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Islamic Definition of Water Ownership: A Case Study of Aflaj System in Sultanate Oman

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Abstract

The falaj systems (plural aflaj), the most ancient aqueduct in Oman, not only a technique to convey aquifer water naturally, but also hold water distribution institutional knowledge based on Muslim jurist view. Currently, several villages and towns in Oman still hold this knowledge using different water rights categories and it passes from generation to generation. Although the literature support there exist three types of aflaj in Oman (duadi, ghaili and ayni), large variation with respect to water extraction process exist. Hence, this paper investigates, through a fieldwork case study the extent such variation influences Islamic definition of irrigated water ownership. The study concluded the fact that the ongoing and operated institutional arrangements historically were initiated upon the water extraction variation among the three aflaj types, hence they innovated two common rotation systems locally known as raddat and sharib.

Keywords: Water ownership, institutional arrangements, water rights, flow rotation.

1. INTRODUCTION

While it is clearly mentioned in the Holly Quran[1] that Allah almighty created from water every living thing, availability of water is required in almost all aspect of day-to-day activities. This had led mankind over history to innovate and develop water rights and associated institutional arrangements. The main purpose for such development is to regulate and govern natural watercourse through what is known as water law/water doctrine. For example, fast body of literatures discussed the newly developed water market policies and mechanism in allocating water within two existing water doctrines: prior appropriation and riparian water in many countries (Milliman, 1965; Senzanje & van der Zaag, 2004). In addition, other researchers innovated and developed what known as water tradable rights (Rosegrant, Schleyer, & Yadav, 1995)).

However, these were faced/challenged with water physical characteristics because any attempt to define and insert private ownership such factor tends to reflect upon managerial strategy. From the early-stage Randall (1981), Milliman (1965) and young (1986) clearly conclude that the physical nature of the resources is to be blamed for the difficulty of asserting a private ownership. Given the difficulty in arriving and defining water ownership concept along with

[1] Do the disbelievers not see that the heavens and the earth were one mass, and We tore them apart? And We made from water every living thing. Will they not believe?" (Chapter 21 verse 30),

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associated water right classification, this paper main purpose is to contribute toward such matters using three main variables: 1) physical water extraction variation of the naturally flowing watercourse 2) ancient *aflaj* system operated in northern of Oman 3) Islamic water law and the customary arrangement (*urf)*. Note while the issue of water rights ownership and their associated institutional arrangements is not yet fully evaluated using empirical data, empirical knowledge with specific guidance from Omani Islamic point of view will be presented. In addition, much of ancient tradition knowledge has values which, in our view, different from those found in western literatures, where very little studies or documentation carried out. Finally, worldwide the issue of the ancient systems and associated inherited management knowledge is viewed as an important indigenous knowledge within the area of water management. For example, Trawick (2001) wrote "…. a fresh look at organization through case studies which look at the history and broad cultural environment of, and non-vertical relationships in new types of organizations which do not conform to the bureaucratic model".

2. PROBLEM BACKGROUND

As earlier mentioned, that water is considered as a necessity element in our day-to-day activities and at the same time treated, when analysed, found to be a very complex commodity to manage. Since 1960s researchers and water professionals continuously suggested and introduces regulatory measures and solutions to ease water management complexities. Jerome Milliman, properly one of the earlies water scholars in the United State, clearly emphasize in one of his studies (1965) that the problem of water resources appears to be not one of inadequate supply, but rather of rational allocation among competing users. He pointed out that it is a managerial crisis. Followed this study most of the western water researchers concentrated on two main output criteria: 1) equitably using water property rights (institutional setting) (Dietz, 2003; R. M Saleth & Dinar, 2004; R. Maria Saleth & Dinar, 2005) and 2) efficiency using water market approach (Bitran, Rivera, & Villena, 2014; Easter et al, 1999).

The first water problem, extensively carried out by western researchers, is concerned with how to implement the concept of equability and efficiency along the two existing common water laws. For example, although priority date system (or prior appropriation) (Senzanje & van der Zaag, 2004) used volumetric as basis for water allocation among users, two main problems have been identified. First, it operates against new water right holder and thus going against the principle of equity. Second, it has been found to be too rigid in a dynamic environment thus failing on the principle of efficient use (Senzanje & van der Zaag, 2004). The second water problem deal in resolving the difficulties arise in arriving at equal distribution during water scarcity. In many countries worldwide there exist large number of small, irrigated farms which located between two main extremes: tail and head. Coward (1979) and Trawick (2001) discussed such problem using case studies from Peruvian Andius, northern Philippian. For example, Trawick argued that even though all holders assigned parcel of land arranged perpendicular to the source of water and located within blocks of increased distance from the water source, does not overcome the problem of the located irrigators in the tail and head of the pattern of the parcel. However, he clearly mentioned that community dispute of water allocation between the trail parcel plots and head slightly reduced.

3. AN OVERVIEW OF THE STUDIED SYSTEM

In Oman, located within arid climatical environment, there exist unique hydro-geological rocks and oasis. This natural phenomenon resulted in a high level of water table/aquifers, accumulated over thousands of years. Within such circumstance, settlers innovated techniques to extract water supply from these aquifers. The most known technique is the ancient *aflaj* system which fall into three main types: *daudi, gaili* and *ayni*. Historically, irrigated water, in this arid region, have been collected from two main sources: the surface water and groundwater. It should not be confused by using the term 'surface' water with the concept of surface water collected from river and lakes. In this region the surface water has been collected through the accumulated rainfall over the oasis (locally refereed as *wadis*). This technique widely operated in the northern part of the country where an *aflaj* system known as *ghail* have been operated and constructed. In contrast, groundwater supply extracted water deeply from an aquifer using long tunnel and without the use of any mechanical devices (gravity natural flow). From this process, *aflaj* system known as *daudi* and *ayni* have been constructed (see Figure 1).

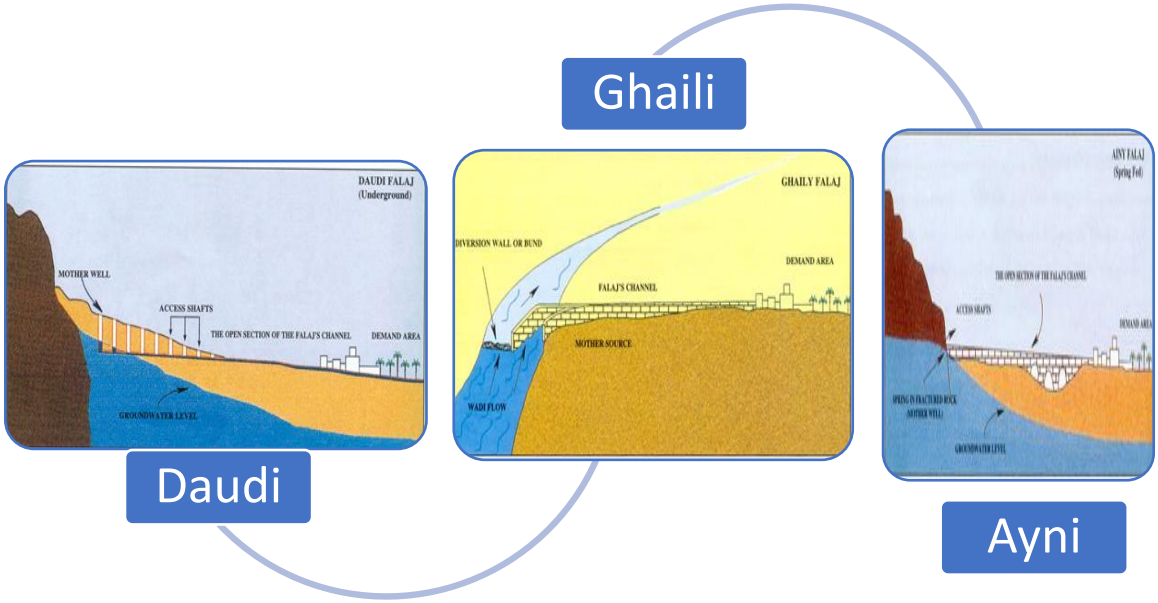

Fig. 1. Show the three *aflaj* types found in the northern part of Oman. By far, the *duadi* and the *ayni* type extract water from the upper part of the water table (aquifer) while the *ghaili* type from the surface of an oasis.

With this context, and despite the fact that in the literatures the three aflaj types differ greatly over the physical water extraction process, *ayni* and *daudi* may be viewed as falling under same category (Al-Rawas, 2000). This is attributed to the fact that both types physically extract water from upper part of the aquifer and hold single water sources (see Fig. 1). However, with respect to the maintenance and the day-to-day activities the daudi type is more complex. This complex physical layout can be explained by having a sophisticated construction layout with a long tunnel, extending deep into the aquifer's water table and with several branches. Therefore, one would expect strong institutional arrangement which capable to provide maintenance and to solve any shareholders disputes. In contrast, ayni and *ghaili* types are less complex and easier to maintain, as the *ghaili* extracts its water from the surface of an oasis and the *ayni* from a spring, both of which require short open channels to convey water to the village. The last *aflaj* census reported that there are 3017 falaj systems in Oman of which are still in operation and irrigate an area of 26,498 acres and supply annually 459 million cubic meters of water, representing 38% of the total cultivated area (MAFF, 2004; MRMWR, 2000)[2]. It is worth noting that this particular falaj system irrigated areas (sometimes referred as demand irrigated zone) encompasses all the village boundary, locally known as *amwa'al,* which means a public community owned property because traced from very ancient, settled land. Despite the fact that Wilkinson (1977) and Zekri and Al-Marshudi (2008) provided evidences of the existing water rights ownership, they concentrated over the daudi type. Therefore, the subsequent lack of this information motivated the authors to explore and document a sample among three aflaj types.

A total of twelve *aflaj* were selected for the present study (see table 3). As earlier indicated that seven *aflaj* to represent the *daudi* type, three to represent the *ghaili* type and two to represent the *ayni* type. Although this selected sample appears to represent a limited number of the aflaj population, they are representative with respect to irrigated area and water volume.These located in four main areas*: Nizwa, Smail, rustaq* and *Tawwi,* all of which situated in the northern part of the country[3]. In addition, these areas belong to three main regions: *Dakhiliya* (the interior) hold the area of *Nizwa* and *Smail*, Southern *Al-Batinah* hold the area of *Rustaq* and *Al-Sharqyah* hold the area of *Tawwi* (Figure 2).

[2] Other studies indicated that *daudi* and *ayni* irrigate 20% and 10% of the area respectively while *ghaili* only irrigate 8% of the total cropped area (Zekri and Al-Marshudi, 2008).
[3] Along the main sample of the five aflaj (which were included on the UNESCO heritage list in the year 2006 (MRMWM, 2008))

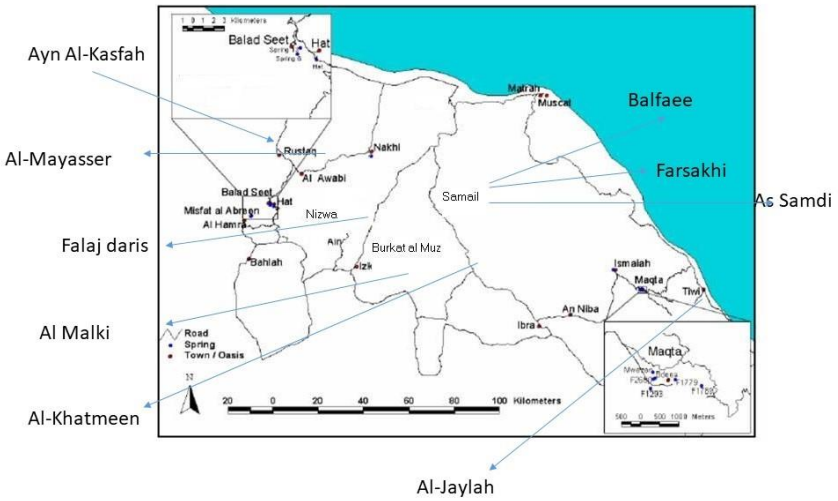

Fig. 2. The location of the selected *aflaj*

4. RESULT

Although the revealed information appeared at first sight complex (because of use of many local terms), multi-sampling framework ease the complexity and provided a thorough understanding of the existing institutional arrangements. While there are many tasks which must be accomplished to smooth and complete the overall flow circulation, three are of fundamental important.1) management of the large scattered small private right holders 2) flow circulating mechanism in accordance the local customary irrigation codes 3) the alternative and fixed flow scheduling.

Table 1. The two identified rotational systems: *raddat* and *sharib*

Falaj name /inventory number	Location/ wilayat	Falaj type	Circulation/rotation	*No. of sharib/raddat*	
				abundan flow	*during drought*
daris (F0500)	*Nizwa*	*daudi*	*raddat*	*8 raddat*	*16 raddat*
al-mayasser (F1446)	*Rustaq*	*daudi*	*raddat*	*13 raddat*	*26 raddat*
al-malki (F0606)	*Izki*	*daudi*	*raddat*	*9 raddat*	*18 raddat*
al-khatmeen (F3071)	*Burkat-al-mouz*	*daudi*	*raddat*	*9 raddat*	*9 raddat*
al hamra (F0201)	AL HAMRA	*daudi*	*raddat*	*8 raddat*	*16 raddat*
abu Tha'alab (F1406)	*Rustaq*	*daudi*	*raddat*	*11 raddat*	*22 raddat*
ayn al-kasfah (F2750)	*Rustaq*	*ayni*	*raddat*	*11 raddat*	*22 raddat*
as-samdi (F1714)	*Samail*	*ghaili*	*sharib*	*7 sharib*	*14 sharib*
al- mihaydith (F1714)	*Samail*	*daudi*	*sharib*	*7 sharib*	*14 sharib*
al-farsakhi (al-alayah)	*Samail*	*ghaili*	*sharib*	*7 sharib*	*14 sharib*
balfaee (asifalah)	*Samail*	*ghaili*	*sharib*	*7 sharib*	*14 sharib*
aL jaylah	*Sur*	*ayni*	*sharib*	*7 sharib*	*14 sharib*

Table 1 shows the overall finding of the study *aflaj* sample. In column 4 of Table 4.1 the two identified rotation systems: the first known as *raddat* (singular *raddah)* (literally mean to re-schedule or turn) the second called *sharib* (literally mean to fulfil thirst). In the upper part of column 4 shows seven *aflaj* by which operated using *raddat* institutional arrangements (58 percent). These are *falaj daris* in Nizwa, *al-mayasser* in Rustaq, *al-malki* in Izki, *al-khatmeen* in burkat-al-mouz, *al-hamra* in al-hamra, *Abu Tha'alab* in Rustaq and *ayn al-khasfah* in Rustaq. Finally, in the lower part of column 4 shows the five *aflaj* which normally operated using *sharib* institutional arrangement (42 percent). These are *as-samdi, balfahee, falsaki al-mihaydith* in *Samail, and al-Jaylah* in Sur. From this overall finding, there are several principles concerning the two identified rotation systems. The first principle is the fact that they

follow a time-share interval not volume. Historically, a particular *falaj* was designed so that all shareholders would receive water at set intervals, which is the time of the complete day (24 hours) operated by either through raddat or sharib system as follow: in case of the *sharib* identified *aflaj* follow simple 7-day of the week circulation mechanism, as shown in the lower part of column 5 of Table 1, while , the *raddat* system is more complex and each falaj rotation (turn) differ from other depending upon each *falaj* overall flow rate.

For example, data in column 5 of Table 4 show that *falaj daris* in Nizwa normally re-scheduling over eight *raddat*. This imply that this falaj capable in circulating its overall flow over eight raddat (see below). The second principle concerned with the ability to divide each circulating days into two different parts; to distinguish between daytime and night. The main purpose of this division is to form a fair distribution among shareholders as water flow scheduled alternatively between these two time-interval (day and night), that is suppose a farmer receives his/her share at night this week then the next turn shall be re-scheduled during the daytime and so on. Several of what known as custom-time codes have been innovated for such purposes. In case of the sharib system, each single turn is sub-divided into several unequal parts, while *raddat* (turn) sub-divided into two equal parts: night *baddah* and day *baddah.* Nevertheless, the survey finding clearly indicated the fact that this knowledge must be understood in accordance with each *falaj* institutional arrangements. This is highly appreciated because originality of the knowledge, in our view, based upon historical Muslim scholars within Omani community.

First, they innovated and defined day and night-time in accordance with irrigation scheduling mechanism. First, within most *raddat* identified *aflaj*, there are two commonly exchangeable concepts. The first one known as *raddah*[4] (simply means number of turns) (plural *raddat*); that is the time of the complete day (24 hours) represents a distributive *raddah* (turn). The second revealed concept known as *baddah* which provides a measuring unit of the overall flow of each falaj. In principle, each *baddah* hold 12 hours water circulation. This is normally attached with each raddat to obtain sub-divides each *raddat* into two equal parts: they say night *baddah* and day *baddah*. The third principle is concerned of how the two systems were designed to cope with problem of drought. In Oman, as an arid region, experiences periods of drought with extremely hot summer temperatures and in other years a period rainfall normally provide some sort of abundant water supply. This greatly influences the original water aquifer which supplying these *aflaj*. Hence, some years the flow in abundance and in other reduced dramatically. Since the most challenging matter in circulating aflaj flow is drought, the two systems were developed with a common principle/mechanism in dealing with such circumstances. When the overall flow of each falaj reduced dramatically, the re-scheduling cycle (either using *raddat* or *sharib*) can be easily extended say from seven days to fourteen. For example, abundant flow shown in column 5 of Table 1 expressed on time share for raddat and sharib system. In case of the sharib system, the seven days of the weeks simply extended to 14 sharib, while in case of the raddat is completely different. This takes different pattern with each falaj, for instance, for the eight raddat for falaj daris in Nizwa extended to sixteen and same explanation apply to other falaj raddat system.

4. DISCUSSION

Much of our knowledge with respect to above illustrated water share principles in general, using to main aspects. First, many researchers described water share principle using the term *dawarn/*cycle; they did not differentiate between the two identified systems. (Megdiche Kharrat, Ragala, & M, 2016; John Craven Wilkinson, 1977). This is attributed to the fact that they used single or several sample of one single falaj type. For example, in the past, Wilkinson (1977) provided details of the *aflaj* organization and water rotation based on a single sample; falaj *al-malki* in *Izki*; the same falaj in which this study sample was included. Megdiche Kharrat et al.,(2017; 2016) used a sample of the two most popular duadi type (falaj darise in Nizwa and falaj al-khatmeen); they wrote "…the underground aqueduct *falaj daris*, in Nizwa, is the largest of its type in the *Ad Dakhiliyah* governorate, followed by *falaj al-khatmeen* in a neighbor village named *Birkat Al-Mouz*" (P. 203). Another related issue is the fact that many studies did not differentiate between the *raddat* and *baddah (Megdiche-Kharrat, Ragala, & Moussa, 2016; Zekri, Powers, & Al-Ghafri, 2014).* For example, Zekri et al., wrote "…inside the Falaj community, the water is divided into time shares called *athars*" (P.1) In other occasion he stated "… the most common time share is the athar, which corresponds to approximately half an hour share per water cycle" (P.2). *Megdiche-Kharrat et al., (2016)* wrote "… the irrigation rotation differs from one aqueduct to another, depending mainly on the number of shares and shareholders, the agricultural land sizes,

[4] It is considered as the main component of the distribution and allocation system known by custom as *number of raddat using plural term,* which means 'rotation over a defined period', normally a week or more.

and the flows of the water. He went on to "… each day is divided into two timings (*baddah*): a daytime *baddah* and a nighttime *baddah"* (P. 202).

5. CONCLUSION

Aflaj institutional arrangements investigation in Oman revealed special and unique form of institution based upon the fact that water rights and associated institutional arrangement must be developed and initiated over the physical overall flow water supply variation among the three aflaj types. In other word, since the two identified rotation systems (*raddat* and *sharib)* have reflected the original hydrological characteristics of each *falaj*, governed/control the development of water rights. This can be explained as follow: from the two illustrated construction methods (the simple and sophisticated), it is apparent according to the revealed information the fact that only *raddat* aflaj system, whether *daudi* or *ayni* type, linked with explicit water right ownership[5]. In other words, they are in position to provide a better secure possibility of asserting an explicit privately owned water right. Our interpterion of this as follow: since the *daudi* and *ayni* types (in general) characterized by holding a high discharge rate and constant flow (high reliability), usually linked with the *raddat* system. This is attributed to the fact that these a*flaj* have been constructed with a more sophisticated physical-network components. In contrast, because the *ghaili* type characterized by seasonality and low flow, normally attached with the *sharib* system. In other word, the ghaili being associated with irregular flow considered as unsecure and hence the possibility to insert a privately owned right become unfeasible. Hence, they say that each shareholder has only the right to irrigate their land/garden, but not legal transaction of water rights because measuring units are not attached. In this case, during dry years a major concern is the reduction of the flow dramatically and as a result create high level of dispute among shareholders.

REFERENCES

Al-Rawas, A. (2000). Construction problems in traditional irrigation systems: a case study from the Afalj of Oman. In M. F. a. S. A. W. Goosen, W. H. (Ed.), *Water management purification and construction in arid climates* (pp. 22-31): Technomic Press

Alan, R. (1981). PROPERTY ENTITLEMENTS AND PRICING POLICIES FOR A MATURING WATER ECONOMY. *Australian Journal of Agricultural Economics, 25*(3), 195-220. doi:doi:10.1111/j.1467-8489.1981.tb00398.x

Bitran, E., Rivera, P., & Villena, M. J. (2014). Water management problems in the Copiapó Basin, Chile: markets, severe scarcity and the regulator. *Water Policy, 16*(5), 844-863. doi:10.2166/wp.2014.107

Coward, E. W. (1979). Principles of Social Organization in an Indigenous Irrigation System. *Human Organization, 38*(1), 28-36.

Dietz, T., Ostrom, E. ,& Stern, P.C. (2003). The struggle to govern the commons. *Science, 302*(12), 1907-1912.

Easter et al. (1999). Formal and Informal Markets for Water: Institutions, Performance, and Constraints

MAFF, M. o. A. a. F. (2004). *Agricultiral Census* Retrieved from http://www.maf.gov.om/Pages/PageCreator.aspx?lang=AR&I=0&DId=0&CId=0&CMSId=800708.

Megdiche-Kharrat, F., Moussa, M., & Rejeb, H. (2017). Aflaj' Water Management in Oman: The Case of Falaj Al-Khatmeen in Birkat Al-Mouz, Wilayat Nizwa. In M. Ouessar, D. Gabriels, A. Tsunekawa, & S. Evett (Eds.), *Water and Land Security in Drylands: Response to Climate Change* (pp. 119-128). Cham: Springer International Publishing.

Megdiche-Kharrat, F., Ragala, R., & Moussa, M. (2016). Chapter 12 The Aqueducts of the Sultanate of Oman Sustainable Water-Supplying Systems Irrigating Oases Cities. In *Underground Aqueducts Handbook* (pp. 197-210): CRC Press.

Megdiche Kharrat, F., Ragala, R., & M, M. (2016). The aqueducts of the sultanate of Oman: Sustainable water-supplying systems irrigating oases cities. In (pp. 197-210).

Milliman, J. W. (1965). Economic Considerations for the Design of Water Institutions. *Public Administration Review, 25*(4), 284-289. doi:10.2307/974018

MRMWR, M. o. R. M. a. W. R. (2000). *Statitical and infontory of the aflaj in Sultanate of Oman*. Retrieved from

Rosegrant, M. W., Schleyer, R. G., & Yadav, S. N. (1995). Water policy for efficient agricultural diversification: market-based approaches. *Food Policy, 20*(3), 203-223. doi:Doi: 10.1016/0306-9192(95)00014-6

Saleth, R. M., & Dinar, A. (2004). *The Institutional Economics of Water: A Cross-country Analysis of Institutions and Performance,* : Edward Elgar, Cheltenham (UK). .

Saleth, R. M., & Dinar, A. (2005). Water institutional reforms: theory and practice. *Water Policy, 7*(1), 1-19.

Senzanje, A., & van der Zaag, P. (2004). Institutional aspects of proportional water allocation in practice: case of the Odzani River Irrigation Company, Save Catchment, Zimbabwe. *Physics and Chemistry of the Earth, Parts A/B/C, 29*(15), 1343-1348. doi:https://doi.org/10.1016/j.pce.2004.09.009

Trawick, P. B. (2001). Successfully Governing the Commons: Principles of Social Organization in an Andean Irrigation System. *Human Ecology, 29*(1), 1-25. doi:10.1023/A:1007199304395

Wilkinson, J. C. (1977). *Water and tribal settlement in South-east Arabia : a study of the Aflaj of Oman*. Oxford [England]: Clarendon Press.

Wilkinson, J. C. (1977). *Water and tribal settlement in South-East Arabia. A study of the Aflaj of Oman*: Clarendon Press, Oxford.

[5] One probably can apply the concept used by Dales (1968) and Zekri et al., (2014) (the explicit and implicit) to differentiate between the existed *aflaj* water rights ownership. Note although Zekri and al-marshudi (2008) differentiated between implicit and explicit water right with respect to opportunity to trade, they did not mention the concept of ownership. They wrote "…most ghaili falaj systems are linked with the implicit water right. They went on to say "…. In contrast, daudi and aini falaj systems are characterized by explicit defined water rights with property licenses" (P. 353).

Young, R. A. (1986). Why Are There so Few Transactions among Water Users. *American Journal of Agricultural Economics*, *68*(5), 1143–1151.
Zekri, S., & Al-Marshudi, A. S. (2008). A millenarian water rights system and water markets in Oman. *Water International*, *33*(3), 350-360. doi:10.1080/02508060802256120
Zekri, S., Powers, D., & Al-Ghafri, A. (2014). Century Old Water Markets in Oman. In (Vol. 11, pp. 149-162).