sites is lack of canal maintenance, it seems clear that these canals, which followed a course higher up along the base of the mountain, would be the first to suffer a water shortage.

Another indirect evidence of the shortage of water in the Fayyum is the relative insignificance of the reservoir, known as al-Gharaq, in the south-western corner of the depression. The purpose of this reservoir was to store excess water flowing into the depression during the inundation. In pre-Islamic times it had been an important source of water during the drier seasons, and it is referred to repeatedly in Ottoman sources as a massive body of water.³⁰ In al-Nābulusī's work, however, the references to the al-Gharaq reservoir are few. Only three minor villages in western Fayyum—Muqrān,

²⁶ Al-Nābulusī, *Tāʾriḫ*: 11-12.

²⁷ Al-Nābulusī, *Tāʾriḫ*: 15.

²⁸ *Ibid.*: 17-18.

²⁹ Al-Maqrīzī, *al-Mawāʾiz*, 1:671.

³⁰ For the Ottoman period, see A. Mikhail "An Irrigated Empire: The View from Ottoman Fayyum," *International Journal of Middle East Studies* 42: 569-90. On the al-Gharaq reser-

Diqlawa, and Masjid ʿĀʿisha—were irrigated by water from al-Gharaq, by two different outlets (one for Muqrān, and another for Diqlawa and Masjid ʿĀʿisha). The three villages irrigated from the reservoir were marginal to the Fayyum economy; their combined tax revenue amounts to less than 1 percent of the total tax revenue of the province.³¹ It seems, therefore, that the reservoir was not fully functional and that only a small part of it retained water, further suggesting a low level of water supply to the depression.³²

While al-Nābulusī blames this water shortage on lack of investment by the central government, he also leaves us a fascinating account of expensive collaborative attempts by the provincial *iqṭāʿ* (land-grant) holder and local villagers to increase the water supply to the Fayyum, attempts that were carried out without recourse to the central government. Fakhr al-Dīn ʿUthmān, majordomo to the sultan al-Malik al-Kāmil, received the entire Fayyum as an *iqṭāʿ* in 620/1223–4 CE. In the early decades of the seventh/thirteenth century, the Fayyum was usually granted in its entirety as an *iqṭāʿ* to members of the ruling family, contrary to the generally increasing fragmentation of *iqṭāʿ*s under the Ayyubids. Fakhr al-Dīn was granted unconditionally (*darbastā*) the grain revenues (*ḥawāṣil*), sugarcane, and cattle of the Fayyum. In return, Fakhr al-Dīn committed to providing 200 horsemen, unspecified cash payments, and grain to the royal granaries. The Ayyubid chronicler Makīn b. ʿAmīd, to whom we owe this information, also extols the generosity of Fakhr al-Dīn, who is said to have built madrasas and mosques, as well as schools and endowments for orphans.³³

Al-Nābulusī tells us that, once Fakhr al-Dīn became aware of the water shortage in the province that had been granted to him, “he wished to display to him [the sultan] evidence of his efforts in all that he was in charge of, and he looked for ways to bring prosperity to the Fayyum.” He then embarked on lengthy and expensive attempts to repair the water supply of the Fayyum, for which he received no support from the central government. His first attempt to deal with the water shortage was to clean up the Baḥr Yūsuf. At his orders the banks of the canal were cleared of reeds, shrubs, and trees,

voir, see also G. Garbrecht “Historical Water Storage for Irrigation in the Fayyum Depression (Egypt),” *Irrigation and Drainage Systems* 10 (1996): 47–76.

³¹ For the water sources and tax revenues of these villages, see “The Database: Village Details,” on the “Rural Society in Medieval Islam” website (Rapoport and Shahar).

³² This corrects Garbrecht’s conclusion that an important part of the dam (which survives today) was not built until after 1245 (Garbrecht, “Historical”: 65).

³³ Makīn b. al-ʿAmīd (d. 672/1273), *Tāʾrikh*, ed. Cl. Cahen, *Bulletin d’Études Orientales*, 15 (1955): 133–4; see also Sato, *State*: 181.

with the objective, it seems, of preventing loss of water to the vegetation. This, according to al-Nābulusī, “had no effect whatsoever, except for having no trees [on the banks], and the greenery of the canal went away along with the trees on its banks.”³⁴

Fakhr al-Dīn’s second attempt to fix the problem was a much more ambitious and expensive project, an alteration to the dam at al-Lāhūn. As noted above, silting in front of the embankment made the canal shallower and caused more water to escape through the dam and back to the Nile. Fakhr al-Dīn therefore decided to raise the height of the entire length of the dam by a cubit and a half (1 metre), with the aim of diverting more water to the Fayyūm. We are not told how this major construction work was executed, but it seems to have been financed out of Fakhr al-Dīn’s coffers; no *corvée* labour is mentioned.

Raising of the dam also had the unintended effect of increasing sedimentation in front of the dam and at the entrance to the Fayyūm itself. Al-Nābulusī claims that the original height of the dam, as planned by “ancient” pre-Islamic engineers, was precisely calculated to prevent the problem of silting, but the engineers of al-Nābulusī’s time were not as knowledgeable and disturbed the delicate balance. The continuous accumulation of silt kept blocking the mouth of the Grand Canal entering the Fayyūm, the vital canal that flowed through the Lāhūn gap. The only way to allow enough water to flow into the Fayyūm was for peasants from all the villages of the Fayyūm to gather before the inundation period began, for removing huge amounts of silt:

The soil and the sand were held back until they formed mounds within the al-Munhā canal [Baḥr Yūsuf].³⁵ And in the place from which the water enters to the Fayyūm, in front of its opening, a huge shoal (*dikka*) of soil was formed. This shoal becomes visible every year in the Coptic month of Bashans (or Pashons, May 9-June 7), and the water gets absorbed in it. So, men from all the villages of the Fayyūm gather there and they cut it with shovels, carrying it off with large baskets. Then, the water bypasses the shoal from its two sides, entering the canal that connects to the Fayyūm and its villages through two narrow mouths, one seven cubits wide and the other five cubits wide. Both have a depth of no more than two cubits.³⁶

³⁴ Al-Nābulusī, *Ta’rikh*: 16.

³⁵ Al-Nābulusī often refers to Baḥr Yūsuf as Baḥr al-Munhā.

³⁶ Al-Nābulusī, *Ta’rikh*: 16.

Remarkable, again, is the lack of any official directive by the state to organize this annual cleaning of the mouth of the Grand Canal. The peasants of the Fayyum apparently did this work voluntarily, in order to secure a sufficient supply of water for their fields.

Al-Nābulusī's account of the raising of the dam and its unexpected consequences is one of rudimentary engineering, which did not reach the standards of the pre-Islamic sages. This theme is even more pronounced when he describes Fakhr al-Dīn's most ambitious attempts to improve water supply, which involved cutting a new opening on the western bank of the Nile, at the head of Baḥr Yūsuf, and erecting artificial islands in the Nile itself. First, at the advice of local experts, he travelled with tools and beasts of burden to the mouth of the Baḥr Yūsuf, some 300 kilometres south of the Fayyum, where he ordered a new opening to be cut about 350 metres north of—i.e., downstream from—the old opening. But, again, this effort had unexpected effects, with some of the water that used to enter through the old opening escaping through the new opening back into the Nile, thus actually reducing the flow in the Baḥr Yūsuf. Eventually, the new opening was blocked with sand and clay, in two years.

Following this failure to increase the volume of water in Baḥr Yūsuf through a new opening, the relentless Fakhr al-Dīn tried sinking several large boats in the Nile itself, right off the head of the canal. The objective was to form an artificial island that would divert water into the opening of Baḥr Yūsuf, but, because the boats were positioned incorrectly, the water was diverted around it, and a huge island was formed at the head of the canal, with the water of the Nile flowing behind it and away from Baḥr Yūsuf. According to al-Nābulusī, this spectacular failure caused a further decrease in the amount of water available to the Fayyum, and it is only after the creation of this artificial island that the head of the Baḥr Yūsuf began to dry up for eight months of every year.

The striking feature of this scathing and almost comic account of the attempts to increase the water supply to the Fayyum is the decisive role of the local villagers and their rustic knowledge. Al-Nābulusī says that Fakhr al-Dīn's advisers were all men from the village of al-Lāhūn who had no formal training but had evidently become local experts because of their knowledge of the operation of the dam located next to their village. They are the “so-called engineers” (*al-musammūn bi-l-muhandisīn*):

A group of people known as engineers, from among the people of the village called al-Lāhūn. It [the village] lies in the vicinity of the aforementioned dam, and it is their

custom to oversee the operation of installing the “piece” that was mentioned above. For that reason they are called engineers, not for their knowledge of engineering or for their experience of it.³⁷

These villagers from al-Lāhūn are the ones who went with Fakhr al-Dīn to the head of the Baḥr Yūsuf and advised him first to divert to Nile water to a new opening, then to sink boats in the Nile in order to create an artificial island. Fakhr al-Dīn did not bring with him professional engineers from Cairo. In fact, the account gives a sense of collaboration between the *iqṭāʿ* holder and the local peasantry in order to increase the prosperity of the province.

Why did these attempts fail? Overall, the picture that emerges is one of ambitious and expensive attempts to solve the problem of water shortage in the Fayyum. While al-Nābulusī blames the problem on negligence and lack of investment and states that the central government had not spent any money on maintaining the water supply of the Fayyum for over a century, Fakhr al-Dīn ʿUthmān’s persistence demonstrates that funds for maintaining the local irrigation system actually came from the local *iqṭāʿ* holder and not from Cairo. If the Fayyum suffered a water shortage, it was not due simply to a lack of investment or commitment by the military elite.

Nonetheless, al-Nābulusī’s account suggests that the challenges facing Fakhr al-Dīn were related to the decentralized and localized nature of the irrigation system that developed in the Islamic period. First, Fakhr al-Dīn lacked cadres of professional engineers trained in the capital, who would be able to advise him technically on the grand projects he was undertaking. He relied on the local knowledge of the peasantry, which was appropriate to the upkeep of the irrigation system but not to its development. Second, as noted above, al-Nābulusī believed that part of the problem of water supply in the Fayyum was caused by water of the Baḥr Yūsuf being drawn off by upstream villages, in the provinces of al-Ashmūnayn and al-Bahnasā. A solution to this conflict of interests would have required coordinated planning from the centre, something that Fakhr al-Dīn, as a provincial *iqṭāʿ* holder, could not have achieved on his own.

Water Allocation

The other key element of all irrigation systems, besides the water supply—which was more important in the Fayyum than in other Egyptian provinces—was the management and mechanisms of water allocation to

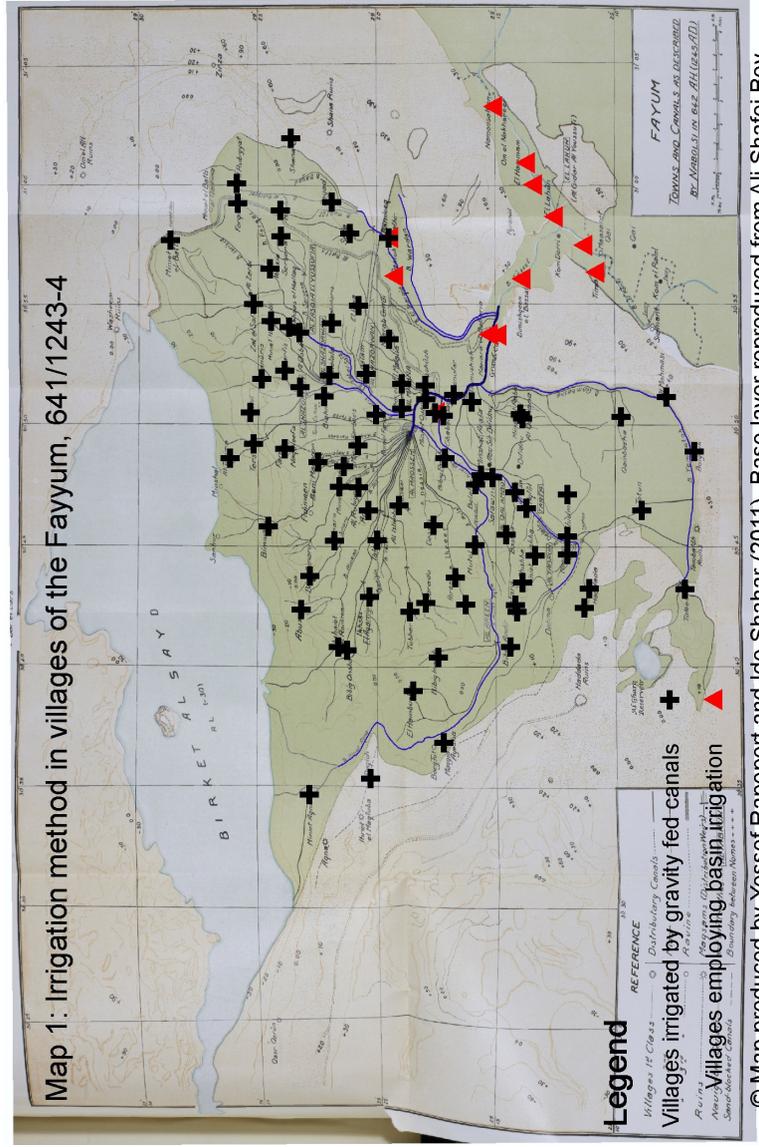
³⁷ Al-Nābulusī, *Taʾrikh*: 16.

villages. Unlike the rest of the Egyptian countryside, the Fayyum depression was irrigated by gravity-fed canals, which enabled the spread of summer crops, plantations, and orchards. But gravity-fed canals, like small rivers, cause friction between upstream and downstream communities. Analysis of al-Nābulusī's survey, however, shows that the water allocation in the Fayyum was devised in a way that ensured downstream communities were compensated for the loss of water through seepage and evaporation, known as conveyance loss. Most importantly, this system appears to have been largely self-regulated, with minimal interference from the central or provincial governments.

While almost all the villages in the Fayyum depression were irrigated by gravity-fed canals, a minority of villages in the eastern part of the province were watered only by the annual Nile flood, in the manner common to the rest of Egypt. Al-Nābulusī describes these villages as being irrigated in "the manner of the Rīf," that is, Lower Egypt. As shown in Map 1, annual-flood irrigation was used in villages that lay on the banks north and south of the al-Lāhūn dam, as well as in villages along the arm of the Baḥr Yūsuf that led water from the al-Lāhūn dam to the centre of the depression. It is also mentioned as an alternative or additional method of irrigation in two villages that were located on the eastern slopes of the depression.³⁸ The villages irrigated in the "manner of the Rīf," by the annual Nile floods that take place in the late summer and early autumn, were necessarily limited to winter crops, as al-Nābulusī repeatedly comments. Most of these were small or medium-sized villages, specializing in the cultivation of flax; most of the flax in the province was cultivated there.

As noted above, the vast majority of the villages in the Fayyum were irrigated by gravity-fed canals that branched off the Grand Canal (*al-khalij al-a'zam*), the name used at the time for the arm of the Baḥr Yūsuf that entered the depression. After the water was diverted by the Lāhūn dam towards the Fayyum, the water entered the Grand Canal and flowed from southeast to northwest, towards Madinat al-Fayyum. A dense network of

³⁸) These are Bandīq and Dumūh al-Dāthir. See also the insightful comments on these villages by Ball, *Contributions*: 220. Bandīq is said to have been irrigated in the manner of the Rīf but is also mentioned as being fed by the Wardān canal. This probably means that the Wardān canal was used as a drainage canal in this period; a similar link between drainage and irrigation by annual inundation is mentioned for the village of Dumūshiya, close to Madinat al-Fayyum. Dumūh al-Dāthir is mentioned as a small village, where some land is cultivated by the water of the Nile, as in Lower Egypt (al-Rīf) and some of it by means of waterwheels (*saqq*), as in the villages of the Fayyum.



© Map produced by Yossef Rapoport and Ido Shahar (2011). Base layer reproduced from Ali Shafai Bey, 'Fayum, towns and Canals as described by Nabolsi in 642 A.H. (1245 A.D.)', Bull. de la Soc. royal de Géographie d'Égypte XX (1940), with the permission of the British Library.

feeder canals branching out from the Grand Canal provided water for about 120 villages and hamlets in the depression.

The network of the main irrigation canals is recorded carefully in the fifth/eleventh-century account of Abū Iṣḥāq, who was interested mainly in the infrastructure of the irrigation system rather than in the village communities and their tax revenues. According to his account, most major branch canals were controlled by systems of ancient, pre-Islamic sluice gates (*bāb*), “dating from the time of Joseph,” with a capacity, i.e., width, of two to three cubits. The Tanabṭawiya canal, branching off south of the Fayyum, was said to be controlled by three sluice gates, each with a capacity of two cubits. The Dilya (or Delahe) canal was said to be controlled by two sluice gates, with a capacity of 2.25 cubits each. The next three major canals, called Tlālḥ, Bamūh (Bamūya or Bimwa) and Tndh, were also controlled by symmetrical pairs of sluice gates of 2.33, 2.5, and 2.25 cubits.³⁹

Abū Iṣḥāq notes that almost all the canals that had sluice gates were subject to a strict schedule of opening and closure and were therefore known as *al-muṭāṭīyya* (literally, “alternating”). According to this schedule, all the alternating canals were simultaneously closed and opened for periods of twenty days between November and April, before the driest season.⁴⁰ The term is already mentioned in the third/ninth-century work of Ibn ‘Abd al-Ḥakam. He reports that Joseph set up the irrigation of the Fayyum so that “that ‘alternating’ [canals] will be diverted to upper-level [canals], and vice versa, according to an hourly schedule, by night and day” (*wa-uṣayyiru muṭāṭī‘ān li-l-murtafi‘i wa-murtafi‘ān li-l-muṭāṭī‘i bi-awqāt min al-sā‘āt fi l-layl wa-l-nahār*).⁴¹ In his fourth/tenth-century account of the Fayyum, al-Mas‘ūdī also mentions that the canals of the Fayyum fell into several categories: upper-level (*murtafi‘i*), the alternating (*muṭāṭī‘i*) and

³⁹) Al-Maqrīzī, *al-Mawā‘iz*, 1:671-4.

⁴⁰) The schedule of these canals was as follows: they were closed from 10 Hatūr (20 November) until the end of that month (9 December); then open from the beginning of Kihāk (10 December) for 20 days; then closed for the 10 remaining days of Kihāk, until Epiphany (January 6), and opened on Epiphany, until the end of Ṭūbah (7 February); then they were closed from the beginning of Amshir (8 February) for 20 days; then they were opened for the 10 remaining days of Amshir (28 February), until the 20 Baramhat (29 March); then they were closed for 30 days, until they were opened 10 days before the end of Barmūda (28 April). Presumably the canals were then left open until the cycle began again in November.

⁴¹) Ibn ‘Abd al-Ḥakam, *Futūḥ Miṣr wa-l-Maghrib* (Cairo: Maktabat al-Thaqāfa al-Diniyya, 1995):14; repeated in al-Maqrīzī, *al-Mawā‘iz*, 1:665.

muṭāṭī al-muṭāṭī, which is, explains al-Masʿūdī, “a term used by the Egyptians, meaning the lower (*al-munkhafid*).”⁴² These references from the earliest Islamic geographical literature indicate that the annual schedule for opening and closure of the “alternating” low-lying canals was intended to prevent excessive flow of water during the winter months, in order to divert some of it to canals crossing higher grounds.⁴³

Al-Nābulusī’s survey is focused on the end users, the communities of cultivators and their water rights, and he never mentions the alternating schedule of canals. This is probably not the result of any dramatic change in water allocation and management. The pre-Islamic methods of ensuring that higher-level canals received sufficient irrigation water would have been as necessary in the seventh/thirteenth century as they were in the fifth/eleventh, but, because al-Nābulusī is interested mainly in the villages as units of production, he says little about the management of the irrigation system as a whole. Instead, his focus is on identifying the feeder canal that irrigates each peasant community, and the water rights (*ḥuqūq*) of the community or individuals within it.

The distinctive element of the irrigation system described by al-Nābulusī was that most villages irrigated by gravity-fed canals were accorded a water right, determined by the width of the weir at the head of the local feeder canal.⁴⁴ This water right was measured in fist-lengths (*qabḍas*), each fist-length measuring one sixth of a cubit. Often, the allocation of water was through dividers (*maqṣam*, pl. *maqāsim*), which consisted of clusters of weirs. These dividers were used when more than one canal was splitting off at the same spot, and they were found only on the Grand Canal and other major canals (the *baḥrs*). In some cases, internal divisions of water quotas within a village to certain crops or individual land owners were also specified: In the village of Dhāt al-Ṣafā, for example, five *qabḍas*, out of the 31 *qabḍas* allocated to it, were designated for newly planted sugarcane. There are several more such examples in al-Nābulusī’s work, mostly with the water being allocated to specified orchards or to the plots of village headmen.⁴⁵

⁴² Al-Masʿūdī, *Murūj*, 2:72 [no. 784].

⁴³ On the relatively little we know about this system in the pre-Islamic period, see Ball *Contributions*: 216.

⁴⁴ For more technical details about the Fayyum weirs, see D. B. Kraatz and K. Mahjan, *Small Hydraulic Structures*. FAO Irrigation and Drainage Paper 26/1. (Rome: Food and Agriculture Organization of the United Nations, 1975).

⁴⁵ See also the examples from al-Nābulusī’s survey, discussed in Sato, *State*: 222-4.

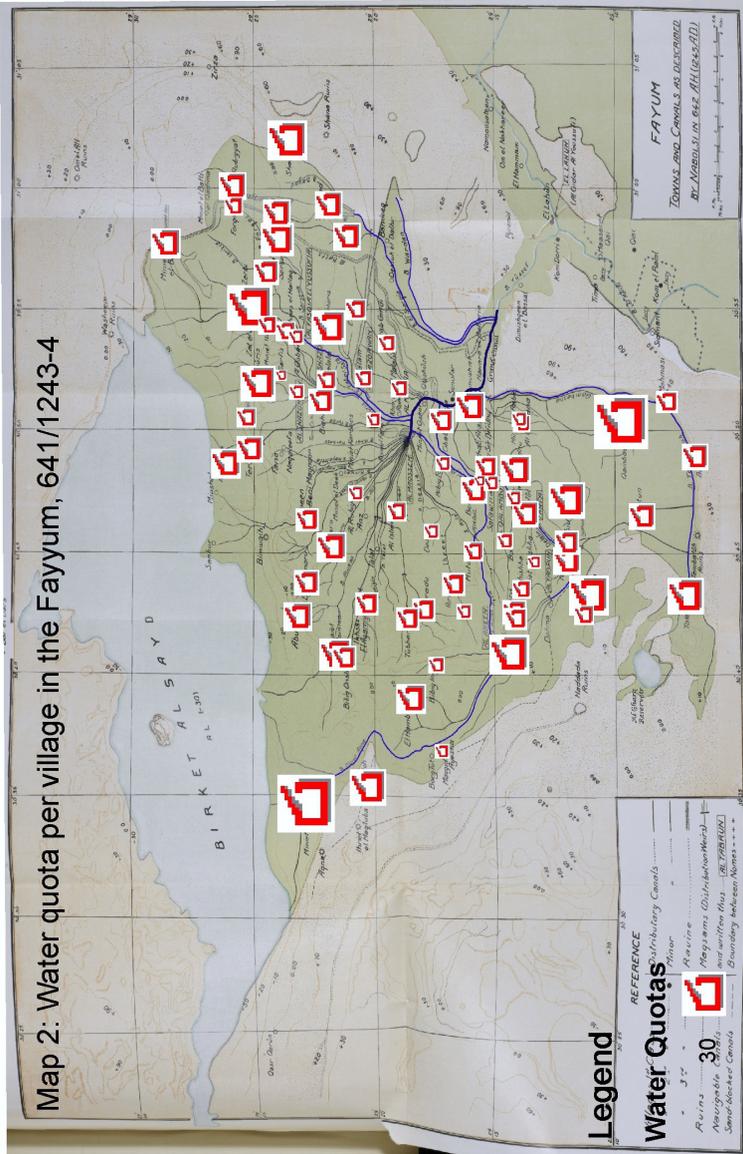
This allocation of water rights by specifying the width of the weir at the head of the local branch canal is mentioned in the third/ninth century by Ibn ‘Abd al-Ḥakam, alongside *muṭāṭī* canals. Ibn ‘Abd al-Ḥakam reports that, after setting the schedule for opening and closing *muṭāṭī* and *murtafi* canals, Joseph also decreed that “each of the villages would be apportioned fist-lengths (*qabadāt*), so that none will receive less than it has a right to (*ḥaqqihi*), nor will it receive more than what it is able (to use).”⁴⁶ The terms used in this early Islamic account are precisely the terms used by al-Nābulusī in the seventh/thirteenth century.

Allocation of water rights was necessary only where access to gravity-fed canals needed to be regulated. Those villages mentioned earlier, which were irrigated solely by the annual flood, “in the manner of the Rīf,” were not part of this network of water allocation. In addition, there was a minority of villages irrigated by gravity-fed canals that had no specified water rights. This meant that the local canal that irrigated the village had no weir at all, or that the head of the weir had no specified width. This was an indication of insufficient water flow, which was in no need of regulation. In six of these villages, al-Nābulusī uses the formula “canal without quota, due to the elevation of the land” (*bi-ghayr ‘ibra bi-ḥukm ‘uluwwi al-ard*), meaning that there was no need to regulate the flow of water into these canals, as it was limited by topography.⁴⁷

The actual water right of a village—measured by the width, in *qabḍas*, of the opening at the head of the local feeder canal—was dependent on the location of the village and its size. Map 2 clearly shows that the water quota of a village was often related to the distance of the village from the Grand Canal; the further downstream the village was along a branch canal, the larger was its water quota. The pattern is very clear in the long Minyat Aqnā canal, which fed the villages at the western end of the Fayyum. The villages closest to the centre of the province were the village known as the Dinfāras of Jaradū and Ihrīt and the village of Babīj Anqāsh. These two villages had quotas of four and 4.5 *qabḍas* respectively; the next village downstream, al-Ḥanbūshiyya, had an opening of fourteen *qabḍas*; and the large village of Minyat Aqnā, right at the western end of the cultivated area, received its water from a feeder canal with an opening of fifty *qabḍas*. A similar pattern is seen in the Dhāt al-Ṣafā’ canal, feeding villages in the

⁴⁶ Al-Maqrīzī, *al-Mawā’iz*, 1:665.

⁴⁷ These are the villages of Ṣanūfar, Ghābat Bāja, Qushūsh, Minyat Karbis, Minyat al-Dīk, Banū Majnūn, and Shalmaṣ (al-Nābulusī, *Tā’rikh*: 126, 132, 143, 146, 165).



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northeastern Fayyum, where the first village upstream had a right to an opening of six *qabḍas*, while the sixth village downstream had a right to 31 *qabḍas*. The pattern is less obvious along the two large branch canals—the Dilya and the Tanabṭawiya—that watered the southern Fayyum, where some villages close to the centre had relatively large openings in their feeder canals.⁴⁸

The system of allocation in the Fayyum is of a type well known in other Islamic societies, which Glick terms “Syrian.”⁴⁹ In this system, the total discharge of the river or spring was divided among the principal canals taking water from it, in proportion to the amount of land served by each canal. The water was assigned to the lands it irrigated and could not be alienated or sold. The fifth/eleventh-century jurist al-Māwardī refers to this model as one of several methods for dividing water rights in rivers or canals. He said that in this method the cultivators “divide the mouth of the river with a board (*khashaba*) that stretches across both banks of the river. The board is divided by gaps (*ḥufūr*) according to their water rights. In each gap water enters according to what is due its owner, whether a fifth or a tenth.”⁵⁰

While the method of water allocation is familiar, the actual distribution of water rights in the Fayyum shows uniquely that downstream communities had rights to disproportionately wide openings in their feeder canals. The reason for this was probably that the inevitability of conveyance loss through evaporation and seepage.⁵¹ As the above discussion makes clear, the width of the opening was not the only factor determining the amount of water available to each of the villages. Some villages were never allocated a set width to their feeder canal, because their lands were located on higher ground, and there was no need to restrict them. Individual topographical conditions must have been a factor in determining the width of the local weir in other villages as well. But, overall, the system of rights was intended to ensure that each of the villages along the gravity-fed canals received a fair share of water and that downstream communities were not disadvantaged.

⁴⁸ For full details of the water rights of each of the villages, see “The Database: Village Details,” in “Rural Society in Medieval Islam” website (Rapoport and Shahar).

⁴⁹ Glick, *Fortress*: 79; Price, “Evolution”: 73.

⁵⁰ Al-Māwardī, *Kitāb al-Aḥkām al-sultāniyya wa-l-wilāyat al-dīniyya*, ed. Samīr Muṣṭafā Rabāb (Beirut: al-Maktaba al-‘Aṣriyya, 2000): 202-3.

⁵¹ On conveyance loss, see Price, “Evolution,” 323-56, and the sources cited there.

Canal Management and Maintenance

The mediaeval accounts of the irrigation system of the Fayyum indicate two mechanisms that aimed at egalitarian distribution of water: the “alternating” regime of low-level canals, diverting water to canals which lay on higher grounds; and the allocation of “rights,” which ensured that downstream communities were compensated for conveyance loss. Both of these egalitarian mechanisms were known in early Islamic times, and were probably pre-Islamic. While the preceding section explains the general principles of water allocation, we have yet to identify the institutions that governed the actual functioning of the system, year by year, season by season. Who decided how many *qabdas* a village would be entitled to? Who coordinated the opening and closure of the low-lying alternating canals? What were the mechanisms for resolution of conflicts between downstream and upstream communities, which must have occurred during water shortages?

For historians of Greco-Roman, pre-Islamic Fayyum, the answer would be the state or the provincial governor. In the papyri we find a wide range of irrigation officials, corvée labour, a separate workforce of irrigators distinct from ordinary peasants, and strong central control.⁵² In the Fayyum visited by al-Nābulusī in the seventh/thirteenth century, however, the intervention of the state appears to have been minimal. There are only minimal fees associated with local irrigation maintenance, and they support simple irrigation administration and dredging tools, not a distinct class of irrigation labourers. There is no reference to corvée labour. Rather, the management of water rights in mediaeval Islamic Fayyum was subject to the authority of local *iqṭāʿ* holders, as well as tribes or clans, which negotiated water rights and coordinated labour contributions.

⁵² On the nomarchs, or provincial governors, of the land-reclamation era in the early Ptolemaic period, see Thompson, “Irrigation”: 107-22; on the *hydroparochia* (lit., “water supply”), a term that appears beginning in the fourth century CE, and professional irrigators, see D. Bonneau, *Le régime administratif de l'eau du Nil dans l'Égypte grecque, romaine et byzantine* (Leiden: Brill, 1993): 216; D. Rathbone, *Economic Rationalism and Rural Society in Third-Century A.D. Egypt: The Heroninos Archive and the Appianus Estate* (Cambridge: Cambridge University Press, 1991): 166. On corvée labour in Roman Fayyum, set at five days a year, see Price, “Evolution,” 176-8, and the sources cited there. Bonneau does, however, concede that the actual distribution of water in the Roman period was probably relegated to customary laws (D. Bonneau, “Loi et coutume en Égypte: Un exemple, les marais du Fayoum appelés drymoi,” *JESHO* 26/1 [1983]: 1-13, here 3-4).

The mediaeval authors do not say explicitly who had the ultimate political power to allocate water rights. Abū Iṣḥāq, who is not directly interested in the water allocation but only in the infrastructure, refers vaguely to local, customary laws: “They [the villages of the Fayyum] have a division (*qism*), by which every locality gets its water share (*shurb*) justly, according to their customary rules (*al-qawānīn al-mashhūra ‘indahum*).”⁵³ Al-Nābulusī, who does record the water rights of gravity-fed villages, does not explain the mechanism for the allocation of these rights. He does relate, however, one case of an *iqṭā‘* holder who decided to deny water rights to a village. In his account of the village of Bushṭā, along the Dilya canal in the southern Fayyum, he reports:

This village was formerly large and populous, but when its people became impudent (*ta‘addā*) and, in their numbers, prevailed over the *iqṭā‘* holder, he reduced their right to water and transferred it to other villages, whose people are obedient. It has now turned into a small village, with few tenants, and spacious land that lies fallow every year, because of the reallocation of the water from it to other villages.⁵⁴

This clear case of an *iqṭā‘* holder diverting water from one village to another has been seized upon as a testimony of the absolute power of the *iqṭā‘* holder over the peasant communities in the mediaeval Fayyum and the Middle East in general.⁵⁵ For our purpose, the case does show that *iqṭā‘* holders were able to intervene in the allocation of water rights, with serious consequences for the local community, but the implications of this example are limited by its circumstances. The village of Bushṭā formed part of a much larger *iqṭā‘* fiscal unit, the *iqṭā‘* of the Dilya canal, which included at least ten other villages. This was the largest *iqṭā‘* unit in the province, and it stands out against the backdrop of the vast majority of *iqṭā‘* units, composed of individual villages. This is crucial, because an *iqṭā‘* holder who deprived his village of water was also depriving himself of fiscal revenue. The *iqṭā‘* holder of the Dilya canal could afford to do that, because the water diverted from Bushṭā went on to irrigate other villages within the large *iqṭā‘* unit. But officers who held an *iqṭā‘* of just one village were not in a position to intervene in the allocation of water rights to the village—unable to reduce it, because they would lose revenue, and unable to increase

⁵³ Al-Maqrīzī, *al-Mawā‘iz*, 1:674.

⁵⁴ Al-Nābulusī, *Tā’rikh*: 65-6.

⁵⁵ Sato, *State*: 233.

it, for that would divert water from villages that belong to the *iqṭā'* units of other officers.

By and large, the *iqṭā'* system created mutual dependency between *iqṭā'* holders and peasant communities with regard to irrigation works, and it encouraged a great deal of decentralization. For Egypt as a whole, Ibn Mammātī explains that the maintenance of irrigation was divided into major dykes and local dykes. The major dykes were the responsibility of the sultan but were funded by fees (*rusūm*) from the provinces, collected by agents of the central government. The local dykes, says Ibn Mammātī, were the joint responsibility of local peasants and *iqṭā'* holders, who spent their own funds on it.⁵⁶ This general description applies to lands irrigated directly by Nile floods, but the principle of collaboration between *iqṭā'* holders and peasants on the local level would have applied in the Fayyum too.

Had the irrigation system been controlled closely by the state, we would expect to see indications of this in the tax obligations of the villages. In fact, taxes specifically designated for irrigation purposes indicate a low level of state intervention in the management of irrigation. There are three such taxes recorded by al-Nābulusī. First, about half the villages along gravity-fed canals—but not villages fed directly by the Nile floods—made small payments, in kind, to the official known as *khawli al-baḥr* (canal controller). These annual payments ranged from one-half to three ardebs (an ardeb is about ninety litres) of grain, usually wheat. The total for 47 villages was just under sixty ardebs for an entire year.⁵⁷ These fees were clearly intended to support this individual official and his household and could not have supported a significant contingent of irrigation workers.

A second irrigation tax was known as the “raking” or “dredging” fee (*rasm al-jarārif*). The *jarāfā* (pl. *jarārif*), was a simple tool, measuring roughly a metre on a side, used for the annual dredging of canals in Mamluk and Ottoman Egypt.⁵⁸ Like the payments to the *khawli al-baḥr*, the dredging fee was paid by villages along gravity-fed canals but not by villages fed directly by the Nile flood. The total paid for 62 villages was just under 4700 silver dirhems. The payment per village seems closely related to the size of the village.⁵⁹ Like the payments to the *khawli al-baḥr*, the

⁵⁶ Ibn Mammātī, *Qawānīn*, 232-3.

⁵⁷ For full details of the payments to the *khawli al-baḥr*, see “The Database: Miscellaneous Taxes,” on the “Rural Society in Medieval Islam” website (Rapoport and Shahar).

⁵⁸ Borsch, *Black Death*, 34-9.

⁵⁹ The 24 gravity-fed villages that al-Nābulusī described as “large” paid 2303.5 dirhems, just under 100 dirhems per village; the 22 “medium-size” villages paid 1069.25, about

dredging fee was directly related to the management of the gravity-fed canals and was paid locally, not to the *iqṭāʿ* holder. This tax paid for the construction and upkeep of the *jarārīf*. These taxes likewise could not have sustained a workforce.

A third irrigation-related tax, mentioned at the end of al-Nābulusī's survey, is a levy of just over a hundred dredging tools (*jarārīf*) for the construction of a dike in the district of Giza, outside of the Fayyum.⁶⁰ Al-Nābulusī lists the contribution of each village in the Fayyum, measured in the number of units (*qiṭāʿ*) of dredging tools, with many villages obliged to provide fractions. Al-Nābulusī reports that out of 104 *jarrāfa* units listed in the decree, the villages actually provided 95. Almost all villages in the Fayyum were expected to participate, and there is no distinction between gravity-fed villages and those irrigated by the Nile flood. The number of units per village is, as with the local dredging fee, closely related to the size of the village.⁶¹ The interesting feature of this levy is that the sultan expected the local communities of the Fayyum to provide the dredging tools for the work in Giza; he did not, as far as we can tell, demand corvée labour but rather a contribution in tools, which were produced locally.

In the near absence of state intervention, the institution that most likely took upon itself the management and the upkeep of the canal system was the tribal group. While the population of the villages and towns of the Fayyum consisted almost entirely of settled peasants, these settled communities were divided into sedentary inhabitants (*ḥaḍar*) and Arabs (*ʿarab*). The number of communities described as sedentary in al-Nābulusī's Fayyum was small, and they lived in only a handful of villages. The Arab tribes constituted the vast majority of the population, inhabiting more than ninety villages in the Fayyum. The Arabs were divided into three large tribal confederacies: the Banū Kilāb, the Banū ʿAjlān, and the Lawāta. The Banū Kilāb resided in the western part of the depression, the Banū ʿAjlān in the east, and the Lawāta at the Lāhūn gap and at the entrance to the depression. Each of these tribes was subdivided into several clans (see Map 3).

50 dirhems per village; and the 29 "small" villages paid 599.375 dirhems, an average of 20 dirhems. For full details of the fees, see "The Database: Miscellaneous Taxes," on the "Rural Society in Medieval Islam" website (Rapoport and Shahar).

⁶⁰ Al-Nābulusī, *Taʿrīkh*: 178-9.

⁶¹ The 25 "large" villages were expected to provide 57.3 units, the 25 "medium-size" villages 20 units, and the 35 "small" villages 11.2 units. This does not add up to 104 units, because the size of some villages is not specified by al-Nābulusī. For full details of the fees, see "The Database: Miscellaneous Taxes," on the "Rural Society in Medieval Islam" website (Rapoport and Shahar).

A comparison between the distribution of the tribal groups and the irrigation system of the Fayyum (Map 1 above) suggests a close correlation between certain tribal groups and irrigation districts. In the case of some particular branch canals, there is a definite overlap with a local clan or subdivision of a tribe. All five villages lying along the al-Sharqiyya canal, in the water-scarce area of the eastern Fayyum, were inhabited by the Banū Zar'a clan of the 'Ajlān tribe. The Banū Zar'a also occupied ten other villages in the eastern Fayyum, and their predominance in the region would have allowed water management across several smaller canals. Eight of ten villages along the Sinnūris canal were inhabited by the Qayāšira, or the Banū Qayšar, of the 'Ajlān tribe. No other villages in the Fayyum were inhabited by the Qayāšira, a case of nearly complete overlap between a branch canal and a tribal group. The pattern is also marked in the southern part of the province: of a total of sixteen villages along the Dilya canal, eight were occupied by the Banū Ghušayn of the Kilāb tribe, and five of nine villages along the Tanabṭawiya canal were inhabited by the Banū Ḥātim, who also belonged to the Kilāb.

As is evident from the comparison of the two maps, it was not only that individual irrigation canals were dominated by specific clans: Practically all villages that were irrigated by the Nile flood were inhabited by the clans, or subdivisions, of the Lawāta tribe; the Lawāta, on the other hand, did not inhabit any of the villages irrigated by gravity-fed canals. These gravity-fed villages, including villages in the eastern Fayyum that were seasonally irrigated directly by Nile floods, were divided between the 'Ajlān and the Kilāb tribes, but the 'Ajlān and the Kilāb shared no main branch-canals on the Fayyum. Thus, all the villages along the al-Sharqiyya, Dhāt al-Ṣafā', and Sinnūris canals were inhabited by the 'Ajlān; all the villages along the southern Tanabṭawiyya, Dilya, and Minyat Aqnā canals were inhabited by the Kilāb.

The overlap between tribal groups and irrigation canals is surely not coincidental. As we have seen, allocation and administration of water rights in mediaeval al-Andalus was in accordance with tribal norms. This is a feature of many irrigation systems, where a rigid social ordering of space gives rise to self-sufficient communities, displaying a political unity and an egalitarian ethic, with mechanisms for retaining exclusive control of water.⁶² Anthropological studies of peasant tribal communities in modern Iraq, Yemen, and Oman examine the ways in which tribal groups of

⁶² Glick, *Fortress*: 69-73.

settled peasants try—not always successfully—to mobilize labour and resolve conflicts between downstream and upstream communities.⁶³

In the absence of strong state institutions for the maintenance and upkeep of irrigation canals, the tribal segments in the mediaeval Fayyum would have offered a readily available alternative. At the level of the local branch canal, the dominant clan would perhaps have offered a mechanism for resolving disputes between upstream and downstream communities along the gravity-fed canals of the Fayyum, as well as a way of retaining within the group its rights to the canal waters. At the level of the province as a whole, it seems likely that the tribal confederacies of the ‘Ajlān and the Kilāb offered an institution for managing the allocation of water between the different branch canals, as between the low-lying *muṭāṭī* and the upper-level *murtafi*.

Conclusion

The irrigation system of the mediaeval Islamic Fayyum, as recorded by al-Nābulusī, was locally run and tribally controlled, in a manner much different from the centralized models often suggested for pre-modern Egypt. This was much to the chagrin of al-Nābulusī himself, who, as a state bureaucrat dispatched from Cairo, believed that irrigation solutions should come from the centre, and who considered the local Fayyumis primitive rustics. Like many other mediaeval Muslim authors, al-Nābulusī is writing within a well-established conceptual framework, which tends to contrast a legendary glorious past with a perceived corrupt present.⁶⁴ A closer reading of his account reveals, in fact, a system that was at least reasonably maintained, and perhaps even developed, during the first half of the seventh/thirteenth century. We have noted the numerous attempts by Fakhr al-Dīn ‘Uthmān to improve the water supply. New villages were established next to the ones abandoned or in the centre of the depression, on lands that became available after the contraction of Lake Qārūn. There are many other indicators of maintenance and development of the irrigation system. Newly planted orchards and sugar plantations are reported in the villages

⁶³ Varisco, “*Sayl* and *ghayl*”: 379.

⁶⁴ For a discussion of this tendency, see N. Matar, “Confronting Decline in Early Modern Arabic Thought,” *Journal of Early Modern History* 9 (2005): 51-78.

of Maṭar Ṭaris, Fanū, and Saynarū; a new canal provided water to Talīt, a village that relocated to a new site; a new sluice gate was built on the Dhāt al-Safā' canal; and a new sugar press was installed in Sanhūr and a new mill in Abū Ksā, both of which required an ample water supply.

Locally controlled and managed, the irrigation system did function. The upkeep and regulation of the pre-Islamic al-Lāhūn dam continued but was now based on local knowledge and materials, apparently without the involvement of state officials or corvée labour. Mobilization of labour for maintenance work on the dam appears to have been organized locally and voluntarily. Funds for maintaining the local irrigation system came from the local *iqṭā'* holder and not from Cairo. If the Fayyum suffered a water shortage, it was not due simply to lack of investment or to a lack of commitment by the military elite. This localization of knowledge and control was, however, not without its faults: it was probably related to the abandonment of the more labour-intensive sluice gates and weirs on the al-Lāhūn dam. The lack of central planning and coordination may well have contributed to a growing water shortage. Yet, the irrigation system of the Fayyum did not collapse—far from it.

In line with the localization of irrigation knowledge and control, the allocation of water rights in mediaeval Fayyum was remarkably egalitarian. The “alternating” regime of low-level canals and the allocation of water rights, measured by the maximum width at the head of the village feeder-canal, ensured that both higher-elevation villages and downstream communities received a fair share of the water. Both of these mechanisms are attested in the third/ninth-century work of Ibn 'Abd al-Ḥakam and may well be a pre-Islamic legacy. Al-Nābulusī's survey also strongly suggests that these mechanisms were managed locally, with little interference from the state. A single local official, the controller of the canal (*khawli al-baḥr*), received small fees in kind from villages that lay along the gravity-fed canals; the same villages also made small contributions to the construction of dredging equipment. But control of access to water was, overall, invested in the local *iqṭā'* holders, in cooperation with the omnipresent tribal groups that inhabited villages along individual canals. In the absence of centralized control, it was the clan, and above it the tribal confederacy, that seem to have negotiated water rights and coordinated labour contributions. Despite the stark differences in topography and history, al-Nābulusī's Fayyum was as tribal as the rural parts of al-Andalus, suggesting a far-reaching pattern of Islamic history that has yet to be fully explored.

Bibliography

- Bagnall, Roger S., and Dominic W. Rathbone. 2004. *Egypt: From Alexander to the Copts: An Archaeological and Historical Guide*. London: British Museum Press.
- Ball, John. 1939. *Contributions to the Geography of Egypt*. Cairo (Bulaq): Government Press, Survey and Mines Dept.
- Boak, A. E. R. 1926. Irrigation and Population in the Faiyum, the Garden of Egypt. *The Geographical Review* 16/3: 353-64.
- Bonneau, Danielle. 1983. Loi et coutume en Egypte: Un exemple, les Marais du Fayoum appeles drymoi. *JESHO* 26: 3-4.
- . 1993. *Le régime administratif de l'eau du Nil dans l'Égypte grecque, romaine et byzantine*. Leiden: Brill.
- Borsch, Stuart. 2004. Environment and Population: The Collapse of Large Irrigation Systems Reconsidered. *Comparative Studies in Society & History* 46: 451-68.
- . 2005. *The Black Death in Egypt and England. A Comparative Study*. Austin: University of Texas Press.
- Clarysse, Willy. 2011. The Fayum: A First Introduction, in *The Fayum Project* (<http://www.trismegistos.org/fayum/index.php>) [accessed 22 July 2011].
- Cooper, Richard, S. 1973. *Ibn Mammātī's Rules for the Ministries*. Ph.D. dissertation, University of California, Berkeley.
- Christiansen, Peter. 1993. *The Decline of Iranshahr: Irrigation and Environment in the History of the Middle East 500 B.C. to A.D. 1500*. Copenhagen: Museum Tusulanum Press.
- Decker, Michael. 2009. Plants and Progress: Rethinking the Islamic Agricultural Revolution. *Journal of World History* 20/2: 187-206.
- Garbrecht, Günther. 1996. Historical Water Storage for Irrigation in the Fayyum Depression (Egypt). *Irrigation and Drainage Systems* 10: 47-76.
- Glick, Thomas F. 1992. Hydraulic technology in al-Andalus. In *The Legacy of Muslim Spain*, ed. S. K. Jayyusi. Leiden: Brill: 974-86.
- . 1995. *From Muslim Fortress to Christian Castle: Social and Cultural Change in Medieval Spain*. Manchester: Manchester University Press.
- Hewison, R. Neil. *The Fayoum. History and Guide*. Cairo: The American University of Cairo Press, 2001.
- Ibn 'Abd al-Ḥakam. 1995. *Futūḥ Miṣr wa-l-Maghrib*. Cairo: Maktabat al-Thaqāfa al-Dīniyya.
- Ibn Mammātī. 1943. *Qawānīn al-dawāwīn*. Cairo: al-Jam'īyah al-Zirā'iyya al-Malikiyya.
- Keenan, James, G. 1999. Fayyum Agriculture at the End of the Ayyubid Era: Nabulsi's Survey. In Alan K. Bowman and Eugene Rogan (eds.), *Agriculture in Egypt from Pharaonic to Modern Times* (Proceedings of the British Academy 96). Oxford: Oxford University Press: 287-99.
- . 2003. Deserted Villages: From the Ancient to the Medieval Fayyum. *Bulletin of the American Society of Papyrologists* 40: 119-40.
- . 2005. Landscape and Memory: Al-Nabulsi's Ta'rikh al-Fayyum. *Bulletin of the American Society of Papyrologists* 42: 203-12.
- Kirby, C., and D. Rathbone. 1996. Kom Talit: The Rise and Fall of a Greek Town in the Fayyum. *Egyptian Archeology* 8: 29-31.

- Kraatz, D. B., and I. K. Mahjan. 1975. *Small Hydraulic Structures*. FAO Irrigation and Drainage Paper 26/1. Rome: Food and Agriculture Organization of the United Nations.
- Kraemer, Bryan. 2010. The Meandering Identity of a Fayum Canal: The Henet of Moeris / Dioryx Kleonos / Bahr Wardan / Abdul Wahbi. Proceedings of the Twenty-Fifth International Congress of Papyrology, Ann Arbor 2007, *American Studies in Papyrology*: 365-76.
- Makīn b. al-'Amīd. 1955. *Tā'rikh*, ed. Cl. Cahen. *Bulletin d'études orientales*, 15: 121-40.
- al-Maqrīzī, Aḥmad b. 'Alī. 2002-4. *al-Mawā'iz wa-l-i'tibār fī dhikr al-khiṭaṭ wa-l-ābḥār*, ed. A. F. Sayyid. London: Mu'assasat al-Furqān li-l-Turāth al-Islāmī.
- al-Mas'ūdī, 'Alī b. Ḥusayn. 1965-79. *Murūj al-dhahab wa-mā'adin al-jawhar*, ed. Ch. Pellat. 7 vols. Beirut: al-Jāmi'a al-Lubnāniyya.
- Matar, Nabil. 2005. Confronting Decline in Early Modern Arabic Thought. *Journal of Early Modern History*, 9: 51-78.
- al-Māwardī, 'Alī b. Muḥammad. 2000. *Kitāb al-Ahkām al-sulṭāniyya wa-l-wilāyat al-dīniyya*, ed. Samīr Muṣṭafā Rabāb. Beirut: al-Maktaba al-'Aṣriyya.
- Mehring, Peter J., Jr., Kenneth L. Peterson, and Fekri A. Hassan. 1979. A Pollen Record from Birket Qarun and the Recent History of the Fayum. *Quaternary Research* 11: 238-56.
- Mikhail, Alan. 2010. An Irrigated Empire: The View from Ottoman Fayyum. *International Journal of Middle East Studies* 42: 569-90.
- al-Muqaddasī, Shams al-Dīn Abū 'Abdallāh. 1906. *Kitāb aḥsan al-taqāsīm fī mā'rifat al-āqālīm*. Leiden: Brill.
- al-Nābulusī, Abū 'Uthmān. 1898. *Tā'rikh al-Fayyum wa-bilādihī*, ed. B. Moritz. Cairo: Publications de la Bibliothéque Khédiviale.
- Price, David H. 1993. *The Evolution of Irrigation in Egypt's Fayoum Oasis: State, Village and Conveyance Loss*. PhD diss., University of Florida.
- Rapoport, Yossef, and Ido Shahar. Rural Society in Medieval Islam (<http://www.history.qmul.ac.uk/ruralsocietyislam>) [accessed 22 July 2011].
- Rathbone, Dominic. 1991. *Economic Rationalism and Rural Society in Third-Century A.D. Egypt: The Heroninos Archive and the Appianus Estate*. Cambridge: The University of Cambridge Press.
- Sato, Tsugikata. 1997. *State and Rural Society in Medieval Islam*. Leiden: Brill.
- Shafei, Ali. 1940. Fayoum Irrigation as Described by Nabulsi in 1245 A.D. *Bulletin de la Société Géographique Royal d'Égypte* 20/3: 283-327.
- . 1960. Lake Moeris and Lahun Mi-wer and Ro-hun: The Great Nile Control Project Executed by the Ancient Egyptians. *Société d'Égypte Bulletin* 33:187-215.
- Varisco, Daniel, M. 1983. *Sayl and Ghayl: The Ecology of Water Allocation in Yemen*. *Human Ecology* 11: 365-83 (reprinted in his *Medieval folk astronomy and agriculture in Arabia and the Yemen*. London: Ashgate, 1997).
- Wittfogel, Karl. 1957. *Oriental Despotism: A Comparative Study of Total Power*. New Haven: Yale University Press.