

THE CLIMATIC CONDITIONS OF THE TARIM BASIN:

*A paper read at the Afternoon Meeting of the Society on 17 February
1930, by*

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THE Tarim Basin is the name given to the great amphitheatre of plain, largely desert, that is girdled on three sides by the Kunlun and Tien Shan mountains, and which forms the most valuable and important part of the province of Sinkiang, or Chinese Turkistan. These notes put forward a few observations made in a two-years journey in the country.

The conditions generally have led some travellers in Chinese Turkistan to believe that in recent, certainly in historical times, the climate of this region has been greatly modified, and that a marked increase in aridity has taken place: briefly, that the country is drying up. In proof of this theory, the remains of extensive towns, especially of Loulan, the diminished length of the Keriya and other rivers east of it, and the decrease of water in the Lop Nor, are all cited. The Turfan depression has also been brought to witness as having had a very different climate from its present one. (There was a note on this in the *Geographical Journal*, 72, 357, October 1928.) It has therefore been argued that in the Tarim basin a continuous and appreciably rapid process of desiccation has been going on, caused by failure of water as evidenced by the phenomena above quoted. An endeavour will be made in this paper to modify this proposition.

The theory of desiccation has been chiefly built on the aridity existing in a district stretching from the Keriya river inclusive to the eastern boundary, where the Niya and other rivers have decreased in length, and where several sites of abandoned towns have been excavated in the desert. Here it is well to make it clear that the writer has never been east of Khotan or south of Tikenlik in the lower Tarim. It is generally admitted that at no time was the population east of Keriya other than sparse, and that the whole of this small corner of a large province is, and has been, a barren and forlorn area, occupied only by gold-miners and convicts. Conditions therefore prevailing in this part of Sinkiang cannot be regarded as typical of the rest of the province. Such an assertion would assuredly be far fetched. It is also difficult to believe that the climate should have changed here, and not elsewhere—or, to put it differently, that the decreased flow in rivers east of Keriya should be caused by climatic rather than by other natural causes.

There is one theory that deserves mention. As all rivers in Turkistan are fed by the melting snows, it has been suggested that the Keriya and other rivers have failed to obtain their supply, owing to the coating of debris, detritus, or other deposit covering the glaciers, or even to actual decrease in the glaciers themselves. Yet no decrease whatever has yet been observed in the neighbouring Khotan river.

It is hoped in this paper to put forward other causes for the diminished flow in the rivers of this area; and to bring to bear on the subject observations made elsewhere.

Swinburne was no geographer, or he would not have said that even the weariest river winds somewhere safe to sea. There is probably nothing so

striking geographically in Central Asia as the ubiquity of drainageless basins, which vary from basins so large as almost to lose their individual character, such as the Aral or Caspian seas, to small cups in the mountains or shallow lagoons in the plains. The whole of the Tarim Basin south of the Tien Shan is of this character, but so too is the Dzungarian region north of those mountains. Both these immense districts are similar in many respects; and it is thought that the behaviour of the rivers in both places explains at once the



Sketch-map to illustrate Colonel Schomberg's paper on the Tarim Basin

decrease in the waters of Lop Nor as well as the gradual disappearance of the Keriya and other insignificant streams to the east.

It is significant that south of the Tien Shan, although there are several minor depressions and drainageless areas, the lakes formed are comparatively trivial. There are the fresh and salt lakes of Lop Nor—these should be kept distinct, as no water from the north is likely to reach the salt-water lake in the Lop depression; and the lake in the Turfan area. The Baghrash Köl or Tenggris Nor near Qara Shahr is a true lake. Thus south of the Tien Shan with a greater water supply there are markedly fewer lakes, and this difference can be attributed to irrigation and the porous nature of the soil.

The Tarim is the name given to the aggregate of rivers that fall into the main stream of the area. This great stream centuries ago fed Lop Nor, whose shrinking and exiguous waters point either to a failure of supply in the Tarim; or, what is more likely, a failure of the Tarim water to reach the lake.

The chief river north of the Tien Shan is the Manass, a very large and imposing stream, but not the equal of the Tarim. The behaviour of this river is worth attention. It leaves the cultivated area of Manass and flows through extensive swamps and backwaters, overgrown with reeds and jungle, and fringed with dense forests of toghraq, elm, and other trees. The right bank of the river is often a high and dangerous cliff, and from the top the traveller looks over a waste, impassable as it is impenetrable; and through this territory the Manass has made for itself many new channels, a process of which it never wearies.

For years the Manass fed the Telli Nor (lake), reaching it through swamp and morass just as the Tarim ages ago reached and fed Lop Nor. But the Manass is now abandoning the Telli Nor, and in April 1928 there was not a trace of moisture in the lake-bed. It was possible to ride everywhere over it, and very exhausting work it was, for the going was heavy. At that time of the year the river was not full, and the people, who said the lake was drying up, said that later a little water would reach it. The remains of canals and lines of trees at the northern end of the lake bore witness to a departed period of irrigation. It was due to no lack of water in the river that the Telli Nor was degenerating into a mere dismal depression and a mass of flickering mirage. Its cruel fate is caused by the Manass leaving it. The river has already turned to the east, and as time goes on it will form another lake, unless with the fickleness of all these Central Asian rivers, it turns once more to its former channel.

This seems to have been the fate of Lop Nor, as a brief examination of the state of the Tarim river will show. The Tarim alone is mentioned, as no one suggests that the Keriya and its diminished neighbours had any influence on Lop Nor, always excepting the Charchan river, not even in the happy days when a slight trickle from the Keriya occasionally found its way to the Tarim. It seems very doubtful if the former river flowed perennially as far as the latter, since there are practically no remains of man in its northern half.

In the behaviour of the Tarim the secret of Lop Nor must be sought. The rivers of Turkistan depend wholly on the snow which usually varies little, although it sometimes happens (as in the winter of 1928-29), but without affecting the argument, that the fall is excessive. Taking however the average winter, the rivers begin to rise in April when the first melting snow comes down. The greater part of the water is taken for irrigation, and it is very rarely that a river is untapped after it reaches the plains. So much is this the case that in the height of the season, the season of highest water and intensest cultivation, many rivers—the Kucha, for example—are but a mere trickle; the whole volume has been deflected into the fields.

In April and late autumn, when the first and last snow water comes down, the rivers are practically untouched for irrigation, but at both these periods, owing to the diminished melting on the high peaks, arising from colder weather, shorter days, and in autumn less snow, the rivers never carry their full capacity, and so the full force of the current is now never felt in the Tarim.

As the cultivated area of the Tarim basin has greatly increased of late years, for example between Maralbashi and Yarkand, the fields are almost continuous, though Sir Aurel Stein's map of twenty years ago shows many gaps; so year by year more water is taken for irrigation and less reaches the rivers. A comparison with Turkistan as it is now, with the account given by Mr. A. D. Carey of his journey in 1885 (*Proc. R.G.S.*, N.S. 9, 731; Dec. 1887), will still further support this point and emphasize the contrast. The difference is really amazing.

The flood water has in fact been decreasing for fifty years, as the irrigated land has extended. A brief glance is necessary at the nature of the country watered by these rivers. The plain of Turkistan consists of a soft friable soil, and there is thus nothing to control or guide the rivers as they roll down into the plains. When they reach this level yielding plain, there is no hill, no rock formation, no immovable forest, to curb their will: unrestrained and unchecked, they wander aimlessly through this monotonous region. Indeed, it is remarkable that they do not roam more freely.

Flowing north from the Kunlun, until stopped by the Tien Shan, which turns them east, the rivers are again diverted by the Quruq Tagh, and finally find their grave in the Lop district. Throughout their course, they lose volume steadily, through irrigation and in the immense marshes, swamps, and backwaters which they form as they go. It is true that their affluents are important. The chief is the Aqsu, which took two hours to cross in August 1929, and others are the Muzart and the Kucha; but the toll of irrigation from both these tributaries is severe. It is however south of Kucha that the Tarim begins to lose volume as lagoons, lakes, and bogs absorb its water.

Mr. Rickmer Rickmers, in his lecture before the Society in April 1929 (*Geogr. Journ.*, vol. 74, p. 213), remarked that he cherished the belief that the riddle of the dead cities of Chinese Turkistan was to be sought amongst the Pamir glaciers, and added that nothing warranted a zone of rainfall cultivation for the Tarim basin. A brief digression with reference to the rainfall will settle the latter point. The average rainfall at Kashgar is 2 inches, and the influence of rain may be disregarded in discussing the climate of Southern Sinkiang. It is generally agreed that in recent centuries there has been no change in the rainfall. To show how dependent the whole country is on irrigation, it is interesting to note that not a single piece of unirrigated cultivation was seen anywhere south of the Tien Shan, whether in the plain or in the hills.

To take Mr. Rickmers' other point, it is presumed that he means that the Tarim river has decreased in volume owing to a decrease in snow and glacier in the Pamirs, thereby causing the Tarim to fail to reach Loulan; and it is Loulan, after all, which is the largest of the derelict cities in the whole country, and compared with which the other cities are negligible. When the Quruq Darya ran dry, the water turned more southerly and formed the lower Tarim. The process of drying up in Lop Nor meant the same process in Loulan, for the fate of lake marshes and city was the same.

Now, however, the Quruq Darya has again come to life, and in process of time perhaps Loulan too will be habitable. This great change must rule out any diminution in snow-fall or glacier formation in the Pamirs, as it indicates that Loulan came by destruction, not through an altered climate but through



Dead toghraqs on the banks of the Qum Darya



The Qara K l river south of Maralbashi



The Qum Darya near Yingpan



Tamarisk cone near Tikenlik



Toghraqs growing in sand by the left bank of the Manass



Dead and living tamarisks near Ordeklik on Kashgar-Maralbashi road

riverine vagaries. If it can be shown that Loulan was abandoned because the river left the course to which it has now returned, the case against a climatic change as the causative reason must be in part established.

It is interesting to note that Professor Ellsworth Huntington ('Pulse of Asia,' pp. 280 *et seq.*) mentions a period of increase in Lop Nor in the middle ages, which perhaps indicates the time when the Quruq river definitely flowed for the last time. In the *Geographical Journal* for December 1929 there was a note on the recent fluvial changes in the Tarim Basin, but perhaps it is desirable to amplify in this paper the recent events in the eastern part, so as to indicate clearly what is happening.

Until five, or perhaps six, years ago the Tarim, reinforced by the Konche Darya, a most important stream, flowed south through Tikenlik and so into the swamps of Lop Nor. At that time the greater part of the Konche river water was lost in the Chong Köl and Tais Köl, and the main river was a comparatively narrow stream, some 40 yards wide, when it flowed near Tikenlik into the Tarim. The Tarim river, too, carried in its lower reaches in those days a comparatively small proportion of its proper volume. The result was that both the Konche and Tarim rivers had lost the greater portion of their volume by the time they had reached Tikenlik, with the result that the flow at the Lop Nor end, but not to the lake itself, was correspondingly scanty.

The present condition of affairs is very different. The Tarim has turned more east, taken the Konche Darya with it, and has flowed into the Quruq Darya, now the Qum or Yangi (Sand or New) Darya; with the result that the combined volumes of the two are now much greater than they were before after their union at Tikenlik. The Chong and Tais Köl are still full, but their water is now diverted to the new river, as is manifest from a glance at the attenuated Yarkand river, as just at this point the Tarim is called, flowing close by, lower in level than the lakes, and deriving no benefit therefrom.

The new river, flowing past Yingpan, forms an immense swamp south of Altmish Bulaq, making it impossible to reach Loulan from the west; indeed, it is difficult to say how Loulan can be approached, except from the east. If, therefore, the new river remains faithful to its bed, and if it can extricate itself from the swamp, it is a fair presumption that the Lop Nor marshes will become a considerable lake, but not the present salt lake. The unhappy people at Tikenlik, Daral, and Yangisu, the settlements on the lower Tarim, are now suffering the lot of the Loulan people when their river capriciously turned elsewhere.

The Yangi or Qum river itself was a remarkable stream in October 1929, broad and powerful. As it rolled along it tore down forests of dead toghraq, and undermined high sand-hills. Day and night the thud of falling sand sounded in the silent air, as the river restlessly rolled hither and thither, scouring new channels for itself out of the great shallow bed of its age-dead predecessor. Delicate patches of new reed were replacing the grey remnants of a thousand years ago, and a gradual but definite change was taking place in the environs of the Quruq Darya. The river had gone down considerably, for it was October, and a month previously it must have been an even more wonderful spectacle. As it was it was truly inspiring, and the reflections it evoked gave an added glamour.

Having thus discussed the present state of the Tarim, it is worth while noting the conditions in the Quruq Tagh, as this small offshoot of the Tien Shan has been regarded as a victim of the effects of desiccation, and as having played a part in the destruction of Loulan. Sir Aurel Stein—for no paper can dispense with his admirable and well-reasoned observations—remarks that he found the Quruq Tagh less dry than he had anticipated. A journey in October 1928 in these mountains left Sir Aurel's route at Singer, and passing beneath the Heita Shan (Black Head or Big Black Mountains) joined his route at Shindi. The country was pleasant, and certainly the name Quruq or Dry was a misnomer, as indeed the people at Kurla had already told us. Brushwood and grass were ample, the toghraqs abundant and well grown, and vegetation generally good. Indeed, the conditions were far better than in the lower valleys of the Southern Tien Shan, and at Heita Shan the water was copious. The snowfall is heavy in the Quruq Tagh, and although the soil fails to retain much water, the verdure is considerable. It is remarkable, too, that the Quruq Tagh is the winter pasture of the Khoshut Mongols from Qara Shahr.

Speaking generally, it would not seem likely that the Quruq Tagh had ever any effect on the fate of Loulan: it is difficult to see how it could; still less that it shows any climatic changes, though the visit was admittedly brief and observation cursory.

The rivers of Turkistan, owing to their circumstances, appear subject to erosion and to sub-soil changes, and the effects of both react on the country in the vicinity, leading to serious dispersion or loss of the water supply. It is accordingly suggested that the real explanation of the shrinking of the Keriya and other rivers must be sought in local influences of such a nature.

The process of erosion may be pictured as follows: A river carves its way in the soft desert soil, and the water at first is near the surface. The cultivator comes, and starts to irrigate; but gradually the water eats into the soil, the level falls, the fields become unirrigable, and the peasant departs elsewhere, leaving his fields behind him. To the uninitiated these marks tell their sad tale, of withering rivers and homeless men, of ruthless desiccation, and a harsh drying clime.

The next development in the river is the formation of backwaters, caused by the high eroded banks falling in, and gradually being silted up in the narrower parts with fallen trees and brushwood to aid the process. Good examples of this were evident on the left of the Yarkand river, south of the main Maralbashi-Aqsu road, where there was a maze of backwaters and old channels, often hidden by forest, with abandoned fields and irrigation cuts. All this is more easily understood if it is realized that the most trivial alterations will have considerable results in the soft friable soil.

Sub-soil changes accompany erosion, but are frequently distinct. The soil in Sinkiang is very porous, and often incapable of retaining the water. In Hami (Qomul), in the hills north of Kucha, near Uch Turfan and Kona Turfan and elsewhere, the tendency of streams issuing from the foothills is to lose themselves in the sandy plain, often but not always, reappearing again at a lower level. This action is common enough everywhere, but it does explain much in Sinkiang. For example, in the very well-watered Yai Döbe plain, north of Faizabad, in the Kashgar district, the water supply is always altering. Several

villages marked in the maps have been abandoned, owing to failure of water which has come to the surface again in other parts of the plain.

At Tang Toghraq, 40 miles north-east of Maralbashi on the main road, the results of both erosion and divagation of the water are evident. There half the cultivated area is in good workable order. The other half has been abandoned, as the erosion first made the level of the water too low, and then caused the supply to fail, which prevented all tapping of the stream higher up. It was noticeable as new settlements were being made some way off, where the water was more accessible.

In the southern slopes of the Barköl Mountains the streams would disappear at the point where they reached the plain, and either reappeared a great deal farther on, 15 or more miles away, or else vanish.

So too the Karez system of the Turfan depression demonstrates the presence of abundant sub-soil water—every year new Karez are being made, and the latest series is at the western extremity of the depression, near Bejantura, which will alter the whole character of the present arid plain. An even more remarkable case is the Algoi Sai, a beautiful mountain stream which vanishes completely into the desert to reappear 25 miles east, at the settlement of Toqsun, west of Kona Turfan.

There are two small points connected with the effect of aridity on vegetation in Chinese Turkistan to which brief reference is necessary: the value of the toghraq and the tamarisk as evidence of defective moisture. Sir Aurel Stein has remarked that the tamarisk can never exist without moisture, and although careful watch was kept, in no place was a tamarisk found where it could be said that the ground was true desert. Either occasional or periodical water is essential for tamarisks. The toghraq (*Populus balsamifera*), or desert poplar, appears to be less sensitive to aridity, and better able to resist drought. The argument from these two plants in favour of aridity is drawn from the dead and not living organism. It is a common sight to see forests of dead toghraqs, gaunt and melancholy, thrusting their barren trunks starkly through the cloying sand. But although failure in the water supply usually kills them, they can die from other and not always easily distinguishable causes. Near Chilan, on the main Aqsu road, there is a forest of these dead trees, killed by a flood. At Aqsuq Maral, south of Maralbashi, there is a grove of dead toghraqs, with a belt of living tamarisk close by. The inference is that the water disappeared and killed the trees, it then returned later and enabled the tamarisks to grow. As it is the habit of the toghraq to grow in sand, the cause of its death must, as has been just said, often be obscure.

The tamarisk cone, whose age has been ably estimated by Sir Aurel Stein, has often some perplexing habits. It is often difficult to tell why plants have died, especially when new seedlings are found growing in the humus of long-dead cones. Again, there will often be a number of these cones scattered over a plain, all of them rotted; yet between them will be found abundant tamarisk, often growing comfortably in the protection of their defunct kinsmen. As the tamarisk grows, after surviving with some trouble the fierceness of the dust-storms, or "Burans," it collects round its roots sand, leaves, and other dejecta; and this hill of debris rises with and finally stifles the plant, if the latter is not killed by lack of water.

Sometimes there is a plain covered with dead tamarisk cones and also with a luxuriant growth of new low tamarisk. Owing to the age and state of the cones, and the small size of the new growth, it would appear that there was an interval between the death of the one and the advent of the other, and this predicates subterranean water changes, as the neighbourhood seldom shows any alteration in itself. These two references to the toghraq and tamarisk indicate that these, when dead, are not a certain sign of permanent aridity subsequent to their growth, though of course in certain places the dead toghraq plants are but the inevitable result of the desert's victory.

To summarize the remarks in this paper. Climatic changes in the Tarim Basin have been based on two distinct and unreciprocating features: (1) the drying up of Lop Nor and the destruction of Loulan; (2) the increased aridity east of Keriya. Owing to the fluvial changes in the Tarim Basin and the rejuvenation of the Quruq river, the evidence drawn from the first point needs revision. The argument for the second appears too vague and certainly too local to be applied with any force to the rest of the province; and the withering of the rivers can be explained by causes observable in many parts of the country. It may be noted parenthetically that in the south of the Punjab whole rivers have vanished, to flow elsewhere. It is admitted that the district east of Keriya, although now more populous and cultivated than before, is drier than the rest of the country, and this is a predisposing cause in itself, for sub-soil and erosive changes.

The river system of the Tarim Basin must remain an ineluctable problem, as the nature of the swamps and jungle, lagoon and river, makes true exploration impossible. Even an aeroplane would be useless, as the depth of the various sheets of water, the identification of the true river, and its separation from some vagrant tributary, could not be arrived at from the air.

Let a poet who never saw Central Asia describe accurately how the rivers of that distant region flow: a remarkable description indeed of the Tarim:

He flowed
 Right for the polar star past Orgunjé
 Brimming and bright and large. Then sands began
 To hem his watery march and dam his streams
 And split his currents, that for many a league
 The shorn and parcelled Oxus strains along,
 Through beds of sand and matted rushy isles,
 Oxus—forgetting the bright speed he had
 In his high mountain cradle in Pamere,
 A foiled circuitous wanderer. MATTHEW ARNOLD
 (*Sohrab and Rustum*).

DISCUSSION

Before the paper the PRESIDENT (Colonel Sir CHARLES CLOSE) said: Colonel Schomberg is going to give us a paper this afternoon on "The Climatic Conditions of the Tarim Basin." Colonel Schomberg has seen much service in India and has always taken a great interest in Central Asia. He has spent some years in the Tarim Basin, the Tien Shan and neighbouring regions, and has some important observa-