

WATERMILLS IN MUSTANG: NOTES ON ARCHITECTURE, FUNCTION AND MANAGEMENT¹

—John Harrison and Charles Ramble

In a land which traditionally has possessed only the simplest technology—the loom, the door lock, the potter's wheel, and no wheeled vehicle—the horizontal watermill is the only machine which reaches beyond the power of human and animal muscle to harness the force of nature. It is still a very simple machine—in Europe the small horizontal watermill was superseded by more powerful geared vertical water-wheels as long ago as the early Middle Ages—but a very appropriate technology and an essential part of agricultural life and economy in Mustang. Watermills are usually powered by irrigation canals or by channels diverted from rivers. In the Tibetan dialect of Baragaon, such mills are known as *churag* (Tib. *chu-rags*), a term that literally means "dam" or "dyke".² Less commonly, they may be operated by the outflow of a reservoir, as is the case in Taye (Nep. Tangbe), where a long series of mills is disposed along the channel between the reservoir and the first distributaries. Although they are no different in terms of their construction, such

mills are called *dzingrag* (Tib. *rdzing-rags*), "reservoir mills".

The mills in Mustang conform to the general pattern observed throughout the Himalaya, Karakoram and Hindu Kush. Over this vast area there is a remarkable consistency in the machinery and mode of operation; only the building envelope changes to reflect the construction techniques and available materials of a particular region.

The motive power, water, is conducted along a man-made channel, also called *churag* or *yura* (Tib. *yur-ba*), "canal", which may run for some considerable distance away from its source in the river. The channel is built up across sloping ground until a height of at least two metres is gained and the water can be directed down a chute into the mill. The direction of the water is controlled by small wooden sluice gates, *ka* (Tib. *rka*), so that the mill can be by-passed when not in use. (For illustrations of the component parts of a mill, see fig. 3.)

The chute, *a* (Tib. *wa*), is formed from a single

hollowed pine log, three to four metres in length, laid at an angle of 30-40° on the raised masonry end of the water channel to direct a jet of water onto the blades of the wheel. The blades, *shokpa* (Tib. *shog-pa*, literally "wings"), are shaped from flat boards, between ten and twenty in number, and slotted and wedged at an angle of 20° from the vertical into a heavy wooden hub, *bumpa* (Tib. *bum-pa*). A small iron, or formerly stone, pin, *bumchang* (Tib. *bum-'chang*), is set into the bottom of the *bumpa*, and revolves in a stone socket, *mamone*, set firmly in the bed of the wheel chamber. The southernmost mills seen in Mustang, in Thini and Jomsom, were fitted with a tentering rod and beams on which the wheel revolved: this device enables the beam to be raised or lowered slightly from within the millhouse to adjust the fineness of the grinding. The tentering rod was not seen in any mill north of Jomsom. Without the tentering rod any adjustment to the stones has to be made from below—so it will not be done very often.

Mills—hand and water—turn anticlockwise in Buddhist communities and clockwise in Bonpo ones, since a non-sacred object turning in the direction of a prayer wheel would be sacrilegious.

Into a socket in the top of the *bumpa* is fitted the vertical spindle (also *bumchang*), held in place with wedges, *ser* (Tib. *gzer*). The top of the wooden spindle, *kolem*, passes through the hole in the centre of the lower millstone, *magap* (Tib. *ma-gab*), and terminates in the iron *kya* (Tib. *skya*) and *te* (< Tib. *rtod[-pa]?*) which fit into a slot in the bottom of the upper millstone, *yakap* (Tib. *ya-gab*). There is no gearing in the horizontal watermill, simply a direct drive shaft from the wheel to the upper millstone, which revolves above the stationary lower stone. Grain is fed into the hole in

the centre of the upper stone and is ground between the two stones, gradually working its way to the outer edge along the grooves cut between the flat sections, *kha* (Tib. *kha*), in the upper surface of the lower stone. The stones are not very large, 60 to 70 cm in diameter, with a raised rim around the central "eye" of the upper stone. The ground flour falls into the wooden box surrounding the stone. The grain is fed into the millstones from a hopper suspended by straps or string from the roof. The hopper, *ding* (< Tib. *ting* or *gting?*), is now usually a four-sided tapering container of wood or metal (ghee tins), but in the Thini mill illustrated (figs. 1, 8) it is circular with a curved profile. This tin hopper is the exact shape of the hoppers in the Hindu Kush which are carved from a single large tree-trunk section; perhaps a memory of the time when the local forests were more extensive and less precious. The shoe is suspended below the hopper at a slight angle which can be adjusted to control the flow of grain. Attached to the shoe is the damsel, *ragyok* (Tib. *rwa-skyogs*), a sheep or goat horn which shakes the grain from the shoe as is vibrated by the turning stone.

Before it is loaded into the hopper, the grains may be sifted on a flat circular basket tray inside the millhouse. There will also be a wood-framed sieve, *tshaktsa* (< Tib. *'tshag-pa*, "to sieve"), and a soft sheepskin brush, *phebyak* (Tib. *phye-yag?*), for brushing the flour together from around the millstones.

Some mills in Tsarang had no hopper at all: the grain was simply fed into the stones by hand. As only a few mills were inspected in Lo I am unable to say if this is the general pattern, of a gradual simplification of the machinery the further north one goes up the Kali Gandaki, as the secondary mechanisms of tentering rod and hopper feed are

stripped away, leaving only the essential wheel, spindle and stones.

Although most grinding of grain is done at the watermill, a household may also have a hand-quern, *lekhor* (Tib. *lag-'khor*), for daily use or for small quantities. However, the *tsampa* produced is very coarse, and so the quern is generally only used for breaking up rape-seed before it is pressed to extract the oil.

The millhouse, *churag khangba* (Tib. *chu-rags khang-pa*),³ is a simple rectangular building, large enough to accommodate the millstones and surrounding flour box at one end, with a space for the operator to sit and sift flour and grain inside the door. There may be a roof vent to light the interior, but not usually a window. The machinery area, sitting above the wheel chamber and watercourse on timber joists, has a higher floor level than the entrance area which is built on solid ground. The wheel chamber, just high enough at 80 cm - 1 metre to fit the wheel and its *bumpa*, is raised in dry stone wall construction, using substantial river boulders if the mill is near the river bed.

The roof has one or two main beams, poplar pole joists and a ceiling of small round poles topped with twigs, mud and flat edging stones.

The horizontal watermill is not a very efficient piece of machinery in terms of energy conversion: the water power is limited by the available length of the tree trunk chute and by the feasible height of the water channel; the angle of the chute (more powerful as it approaches the vertical) and the possible angle of the wheel blades, which should be perpendicular to the water jet; the lack of gearing; the inefficiency of stone bearings and roughly-hewn wooden moving parts. Nevertheless, it serves its purpose admirably in a rural community possessing few technological skills. It can be maintained and

repaired, or even replaced, by the community, using local materials, and the speed or slowness of its operation is not a critical factor.

Management of watermills

All the villages of southern Mustang grow two crops a year: barley (which is supplemented by wheat in a few settlements and replaced by it entirely in Lubra), followed by sweet buckwheat. These constitute the staple food-crops of the region. Other crops, such as bitter buckwheat and a variety of other vegetables are also grown in smaller quantities. Of the latter, only bitter buckwheat is milled.

Barley is never ground raw (although it is said that it used to be before the wider availability of wheat); it is used only for *tsampa*, and is therefore parched in hot sand before being milled. Wheat and buckwheat are simply dried before being ground, since it is the raw flour that is used in a number of food preparations (principally flat bread).

Dogfood—made from reconstituted lees, the dried husks of barley or wheat after it has been fermented, and the beer pressed out of it—is also ground in watermills. It is not liked by mill owners as it is not a very substantial grist, and the resulting friction between the millstones tends to damage them.

Most frequently, watermills are the common property of a village. Some, however, are privately owned or belong to an institution such as a monastery, and the regulations surrounding their use differ slightly in consequence. The management of mills varies from place to place. Particular attention will be given here to Kag, since this village contains examples of all three types of ownership mentioned above.

There are four watermills in Kag, arranged in a

series over several hundred yards along an irrigation canal. The canal in question, called Shung (gZhung, "middle"), passes through the centre of the village, on a course roughly parallel to and north of the Dzong Chu (see fig. 9). Traditionally the maintenance of this canal—one of three in Kag—was carried out by women, and it is accordingly also known as Mo-yur, the Female Irrigation Canal. The reason for this is its convenient proximity to the hearths which the women would be tending. Since milling is carried out primarily by women, the central situation of the mills is also appropriate.

While the four mills are particularly accessible for the people of Kag themselves, they are also used by villagers from further afield: the inhabitants of Tshug (Nep. Chusang) and Gyaga—between three and four hours' walk to the north—also bring their grain to Kag to be milled. Tshug has no watermill of its own. The nearest settlement to Tshug, Te (Nep. Tetang), has two mills of its own in the floor of the Narshing Khola, but access is forbidden to outsiders (for reasons mentioned below). However, the single mill of nearby Tshognam, which straddles the territory of Te and Tshug, is also sometimes used by the inhabitants of the latter.

The ownership of the four Kag mills, in descending order, is as follows:

1. The village (*lungba*; Tib. *lung-ba*)
2. Pema Drolkar (private ownership)
3. The village
4. The monastic community (*chos-sde*)

All villagers are in principle free to use whichever mill they choose, but users are required to pay a fee to the owner, in the form of a proportion of the flour or *tsampa* that has been milled in the course of a session. The requisite quantity varies from place to place, but usually comprises one-fifteenth

of the flour. In some places, however—Kag is one example—the fee is not fixed and the user gives whatever she or he considers reasonable. The convention in fact works in favour of the owner, since users tend to give more, rather than less, than the more usual figure for fear that they should be seen as mean. This is especially the case when a user has milled only a small quantity of grain, and a strict one-fifteenth payment would look miserably parsimonious.

In the case of the private watermill the fee is paid directly to the owner herself. The management of the two community-owned mills is more complex. In Kag, the fees that are incurred are not as in some other communities, paid directly to the village fund. Instead the right to collect the user fees is auctioned every year at a meeting. The highest bidder pays the agreed sum to the village and, for a period of one year thereafter, is entitled to collect all fees. At present, the winning bids are around Rs. 5000 to Rs. 6000, but the pecuniary equivalent of the flour collected is likely to amount to over Rs. 10000. One of the mills in Dzong is run along similar lines: imangement rights are auctioned for Rs. 2-3000, and the revenue amounts to around Rs. 10000 (Rebecca Saul and Tim Calder, personal communication). The lower of the two village mills has recently been renovated and upgraded by CARE, a non-government organisation that has established a number of development projects in Mustang. Since wastage at this mill is less (at least one-tenth of flour is lost through the inherent inefficiency of the technology), it is more popular than the other and the prices bid are therefore higher.

The management of the monastery mill is similar to that of the two village mills, to the extent that the fees collected do not go directly to the monastic

community but to an individual agent. The agent in this case is the steward (Tib. *dkon-gnyer*), an office that is held by each of the monks in turn on the basis of annual rotation. During his incumbency the steward is entitled to keep all the fees contributed by users of the mills. However, as part of his duties he is also required to provide all the oil required for fuelling the votive lamps (*mchod-me*) that are lit in the monastery every evening. The oil used is a type of Indian margarine, locally called *shing-mar* (lit. "wood butter") that costs around Rs. 1000 for a large tin. The annual requirement of this oil is about six such tins, and the profit margin is therefore similar to that on the village mills. The monastery mill probably attracts a larger number of users than the other two, because of a belief that, by donating their fees to the monastic community, the millers are also earning a certain amount of merit.

In a number of villages in Mustang it is the case that fees collected at watermills provide the payment of public servants. This is true, for example, in Dzong. In Dzong there are four watermills, three of which are powered by the water of the Dzong Chu and one by the main irrigation canal. The village officials include six constables (*rol-po*) who are selected by lottery and serve for a period of one year. Local officials do not always receive remuneration for their services: until 1992 in Te, for example, it was customary for headmen to be *fined* a sum of money at the end of their term of office. Elsewhere (as in Kag) the constables and headmen receive a fixed stipend in cash, while in other villages (such as Tshug) they are entitled to keep a percentage of all fines that are levied within the community. In Dzong, however, the constables receive a percentage of the flour produced at the two mills. The system operates as follows. The

constables are paired, and the three pairs collect the user fees according to a three-day roster. The quantity in question is one-fifteenth of the amount of flour milled on a given day. One of the mills is more efficient than the other and attracts a larger clientele: villages which have no mill of their own (Putra and, until recently, Chongkhor) also come to Dzong to grind their grain. In this case, however, the flour is not shared equally between the two constables who are the beneficiaries. Instead the two constables themselves alternate, every third day, with respect to the mill from which they will claim a fee. Let us say, for example, that the turn of constables A and B falls on a Saturday. Constable A will collect the fee from the users of the superior mill, and B will receive a percentage of whatever is produced at the other. The following Tuesday, when the turn of constables A and B comes around again, it is B who will be attached to the more profitable site, while A will take his chances at the poorer mill. There is, in fact, a tendency for millers to time their use of a mill so as to benefit a constable who happens to be a friend.

A similar system to that of Dzong operates in Thini. A document in Tibetan, dated 1934 and dealing with the regulations of the community, contains the following clause: "The income of buckwheat at the upper watermill shall be the headman's; that of the three other mills shall be for the constables". Since there were at this time six constables in Thini and only one headman, it is apparent that the flour stipend of the latter was double that of his assistants.

Traditionally, it was not only these monastic and secular officials whose remuneration was linked to watermills. A document from Te, probably dating from around the early eighteenth century contains

the following passage:

After Buchen Thorang left [Te] for the religious life, our nobles masters [the rulers in the Muktinath Valley] told us to bring him back. He has returned here after becoming a wandering bard. While awaiting [the appropriate] permission from you nobles, he has not shared any utensils with us Tepas. We made Yungdrung Norzab beg for his flour beside the watermill, and hesitated to associate with him. This is an instance of how we honour you.

Wandering bards (Tib. *ma-ni-pa*) are, even today, regarded as being of low social status. Although it is not explicitly stated, the Yungdrung Norzab named in this extract is presumably also a bard like Buchen Thorang. For mendicants of this sort whose lowly rank forbade them entry to households, the watermill represented a place where they could hope to benefit from the generosity of villagers. In Dzar (Nep. Jharkot) there are six watermills (one fell into disuse in 1993) at the bottom of the river gorge below the village. They are all situated along one water channel close to the river, and this channel appeared to be solely for the mills, without any irrigation function. One of the mills is owned by the monks of the village gumpa, one by nuns, and four are collectively owned by the villages. Users pay in flour for the use of the mill, but there is no fixed amount.

Mill owners in Chongkhor traditionally received payments from the village in excess of the standard

user fees. As in Kag (Nep. Kagbeni), the latter were not fixed but consisted of whatever the millers deemed appropriate. (The three Chongkhor mills fell into disuse over twenty years ago, and until the recent construction of several watermills by the aid organisation CARE Nepal the villagers used to grind their grain in neighbouring Dzong.) For the merit-making funeral feasts called *gewa* (Tib. *dge-ba*), every individual in the village receives a ball of boiled rice or buckwheat stodge and one rupee from the bereaved family. On these occasions the mill-owners were particularly honoured. Of the three mills in the village one belonged to a single individual, one to two joint owners and one was owned by three shareholders. In the latter case, one person owned a half and two others a quarter each. The fees for each of the mills were divided according to the proportion that each held. On the occasion of *dge-ba* ceremonies the owners of each mill would receive one ball of food and one rupee above their quota as inhabitants of Chongkhor. Thus of the three shareholders of the third mill, one would receive half a football and 50 paise, and the two others would each a quarter of a ball and 25 paise. Although the mills have been out of use for over two decades, the owning families continue to be so honoured.

In Te there is a household roster for use of the mills. Each of the mills is used by two of the four sectors into which the community is divided, and any changes within the two circuits may be made only by arrangement between the households concerned.

In a Tibetan Buddhist society where the power of the winds is employed to spin prayer wheels, and where prayer flags fly from every house, it is not surprising to find the mechanism of the horizontal watermill also adapted to turn prayer wheels,

Watermills in Mustang

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chukhor (*chu-'khor*, lit. "water wheel"). Since the purpose of these devices is religious, and without any direct material benefit, the wheels turn in the opposite direction to the rotation of mills (viz. clockwise and anticlockwise for Buddhist and Bonpo communities respectively). Several examples were seen, in Geling, Muktinath, and across the Thorong La in Nyeshang, with a chute and wheel half the size of a mill, housed in a small stone structure surmounted by a *chörten*. *Chukhor* are also quite common in neighbouring Dolpo. A particularly good example is to be found in the religious community of Shey, which, although it has no flour-mill, boasts a cluster of half-a-dozen water-driven prayer-wheels.

Notes

¹ The authors are grateful to Rebecca Saul and Tim Calder for their valuable remarks on an earlier version of this article.

² The usual Central Tibetan word, *chu-'thag*, is not used in Mustang (*chu*: water; *'thag-pa*: to grind).

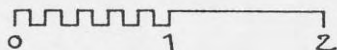
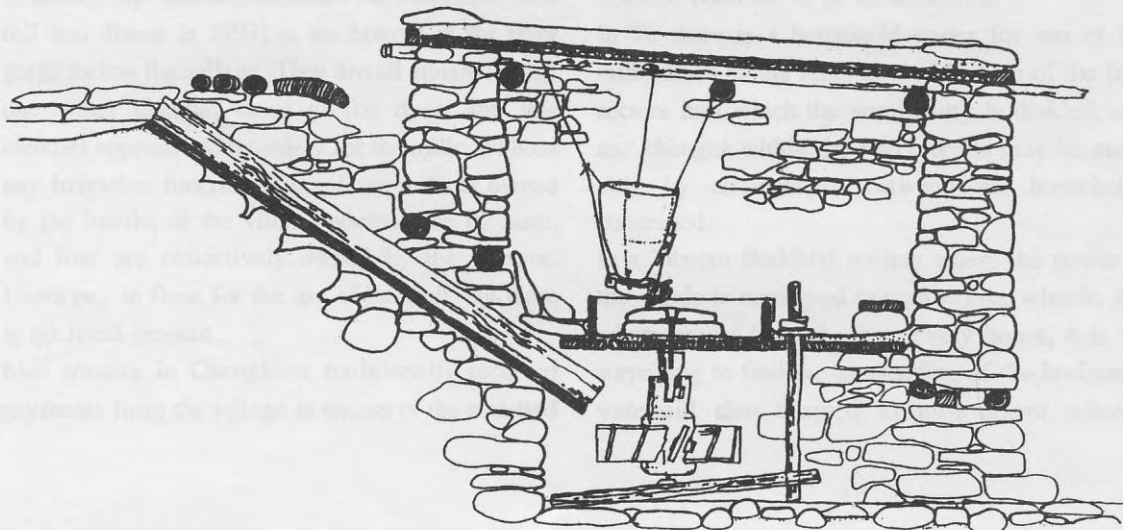
³ *Churag* is also used as a derogatory term for a small dwelling house.



List of Illustrations

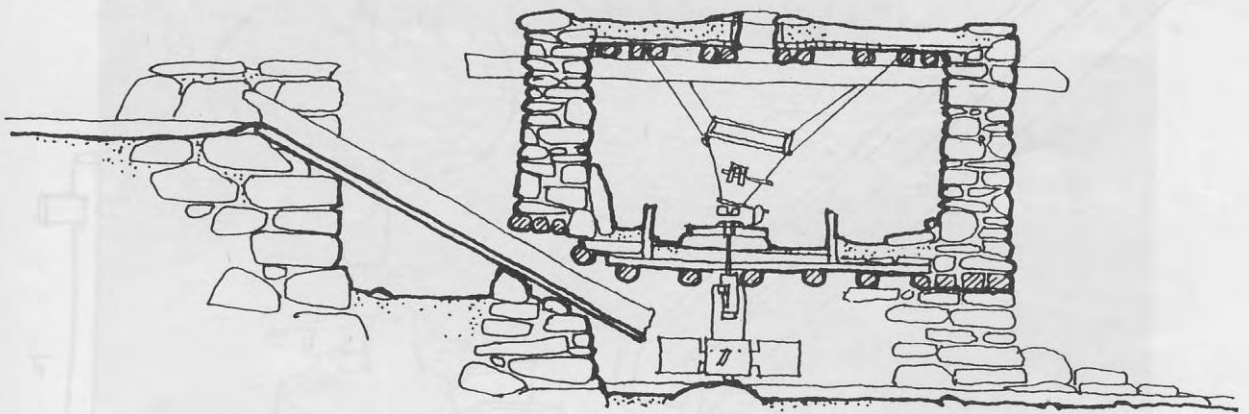
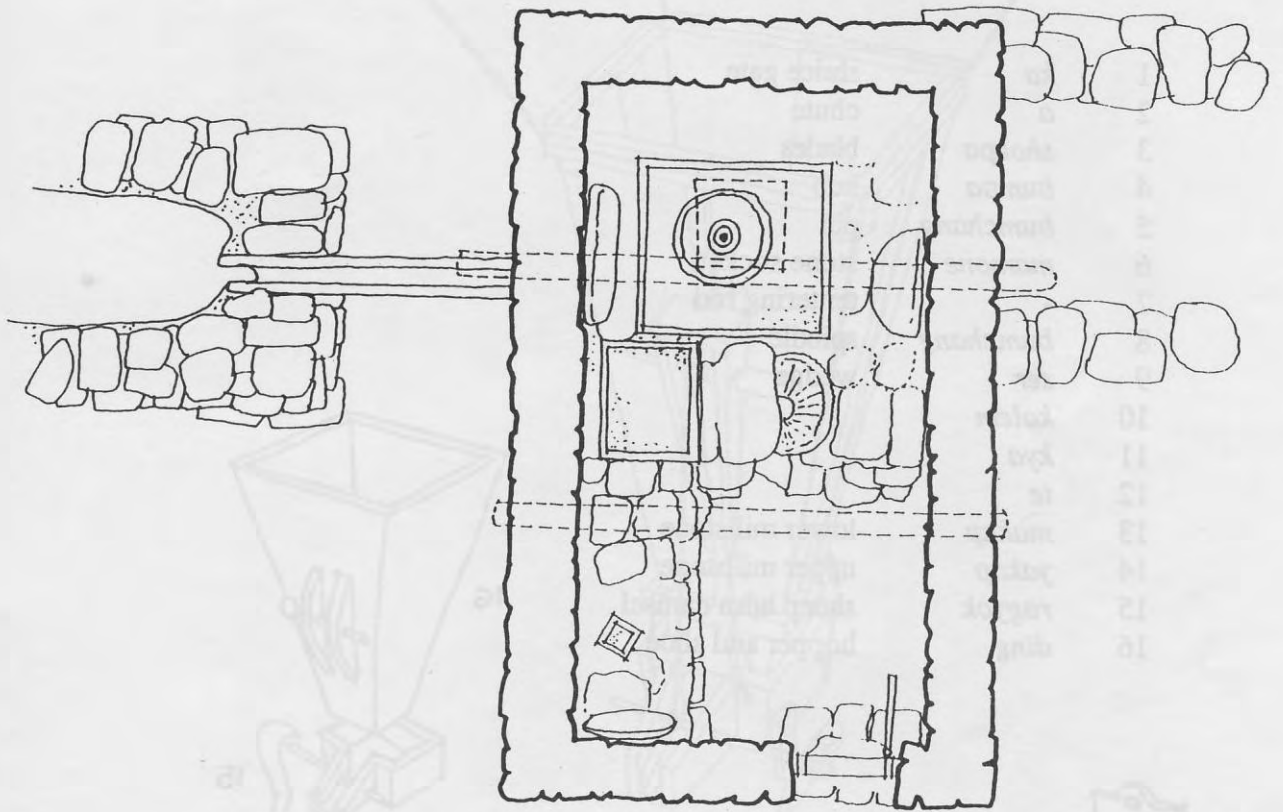
1. Watermill, Thini, section
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1. Watermill, Thini, section



THINI WATERMILL
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2. Village watermill, Kagbeni, plan and section

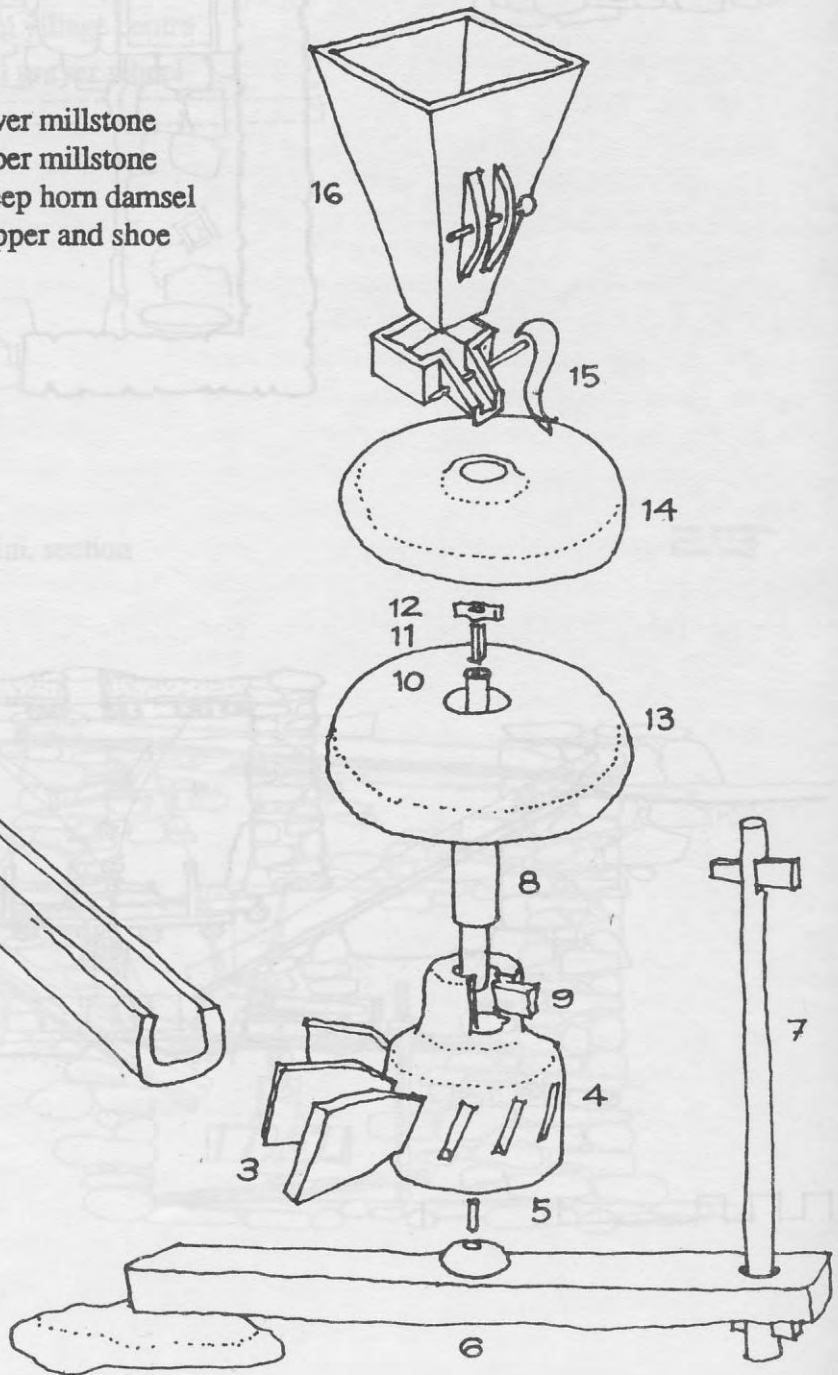
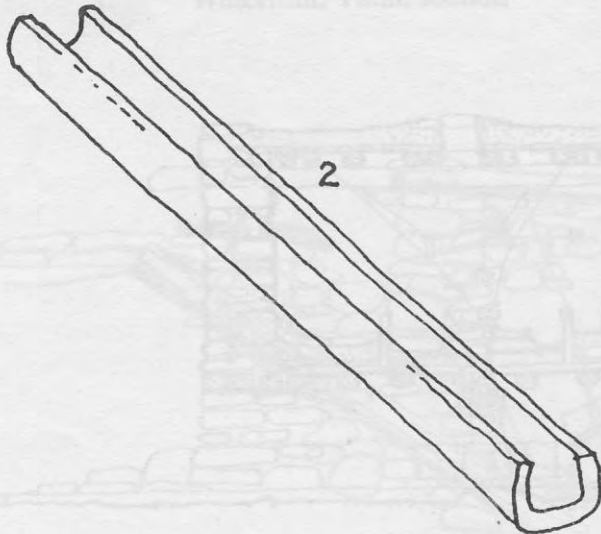
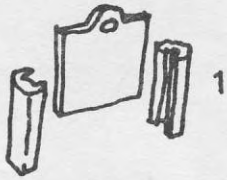


KAGBENI,
VILLAGE 1461
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SCALE 1:50

3. Watermill machinery parts

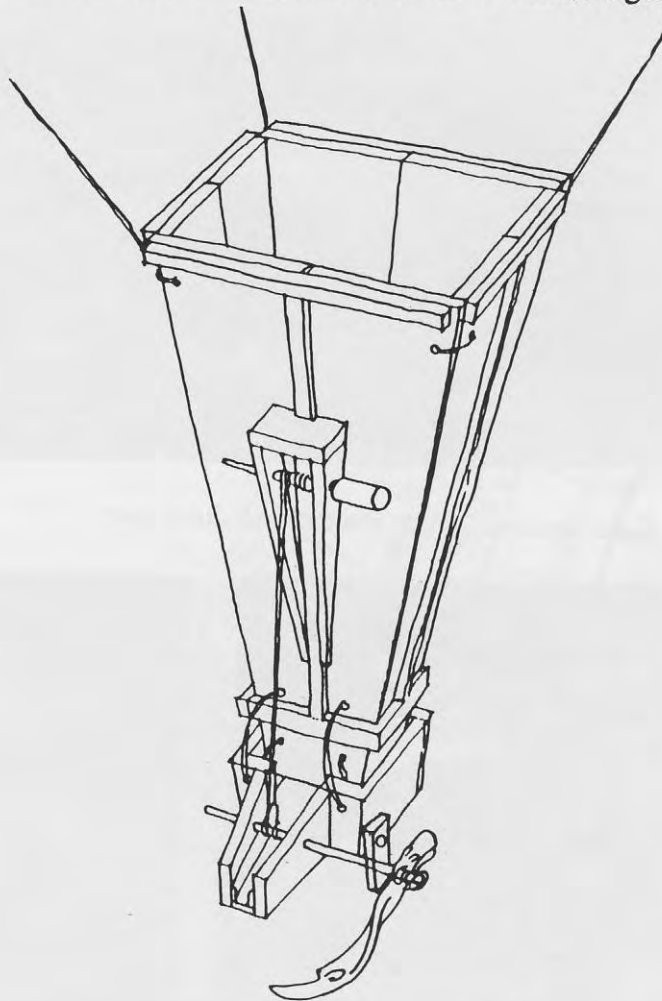
Parts of the watermill (*churang khangba*) as named in Kagbeni

- | | | |
|----|-----------------|-------------------|
| 1 | <i>ka</i> | sluice gate |
| 2 | <i>a</i> | chute |
| 3 | <i>shokpa</i> | blades |
| 4 | <i>bumpa</i> | hub |
| 5 | <i>bumchang</i> | pin |
| 6 | <i>mamone</i> | stone socket |
| 7 | - | tentering rod |
| 8 | <i>bumchang</i> | spindle |
| 9 | <i>ser</i> | wedge |
| 10 | <i>kolem</i> | |
| 11 | <i>kya</i> | |
| 12 | <i>te</i> | |
| 13 | <i>makap</i> | lower millstone |
| 14 | <i>yakap</i> | upper millstone |
| 15 | <i>ragyok</i> | sheep horn damsel |
| 16 | <i>ding</i> | hopper and shoe |



4. Grain hopper

Wooden hopper in watermill of Pema Drolkar, Kagbeni



5. Kagbeni watermill



6. Thini watermill, water channel and sluice gate



7. Thini watermill, showing chute, wheel and tenting rod



8. Thini watermill interior

9. Plan of Kagbeni village centre



Plan of Kagbeni showing location of watermills

KAC - SITE PLAN - OCTOBER 1991

BUJAY BASUKALA - NIELS OUIŠCHOW - ROBERTI KOSTKA





10. Water-powered prayer wheel