Chapter 11

WATER MANAGEMENT IN MEDIEVAL INDIA : TOWARDS AN ECONOMIC DEXTERITY AND ECOLOGICAL SUSTAINABILITY

Jenia Mukherjee

"Water management is the planned development, distribution and use of irrigation water in accordance with pre-objectives and with respect to both quantity of the water resources. It is the specific control of all human intervention on surface and subterranean water. Every planning activity that has something to do with water can be looked upon as water management in the broadest sense of the term."— http.//webworld.unesco.org/water/ihp/db/glossary/gw/EN/GF137/EN-HTM.

International Glossary of Hydrology

'Muslim India', a communal characterization of the Medieval period[1] had its own method of hydraulic use and management, the outcome of which was massive agricultural productivity with a large number of food and non-food crops being raised by the Indian peasant. And Prof. Irfan Habib argues, *"This set him apart from the peasants of a large portion of the globe, whose knowledge remained confined to a very few crops."*[2] Harbans Mukhia in his treatise *'The Feudalism Debate'* while pointing out the dissimilarities between European serfs and Indian peasants bolsters this view.[3] The new crops and their rotation around the seasons necessitated more water especially the new summer ones such as sugar, rice and cotton and rabi crops like wheat. The old irrigation systems had fallen into decay and the areas that were watered had shrunk; in any event, pre-Islamic methods were inadequate to meet the new agricultural revolution. The technology of water-raising devices and methods of storing,

conveying and distributing water, were successfully developed and diffused.

So, irrigation can be a major theme in the history of South-Asia. J.Tambiah explores this ground in his *'Hydraulic Society of Ceylon.'* This paper would mainly like to focus on the medieval irrigational practices (wells, tanks, canals), the science and technology, skills involved in it in exploring the story of water-management under the Sultanates and the Mughals. Sher Shah's sketching out of the 'nahars', Akbar's initiative in the control of summer temperature in Fatehpur Sikri, the lifting of water in the Golkonda Fort by means of 'Persian wheels' are unique hydraulic enterprises and of course fall under the purview of water management. But here we will constrict ourselves in dealing and discussing with the focal theme of the use of water.

To supplement to the natural bounty of the monsoons, an important aspect of Indian agriculture became irrigation. The principal means employed for this purpose has been the construction of wells, tanks, and canals. Again irrigation based on small dams were also important for agriculture of which very little is known. Thus, David Hardiman argues in his *'Small-Dam Systems of the Sahyadris'* that still now the existing literature provides no clear answers about *"the extent of such systems, the manner in which they or reasons why they often declined."*[4]

Mohammad-bin-Tughluq advanced loans to the peasants for digging wells in order to extend cultivation. Alauddin Khalji's 'Haus Kas' was a remarkable development. In the fourteenth century we begin to hear of canals. The first ruler credited with digging canals for promoting agriculture was the immigrant 'Qarauna' Sultan Ghiyasuddin Tughluq. But it was under Firuz Shah Tughluq that the biggest network of canals was created. Abha Singh in his *'Irrigating Haryana: The Pre-modern History of the Western Yamuna Canal'*[5] makes a detail study of the canals built by the Sultan using the original Urdu sources.The Western Yamuna Canal was cut by Firuz Shah and it was designed to force water from the Yamuna into the Chitang river which was a seasonal river flowing down to Hansi. Shams Siraj Atifs'Tarikh-i Firuz-Shahi' mentions that the Sultan had dug two

canals to bring a continuous flow of water to his newly-built town of Hissar Firuza. One canal was brought from the Yamuna, and the other from the Sutlej. Then from the Yamuna two canals were taken out, the Rajabwah and the Ulughkhani having their head Waters near Karnal, whence, running for about eighty or ninety kurohs, they reached the town of Hissar. Receiving other rivers these two canals glowed past Safedon, Dharat, Jind and Hansi. The *'Tarikh-I Mubarakshahi' of Yahya Sirhindi* mentions that in 1355 Firuz Shah had made a canal which he called the canal of Firuzabad. Akbar's 'sanad' of 1570-01 states that Firuz had used for his canal the Chitang, which brought water from the nalas and drained in the vicinity of Sadhaura, at the foot of the hills to Hansi and Hissar. Abul Fazl in the *'Ain-I Akbari'*[6] says that Firuz's canal was cut from the Yamuna and that it ultimately terminated in a reservoir at Bhadra. The canal was excavated chiefly for the irrigational purposes. The water reaching the desert tracts is said to have greatly helped in extending cultivation. Hisar was so well irrigated by the new canals that while previously only the rain watered autumn crops (kharif) were grown here, now spring (rabi) crops like wheat could also be raised. People even started harvesting high-grade crops like wheat and sugarcane. The canal even raised the ground water level and could then be found at a depth of four 'gaz' from ground level. (Atif). (fig. 1)

Besides the large canals there were a number of smaller canals. Some in the Multan region are said to have been dug and maintained by the local population.

How was water lifted from these wells and canals? This involves the story of high scientific and technical skills. An improvement in one of the systems of water-lift probably belongs to this period. The ancient Indian noria, the 'araghatta', used to carry a string of pots fixed close to its rim; at a larger period, it was given the rope chain enabling to reach water at some depth (saqiya). Finally, it was equipped with pin-drum gearing, which made it possible for it to be worked by animal power. This was the most crucial addition made before the sixteenth century when Babur offers the classic description of the complete machine in his *'Baburnama'*[7]. It was the wood-

and-earthen pot ancestor of the modern metallic 'Persian wheel', and might well have contributed to the extension of irrigation in the Indus basin.

During the Mughal period, in the Upper Gangetic plains wells must have provided the chief source of irrigation. *Abul Fazl's 'Ain-i-Akbari'*[8] makes mention of the fact that, *"most of the province of Lahore is cultivated with the help of well-irrigation."* This is repeated later (1695-96) by an historian (Sujan Rai), who himself belonged to that province. East of the Jhelum, in the districts of Dipalpur, Sirhind, Marwar, etc. there was the wooden 'arhat', or 'rahat' (English: 'Persian wheel') to lift water. Around Agra and further east, the 'charas', or the leather bucket lifted out of water by yoked oxen, pulling rope thrown over a pulley was most common. Fryer describes the 'dhenkli', based on the level principle, which is generally in use wherever the water-level is close to the surface. Most of the wells were 'kachcha', *i.e.,* made without use of masonry. Pebaert attests to the fact after his survey throughout Agra. In pargana Merta, suba Ajmer, out of a very large number of wells recorded in *Nainsi's 'Vigat'* under individual villages (1664), only a few are reported as brick-lined.

Archaeological remains testify to the great antiquity of irrigation tanks in peninsular India. In the years of Shahjahan, we find the Mughal administration proposing to advance nearly Rs. 40,000 to Rs. 50,000 to cultivators in Khandesh and the Painghat portion of Berar for the purpose of erecting dams or bunds. In the north, Mewar, the lake of Dhebar, sixteen kurohs in circumference, dates from our period; it is said to have supported wheat cultivation in the country around.

"In the Dakhin, the practice of leading off small canals from rivers and streams was, like that of making reservoirs, an ancient one." (Habib). In medieval time, thousands of canals cut from river served towns and villages and benefited cultivation; and these were probably managed according to the co-operative 'phad' system.

Large canals were also excavated in the north. The Rajabwah was re-excavated during the reign of Akbar, first by Shihabuddin

Khan (Governor of Delhi, 1560), who then named the canal 'Shihabnahr', after himself. Later on Akbar again ordered the renewal of the canal in 1570-01 which came to be called as 'Shaikhu-ni' after the name of Jahangir (Shaikhu baba as Akbar called him). Akbar ordered that the canal be deepened and widened so that it might supply all through the year upto Hansi and Hissar. Under Nuruddin Muhamaf Tarkhan, the 'Mir-I Ab' (Canal Superintendent) appointed by Akbar, the canal was excavated from the Yamuna 50 kurohs in length, and ran past Karnal beyond the town. Badauni attests that it resulted in a considerable extension of cultivation and added to the prosperity of the region, (fig. 2).

It silted up again, but Shahjahan decided to re-open it from its mouth at Khizrabad, almost under the hills, down to Safedon and thence to dig a new channel, some thirty kurohs or nearly seventy eight miles to serve the new city of Shahjahanabad at Delhi. This was the famous 'Nahr-I-Birhist' or 'Nahr-I-Faiz' which irrigated a considerable area. Abha Khan adds an important information in this context that the construction of this canal was wrongly ascribed to Ali Mardan Khan in later accounts like *'Chahar-Gulshan'*, W. Francklin's History of the Reign of Shah Aulum' (*London*, 1798), etc. The official chronicler Waris and Muhammad Salih mentions that it was excavated under the supervision of Ghairat Khan. Colvin's report describes how the canal *"enters the city [of Delhi]; and passing through it by an open channel it traverses another extensive aqueduct into the palace [the Fort],"* and adds that inside the Fort it *"ramifies in opened or covered water courses having outlets to the Jamuna, thus permitting the passage of constant streams of fresh water."*[9] Susan Gole has published a Persian map showing in several panels the alignment of Shahjahan's canal.[10] *"Undoubtedly, Shahjahan's Western Yamuna Canal was a considerable feat of engineering, for which its builders have yet to receive due credit."* (Abha Khan) (fig. 3).

In Punjab proper, a small system of canals was brought into existence in the Upper Bari doab. The best known of these was the 'Shahnahr', also excavated in the reign of Shahjahan. *"Great benefit accrues to cultivation from these canals"*, says A. Burnes in his *'Travels into Bukhara'*.

We also know of a small canal cut from the Tavi to irrigate Ali Mardan's garden at Sodhra near Wazirabad in the Upper Rechna doab. The presence of canals in the Multan Sarkar is indicated by the draft of an order appointing a mir-i-ab (canal superintendent) for the area, which has survived in a collection of administrative documents. The most southerly portion of the present Sindsagar doab, lying in *"the Baluch country"*, was reputed for its fertility, which Aurangzeb attributed to the inundations and well-irrigation.[11]

In Sind, the Indus is even more prone to throw out its arms and flood channels, which extend as far eastward as the Eastern Nara. In addition to these there have been large artificial works. In 1628-29, a local zamindar, Mir Abra, cut a canal from the Indus into the waterless country of Northern Sind, enabling kharif crops to be raised in a area of 100,000 jaribs (bighas), besides the rabi crops. In the Delta, Darya Khan, a minister of Jams, excavated the "Khan-wah" in the early years of the sixteenth century. By continuously depositing silt, the Indus raised its bed to a much higher level than that of the surrounding plains, so that it is easy to use the supply in its mainstream as well as inundation channels for irrigating the fields. The local practice has been to either cut the karizs, or 'artificial channels' from the rivers or canals, as Bernier tells us.

In the Himalayan valleys and in South Bihar, agriculture depended on irrigation especially using small dams. Water was diverted by the dams to the fields by the irrigation channels. This helped in the growth of rice even in those areas marked by inadequate rainfall. This system was also prevalent in the southern part of the sub-continent. *Nirmal Sengupta in his 'The Indigenous Irrigation Organization of South Bihar'.*[12] finds that they date back to 700 BC and helped in providing a surplus sufficient to allow major civilizations to flourish in the region. So far as their organization is concerned for India, no eminent studies have come up along with definite conclusions. However, contrary to the view of Karl Wittfogel ('Oriental Despotism: A Comparative Study of Total Power', 1957), Robert and Eva Hunt argued that the organization and maintenance of these systems have been carried out at the local most commonly by the local collectivities.[13] M.S.S. Pandian also arguing in the line of Hunt pointed

out that smaller channels were the responsibility of the local communities and concluded that the community-based systems of irrigation did exist in India like Bali, Srilanka and other places.[14]

David Hardiman in his path-breaking study of small dams in the Baglan area, *"situated in the northern reach of the Sahyadri range of the Western Ghats, in the area running from the north of Nasik to the Tapi river"*[15] shows the area's agricultural prosperity under the rule of the Rathod clans and under the Mughal rulers like Akbar and Aurangzeb (when it was finally conquered in 1638). There was a whole network of dams in this area locally known as 'bandharas'. A report of 1857 said that according to the local tradition these were built by "the Mohamedans", and that it was probably that this vast system of irrigation had been constructed when it was ruled by the Mughal minister Malik Amber (1610-30).

The outcome of this skilled water management was the increased productivity in agriculture making the peasants adept not only to grow a multiplicity of crops, but also preparing then to accept new crops. The *'Ain-i-Akbari'* gives revenue rates for sixteen crops of rabi and twenty-five crops of the kharif in Agra and the account of as many as forty-one crops being cultivated within the year in each locality. Again, the seventeenth century saw the introduction of two major crops - tobacco and maize, both immigrants from the New World. Accounts of Jean Baptiste Travernier ('Travels in India', Vol. 1, 1889) and Jean de Thevenot (in S.N. Sen edited Indian Travels of Thevenot and Careri', New Delhi, 1949) is evident of the good quality of the agrarian products of this area like sugarcane, grapes, pomegranates, citrus fruits and the *"odiferous taste"* of rice ('kamod')[16]. Economic dexterity was the consequent result.

These hydraulic enterprises and the exinious water-management skills during the medieval period, mostly under royal initiatives can be sketched and stretched back to the age-old long technological heritage of Central and West-Central Asia *"The supply of water irrigation, drinking, domestic and industrial and agricultural purposes has always been a vital consideration in Muslim lands"*[17] The 'saqiya' or 'Persian wheels' was innovated along the North African Coast which Ibn Bassal described as a standard machine

for irrigation (fig. 4a. 4.b). The wind-mill's use found in India to pump water (also to grind corn and crush sugarcane) was a local Persian adaptation of the horizontal water-mill as the historian of technology Robert Forbes argues. It is to be noted here that Joseph Needham says that by the sixteenth century the Islamic horizontal windmills had become well-known in Europe, and designs based on them figured largely in *'Machinae Novae'* (New Machines) of 1615, the engineering book of the bishop and engineer Faustus Verantius. The Indian medieval Sultanate and Mughal rulers inherited the knowledge from the Islamic heritage that before excavating a canal it was necessary to establish not only its route from start to finish. The use of 'qanats' (underground system) was learnt from the predecessors. Interestingly enough, we find specificities of areas were taken into account. Most parts of Iran was cultivated and irrigated by the use of 'qanat' which is different from the canal network of Baghdad, (fig. 5). The peculiar method of 'rab' was used in the cultivation of the Nasik and the Khandesh districts as the report (1902-03) for Sonadh taluka (Baroda) attests to the fact. This was a method by which initially a ground was selected for seed-bed and then it was fertilized by burning tree-loppings and other vegetation before the seeds were planted. The seedlings were transplanted after the setting in of the rains.

The story changes with the colonial infiltration. It is the story of expansion and *"imbued imbalence"*[18]. When Benares, Rohilkhand, Central Doab, the area stretching from Ganges Valley to Punjab were *"ceded and conquered"* in 1835 and renamed as the *"North-Western Provinces"* under colonial rule, the Company was bestowed with the task of tapping its vast agricultural resources. The latest principles of British civil engineering was to be applied in case of digging irrigation canals *"to preserve the people from starvation. In fact, the whole paraphernalia of a great civilized administration, according to the modern notions of what that means, had to be provided"*. (J and R Strachey in *'Finances and Public Works'*, pg. 2). In 1820s the building of the East Jumna Canal (which was a re-development of an old Mughal Canal line) began. By 1878, its main and branch channels, together with distributaries totaled 748 miles and irrigated 206, 732 acres. It irrigated tracts in the Saharanpur, Muzaffarnagar

and Meerut districts. Rohilkhand canal also irrigated major tracts of the province and its suburbs. The dominant aim of such enterprises under the Company and the Crown was *"nowhere to make a desert blossom, but to stimulate the lagging productivity of traditional agriculture into realizing a greater and greater share of its potential wealth within the shortest space of time".* (Whitcombe)

The effects were deleterious. In 1866, W.A. Forbes and also Blair Smith noted that the inroad canals had left most wells in disuse which were less open to doubt than those of canal irrigation. The big projects under colonial rule also brought to the forefront the dangers of gross-deterioration, argues A.B. Paterson and William Sleeman. Again, more widespread and serious swamping arose from the canals' obstruction of natural drainage lines. According to Alan Cadell, even the climate in Muzaffarnagar went worse in terms of an increasingly unhealthy humidity due to large-scale deforestation. Moreover, deforestation, the obstruction of natural drainage by public work embankments, together with lateral seepage and flush irrigation from canals exacerbated natural geological tendencies towards the accumulation of toxic quantities of alkali salts in the upper layers of the soil. Crosthwaite alarmed the spread of 'reh' (white saline efflorescence) in Etawah districts and Mr. David Roberts in Aligarh district. A depressed peasantry labored in a distorted environment.

Again, the renovation of the Western Jamuna Canal under Lieutenant Yule (1863) was not free from faults. In 1883 it was said that nowhere had irrigation been financially successful; but nowhere are evils more or less associated with a faulty system so apparent, and certainly nowhere are the remedial conditions more complex. The statistical reports show 'malariousness' due to undue rise of the groundwater levels and the highest 'fever mortality' registered as highest in Punjab.[19] Thus, argues Elizabeth Whitcombe in her *'The Environmental Costs of Irrigation in British India: Waterlogging, Salinity, Malaria', "Canals (in British India) did not control the vagaries of nature, but compounded them. The lesson can be learnt better in the subcontinent than anywhere else in the world."*[20]

Long inundation canals, which had long functioned under largely local control in a significant portion of Indus-Basin irrigation in Sind, Bhawalpur and southern Punjab, found their interests often in conflict with those of water planners who sought to distribute water to the canal colonies.

Similarly, the small dams of Baglan also collapsed *"with the decline coming in the early nineteenth century"* (Hardiman). In 1857 where the number of bandharas was 97 that declined to 49 in 1881-02 and 31 in 1902-03. In West Khandesh there were 157 working bandharas while in 1911-12 it was 80 and in 1922-03 only 3! Here also the system collapsed under the British rule when the officials placed a low value on the indigenous systems and considered many of the indigenous techniques like 'rab' as primitive form of agriculture and looked upon the peasants as *"slothful and averse to work"* and inefficient. Though slash-and-burn agriculture practiced by the Bhil and Maochi communities also contributed to the decay, but mainly the primordial cause appears to be a combination of high taxes and growing indebtedness which made irrigated agriculture uneconomic as Hardiman pointed out. The forest policy pursued by the British at the end of the nineteenth century worsened the situation. The hilltops were demarcated as reserved forests preventing the peasants from gathering materials for 'rab' for their seed-beds. This caused resentment and led rise to protests against the forest laws culminating in forest satyagrahas in the 1930s.

Shaped by the increasing influence of capitalist modes of thinking, many British leaders saw domination of nature, its commodification, as both a critical measure of class power and a legitimizer of the British in India as a ruling community. Michael Adas argues in his *'Machines as the Measure of Men: Science, Technology and Ideologies of Western Dominance'* that the Europeans often looked to their own *"vastly superior understandings of the workings of nature"* and their ability to turn nature to human use as among the most powerful justifications for *"their monopolization of leadership and"*[21] Donald Worster also subscribes to the fact that the ethos was rooted in the transformation of water itself into a

commodity. *"All mystery disappears from its depths, all gods depart, all contemplation of its flow ceases. It becomes so many 'acre-feet' banked in an account, so many 'kilowatt-hours' of generating capacity to be spent, so many bales of cotton or carloads of oranges to be traded around the globe."*[22]

Does the concept of 'sustainable development' hold ground in case of the colonial hydraulic enterprises? The 'Bruntland Report' by the *'World Commission on Environment and Development' (1987)* defined sustainable development as simply *"development that meets the needs of the present without compromising the ability of future generations to meet theirs"*. The main stream sees this in terms of economic conditions primarily (David Pearce, Robert Repetto, William Nordhaus, Tom Tietenberg), whereas more critical perspectives (post-structuralist critique of development - Arturo Escobar, Ferguson, Andre Gunder Frank, and environmental Marxist school - Feshbach, Friendly, Jonathan Porritt) emphasize ecological conditions directly. It is through these perspectives we can violently utter that big is not always beautiful and pay heed to Schumacher's argument of "Small is beautiful".

In the course of rotation of time, nature, consisting of water, forest, mountains, carries the sign of hyacinth to the way of civilization and evolution of human beings. The *'Nebular Hypothesis'* (of Kant and Laplace) confirms that the earth is the sole planet where water exists.[23] Water initiated life when its excess and dearth have their heinous design. We are afraid that the doomsday as also the 'day of judgement' may come without notice to announce our permanent washing out of this planet as a curse done by the homo sapien race to the daughter of the Jews, leaving us to cry but in vain, *"Water water everywhere, but nowhere a drop to drink."*

The medieval monarchs with the 'Muslim' attitude to water as a precious source of life were adept enough to contribute towards the broader goal of ecological sustainability.The technology was not only advanced but auspicious and eco-friendly, not involved in the process of *"commodifying"* water as also nature to extract the

penultimate profit. They preached us some practical sermons and amaranth examples. No longer to look upon Medieval India as 'Dark Age', but time is ripen enough for us to delve deep into and learn from their dexterous activities and sustainable projects which can bore exinious fruits (of course paying due consideration to the specificities of particular regions concerned) if applied in today's world of massive hydraulic crisis which would ultimately bring the **WATER FAMINE** around 2020 as to the predictions of the global environmental scientists and ecologists.

The responsibity is ours, the country is ours, the whole world is ours so it is upto us either to let it perish or to boldly assert to its survival.

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23. On 3rd January 2004, however the European Space Agency in the Darmstadt meeting declared that their satellite discovered a water-layer (in the form of ice) in Mars.

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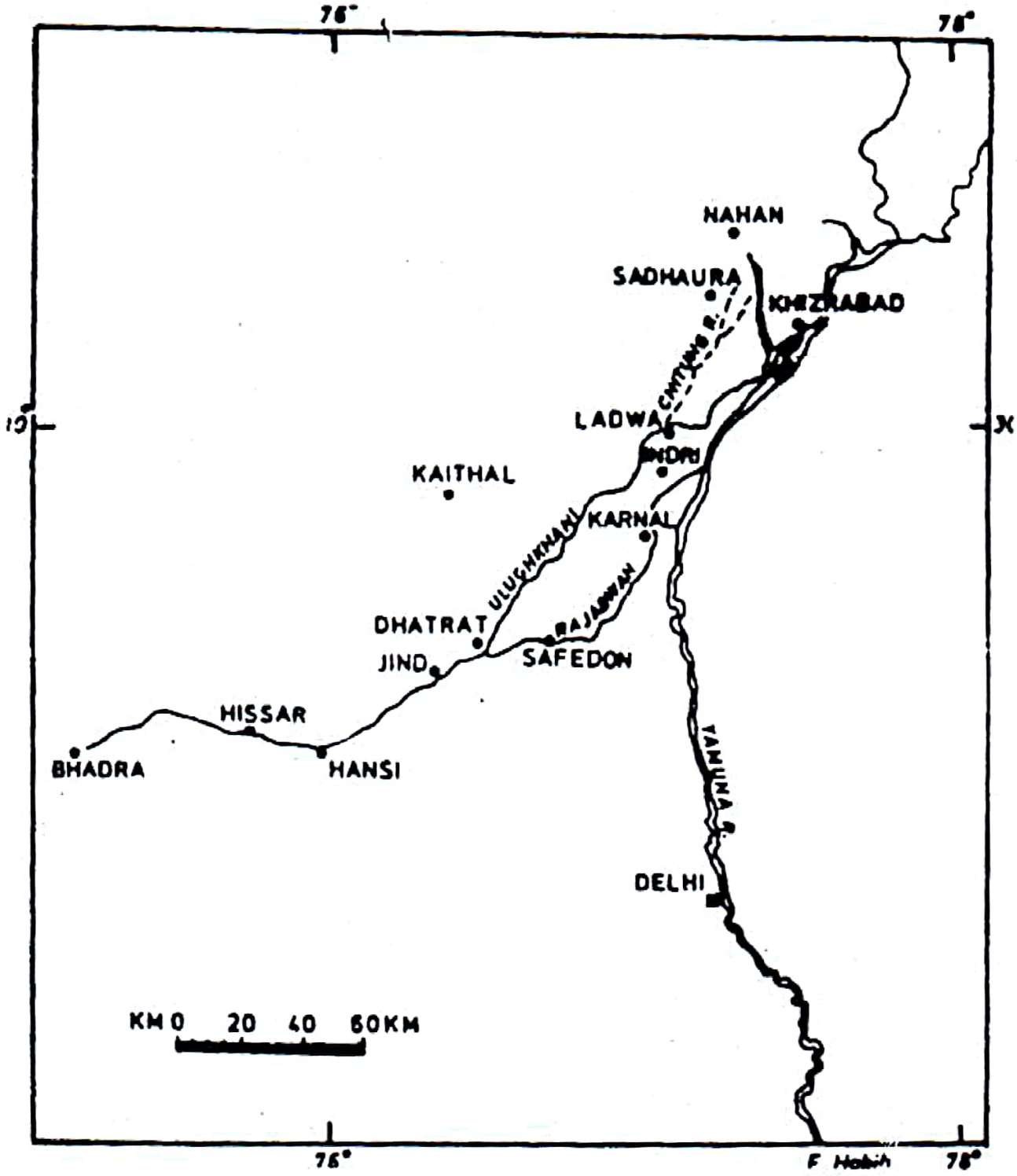


Fig. 1. Firuz Shah's canal.

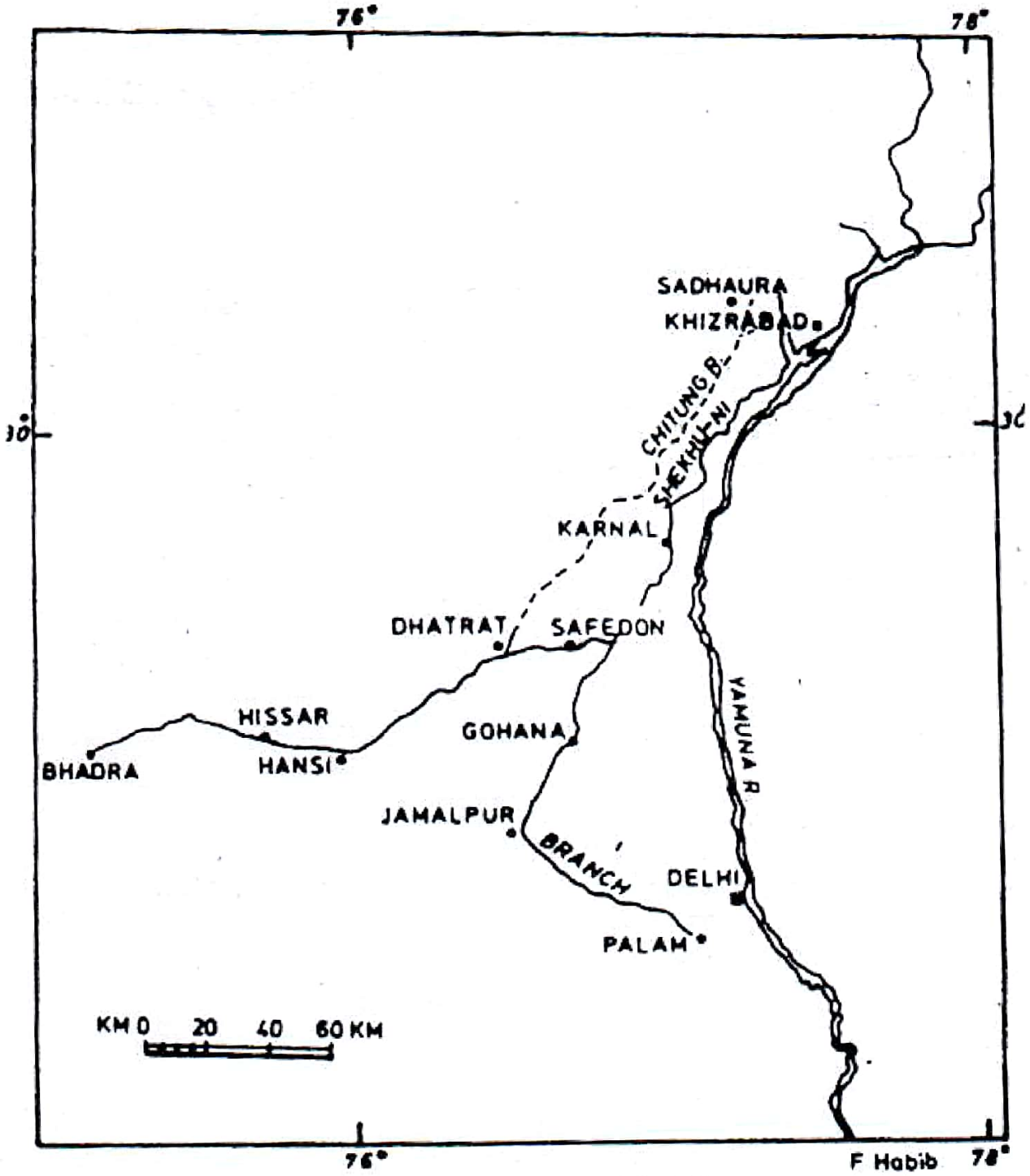


Fig. 2. Akbar's canal, the Shekhū-m.

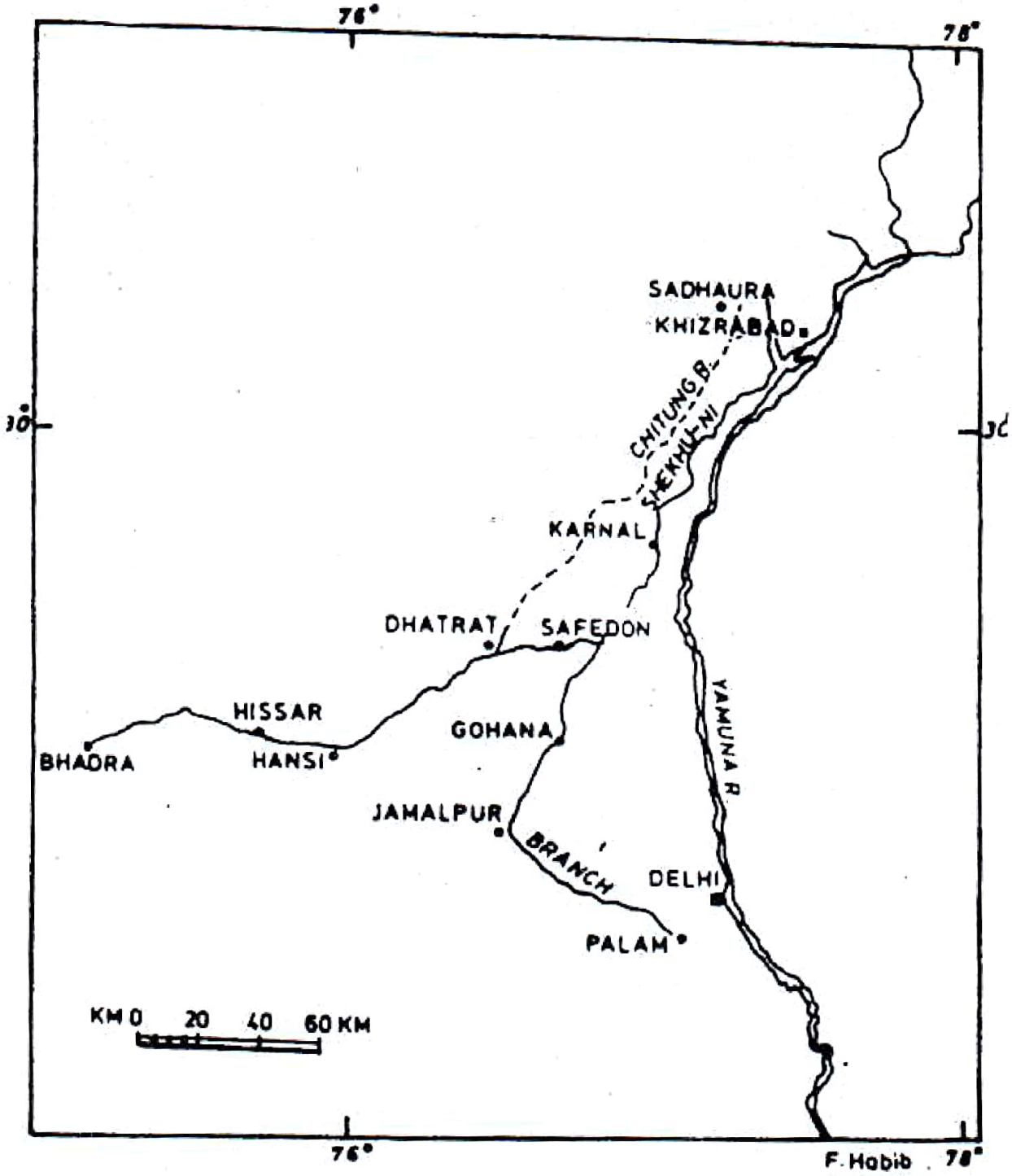


Fig. 3. Shahjahan's *Nabr-i Bibisht.*

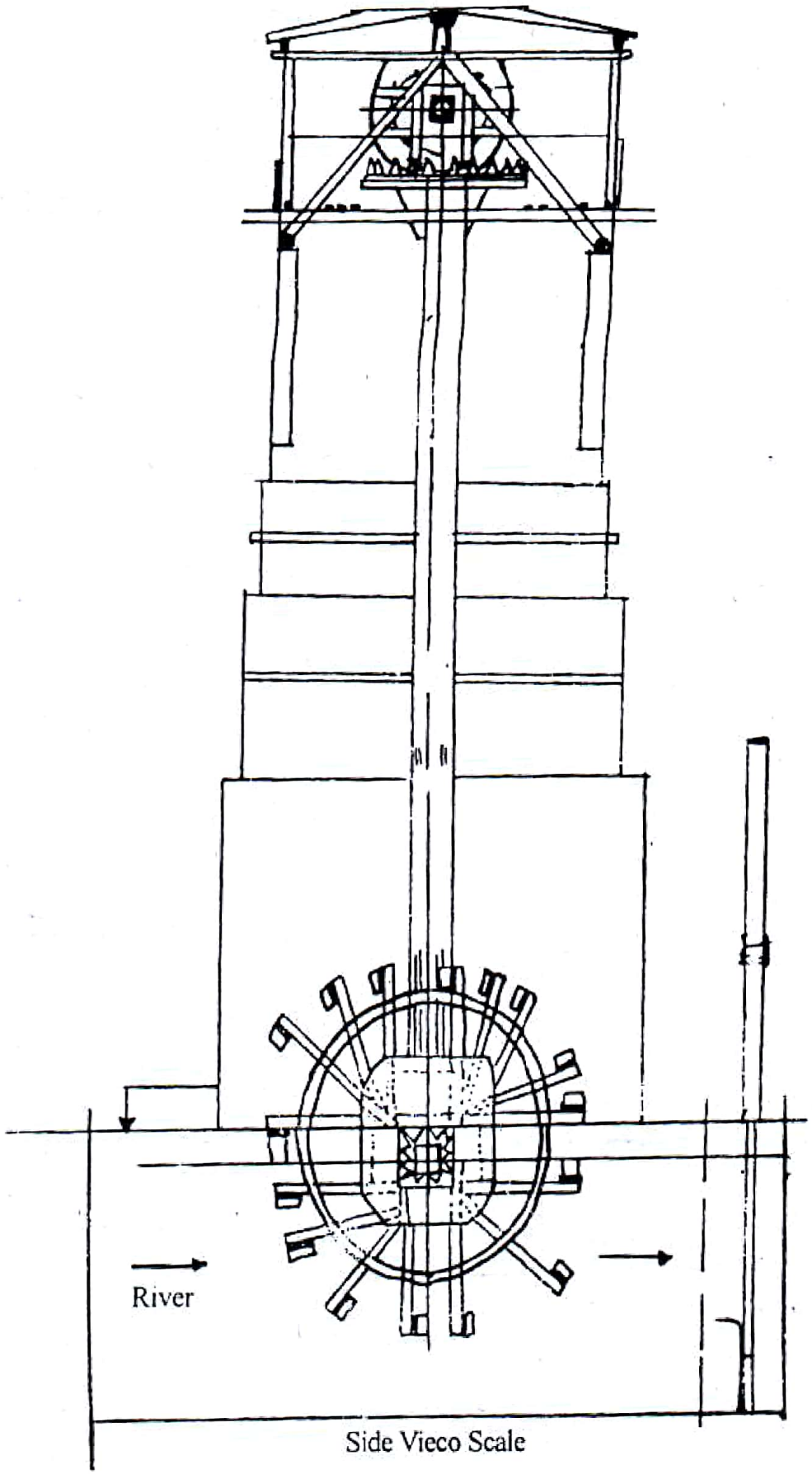


Fig. 4. Saqiya (Paddled wheel driven)/Persian Wheel.

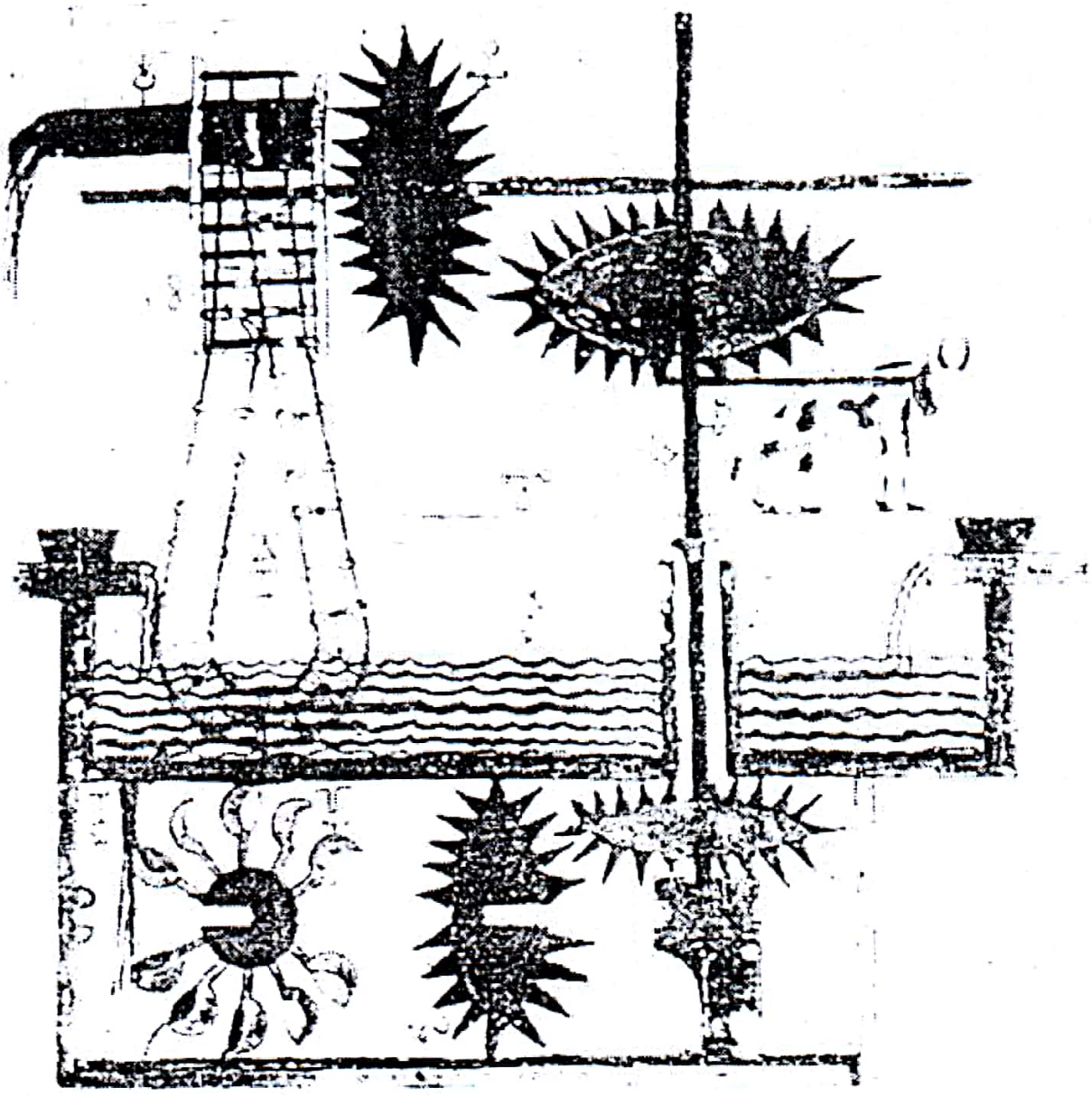


Fig. 4(*a*). A 'Saqiya' producing casdade of water at the side of an ornamental lake. The water driven mechanism was hidden and the wheel appeared to be turned by a wooden model of a cow. 13th A.D. Subymaniya Kutuphanere, Istanbul.

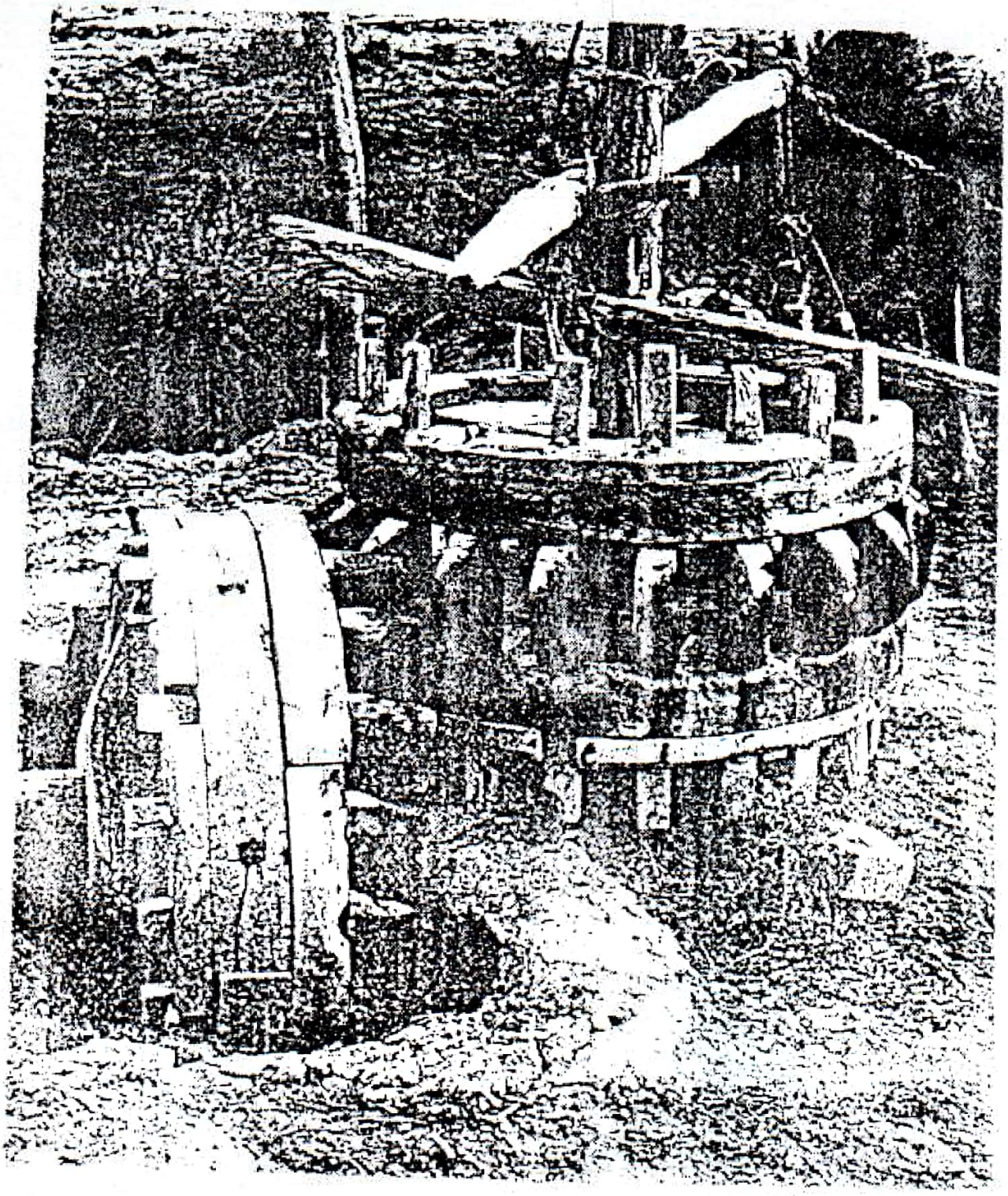


Fig. 4(*b*). The cogs of the gear wheel of a 'Saqiya' meshing with the lantern pinion.

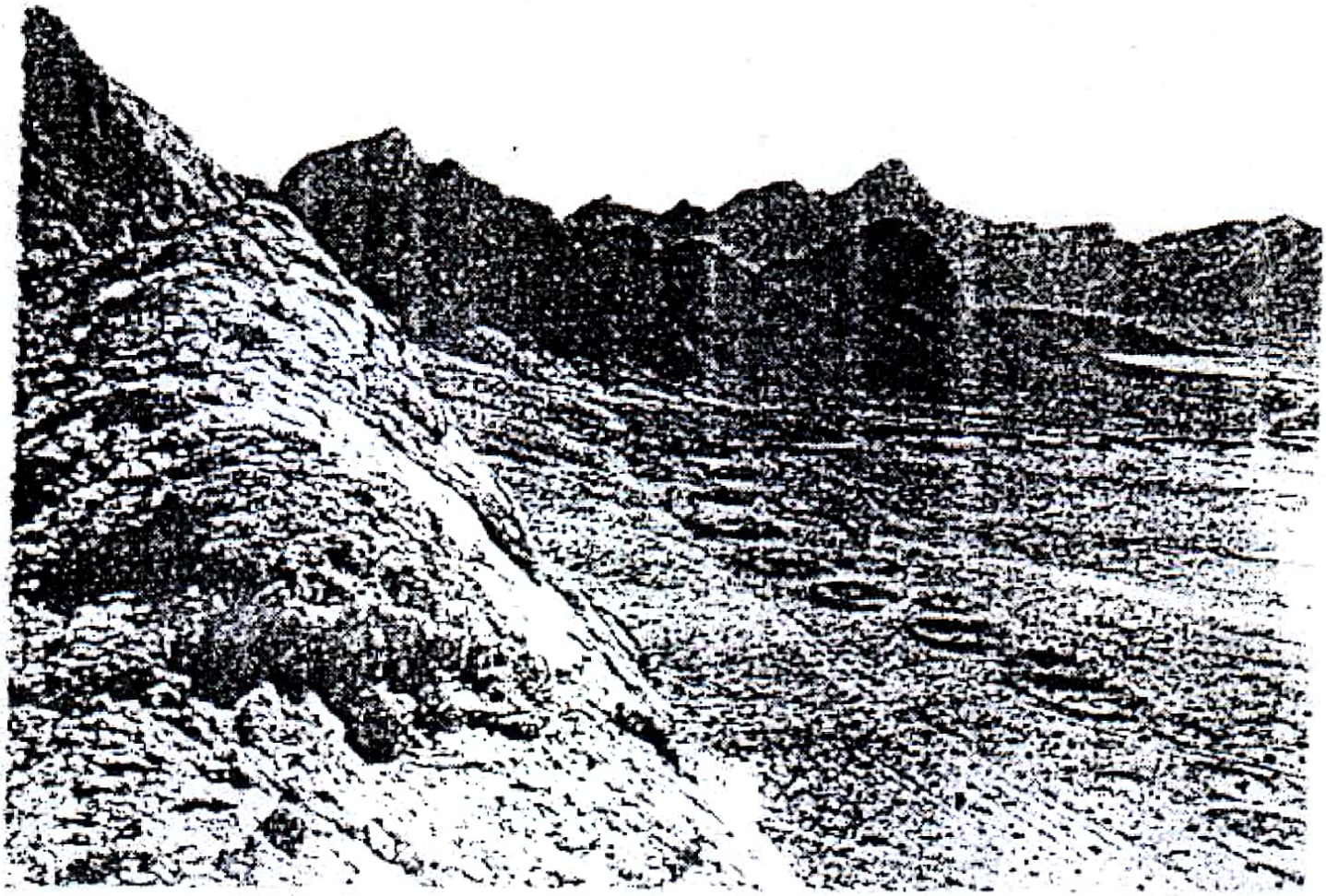


Fig. 5. The course of a 'qanat' in Iran marked at surface by monds of excavated material at tops of the shafts.

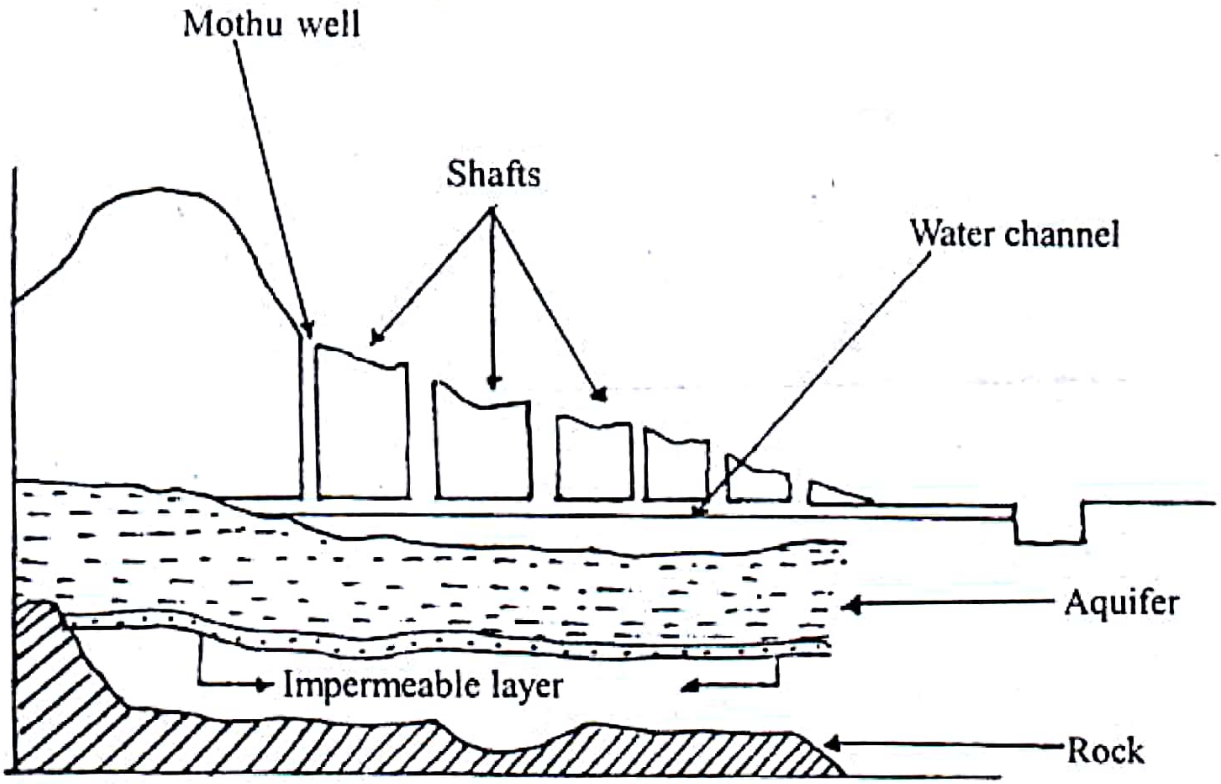
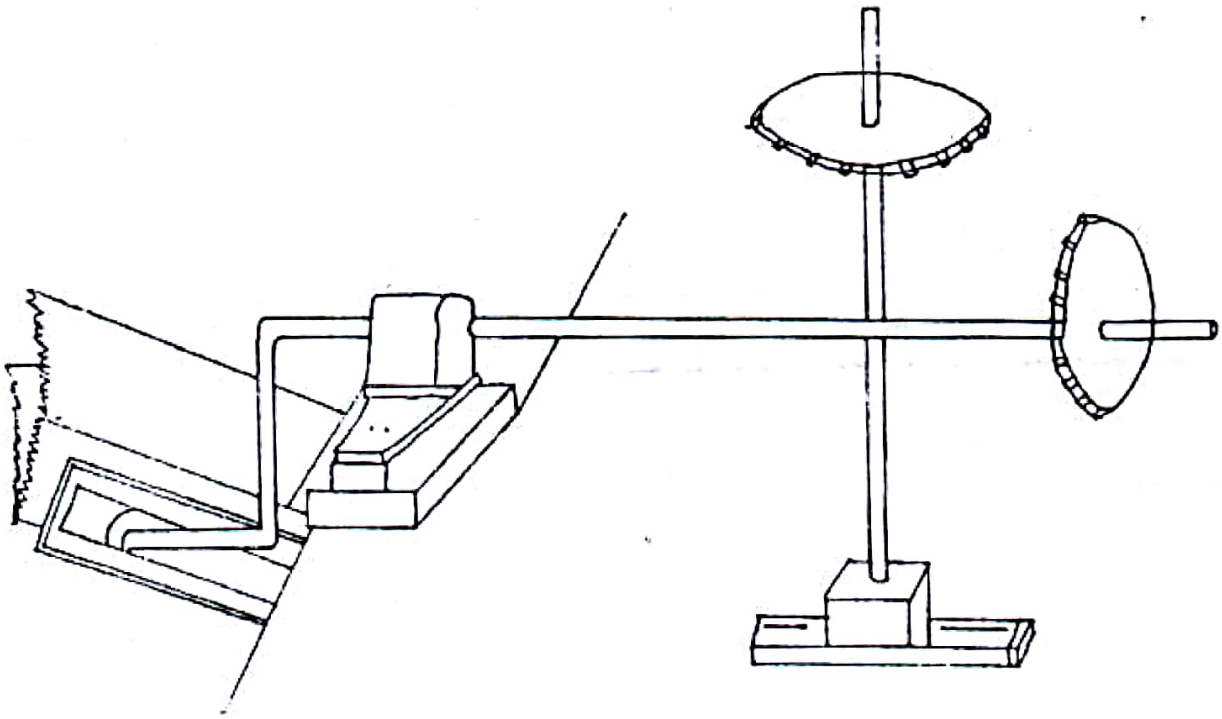


Fig. 5(*a*). Cross-section of a 'Qanat' system for obtaining sub-terranean water.



Gears and Crane of 'Saqiya'