

Traditional Timing of Qanat Water Shares

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Abstract

Until recently, it was thought by the authors that only the water clock together with regulation by means of small reservoirs were used for timing water shares for the qanats of Iran. However, this was not the case. This paper presents recent findings about traditional timing of water, mainly in the Central Plateau of Iran, with a focus on star use. Comparisons are made with Oman, where stars and sundials are still used in places for this purpose.

Up to the 1950s, water clocks were widely used for timing qanat water shares both by day and by night. However, in a few places, sundials were used by day and stars by night, at least at certain times of year. It appears that stars were widely used to know the time at night, while for water division they were used only on certain qanats, and mainly in winter, when short water shares were not needed.

Keeping the time was often the responsibility of only one or two people, and the few surviving people with any knowledge of this practice are now old. This oral history is, therefore, in imminent danger of disappearing completely.

Keywords

Water division, traditional irrigation, star gazing, water timing, indigenous astronomy

INTRODUCTION

There is little published information on the methods of timing water shares for the traditional gravity-fed irrigation systems in Iran, called qanats, and until recently it was thought by the authors that only the water clock or regulation by means of small reservoirs were used. However, this was not the case. This paper presents recent findings about the traditional timing of water, mainly in the Yazd area of the Central Plateau of Iran (Figure 1), with a focus on former star use. It is based on information collected in the field by the authors in the last few years, in particular by Nash in May and September 2010, and on the research of the International Center on Qanats and Hydraulic Structures (ICQHS) on traditional methods of qanat management. The field work was mostly funded by ICQHS based in Yazd, with additional grants to Nash from the Iran Society (UK) and the Seven Pillars of Wisdom Trust (UK).

An overview of the timing of water shares is given for background, followed by the findings of the 2011 field work and information collected by Khaneikhi in Khorosan. This represents practically the whole current corpus of written knowledge on star use for qanats in Iran. Although information on the use of water clocks is also given, more is known, as presented, for example, in the book “Veins of Desert” (Yazdi and Khaneiki 2010). Comparisons are made with Oman, where stars and sundials are still used for timing water shares (Nash 2011).

TIMING OF WATER SHARES

Where rainfall is sufficient for high qanat flows, there is no need to ration the water, as is the case in the hills near Yazd in winter. At other times and places, the water is rationed. Until the 1970s, water clocks were widely used for this purpose. The water clock (clepsydra) is called “tasht” and comprises two bowls, a larger one containing water, and a smaller, called “sabu” with a hole in the

bottom (Figure 2). The sabu is placed on the water and fills and sinks in a set time, depending on the size of the sabu and the hole. The time that it takes for the sabu to sink is also called a sabu.



Figure 1- Location map



Figure 2 - Traditional water clock (clepsydra) from Taft region, Yazd

In some places, sundials were used by day and stars by night, at least at certain times of year. The use of the sundial for timing is based on the movement of the shadow of the sun. The time between the rise of different stars is the same night after night, and hence they can also be used for telling the time.

Keeping the time was often the responsibility of one or two people, sometimes the mirab¹, sometimes the dashtban¹, unlike Oman where it is common for each farmer to keep their own time. Hence in Iran, the traditional knowledge of timing methods was held by only a few people, few of whom now survive, and this oral history is even more endangered than in Oman. In Iran water management systems were run by a special hierarchy at the top of which there was mirab. A mirab hired some people to help him at the lower levels. The second person is taqdar which immediately comes after mirab. Each 24 hour day is divided into two 12 hour unit named taq which was managed by a taqdar. A taqdar was responsible for recording water shares and transactions and reporting to mirab. Kayyals worked for taqdars by operating the water clock and watching everybody's shares and reporting to taqdar. At the next level, jooban was in charge of checking the canals and ditches network to prevent water from wasting or being stolen, and then dashtban oversaw delivering water to each farming unit.

PLANNING OF THE 2011 FIELD WORK

In 2007, Khaneiki understood that stars had once been used in the area of South Khorosan, and knowing about Nash's research on star use in Oman, invited her to investigate further. However, it took a few years to find funding for the project, by which time a paper on star use in Torkabad, some 50 km from Yazd, had come to light (Sanati, date unknown). It was therefore decided to start in the area of Yazd, which would be easier than South Khorosan to access and organise from the ICQHS.

Khaneiki and Yazdi contacted a number of academics with an interest in the history of qanat systems and found from Dr Safinajad at Tehran University that practically nothing has been written on the subject of star use for water division. He wrote all that he knew in *Systems of Traditional Irrigation* (Safinajad, 1989), ie that star use was practiced in Golpayegan in the area of Isfahan. He also said that an MSc thesis written in c 2005 at the University of Shahid Beheshti, Tehran, mentioned the former use of stars for this purpose in Baluchistan.

The information on Torkabad for the article by Sanati was probably collected in the 1970s or 1980s.. His list of stars for timing qanat water is given in Table 2. A similar method of timing with stars was said to have been used in nearby Ahmadedabad. Sanati wrote that people "believe" stars rise $\frac{1}{2}$ a sabu earlier each night, and it is a fact that they rise 4 minutes earlier, which would make a sabu in Torkabad close to 8 minutes.

A number of potential contacts identified by Khaneiki and Yazdi, including the informants named in Sanati's paper, had died before Nash's first field trip. It therefore appeared that the best and, perhaps, only way of collecting information was to go directly to the towns, villages and farms to try to find people with some knowledge of the subject.

Many places were visited where it was found that either stars were not used, or no one was met who had any memory of such use. These include Surmaq in Fars Province and Na'in, together with the nearby villages of Homabad Oliu, Dalat Abad and 'Aqdā, in Isfahan Province. Several of the qanats serving these settlements were too small to need a formal means of timing water; others, such as in Na'in, where there were many qanats, appear to have only used the water clock. When asked if they knew anything about stars in agriculture, several farmers and their families replied "yes", or that they knew someone knowledgeable on the subject. In many cases it turned out that their knowledge was not related to timing water shares, but to the agricultural calendar, such as stars associated with particular weather, or to knowing the time at night for different purposes.

Star lore, whether related to timing water shares or not, is part of the same rich but fast dying oral heritage, and any sayings were, therefore, recorded as part of this project. Also, it is possible that the stars referred to in such lore and stars used for timing water shares were closely connected, and one may shed light on the other.

¹ The accepted form is given, but *mirab* is more often pronounced *mirob* and *dashtban* as *dashtebon*, and similarly for many words.

2011 INTERVIEWS

Deh Bala

Deh Bala is a scattered settlement in the hills west of Yazd, popular as a retreat from the city during the hot summer. A few of the older farmers were able to give some information on former star use. Certain stars indicated the season to gather hay, wood and thorn bushes (for fuel), and to find the time of prayer at night. One star is named: Parvis (a single star) and another Gaz (three stars), both visible in the sky at the same time and 2 metres apart. It is said that when Parvis is small, the year will be good for rain; when large it will be dry, implying that the star is variable.

In the summer months, water is rationed and timed, formerly using the water clock. It appears that stars were not used for timing water shares, although the sun may have been, by looking at shadows on the mountains.

Ahmadebad, near Ardakan

Several former mirabs were interviewed together in May 2010. Most of the information was given by Mohammed Hassan (86 years old) and Mahmud Habibi (79 years old) (Figure 3), but all of them discussed and agreed the names and order of stars used. They stopped using stars for timing qanat water 50 to 60 years ago (ie c. 1950 - 1960) with the advent of modern clocks. At this time the qanats started to dry up. The youngest, Mahmud Habibi, when a child of about 16 years, helped Abu Ghasim, a former mirab, from dusk to dawn, waiting for shareholders to come to know the time for their water, and so learned the system of timing with stars, and was able to provide the most reliable information. Only a few farmers knew the stars – most depended on the mirab. Each qanat had a mirab, each looking at the stars from a different location, but they all used the same stars. By day they used a wall as sundial, but when the sky was cloudy, the water clock was used.

The star list, and time between the stars is given in Table 1. The time between stars was given either as the number of *sabus*, ie bowls, meaning the time for a bowl of water to fill, related to the water clock, or in hours and minutes. Each bowl was said to be equivalent to 7½ minutes.



Figure 3- Interviews in Ahmadebad, Mohammed Hassan (left), Mahmud Habibi (right), Ardakan, 18 May 2010

Table 1- Stars used for timing qanat water in Ahmadebad

Star name	Meaning	Time to next star	Number of stars	Description
Daste Parvis	hand of Parvis	2 bowls	1	
Parvis		7 bowls	5	close together
Dombale Parvis	tail of Parvis	7 bowls	1	bright
Sar gaz	head of Gaz	2 bowls	top of cluster	cluster of 4-5 stars rise in the east over Herisht Mountain
Gaz	the scales (for measuring length)	10 bowls	bottom of cluster	
Dombale Gaz	tail of Gaz	30 minutes	1	white, bright
Dobaradarun	two brothers	1 hr	2	5 minutes difference in time of rise
Madashir	Mohammed the lion	1 hr		
Suhayl		1 hr		
Tana Hamal		30 mins		
Dombale Hamal	tail of Hamal	1 hr		
Setare Rushan	bright star	1 hr to dawn		

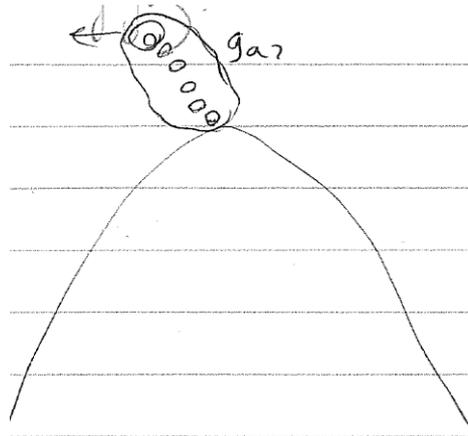


Figure 4- Sketch of Gaz rising above Herisht Mountain

They used stars by night and a sundial by day from 15 Mehr (September) to 15 Favadin (April), while for summer nights the water clock was used. Gaz is in part known through where it rises above Herisht Mountain in the east, and Khaneiki followed their instructions to draw a sketch of Gaz (Figure 4); the first star to rise is the head of Gaz (Sargaz).

Mahmud Habibi would be able to point out the stars in winter: even if some were visible now (May 2010), he would find it hard to recognise them. Unfortunately he was not available during Nash's November visit, and so the stars he and his friends described have not yet been properly identified. Mohammed Hassan related a saying that at the rise of a star you can feel a breeze on your face for a moment,– so you do not even need to see the star to know it has risen. There is also a saying that when all is frozen, Suhayl has struck (risen), and their babies may urinate blood. This star is said to rise in the east but to set a bit off west, which does not fit with the usual (literary) identification of Suhayl as Canopus (α Carinae), which rises SSE.

In Persian literature Suhayl does not have a good connotation. Khaqani (born 1121/1122, died 1190) wrote a poem saying that

گر مرا دشمن شدند این قوم معذورند از آنک
من سهیلم کامدم بر موت اولاد الزنا

"Don't blame these people if they are hostile to me
Because I have appeared to them like Suhayl, which kills bastards"
We think that this belief can be traced to Arab culture, since the same concept is found in the poetry of the Arab poet Motenabbi Ahmed ibn Hussein (born AD 883, died AD 934):

و تنکر موتهم و انا سهیل
طلعت بموت اولاد الزناء

Al-Ma'arri (born AD 973, died AD 1058), describing this poem points out an ancient Arab belief according to which if someone uses an animal for reproduction and breeding without getting permission from its owner, the animal would drop its foetus as soon as Suhayl rises.

Torkabad, near Ardakan

In Torkabad, Beman Ali Ismail, 70 years old (Figure 5), a teacher, remembered some information on the stars, learned from his father, who was not a mirab. He thinks that the stars were used all year round, and that 1 sabu was 7½ minutes. The details he remembered are as follows:

- Parvin: a star cluster rising some 3 hours before Gaz
- Gaz: one star; then 30 minutes to
- Dast Gaz: 2 stars, one to the left and one to the right; then 1½ to 2 hours to
- Dumbale Gaz, which is one very bright star, the brightest in the sky, brighter than Gaz.

People tanning leather believed that to take the skin to the desert when Suhayl was rising made the leather stronger.

Beman Ali said that an 80-year old man living in Torkabad knew more about the stars, but at that time he was in Mashad, and by Nash's second visit he had died. Once Beman Ali had described all he could remember, he was shown the list of stars from Sanati's paper. The stars listed seemed familiar to him, and he described some in more detail (Table 2).



Figure 5 Beman Ali Ismail (2nd from right), Torkabad 18 May 2010

He thinks of the stars in two groups: one for water division, called “banumi”, the other group with names, but not used for a particular purpose, such as Dab Al Akbar (the Great Bear) and Dab Al Asghar (the Little Bear).

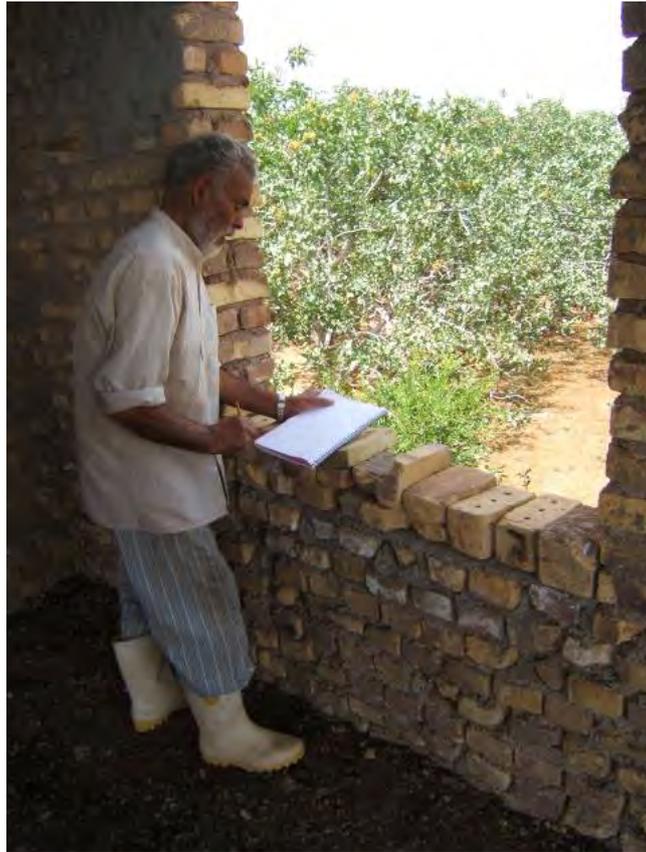
Table 2 Stars used for timing qanat water in Torkabad

Information from Sanati		Meaning of star name	Comments by Bimon Ali Ismail
Star name in order of rise	Number of bowls to next star		
Madshir	7	Mohammed the lion	
Dubaradaron	17	two brothers	Dubaradaron Tang – two stars close together
Jady	3		a single star
Sar Sa Linga	12	head of three pairs	
Sa Linga	7	three pairs	
Sar Hamal	5	head of Hamal	
Hamal	5		
Donbal Hamal	8	tail of Hamal	
Dubaradaron	11	the two brothers	Dubaradaron Farokh – two stars wide apart
Dast Parvis*	3	hand of Parvis	
Parvis	9		
Donbal Parvis	11	tail of Parvis	
Sar Gaz	3	head of Gaz	
Gaz	14		
Donbal Gaz	8	tail of Gaz	
Dubaradaron	17	two brothers	Dubaradaron Farokh – two stars wide apart
Suhayl			rises in the south
* although often written with a “z” at the end, Parvis is a common spelling and more usual pronunciation.			

Ardakan

In Aradakan, information was provided in May 2010t by Mohammed Mahmudian Ardarkan, the family of Hassan Tolli and a shepherd, Mohammed Shaaki. On the second visit, the main interviewees were two farmers: Qasima Hatifi and Sayyid Reza Mirqani.

Mohammed Mahmudian Ardarkani, 81 years old, was found at his farm outside Ardakan (Figure 6). He was once a “moqani”, ie someone responsible for locating, constructing and repairing qanats, and remembered the stars used for timing water shares for Qanat Maajdabo. This qanat is one of about ten still running, compared with about one hundred some 60 years ago when they stopped using stars. The sun was used in the daytime, but he is not sure how.



**Figure 6 Mohammed Mahmudian
Ardakani, 19 May 2010**

According to him, the sequence was :

 sunset
 3 hours
 rise of Dombale Daar
 3 hours
 rise of Zuhol
 3 hours
 daybreak,

and was said to have been the same all year, with stars used in both summer and winter, but in summer, Dombale Dar rose a bit before sunset. Zuhol is one bright white star, and when it rises the weather is cool. Although Zuhol is possibly Suhayl, Mohammed was not familiar with the more literary pronunciation of the name.

He drew a picture of a star cluster known to him as Dombale Dar (Figure 7), which he said had seven stars. When Nash then drew a shape in the outline of the Pleiades and asked if he knew it, he said – “this is the star”, from which it appears that his Dombale Dar is the Pleiades. However, the Pleiades cannot be seen all year round: it can only be used in winter; either stars were not used in winter on his qanat, or he simply does not remember them.

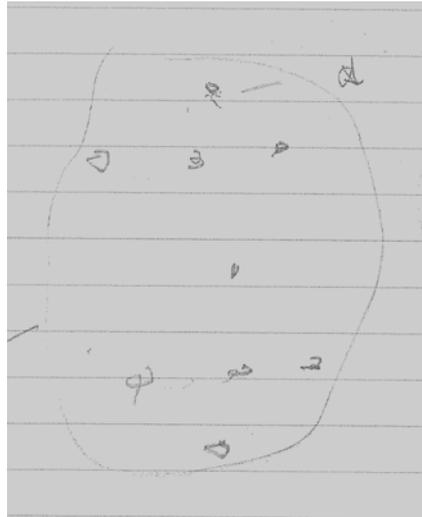


Figure 7- Dumbale Dar

Hassan Tolli, 65 years old (Figure 8), a former employee of City Hall, learned about the stars from his father, who used them to find the direction to build qanats. He had been told by his father that all qanats in the area used same stars, even though each qanat had a different mirab. Hassan also said that they had used stars for timing qanat water – the last time when he was 10 years old (ie c.1955), and that they were used all year except when it was cloudy, at which times the water clock was used. He and his family described the following stars:



Figure 7- Hassan Tolli (2nd from right) and family, Ardakan, 22 May 2010

- Qutby قطبي : usually rises at 8pm; brightest star in sky, used to find the direction
- Trazo (Figure 8), the scales – ترازو : all twelve stars rise together in the southeast at about 10 pm, and reach the middle of sky (the star's culmination) by midnight; also described as eight to ten stars looking like a hand;
- Daste Parvis (Figure 8) : three stars wide apart; the first rises in the northeast, in line with the twelfth star of Trazo (in which case, not all of the stars of Trazo rise in the same part of the sky); the first of the three rises one hour before midnight; the second rises about forty five minutes later; the third rises two hours before sunrise;
- Zohol always rises in autumn (12 Mehr = September) at 3 am. This is one bright star, which rises when the weather is cool;
- Bistochar rises three hours after sunset, and is present in all seasons but is only in the sky for thirty to forty five minutes, and is used for qanat timing.

The description of Bistochar is consistent with the behaviour of the planet Venus, but the other stars cannot be firmly identified from their descriptions.

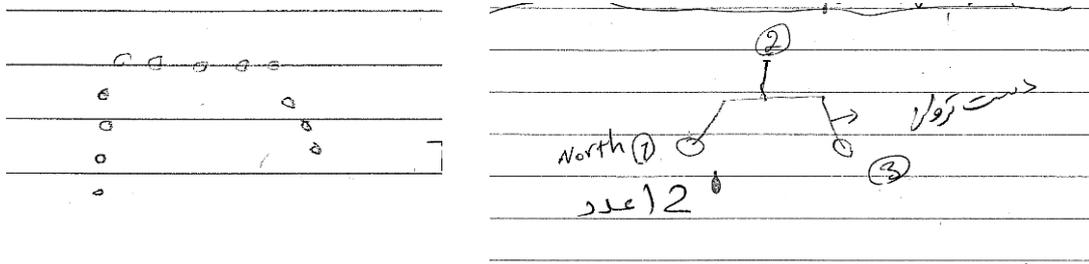


Figure 8- Trazo (left) and Daste Parvis (right)
Although the right hand sketch was described as Daste Parvis, it is written
Daste Trazo

Some of the stars known to Mohammed Shaaki, an 80-year old shepherd living on the outskirts of Ardakan are:

- Gaz (three stars); sets about thirty minutes before Capella (α Lyrae), for which he does not have a name;
- Dumbale Gaz (probably one star);
- Dast Gaz (two stars rising together a bit after Gaz);
- Mishkosh;
- Aqrab, which he described as a red star, and pointed it out in the area of Scorpius, which almost certainly makes it Antares (α Scorpii). This star rises as Gaz sets. The name is also used for the constellation of about six stars.

Two astronomers, Azam Taamehri and Behzaad Bahrami were also present at the meeting and said that Mohammed identified Dasta Gaz as Castor and Pollux (α and β Gemini), and Mishkosh as Venus. However, most of the stars that Mohammed knew had already set and their identification, apart from Aqrab, is therefore uncertain.

The most productive meeting was in November 2010 in Ardakan, when the driver used by ICQHS for the project became so frustrated with the lack of progress, and especially the death of several potential contacts, that he traced a few farmers who had used stars for timing qanat water through one of his relatives. Qasima Hatifi, an 80 year old farmer and former muqanni and Sayyid Reza Mirqani, also a farmer gave the following list of stars, all said to rise in the east. The time was mainly reckoned in sabus, each sabu lasting 7.5 minutes:

- Parvis: a cluster, like a hand; 24 sabus to Gaz;
- Dombale Parvis: rises one hour after Parvis, and one hour before Gaz;
- Gaz, described as “meyzan”, the scales, is possibly two stars rising $\frac{1}{2}$ an hour apart; the last rises 3 hours before Bash;
- Bash: one star;
- Dolingi: two stars, twenty metres apart, which rise at same time;
- Suhayl: the weather is cooler;
- Aqrab/Arkab: six stars like a scorpion; then
- Zahr Aqrab: poison of the scorpion – a red star, followed by
- Bache-ye Aqrab: the baby of the scorpion: four stars;
- Sofre-ye Mortezar Ali: this is the first and main star of a cluster of small stars;
- Haft Baradarun (the seven brothers): four in a rectangle, the others follow;
- Setare Roshani: if there is no moon they used the light from stars like this (ie planets).

These stars were used for timing qanat water, but when it was cloudy, the *tasht* (water clock) was used. Stars were used year round, with different stars at different times of year. They also demonstrated the use of the shadow of a foot for timing. The night was clear, and Qasima Hatifi

pointed out several of the stars as well as confirming some identifications using Starry Night™, computer software showing the stars. The identifications were:

- Dast Parvis: Capella (α Aurigae);
- Parvis: the Pleiades;
- Dombale Parvis: Aldebaran (α Tauri) ;
- Dast Gaz: three stars: Bellatrix, Betelgeuse and Rigel (γ , α , β Orionis);
- Gaz: Mintaka, Alnilam and Alnitak (δ , ϵ , ζ Orionis)– Orion’s belt; there are 24 sabu (bowls) from Parvis to Gaz, and 4 sabu from the first Dast Gaz (Bellatrix) to the last (Alnitak) - these times fit well with a sabu length of about 7½ minutes.
- Bash: Sirius (α Canis Majoris);
- Dolinge: two stars (not seen in the sky) rising at the same time, 1½ hours after Bash and 1 m apart. The distance between Betelgeuse and Rigel was said to be 8 m. Dolinge was identified on Starry Night as Nezen () and Adhara (), which rise approximately 1 hour after Sirius;
- Suhayl: Suhayl also was not seen in the sky; it rises about 1½ hours after Dolinge and is bright like Bash, which with the direction pointed out as further south makes it almost certainly Canopus (α Carinae).

The difference in detail between the star names and descriptions given in daytime in the town, and the stars as seen from the farm where Qasima was used to watching them is not surprising. Zahr Aghrab is clearly Antares (α Scorpii), but there are about seven hours (three to four months of coverage) between the rise of Canopus and the rise of the first stars of Scorpius. Possibly stars were not used so much in the summer months, as seems the norm, or additional stars were used that have been forgotten. Haft Baradarun is almost certainly the Plough, while Setare Roshani is probably Venus.

Several people in Ardakan mentioned the former use of sundials. Ma’suma Shoker, 60 years old (Figure 7 right), Hassan Tolli’s wife, used a wall in the yard of the house for telling the time by day. Ali Sepehri Ardakani, who has set up a museum of the history of Ardakan, provided photographs of an old sundial used for qanat water timing in the area (Figure 9), a wall oriented north-south, 1.5 m high with lines almost parallel to the wall marked by bricks.



Figure 9- Sundial for timing qanat water in the Ardakan region

Eghlid

The town of Eghlid is in Fars Province, on the south side of the Balaji and Koolar Hills, just over the border from Yazd Province. Several farmers were met in the street and at a spring. There are many qanats, but most people talked to use Bideshk/Bidesht, which is not a true qanat as it takes water from a spring. However, there was and is a need to time the water shares, particularly in the drier months.

Several people mentioned Setare Subh (literally “the morning star”). According to Nasr Ullah and Hussein Mohammed, both 78 year old farmers:

- Setare Subh is bright and rises at 4 am every day, but especially in winter, and was used for timing water shares;
- Neemdong has a trail in sky; when it sets behind the mountain it is midnight; it rises in the east after sunset and sets in the west after three hours;
- Haftbrother, meaning seven brothers, is in the north and used for the direction;
- Sehbrotter (three brothers) is three stars close together also called Gaz Trozu; it rises in the east and reaches the middle of the sky at midnight (this is the same description as by Toli in Ardakan). They rise together and point north.

From these descriptions, it is likely that Setare Subh is Venus and Haftbrother is the Plough. Gaz may be Orion's belt, but these three stars are oriented east-west rather north-south.

Namatalo Satori, a 76 year old farmer, formerly a house builder, was able to remember the stars used, and said that the water clock was used between stars:

- Setare Subh is visible from 03:30 – 04:00;
- ½ hour after sunset, a star with trail – Dumbale Dar - rises in the SW and sets 2 hrs later; this was used for timing water shares on qanat Bideshk;
- Haftbrother comprises three stars in front and four at the back, rising at the same time and reaching the middle of the sky at midnight.

His description of Haftbrother makes it clear that this is the Plough; although most people would describe it as four stars at the front and three at the back, it is possible that some accuracy was lost in translation. The description and time of rise of Dumbale Dar is similar to that of Neemdong, indicating that they could be the same star or, given the description of a tail, comet.

Mahmud Abad, near Meybod

Haj Rajab Ali 87 years old, was met in May 2010. His father was a *dashtban* and used stars to estimate midnight, one hour past midnight, and so on, every hour. He himself was a *dashtban* when he married at 20 years old. The qanat is a large one, and called after the village: Qanat Mahmud Abad. They used stars for indicating whether the year would be wet or dry, as well as for the time, but for timing qanat water shares they used the water clock. His father may have used stars for timing qanat water, but he himself did not. The mirab controlled the water clock and informed the *taqdars*; there were several *taqdars*, closer to the fields with different water bowls; checked by the mirab (by day) to see who had taken water.

The stars Rajab Ali remembered are:

- Gaz;
- Gaz Terrazu – the same as Gaz;
- Dumbale Gaz;
- Suhayl, which rises in summer at 10 pm and is the qibla (direction indicator) for south, and he pointed to the south while describing the star;
- Parvis, which rises in the east above Herisht Mountain, a cluster of 5 to 10 stars;
- Zuhra.

He recognised a sketch of the Pleiades as Parvis. Several of his friends also there said that they had forgotten the stars, but that together they would be prepared to try to identify them if we stayed out at night a few hours, provided that they has a few days' notice. Sadly, Rajab Ali died only a few days before a second visit to his house in Novembertober 2010. His son, Mohammed Ali Azar, was also a *dashtban*, and pointed out some stars. Gaz, described as mizan (weighing scales and is also known as Gaz Terrazu, "terrazu" having the same meaning as mizan. Parvis was said to rise after Gaz and further south; Sefide, meaning "bright" rises two hours before sunrise. Parvin could be one or two stars rising either north or south of Gaz; Nim Gazak, meaning half of Gaz, rises after Gaz. The night was cloudy and Mohammed's memory unclear, but firm identifications were made for Gaz (Terrazu), which is the three stars of Orion's belt and Dumbale Gaz, which is Sirius.

Cham

Cham is a Zoroastrian village on the outskirts of Yazd. People do not know of the former use of stars for timing qanat water, but are familiar with the following stars:

Setare Rush in the morning.

Gaz: three stars in a row

Parvis: a group of about four stars.

The stars were used to time travel at night, as that was preferred to travelling by day.

When the moon is full near a bright star, they believe there will be wind or rain.

It appears that qanats became widespread in Iran in Zoroastrian times, but there are now few communities remaining, and the opportunity to record their star lore and relate it to daily (or, rather, nightly) practice in the first half of the 20th Century and before has probably been lost.

Meybod

A meeting was arranged with Abul Hassan Zaare. People here used stars for the time at night, but not for qanat – for the qanat they used the water clock. He knows Setare Subh, the morning star; Gaz: three stars one rising after the other, some twenty minutes before Parvis; and a group called Parvis. Both Parvis and Gaz can be seen at midnight. Each day before sunrise, Safid/Sapid, a white star, can be seen and the light of such stars was used when it was dark at night. It appears that Safid/Sapid is the same as Setare Subh, and is probably the planet Venus. There is also a star called Zuhayl (not Suhayl, although it could well be Canopus). With Zuhayl, the weather changes – it heralds the end of summer, some fruits ripen, including pomegranate; it rises in the east, in the same place as Parvis.

ADDITIONAL INFORMATION FROM KHOROSAN

Application of the water clock for timing irrigation reduces from south to north of Khorasan Province, so that, for example, in the village of Doost Mohammad Beyk near Dargaz (north of Khorasan), the water clock was never used. In this village the smallest time unit is called a *paay* which is between 3½ and 4 hours; each 24-hour day is made up of 6.5 *paays*. In the village of Gapi in Dargaz, north of Khorasan the smallest time unit is called a *leng* which is 3 hours, and 8 *lengs* make up a day. In these villages irrigation is timed by means of a sundial and the movement of shadow, and from sunset to sunrise is considered only one share which may go to a particular farm. In Torbat Heydariyeh (south of Mashhad) stars and sundial were used for timing, together with the water clock. Water clock was used just whenever they needed smaller time units than what the stars provided, or when the cloudy sky did not allow to use sundial. For example, in the village of Zharf a day is divided into four; from sunrise to *nashta* (noon), from *nashta* to *dange sepol* (sunset), from *dange se pol* to *setare* (midnight), from *setare* to sunrise. Midnight is specified by a star, and noon is determined by a sundial. Although in the southern Khorasan the water clock was more widespread than the sundial, there were some areas where sundial was at issue. As an instance in Nehbandan water clock was used only at night, and sundial remained the main technique for timing irrigation at least whenever a clear sky was available. There were two high parallel walls east west with some specific marks on the walls and on the earth between the walls as well. It took the shadow 28.8 minutes to move from a mark to another, and this interval was even divided into shorter intervals which took 3.6 minutes each. At present, there have remained just a few villages where traditional water timing techniques are still being practiced. For example in the town of Kakhk, south of Khorasan razavi province water clock is still the main means of water timing. It seems a must for us to brush up our information about these ancient techniques before their last vestiges disappear from the landscape.

DISCUSSION

It appears that stars were widely used to know the time at night, while for water division they were used only on certain qanats, and generally not all year round but mainly in winter, when there was sufficient water and short water shares were not needed. The sundial was also used, but there is even less information about where and under what circumstances. On most qanats the water clock was used throughout the year.

Given that few people remember anything about star use, especially for qanat purposes, the degree of correlation between accounts in different places is surprising, and is taken as corroboration that

much of the information given was reliable. Venus, the morning star (Setare Rush), Orion's belt (Gaz) and the Pleiades are widely known both for general use and for qanat water. The majority of stars used for timing identified during the study rise roughly in the east and set in the west, and so are only visible for part of the year. At least one planet (Venus) is known and was used, and several statements that the same stars rise at the same time all year, can only be correct for planets or polar stars. In some cases, it appears that people do not really remember what happened in the summer months: in many places it is possible that stars were not used in the summer, which would explain the relatively short list of stars given in several places and recorded by Sanati in Torkabad. Maybe in summer when demand for water is on the rise, they prefer to use water clock which enables them to calculate smaller time subdivisions. However, the use of summer stars in Scorpio in Ardakan indicates that here and possibly in other places, stars were used all year round. Some of the stars identified in Ardakan are shown as seen in the sky in Figure 10

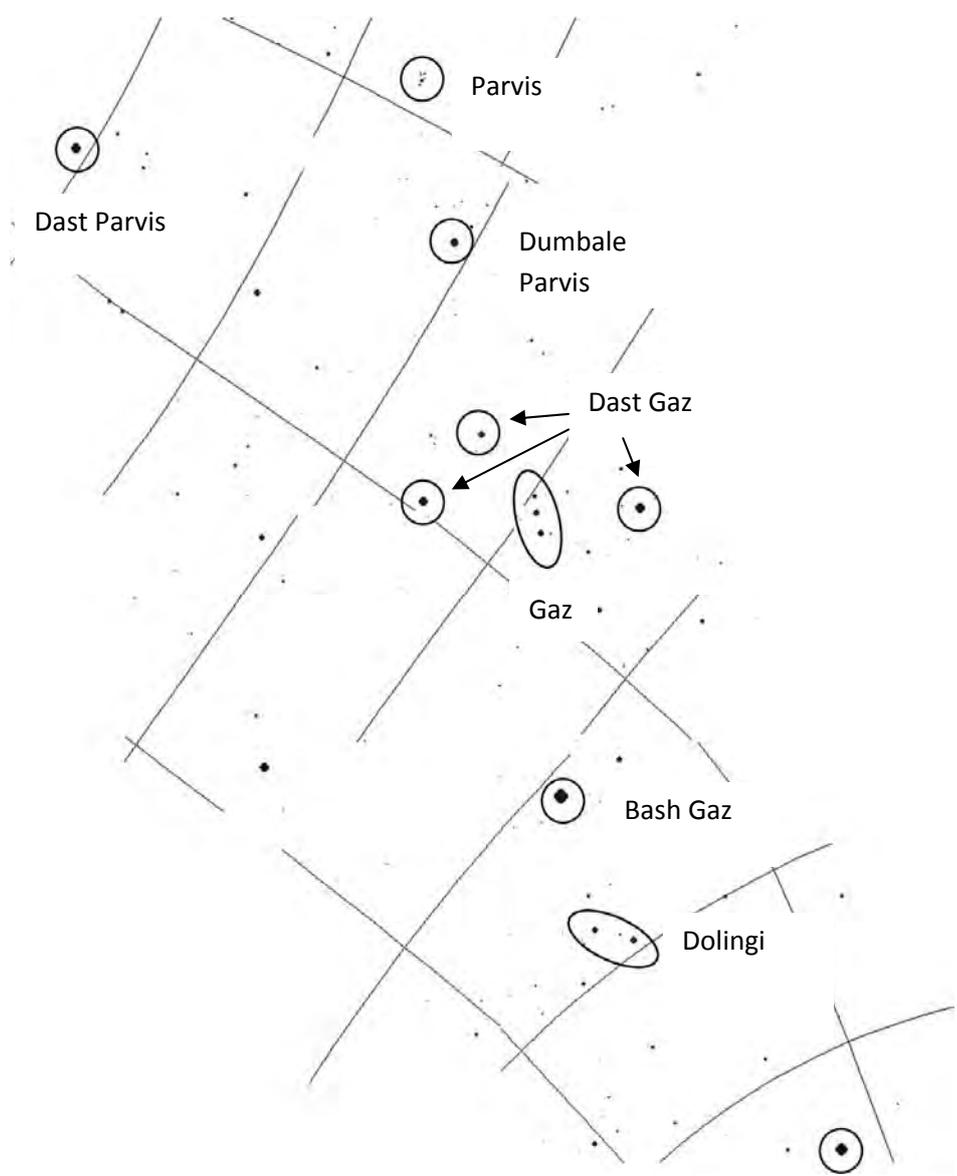


Figure 10- Some stars used for timing water shares in Ardakan

The star names, as in Oman, are not from literary astronomy, even though most of the early Islamic astronomers in the region were Persian. Astronomers and educated people know their “proper” names: Thurayya for the Pleiades, °Ayyuq al-Thurayya for Capella, for example, but the farmers do

not know these names and have never read them in books. The knowledge has been passed down orally from generation to generation. This explains the variation in pronunciation of star names such as Suhayl, and the use of different names for the same star or even the same name for different stars.

There are some striking similarities with star names and lore in Oman, indicating the possibility that such lore was widespread in the region, and demonstrating a subtle link between the qanat systems of Iran and the *aflāj* of Oman. One similarity is that Orion's belt is known both in Iran and Oman as "the (weighing) scales"; another is the saying that a particular star brings weather so cold that animals die and young children urinate blood.

The centralised, controlled nature of the qanat organisation, with officials in charge of, and keeping a close watch on farmers use of water means that relatively few farmers had a good knowledge of the timing systems used. Those few are aging, and their knowledge dies with them. The reader is, therefore encouraged to talk to farmers, not only in Iran, but in all countries which use or once used this type of irrigation system, and record their memories to add to the small kernel of information presented here.

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