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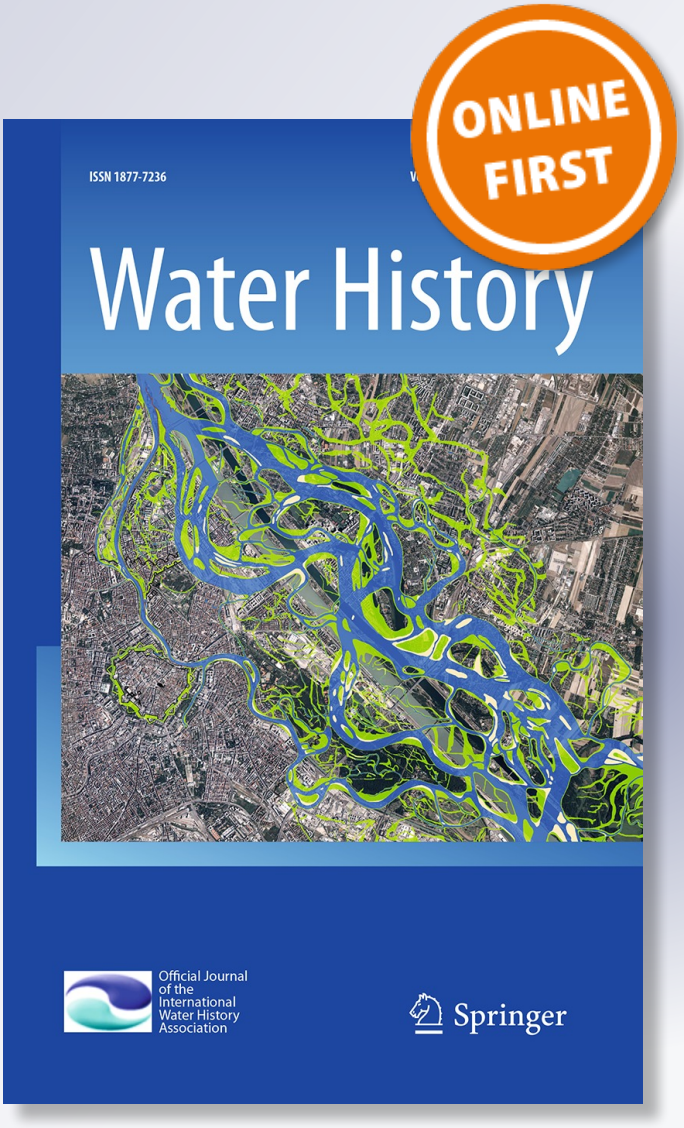

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Bureaucratic control of irrigation and labour in late-imperial China: the uses of administrative cartography in the Miju catchment, Yunnan

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Abstract The sequence of 12 woodblock maps presented here from the mid-nineteenth-century gazetteer for the department of Dengchuan in southwest China shows the Miju river and the irrigation system that lay at the heart of its farming economy. The incorporation into the cartography of much of the administrative detail related to the compulsory mobilization of labour for the annual clearance of mud makes it unusual among Chinese maps depicting water control in this period. The clarity with which it shows the recent formation of a long, spit-like delta of deposited sediment protruding into the Erhai, the large mountain lake into which the river empties, also assists the dating and analysis of the environmental crisis that occasioned it. During the late seventeenth century, and much of the eighteenth, the pressure of population caused the opening for cultivation of the unstable mountain soils on the slopes of the catchment just upstream of the section depicted by the maps. The result was a massive increase in the river's load of sediment. The dykes of its downstream bed rose to a level above the surrounding farmland. The increased need for maintenance led to the restructuring of parts of the system of government, and the lives of the local people, so as to handle the new problems. We have found that the accuracy of the maps was adequate for planning and executing middle-sized water control projects at the technical level of that time.

Keywords China · Irrigation · Cartography · Yunnan · Qing · Administration

The main features of the sequence

The format of the map presented here is that of a traditional Chinese landscape scroll through which, following graphic convention, the reader 'walks' in his or her mind from right to left. There is thus an implicit dimension of time, which in this case matches the

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flow of the river from north to south, that is to say from right to left. The map thus faces west, and the reader is looking from a point close to the old inland frontier of imperial China in the direction of the lower slopes of the Himalayas. The elevation here is already about 2,000 m. To fit into a book format the scroll has been subdivided by its designers into twelve double-page panels shown here as Figs. 1 (i–vi) and 2 (vii–xii). They come from the section on 'Maps for hydraulic works' in a facsimile reprint of the local gazetteer of Dengchuan department printed in 1854–1855 (Hou 1854). This was an official publication and prepared at the departmental office (Fig. 3). Its contents and physical context show that it was intended to accompany a Record of River Works produced early in the nineteenth century, and included in this gazetteer. Much more than this we do not know about its provenance.

These images follow a very ancient Chinese cartographical tradition in hydrographic mapping, following the first treatise of Sang Qin, the Shuijing (Waterways Classic) in the first century BCE, and the appearance of the first river maps from the Qin onwards

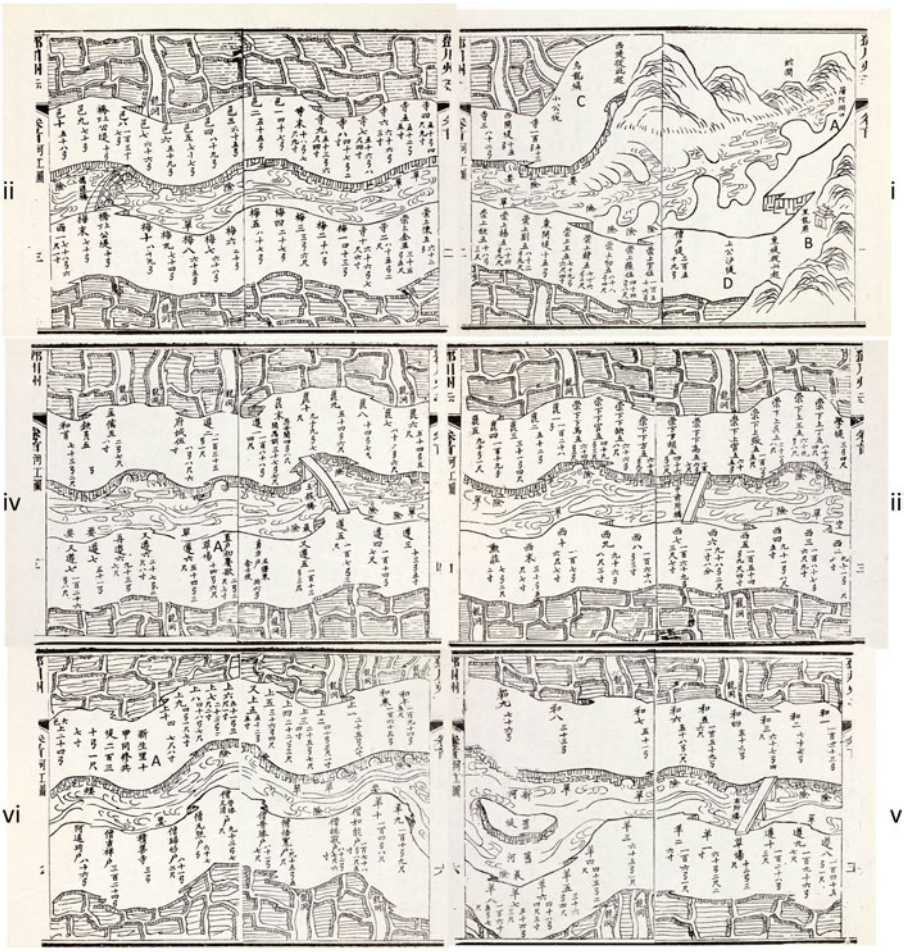

Fig. 1 Work sectors on the Miju River 1–6

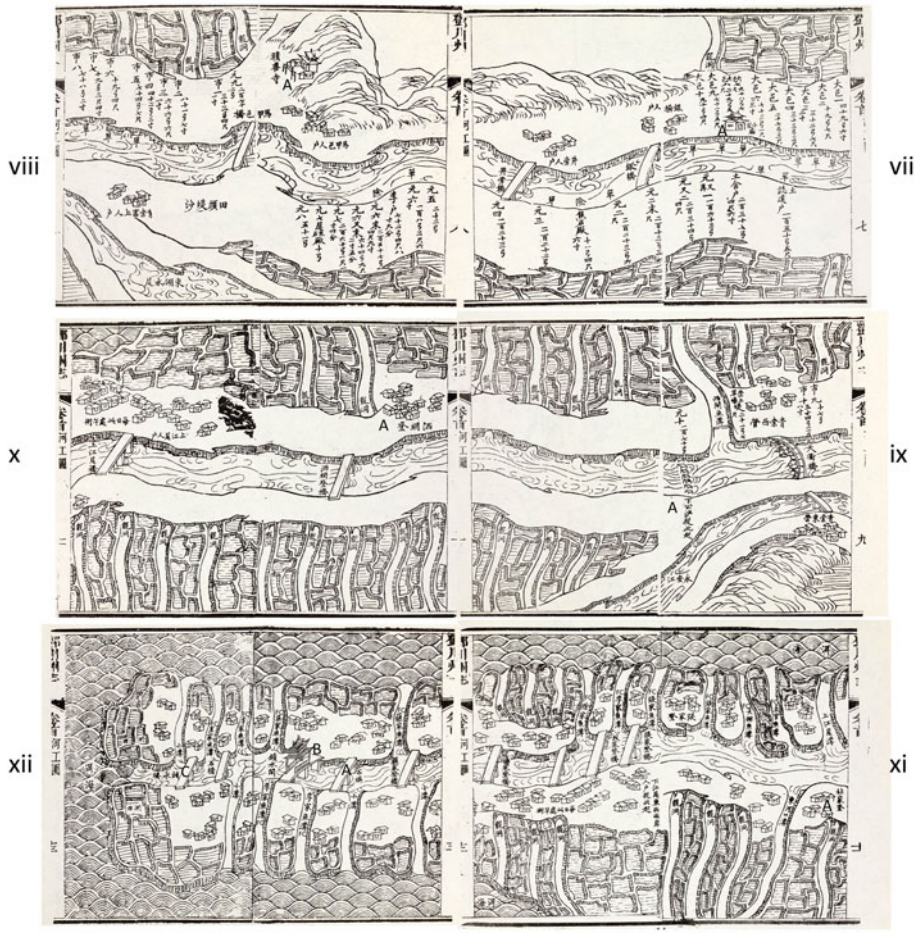

Fig. 2 Work sectors on the Miju River 7–12

(Needham and Ling 1959). However, unlike some other hydrological maps of this period, such as the Hangzhou Cheng Tu, which is a mixture of planimetry and pictorial representation (*dili tu*) (Harley and Woodward 1994), these maps are solely pictorial representations showing a panoramic view like that found in a pictograph map of Erhai in Ming times (Elvin et al. 2002), a panoramic map from Fu Zehong known as the X*ingshui jinjian* (Golden Mirror of the Flowing Waters) from 1752 CE (Elvin and Liu 1998), the prefectural map from the 18th century manuscript of Jiangxi Province (Harley and Woodward 1994) and the complete map of the Jinshajiang (*Jinshajiang quantu*) that relates to a river dredging project in the Chinese Province of Yunnan, 1741–1749 (Vogel no date). This is not too surprising given the somewhat eclectic manner of representation used in hydrological maps that ranges from purely planimetric (although not necessarily to scale) through to purely pictorial, a tradition which goes back as least as far as the Yuan (Mongol Dynasty) (Needham and Ling 1959; Harley and Woodward 1994).

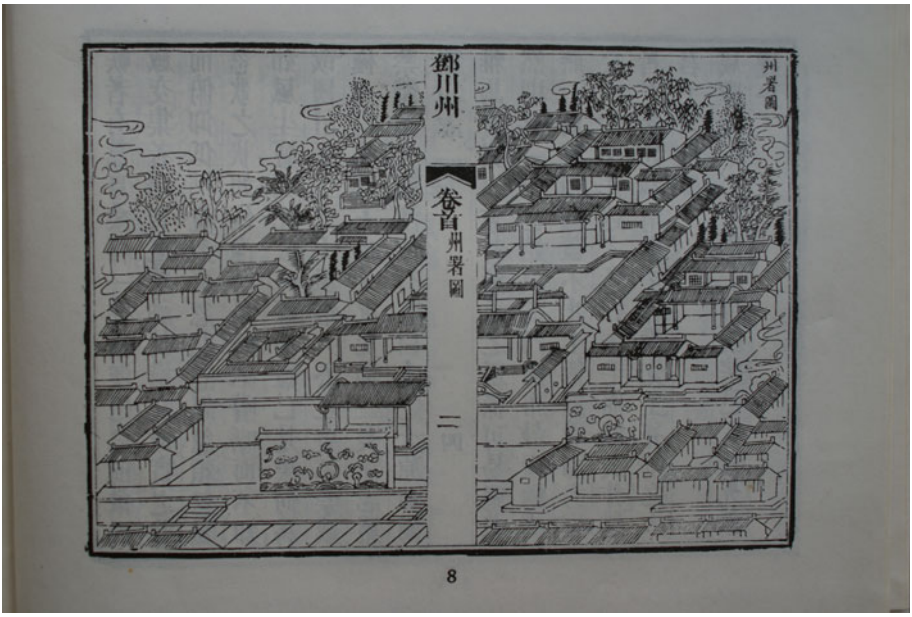

Fig. 3 Dengchuan offices where the maps were prepared

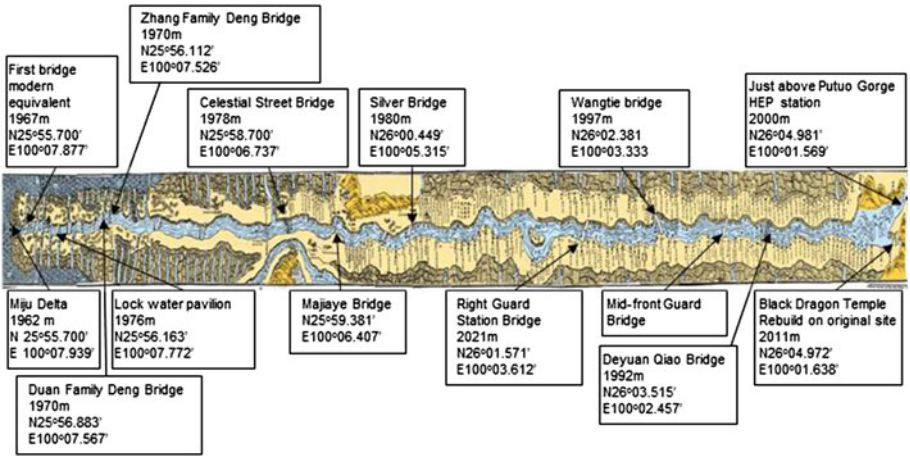

Fig. 4 Composite map and GPS locations

The axis of the map, both visual and conceptual, is the lower Miju river (Fig. 4). The overall length of the section covered by the scroll of panels is about 24 km. Approximately a further 20 km that are not shown in the scroll lie to the north (that is, to the right), upstream of the Putuo 'Cave' (Fig. 1iA). This latter is in fact not a cave but an often vertiginous gorge along whose eastern side a narrow motor road has been cut in recent years. Immediately above the gorge several other lesser rivers join the Miju, greatly increasing the flow through it and below it. This water is the resource that sustains the irrigated agriculture in the levelled and somewhat cellular dyked paddy fields that can be

Table 1 Key to hydrological features found in the Miju River

Chinese character	Hydrological feature
矮	Low point
空	Hole
要	Narrows
險	Dangerous places
單	Sand banks
龍洞	Dragon grotto = drainage sluice

seen lying like the tesserae in a mosaic on either side of the main stream. Before the coming of powered pumps water was mainly obtained through the temporary opening of gates into what are shown in the maps as 'drainage sluices' (see Table 1). The Chinese term for them, *longtong*, literally means 'dragon conduits'. The Chinese dragon of folklore, unlike his western cousin, was an aquatic beast. To read the map in hydrological terms it is necessary to remember that by the date it was made the accumulation of sediment had already raised the course of the river between its dykes above the level of the land to either side of it. Gravitational flow controlled by these sluice gates was all that was needed to irrigate the fields and also, through exit channels not mapped here, to drain them to points further down the slope. So far as is possible to tell, the presence or absence of a levee, that is to say a dyke running parallel to the flow of the water, can be determined by the presence or absence of the short vertical inscriptions in the map bearing both the names of river subsections and their lengths in Chinese numerals (these labels are easily recognized in the overview presented in Fig. 4. They flank both banks along about three-fifths of the waterway.) Along the eastern bank, or in visual terms along the lower part of the scroll, the containing dyke starts just downstream from the Black Dragon Temple (Fig. 1iB). Its counterpart along the western bank begins slightly lower downstream at the Xiaogong Dyke (Fig. 1iC). On the east side it ends where the names and lengths of its sections are no longer recorded; this is about two-fifths of the way from right to left in Fig. 2viii. On the west, after a break where the hills between the Temple of the Little Dragon and the Temple of Accumulated Goodness served as natural defences (Fig. 2viiA, viiiA), it terminates slightly further downstream where the records likewise stop, about one-sixth from the right-hand margin towards the left (Fig. 2ix). The delta was said to start shortly after this at Xiagong Sands (Fig. 2ixA) where there is a line of what look like seven outsize stepping-stones across the river, but whose actual purpose is not known. Two small settlements in the delta area are labelled *deng*, which probably indicates a raised mound that provided some security from flooding (Figs. 2xA, xiA). The primary crop on this irrigated land was historically rice. It was increasingly supplemented as time went by with wheat and interstitial short-term dry-field harvests from the drained paddy-fields of pulses like the broad beans one finds there today. Leaving aside the lesser tasks of tending vegetables and fruit-trees, the Dengchuan gazetteer (p. 7b/42) summarizes the main year's work as follows:

> As a general rule men and women keep each other company for the hard toil, but women are commonly the more numerous. In the second month of the lunar calendar

> the ‹rice› seeds are spread ‹in seed-beds›. In the third month, the broad beans are harvested, and in the fourth moon the wheat. In the fifth moon the rice seedlings are planted out; in the sixth and seventh moons they are weeded. As a general rule there must be three rounds of weeding; if not, then knotweeds will be sprouting forth. In the ninth and tenth months, the rice is harvested and the broad beans planted. In the entire year there are only 2 months for rest, and the obligatory work on the river during the first second, third and fourth months have still not been taken into account.

We can, if we wish, people the empty fields of the map in our imagination with peasants engaged in these tasks. The land was kept fertile under this unrelenting pressure by the constant application of manures, there being no time economically available for fallowing in these high-yielding fields. Maintaining such a system, with its structures built of hardened mud, and constantly undermined by the attrition of weather, currents, and human movements, as well as at times by the breaking of the dykes when the Miju was in spate, was the key to preserving the life-line of the local economy. The map was produced to be of assistance in the administration of this never ending task. Though we have found no explicit statement to this effect, this function emerges at once by implication from the opening lines of the Record of River Works 1845 (p. 9):

> The presence of the Miju river in western Yunnan only amounts to a spoonful of the quantity of the ‹nearby› Lancang [sc. the upper Mekong]. Nonetheless it needs 60,000 men each year to clear and dredge it, and half that number again to ram down the earth for its embankments. This is a massive obligatory task the like of which has never existed anywhere else in Yunnan ‹province›. When one examines the ‹dykes and channels in› precarious places and critical locations, it is essential to inspect the topography with care. Once one has appraised the advantages and disadvantages, one must then draw up tightly formulated regulations. If discipline is strict, the rules made to serve the public interest will be adhered to. If one plans the expenditure and ‹properly› evaluates the schedule for the works, then there should be a ‹budgetary› surplus ‹ready› in reserve. There must be established procedures to cover everything. People's survival is not to be treated as a children's game. Nor should crises be made into a source of profiteering. From investigating, measuring, making recommendations, and putting these last into good order in a form appropriately reduced in length there arises a comprehensive and ‹almost› supernatural understanding. Nonetheless, instituting procedures is only the means, not the substance. To counteract this, one's methods should be systematic. After laying down rules, one follows them. Any heedless remarks, and any relaxation, are dangerously improper.

The map, with its wealth of details, was an exceptional weapon in the armoury of a local government faced with what it saw as an exceptional problem. It is evident why maps of this exact type were relatively rare in late-imperial China. A limited number of somewhat comparable pictorial cartographic scrolls linked to the use of water and land were however produced in other places in the Empire during this period. An example of the latter kind is the sequence of maps covering the Wan river and its banks in southern Zhejiang province, published sometime in the eighteenth century and reissued in 1865 (Morita 1991). Besides serving the basic purpose of geographic orientation for the administrators, this series only provides quantified information regarding the officially approved role of specified cartographically identified areas as 'lakes' where their long-term popular conversion to wet-field farming ran contrary to policy. It implicitly asserts the state's right to dictate the type of economic exploitation practised in these locations, but it seems from the

accompanying historical documents that government had only limited success in getting its way. Reasonably enough, different issues motivated the production of different bureaucratic tools. The last three panels of our scroll (Fig. 2x–xii) show the river flowing out into the Erhai lake. It is running through the middle of a lacustrine delta in the form of an extended spit that it has itself built up, as we know from a variety of other sources (Elvin 2005), over a period of about 150 years before the gazetteer was published. That the process of accretion was still continuing can be deduced from the Chinese label attached to the fields of the growing-point at the tip of the delta. They are called *yutian*, which means 'alluvial lands'. They were created from the sediments dropped by the river when its current was slowing down as it reached the lake, and so losing almost all its remaining capacity to carry its earlier burden of sands, silts, and muds. This final sector of the Miju contained what appear to have been a tripartite structure to control the movement of water. The installation furthest from the mouth was the Stone Barrage (Fig. 2xiiA); the second furthest was the Lock Water Pavilion (Fig. 2xiiB), and that nearest to the lake was the Lock Water Bridge (Fig. 2xiiC). One possible function of these, and presumably some of the other small channels, was to maintain a constant flow of water at the best speed for the fish traps that occupied the twelve 'fish channels' (Fig. 2xi, xii marked as FC). These were devices constructed so as to draw fish from the lake into what were essentially one-way corridors and holding pools where they could easily be caught. The Dengchuan gazetteer describes how they worked:

> The fishermen open up ways for the water to pass through at places where the Miju river runs alongside the Erhai lake. These are termed 'fish channels'. In these channels they interweave bamboos at the channel's foot as if setting up a gate made of railings… Generally speaking, it is in the nature of fish to move against a current. The water from the river enters the Erhai through the channel, and the Erhai fish enter the channel one after the other and run up against the railing-gate. If the water at the railing-gate spits froth, the fish leap and splash about all the more, and make their way ‹more eagerly› into the ‹narrow oblique entry in the› railing-gate. Once the fish have entered its mouth, the fishermen use nets made into ‹the shape of› sacks to hold them without effort, and pull them up at no expense. ‹The fish› leap and splash about like shuttles travelling back and forth in looms. It is beyond imagining how many ‹the fishermen› haul in through the hours of daylight and darkness.

But fishing was a source of contention. The Record of River Works 1845 (p. 80) tells the following tale:

> Households that catch fish have been heard to say that whenever one opens up a fish channel it is essential that one causes the water to enter the channel but ‹ensures› that the sediment remains in the river. If this is done, the channel will not become blocked up, and the fish will swim against the current in large numbers… The ‹owners of› the fish channels struggle with each other for water from the river, but pay no attention to the sediment from it. In this way the current becomes weaker, and sediment accumulates on the bed. People merely rely on 10 days of clearing and dredging at the beginning of spring. The houses of the inhabitants are as tightly packed on both banks as the teeth on a comb. Since there is no place to deposit the sediment that has been scooped out, people are obliged to place it at the sides of these houses. The residents find this offensive; and there are frequent vociferous quarrels. The authorities have become irritated at the popular clamour and put an end to the

> practice ‹of dumping›, ‹with the result that› the lower reaches ‹of the Miju› have become completely blocked… This accounts for the nature of the disasters.

The peaceful impression given by the sketch of the little settlement at the end of the spit in Fig. 2x–xii, where—as elsewhere in the scroll—no people intrude on the scene to impair its tranquillity, should not be allowed to conceal what seems to have been a rough reality.

The detailed features of the sequence

The dominant theme of the maps is the division of the banks along the greater part of both sides of the river into sections identified by distinctive names. The majority of these designations start with the first character of the name of one of the cantons (*li*) that formed the bottom-level administrative units. In other instances they are mostly the names of households, dykes, and work-sites. The majority of the sections are then further split into numbered subsections. Each subsection, and each of the few sections not subdivided, carries a note giving the length of the riverbank dyke for which it is responsible. This is denominated in terms of *gong*, *chi*, and *cun*, that is, according to the Qing dynasty's Board of Works, lengths of five feet, one foot, and 1 in., respectively (Record of River Works 1845, p. 80). The traditional Chinese 'foot' and 'inch' were quite close to traditional British measures, though the Chinese foot contained ten rather than 12 in. Without local physical evidence, the extensive local and function-related variations in late-imperial measures make it hard to be more precise about the foot (see Naval Intelligence 1945; Qiu Guangming 1992). Unfortunately there are two further well-supported traditional equivalents for the *gong*. One is six feet, and the other is eight (Morohashi 1966). Neither, though, is right in this instance. In the Miju scroll here are six cases of some number of *gong* plus nine feet, though none of ten feet or any higher number; and the obvious inference is that in Dengchuan there were ten feet to the *gong*, at least for river dredging (Table 2). Such are the hazards of quantitative work on premodern China. There is no direct proof that the purpose of these labels defining locations and lengths along the dykes with such minute precision was to assist in the allocation of labour for maintenance operations. There are, however, three reasons for thinking that this was so. The first is that in the upper left-hand corner of Fig. 1viA there is an entry for the west bank of the Miju that is unlike any other, and that it is reasonable to read as an exception that is revealing when one poses the question 'exceptional with respect to what?' It reads:

> The tenth tithing of Xinsheng canton together repairs the 1,151.7 feet of the dyke that they have in common.

A 'tithing' was an old term for a group of at least nominally ten families, in this case probably a historical residue of an earlier joint security system, now discontinued. We thus have in this particular case ten or so heads of families who are collectively responsible for maintaining a collective stretch of dyke. Our best guess at the present moment is that the majority the other subdivisions were bureaucratically established areas of residence without necessarily any historical legacy of collective functioning. The second reason is the general one that our knowledge of other parts of China at about the same time suggests that somewhat similar ways of allocating responsibility to particular proprietors were at least sometimes to be found. In the county of Shanghai, after the later eighteenth century, the obligation to furnish a certain quantity of work expressed in terms of a specified volume of mud to be removed, and/or of supplementary taxes to be paid, was imposed on

Table 2 Cumulative work sector lengths as recorded on the maps

Miju River work sector	Cumulative work sector length as recorded† (adjusted Chinese measures)			
	Gong (1 gong = 5 Chinese feet)	Feet (1 foot = 10 in.)	In.	Cumulative length
Sector 1 West	188	0	0	188
Sector 1 East	797 (805)	41 (1)	4	797/41/4 (805/1/4)
Sector 2 West	1,063 (1,068)	25 (3)	36 (6)	1,251/25/36 (1,068/3/6)
Sector 2 East	898 (903)	26 (1)	7	1,695/67/11 (903/1/7)
Sector 3 West	1,166 (1,178)	64 (4)	0	2,417/89/36 (2,434/7/6)
Sector 3 East	1,198 (1,208)	49 (4)	53.8 (3.8)	2,893/116/64.8 (2,917/4/4.8)
Sector 4 West	748* (761)	68 (4)	14 (4)	3,165/157/50 (3,197/4/0)
Sector 4 East	718 (727)	44 (0)	13 (3)	3,611/160/77.8 (3,644/4/7.8)
Sector 5 West	710 (713)	18 (3)	0 (0)	3,875/175/50 (3,911/0/0)
Sector 5 East	1,060 (1067)	38 (4)	13 (3)	4,671/198/90.8(4,712/4/0.8)
Sector 6 West	921 (930)	43 (1)	36 (6)	4,796/218/86 (4,841/1/6)
Sector 6 East	1,302 (1312)	53 (4)	11 (1)	5,973/251/101.8 (6,025/1/1.8)
Sector 7 West	521 (529)	42 (3)	11 (1)	5,317/260/97 (5,370/4/7)
Sector 7 East	1,565 (1569)	22 (2)	6 (6)	7,538/273/107.8 (7,594/3/7.8)
Sector 8 West	684 (689)	24 (0)	18 (8)	6,001/284/115 (6,060/0/5)
Sector 8 East	804 (808)	21 (3)	27.8 (7.8)	8,342/294/135.6 (8,403/2/5.6)
Sector 9 West	241 (241)	3 (3)	8 (8)	6,242/287/123 (6,301/4/3)
Sectors 9E + 10–12E and W (7 sectors)	No measurements given downstream of Xiagong Sands			

† The individual recorded number for 'feet' found on the maps ranges from 1 to 9, this is incongruent with the Chinese measure of 1 gong = 5 Chinese feet a factor best explained as either a Chinese cartographer's or woodblock-cutter's error

* Omission of length from one section of this sector

landowners on the general basis of their proximity to a dredging project being undertaken, and proportionately to the acreage that they owned (Elvin 1968). The third and most persuasive reason is that this pattern fits with what evidence there is about the tightening up of the system of annual hydraulic repairs on the Miju in the later eighteenth century (Elvin et al. 2002). The Record of River Works 1845 (p. 80) describes two stages of reform after repeated breaches in the dykes made clear the urgent need for something better organized. Since the departmental magistrates changed about once every three years, we will not give their individual names in what follows:

> The department magistrate…divided the entire river into four sectors. He ordered each tax-paying household to dig out the sediments accumulated at their own dyke. This was termed 'dyke-matching.' Each sector had a limit of five days; when the sector upstream had finished its dredging, the one downstream of the preceding was dredged next…Regardless, however, of whether the sediment was thick or thin, and whether the dyke was high or low, each length of five feet had a quota of two workers to finish the job. The criterion was workers, not the ‹amount of› sediment, or the dykes ‹needing to be fixed›. Sometimes some of the commoners would hire

> recruits ‹as substitutes› when enrolment approached. Sometimes they would assemble when the officials arrived but scatter once they left. At other times again, they would be present in full numbers at the dykes but regard the dyke-defences as an empty formality. Even if there were sincere commoners, who exerted themselves with all their hearts, these latter would have trouble on every occasion. Either there was no sediment in their assigned area, so they could not bank up and augment a thin dyke, or, if massive deposits had accumulated nearby, where the banks were already as high as mountain peaks, then, being constrained by being in a different area, they could not arrange for mutual adjustments and assistance. Thus thick dykes grew thicker and thin ones thinner, and there were extreme disparities between the solid ones and the feeble. Collapses and breakthroughs appeared forthwith. This was why the river breached them three times in the 2 years 1816 and 1817.

The first major change was attempted the following year:

> In 1818 the departmental magistrate…pondered deeply on these abuses. Then he changed 'dyke-matching' to 'joint digging out'. He divided off from the Miju river a 'head' and a 'tail' at the Upper and Lower Gongsha (Figs. 1i, 2ix), which were directed by the middle ranks of his personal attendants. The four sectors ‹in between› were managed by his court-room officers, and by the Director and Sub-Director of the Department's Schools. At the beginning everyone encouraged each other to show diligence, but as time went on the work gradually came to be regarded as a source of profit. Finally they led one another on with brazen audacity in acquiring money and selling ‹the services of› workers. Functional efficiency did not reach half ‹its initial level›. What was more, they demanded bribes for further repairs to the dykes, paying no attention to the collapse of both banks. In this way the execution of the works fell into an increasingly impaired condition. In the years from 1828 to 1843, the bed of the Miju rose a further ten feet. The alleged reason for this was that 'the work was finished in summary fashion and a deliberate lack of concern'. After further efforts a new system was then promulgated in 1845.

Apart from what seem to have been members of hereditary and or institutional groups, like Buddhist monks, who continued to pay what was called 'commutation money' to provide the salaries of members of the local gentry and the lower levels of the department bureaucracy who supervised the work, 60,000 smallholding peasants were enrolled for seasonal labour-service on the dykes. They were split into groups of 28 persons who in aggregate paid a given amount of tax on their farmlands. When the year's maintenance was being organized, all of them had to participate. Instructions were given to make sure that operations were meticulously controlled (Record of River Works 1845, p. 89):

> It is hard to assign a quota for how many ‹river workers› should be in action on a given day, but if the matter is allowed to become confused and out of control, lacking a proper sequence, then delays and dilatory behaviour are certain to make wasteful use of the quota of workers. It is therefore essential, with regard to the places to be dredged on a given day, to go in person, and on foot, during the preceding day to examine the situation, and to evaluate the thickness or thinness of the sediments and stones,… assigning ten men to each platoon, and personally ordering the head workers to plant posts as boundary markers. When the workers arrive the next morning, there will be two hoes and eight baskets ‹for every 10 men›, which will be laid out for them in an arrangement that corresponds to these posts. After the middle of the afternoon, the manager of the works will inspect what has been accomplished

> platoon by platoon. If the clearing and dredging has been done following the specifications the order will be given to the canton runner to give out tickets to the men, according to their canton. If it has not been so done, then, even if it is getting late, he must still sit and keep watch, waiting until it has been completed. Where sediment is extracted, priority must always be given to banking up the flimsy ‹dykes›. The explanation of this is that, in general, in those places where the sediment accumulates, the bank concerned is always thick, and the bank on the opposite side always thin. Since the river workers have a pressing desire to get the work finished, they invariably dump the sediment on the dyke on the same side ‹as that from which it was dug out›. They are not willing to cross ‹the bridges temporarily erected›, or to walk any distance. This causes the thick dykes to become even thicker and the flimsy ones even flimsier. Therefore, in all the places where sediments have been deposited, if the two banks are equal, ‹sediment› should be divided between the eastern and western sides. But if one bank towers up and the other has slumped down low, it is necessary to dig the deposited sediment out deeply and use it to bank up the thin dykes solidly.

Coordination was essential as one can appreciate when looking at water-control operations done in contemporary China by large numbers of workers without machinery at their disposal (see Elvin 2009, p. 145). Future managers were advised (Record of River Works 1845, pp. 89–90):

> If there are a lot of workers they will crowd each other out in confusion, and deep dredging ‹to obtain mud› to bank up the precarious points will become impossible. If one wishes to wait till the next day and dredge some more, the water that comes through overnight will wash ‹the loosened, but not yet removed› sediments entirely away with its ripples, and it will be difficult to set to work again ‹for lack of material to heighten the dykes›. Therefore the schedule of work should proceed from downstream to upstream, sector by sector…

This is only a sample of the voluminous regulations issued. It is worth adding one more as a reminder of the tensions under which those taking part in the Miju system worked (ibid p. 87):

> After the time of the summer rise of the rivers in the sixth month of the lunar calendar, the water in them is like an overflowing flood. Those in charge of each sector must speedily submit a request to the department authorities asking that the order be given to patrol the river. They will make inspections on patrol both day and night, and if there are any places where ‹a dyke› is falling in ruins, the river patrol concerned must swiftly report it to the dyke-households, who are to make the utmost effort to struggle to repair it.

One might say that, in a sense, the rural inhabitants of Dengchuan lived in this map. But they did not just live in the physical world of its richly irrigated fields, morning and midday markets, hillside and river-bank temples, elevated mounds, teeming fish channels and precarious bridges, their lives sustained by the water wrested from the swirling currents, shifting sand banks, narrowed channels and underwater hazards depicted by its anonymous designer (Table 1). They also passed their years, more deeply and crucially, both supported and controlled by the meshes of this administrative structure of interwoven protection and coercion that the map symbolically represents. And many struggled no less than the fish in the traps to escape.

The attributes and origins of the Miju cartographic scroll

At a first glance the pictorial panels from the Dengchuan gazetteer seem to be careful but informal sketches with a few fleeting hints of height and distance. The artist's used what might be called an 'immortal's-eye view', with reference to the human-like spiritual presences of Chinese legend that were thought to be able to wander through space, roaming the clouds, and looking down on the earth from above. To a significant extent the aerial angle of vision flattens out the topography. More careful examination shows that this initial impression does less than justice to the accuracy of the map-making. This can be seen from Figs. 4 and 5. The original black-and-white images have been joined together here to form a continuous montage, and enhanced with artificial colour. The present-day sites of extant historic bridges and, where appropriate, their modern replacements, have been located by place and family names using readings from a Global Positioning Satellite system. The coordinates for latitude and longitude have been converted to decimal degrees via ERDAS Imagine 9.0 for display in ArcGIS 9.2, and the resulting consolidated transformation of the full scroll is what is shown in Fig. 4. The relevant Landsat imagery from Yunnan has also been downloaded and stacked to make a composite true-colour image of the lower section of the Miju. The GIS points have then been plotted using WGS1984 to see how they compare with the current course of the river. The results appear in Fig. 5, and it is evident that the visual correlation of the upstream parts of the river below the gorge is reasonable, but in the less stable region of the delta somewhat less satisfactory. To provide a sense of scale for the Chinese maps over the 20.7 km from the Deyuan bridge to the end-point of the delta, approximate distances between points—with some omissions—have been calculated on a straight-line basis. Overall, apart from a slight divergence arising from drawing a straight line through the western side of the delta promontory, the late-imperial maps appear on balance, as we have already said, to be accurate enough for practical administrative use. How, then, were they made, and why? We do not know the details, but the basic point to be emphasized is that they developed from an existing tradition of taxation. The Record of River Works 1845 (p. 80) outlines the legacy of the relatively recent past:

> The Miju river dykes. These were successively surveyed in *gong* and *chi* during the Ming dynasty during the Zhengtong reign period (1436–1949) by the department vice-magistrate…, and in the Chongzhen reign period (1628–1943) by the department vice-magistrate, and, under the present dynasty, at the beginning of the Qianlong reign period (1736–1995) by the department vice-magistrate… They demarcated boundaries according the tax grain paid. For every picul of grain tax owed by a commoner-civilian ‹on farmed acreage each year› they allocated 5 *gong*, 7 *chi*, and 3 *cun* of dyke. Each *gong* has 5 *chi* (sic). For the tax grain owing from the soldiers ‹working the fields of one of the military colonies› they set the rate at half of the foregoing. From the fifteenth day of the first lunar-year month, two workers were sent out for every length of the dyke of one *gong*. They had to proceed together to perform repairs and dredge the river on a basis of equality between them. The officials then examined how dedicated or dilatory they were, and evaluated their schedule of work when it came to an end after a month. The reason for ‹working at› this time of year was that the silts and sands in the currents of the river were still few. This is how they economized on the energy that was needed.

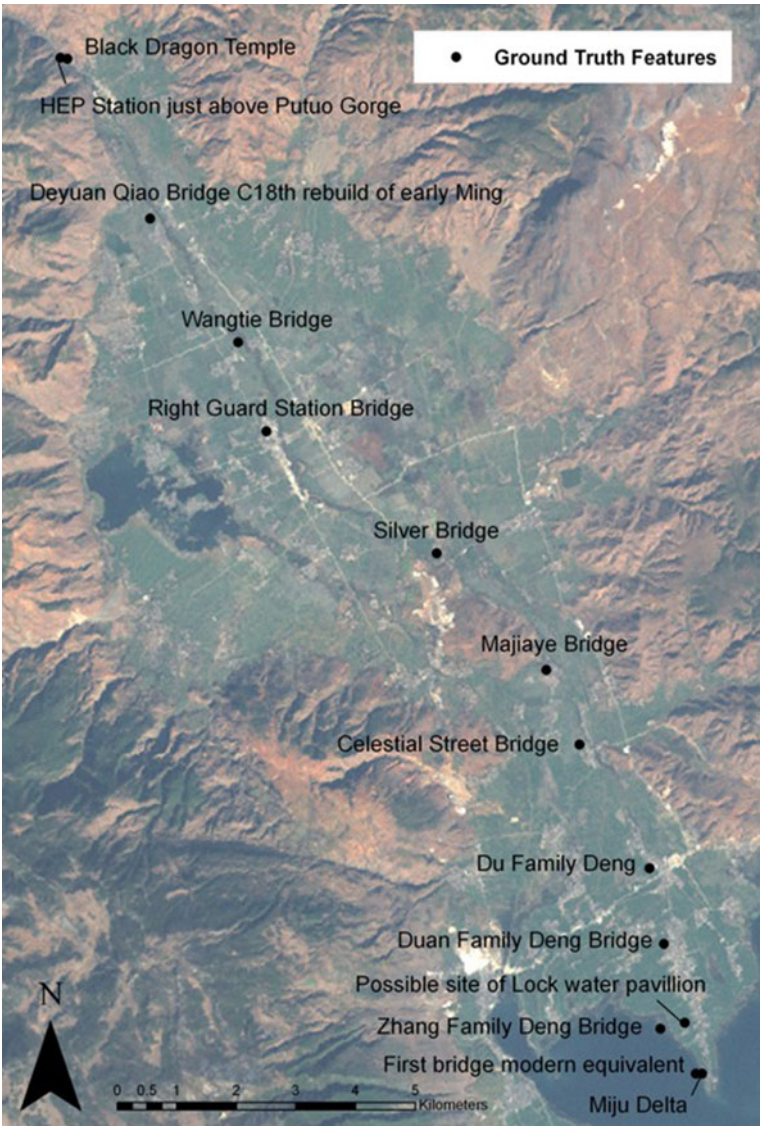

Fig. 5 A comparison of the historically referenced GIS points with the current course of the Miju river

It thus appears that the system that appears on the map associated the lengths of dyke shown to a precision measured in inches with the tax on farmed acreage paid by residential subunits. Most commonly these were divisions of the cantons, which it is reasonable to think of as being something like hamlets. Mensuration as finely graded as this, and with a significant amount of money or labour time over the years at stake for all concerned in the event of any errors, can surely only have been carried out with equipment analogous to graduated measuring poles or surveyors' chains. But we have found no specific information on this. The exact nature of the next change in system, which took place circa 1790, is hard to reconstruct with certainty. The most plausible conjecture is that the

residential units associated with each subsector of dyke no longer paid the local government for the maintenance work required, but had to do it or arrange for it themselves by supplying two workers for each one-*gong* length of dyke. The weakness attributed by the Record of Works to this way of doing things was that the fragmentation caused by a rigid association of responsibility for a given length with each residential unit. Being concerned only their own one short length, workers could no longer be moved around flexibly as technical requirements indicated. In 1818 this so-called 'matching the dyke ‹to the household› was altered to what was termed'joint digging out' managed by second-level local officials. Presumably this was paid for, and partly worked for, by local units proportionate to their tax obligations, but this is not an entirely satisfactory formulation. However it may have functioned, those managing it are said quickly to have found out how to make money from their positions; and it was the only system against which this particular accusation was levelled. In spite of the malpractices the new system seems to have functioned to some effect. This is indicated by a comment in the Dengchuan gazetteer (p. 9:48a/102) that seems to have been written some three to four years before it was published:

> Before 1816 there was either one dyke-break annually, or else several. From 1817 until the present day the overflowing waves have been stilled for 34 years. The essential point is without doubt that at the season when ‹maintenance› work is undertaken each year they scoop ‹the bed› out deeply and bank ‹the levees› up solidly, as well as repairing the stone facing ‹of the dykes in› the dangerous places [marked on the river's course in Figs. 1i–vi, 2vii, viii]. Even so, at the time of the heavy rains in the seventh and 8 months of the lunar calendar, it is still necessary to give strict orders that the river be patrolled day and night, and the moment that a dyke is collapsing that this to be instantly reported to the Dyke Chief for him to have the gongs sounded and the struggle undertaken to protect it.

Presumably able-bodied adults who could reach the threatened spot had to turn up as fast as they could when they heard the alarm. It is also likely that this aspect of the system remained unaltered when other administrative measures were later rethought. The next system, promulgated in 1845 after prolonged anxious pondering, seems to have been a force of 60,000 temporary peasant conscripts divided into four main groups with flexible operation within their own quarter of the main dyke area. Special arrangements were made for two smaller groups to handle the sections at the top of the river and at the bottom, where there were no levees to maintain and the main work was dredging. Specifically, the authorities conscripted a group of 28 commoners, or of 15 soldiers, for every *picul* of land tax owed by the units to which they belonged. Interestingly, the peasants from different groups of units are in some instances recorded in the Record of Work as having distinctive characters. Thus in the second sector "only those of Chongxia and Zun (Figs. 1iii, 1iv)… are hard to discipline. All the others are dedicated. The workers' labour-services are also easy to lead. They are different from ‹the workers› of the first sector, who are dilatory and knavish" (Dengchuan gazetteer, p. 79). The managers were now defined in a different way from their predecessors in the system of 'joint digging out'. They were to be local social notables described as 'gentry and elders' balanced by sub-bureaucrats defined as 'clerks and runners'. In principle a member of the 'gentry' was meant to have an examination degree or at least some standing in the local educational system, for example as a student preparing for the exams. In actual fact, it is unlikely that there would have been enough with even this modest qualification and selection must have used other criteria. To sum up a confusing period of administrative variability, a detailed set of linkages was established

by a survey made around 1740 between the land tax paid by hamlet or village-sized communities together with a few functional subunits such as a hay (Shu et al. 1947) pasturage site[1] (Fig. 1ivA), on the one hand, and specially measured subsections of the dykes for the purposes of quantifying an equitable mobilization of labour and cash for maintaining the Miju levees, on the other. This tabulation, with geographical identifications provided by the cartographic scroll, ensured that there was a labour supply for the entire length of the river contained within dykes. The relative share of each residential unit was also automatically determined. Following this, these data recorded on the map were then used over time in at least four successive separate ways, as is documented in the 'Record of River Works' in the Dengchuan gazetteer. (1) Initially, pairs of workers were conscripted each year in respect of each *gong* of dyke, working under overall official supervision. (2) This was shifted to 'dyke-matching' by which the residential subunits were given responsibility for maintaining only their 'own' lengths of dyke. (3) When this proved unsatisfactory, the method of 'joint digging out' was adopted under the control of second-level local officials who determined who should do what, where, when. After a promising start the latter found that this let them extract improper profits by manipulating the powers thus put into their hands, and this became something of a scandal. (4) Finally four major and two minor flexible seasonal labour forces for different sectors of the river were formed, the control being shared between local notables and departmental sub-bureaucrats. By the time of these two final phases the originally surveyed lengths of dyke would appear to have become little more than fossilized formulations of earlier obligations in labour and in cash owed by different groups of the rural population for the maintenance of the river. Other information in the maps, though, such as that showing the dangerous places in the river, would have retained its value for a while, but probably neither the Miju nor local society was stable enough for this to have endured unchanged for more than a limited time. In the middle of the 1850s, however, everything was brought to a prolonged halt by the damage caused by the great Yunnan Muslim rebellion, whose best-known leader was Du Wenxiu. It was mercilessly suppressed by the imperial forces. It has been estimated that between 1855 and 1874 the population of the province of Yunnan fell from around eight million to three million people (Hummel 1943–1944).

Environmental disaster

One final perspective concealed in the Miju cartographic scroll still needs to be revealed. With the exception of the spit-delta in Figs. 2x to xii, no traces of it can be seen directly in the maps themselves. Taken by itself, moreover, this last mentioned feature, striking but misleadingly static in appearance tells us little or nothing of the swiftly moving events by which it was created. The transformation that the spit represents has to be summoned up by controlled use of historical imagination, using both documents on paper and the quasi-archival residues of information inscribed in the soils and sediments. And, arguably, this perspective is the most important of all. It concerns the environmental destruction upstream of the Putuo gorge that triggered the wholesale erosion of mountainsides, and was thus the driver of the hydrological and human turmoil in the valley below. As so often in such cases, the causes were spatially separated from their most important consequences.

The displacement effect was clear to the administrators of Langqiong county immediately up-river of Dengchuan department, and one whose reality their Dengchuan

[1] Perhaps with the function of facilitating the seasonal equine transit to the horse fair at Eryuan upstream.

counterparts were obliged to accept following the decision of the higher, probably provincial, authorities. When the first massive deflection dyke preventing the entrance of newly dislodged boulders and débris into the upper end of the gorge was being planned after 1762, the county magistrate of Langqiong "obtained permission for there to be minor maintenance every year, met by 120 oz of silver from the surplus funds held by the ‹state› salt monopoly, and major maintenance every third year, costing 320 oz. In addition, the department of Dengchuan was to furnish an ‹annual› subsidy of 50 oz of silver for locks and dykes" (Zhou and Luo 1975). This payment seems to have in the end to have been taken, not from salt monopoly reserves, but from the fees paid by Buddhist monks to avoid conscription for their share of the labour as water-workers. Its main purpose was to reimburse the inhabitants of Langqiong for building and controlling the working of a cross-dyke upstream. The function of this dyke was to allow the level of the water in the Miju to be sufficiently reduced for a prescribed period of hours each day to allow dredging to be safely done below it (Record of River Work p. 82). We have told the story of the onset of the environmental crisis in detail elsewhere (Elvin et al. 2002; Elvin and Crook 2003; Elvin 2005). Here we shall only summarize a handful of points that are immediately relevant to understanding the maps. The first of these is most of that what one sees when one looks at the last three panels, namely Figs. 2x to 2xii, would not have been present in 1640. No deposit sediments visible above the surface of the lake, and thus no houses and markets and hydraulic installations, or, at the very least, nothing distinctive enough to warrant comment. This can be inferred from the almost obsessively detailed record left by Xu Xiake (1568–1641), China's most celebrated travel-writer on journeys within the frontiers of the late-imperial state (Elvin and Crook 2003). It describes a trip he made down the Putuo gorge, then down part of the Miju, and after that along a secondary river to the west until he reached the department capital of Dengchuan. He then proceeded to the western edge of the great Erhai Lake. It was Xu's practice to write brief observations on matters of interest at intervals that were rarely more than a kilometre apart. If the Miju at that time had been above the surrounding fields, he would certainly have remarked on it. He doesn't.

From this it seems likely that it had not yet risen that high. Where his journey took him in 1639 to the shore of the Erhai, it seems clear that either from there, or from the slightly higher ground from which he had descended, or most probably from both, he would have been able to see eastward across the kilometre-and-a-half of mudflat or water to where the delta settlements were later to arise. Again he is silent. It should be noted that though we have ourselves both been past these spots on the west-side road on a number of occasions, we were not at that time looking for an answer to this particular question of visibility, and this statement is therefore based primarily on a later examination of the 1:100,000 Soviet military map produced in 1978. This reconstruction fits with the gazetteer evidence which, aside from one problematic instance where the location is unclear, does not record a breach of the Miju dykes until 1663, followed by a second one a generation later in 1691. At this time, there was as yet apparently no crisis. In the eighteenth century the rate of occurrence of breaches accelerated: there were five between 1713 and 1743, and the situation became worse thereafter. What had happened? The short answer is that, perhaps as a result of the growth of the population, Luoluo tribesmen, and perhaps others, had been opening up for farming the slopes above what is today in the winter and spring seasons a huge dry gorge, the Baihan, that at that time emptied directly during the rainy season into the Miju above the Putuo. By 1757–1758 "all the mountains ‹above the Baihan› had been…opened for farming. Being without vegetation or trees to give them protective cover, as soon as there was heavy rain, soil and rocks come down in violent fashion…choking the body of the river." This continued to happen, and the last days of July 1808 saw one of the worst of

these catastrophes. "The mountains whose sides had been ploughed collapsed in their entirety. An immeasurable amount of water laden with sediments and massive boulders several fathoms in size…filled the channel…so that not a drop of water flowed through it" (Langqiong Dengchuan gazetteer, pp. 175–176). A note following this text further explained how this happened: "The Luo people invariably dig up and loosen the mountain gorges. The soil by its nature is light and mobile. Whenever it rains, the rain sweeps it downhill where it fills up everything" (Langqiong county gazetteer p. 178). The usual pattern on these occasions was that the river would be blocked, so that the water backed up and flooded the county capital of Langqiong, and then, when the gorge had been cleared, it poured downhill along the course of the Miju. There, once the gradient had lessened, the stones and gravels piled up on the riverbed neatly graded, as observers remarked, by size. The pressure was later eased above the gorge by deflecting the outflow from the Baihan, but not removed. Below the gorge the aggregation of sediment was contained, but at a heavy human cost, by the imposition of the system of annual dredging, and strengthening the downstream dykes, that has already been described. The residual sediments were conveyed into the lake, where all but the lightest dropped and formed the lacustrine delta that is shown in the southernmost panels of the scroll. In the Record of River Works 1845 (pp. 90–91) in the Dengchuan gazetteer it says:

> If one compares it to the level land, the approximate yearly increase of sediment accumulation ‹before dredging› varies from 3–4 to 5–6 feet. This why the contents of the river lifts its head so high, and the water travels more and more apart from the land… In summer and autumn the current is turbid… [S]ediment that accumulates in the river has always entered the Erhai, ‹so,› with the passing of time, the mouth of the lake has become obstructed, and the tail-end of the river has also grown congested. For this reason, 30 years ago the place where the river entered was ‹just› downstream of the Lock Water Pavilion (Fig. 2xiiA). Today it is about 2.5–3.0 km distant. 'The sea has turned into mulberry fields'[2] It is undoubted that there are advantages for the people living in the neighbourhood, but harm is caused to the upper reaches. The reason is that greed for the profits from fields formed by the deposition of silt (Fig. 2xii), and the ‹resulting› lack of dredging, cause the tail-end of the river to narrow to the extent that it will not admit ships. If the anus is not wide open, the digestion is incommoded. The disaster of flooding-over arises from this.

Although it is not certain precisely when, in the years around the turn of the eighteenth and the nineteenth centuries, this was written, the numbers suggests a rate of growth in length for the delta of somewhat under a tenth of a kilometre a year. The constriction of the channel as it proceeds from to panel 2x to panel 2xii is also clearly visible in the composite image presented in Fig. 4. Today, with the Miju under the control of modern technology, including the use of its water for a small hydropower station, these conflicts of yesteryear have become all but invisible to any eyes other than those of the environmental historian or the field geographer. They live on, though, in four melancholy lines of verse recorded in the nineteenth-century Dengchuan gazetteer. They were written by Gao Guizhi ('Cassia-twig' Gao), an evidently educated man, but of whom we know nothing else. They seem to have been written on the traditional holiday on the ninth of the ninth lunar month. As with many such Chinese verses there is no way of telling if he was writing about his real-life self, or an imagined self, or empathizing with someone else whom he had seen.

[2] A venerable Chinese literary cliché for any reversal of a situation.

I've been clearing the river out. Then, a second time, getting it dredged.

Its compacted muds were coming apart, with numerous tear-filled runnels.

Though up on the heights now, for Autumn Day, there's no glimpse of a hopeful perspective,

My muscles, and scaffolding of bones, having dissolved into nothing.

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