

# Medieval Urbanization of Mid-Low Syrdarya and Northern Tienshan: Structure, Development and Environmental Impact

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## Summary

The article provides a quantitative analysis of the structure and development of the Medieval urbanization of the Syrdarya and of Northern Tienshan; and proceeds analyzing the possible environmental impact of such a huge urban establishment. Medieval anthropogenic impact could have happened in the form of disturbances of the relief and the soils of irrigated areas, and of non sustainable water use, to which must be partly attributed the XII-XIII regression of the Aral Sea.

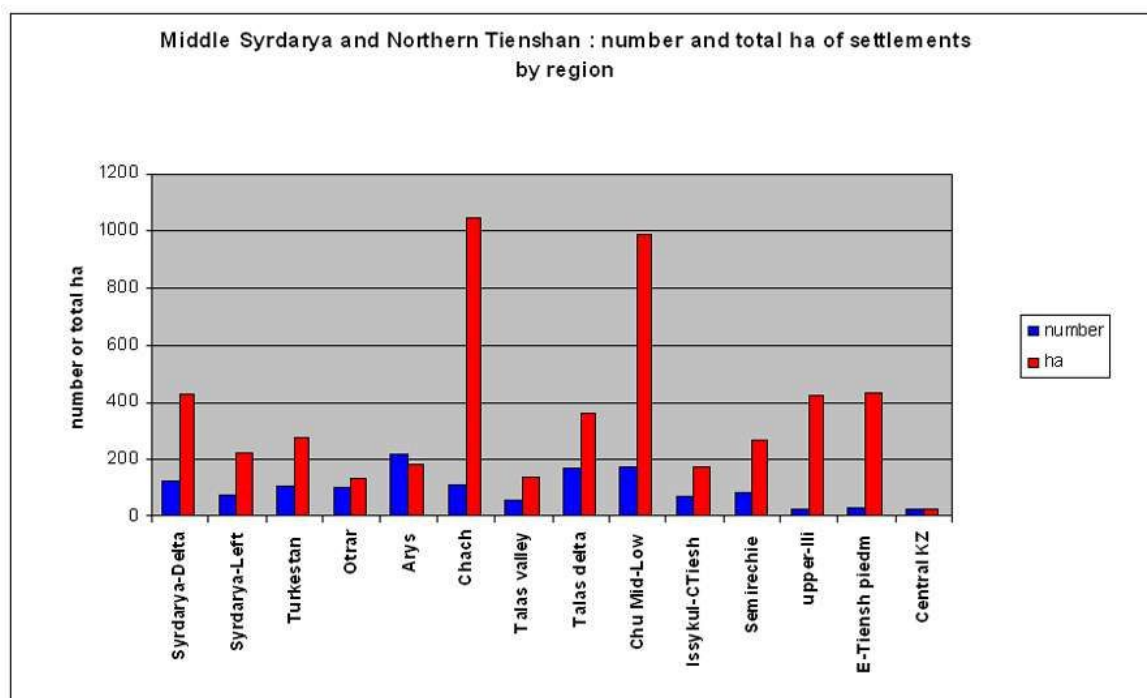
## 1. Regions and dimensions

During the Early Middle Ages the Middle-Low Syrdarya (6 regions: Chach, Arys, Otrar, Turkestan, Syr-darya left bank, Syrdarya delta) and Northern Tienshan (4 regions: Talas, Chu, Semirechie, NE-Tienshan) have been the theatre of a magnificent integrated urban process, counting a total of 1334 fortified towns covering all together an area of 5000 ha. Half of it developed on the Syrdarya and half on the N-Tienshan piedmonts, but with different periodization.

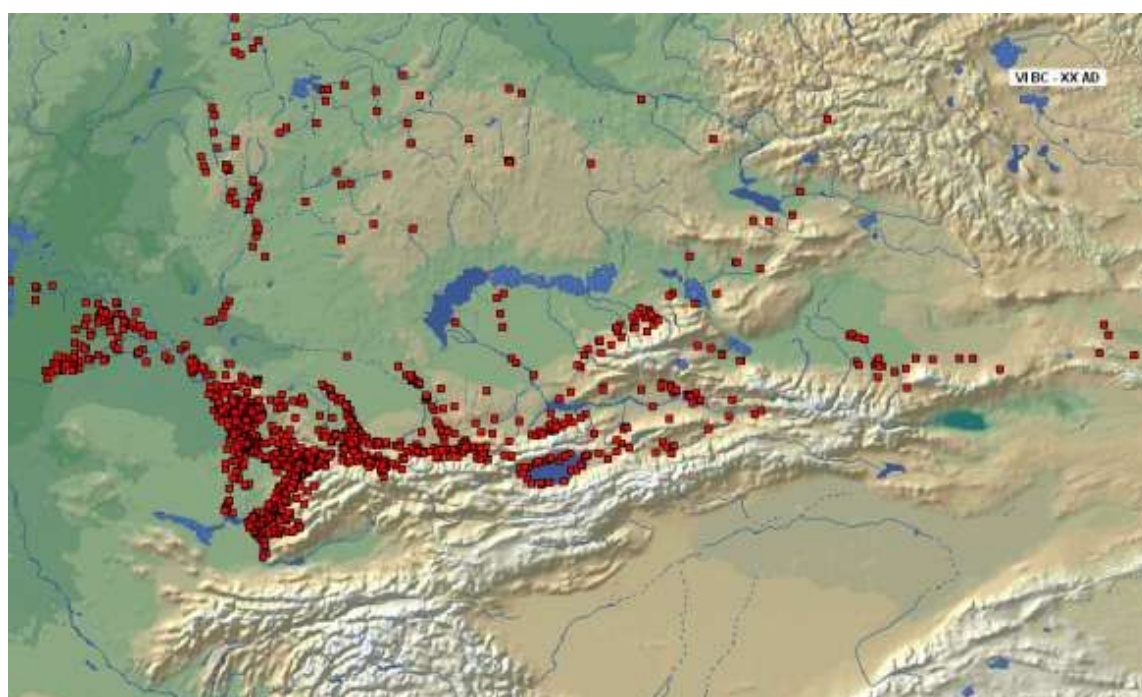
The Syrdarya urban complex starts as early as the VI BC and blossoms between the I and VIII AD, when it reaches a stable plateau that will last to the XII AD. Until the V AD its development is based on irrigated agri-culture, and then is accompanied by metallurgy and international trade. By far the most important urban region is Chach that in X AD represents by itself the 66% of the total urban area of the Mid-Low Syrdarya, with each of the other regions representing just the 5-10%.

The N-Tienshan urban complex practically starts during the V-VI AD in Talas, capital center of the empire of the western Turks, and blossoms all along the northern piedmonts between the VII and XII AD, somehow immediately successive to the stabilization of the Syrdarya complex. Turkic tribes were skillful metallurgists, and the urban development in N-Tienshan from the very beginning coincides with the mining, working and trading of polymetal ore. The most important urban region is Chu that in X AD represents almost the 45% of the total urban area of Northern Tienshan, followed by NE-Tienshan and Talas with the 21% each, and Semirechie with the 10%.

The XII AD already sees everywhere a stasis or small contraction of the urban process. The Mongol invasion of the XIII AD disrupted the NW-Tienshan and Chach complexes, but barely affected the other oases of the Syr-darya and didn't affect at all the urban system of NE-Tienshan. (Figs 1, 2)



**Fig 01 -Syrdarya-NTienshan: number and total ha of settlements per region**



**Fig 02 -Syrdarya-NTienshan: topographic map of all settlements between VI BC and XX AD**

## 2 . Morphology and functions

The morphology (shape and size) of the urban structures of the Mid-Low Syrdarya and of N-Tienshan are quite different, due to different ways of origin and to different endurance.

Concerning the Syrdarya, here towns evolved by organic patterns, growing by steps from village to city, adapting to relief and water facilities, erecting new ranges of walls, etc. They are clearly endowed of agricultural and administrative functions, and self-defended. Longstanding Early medieval towns of any size have been pre-served in the form of a mound (*tobe*), circular or oval, elevated by the repeated rebuilding of walls and dwellings (the *tobe* of

Otrar, in 17 centuries of development, rose to the height of 20 m). The number of zones and walls vary from 1 to 3 or more. Common is the presence of a citadel and a shahristan, both walled, and of an un-walled or walled rabat.

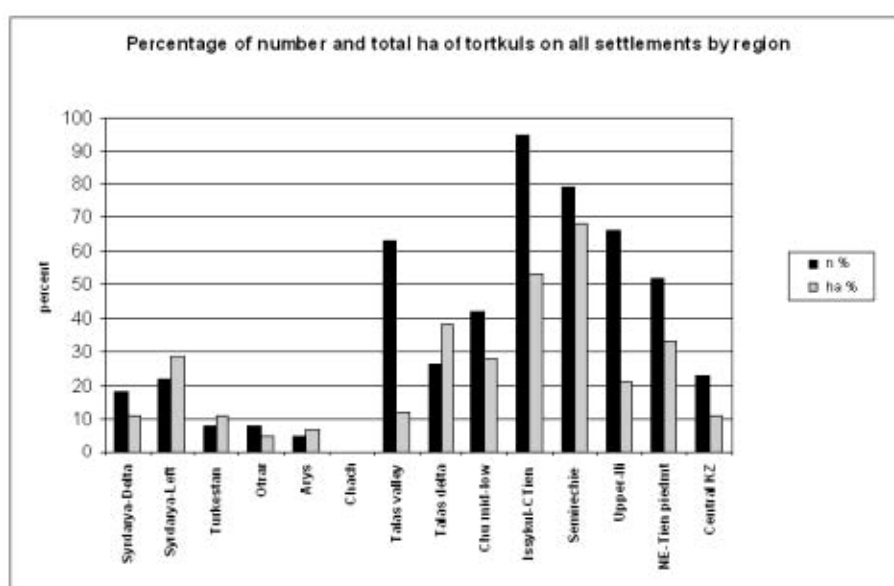
A different morphology characterizes the *Late Medieval towns*, like Turkestan and Sauran, which, by developing for less than 4 centuries as important administrative centers, are instead flat, large and of round or irregular shape.

Both the Early and Late Medieval urban centers of the Mid-Low Syrdarya are surrounded by a significant number of un-walled villages.

Concerning the Northern Tianshan, here only few towns have a tobe form, basically the ones built in the Talas delta between I-V AD. Most of the later constructions are of planned type with square or rectangular walls defended by 4 towers and sometimes additional bastions, and are called *tortkul* (meaning „four ditches“ ). Their interior is sometimes occupied by buildings and sometimes is barren, pointing to different functionality. The proportion of tortkuls grows from Talas and Chu to Issykul and Semirechie, where they constitute almost the 80% of the total number of settlements and cover the 70% of the total urban area.

But in NE-Tianshan, and rarely also in Chu and Semirechie, can also be found another kind of town, *Chi-nese type*, which is large, well planned with specialized quarters, and often surrounded by small defensive tort-kuls.

In Talas, like on the Syrdarya, few un-walled villages are surrounding the urban centers, but their number decreases going to the east and becomes insignificant in NE-Tianshan. (Fig 3 -Graphic ratio tortkuls) (Fig 4 -Karakunchuk tobe) (Fig 5 -Tortkul Intimak).



**Fig 03 -Syrdarya-NTianshan: percentage of number and total ha of tortkul on all settlements by region**



**Fig 04 - Aerial photo of tobe Karakonchuk on the Arys, Otrar oasis, I-VI AD**



**Fig 05 -Aerial photo of tortkul Intymak, Talas delta, Talas delta, VII-XII AD**

Summarizing we can say that along the Syrdarya every town, big or small, is an independent economical center and a kind of fortress, not only in the sense that is walled but in the sense that is heavily protected by strong walls and by an elevated citadel. Few small towers and castles are strategically diffused in peripheral areas but, in substance, each town develops its own defense system, and is the confederation of fortified towns that constitutes the military power of the region. Different is the situation of the urban complexes of Northern Tianshan, which are not defended by the individual towns themselves but by a specialized system of fortresses of standard form playing the double role of controllers and defendants of a large integrated urban complex.

### 3 . Chronological development

The development of the urban complexes is quite different along the Syrdarya and along the Northern Tianshan piedmonts in terms of times of start and abandonment and of internal phases. The Mid-Low Syrdarya urban complex starts earlier and ends later (VI BC -XIX AD), has an enormous impulse during the I AD, reaches a peak and stable plateau around the VI-VIII AD, when the active urban growth switches on the N-Tianshan piedmonts. Here it will continue until the XII AD, through 2 general building peaks in the VIII and in the X AD. As a whole, six main general phases of development can be distinguished. (Fig 6, 7, 8)

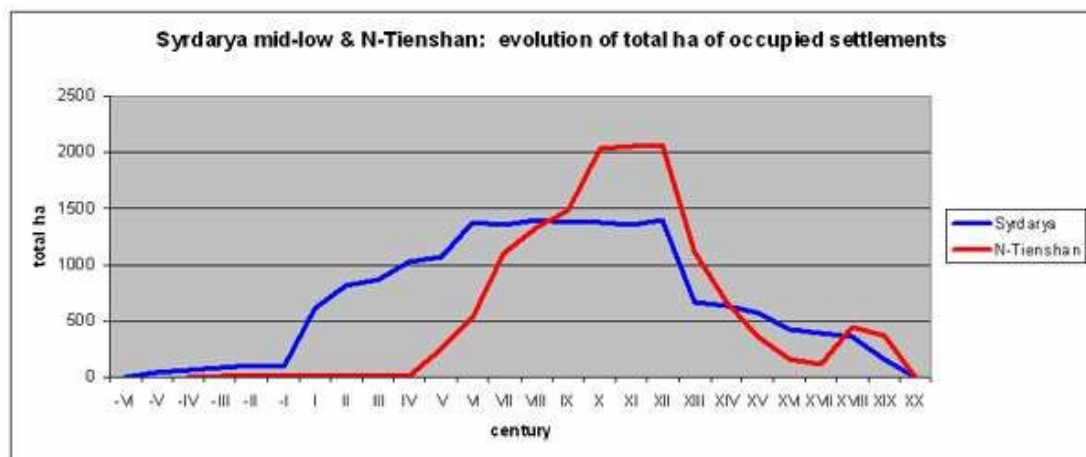
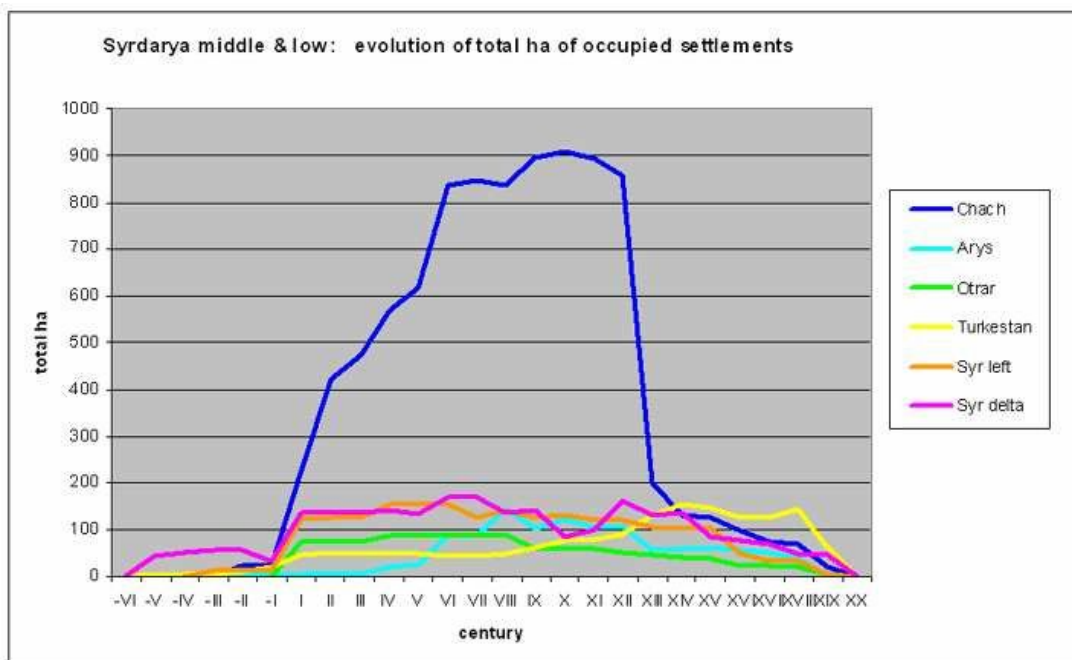
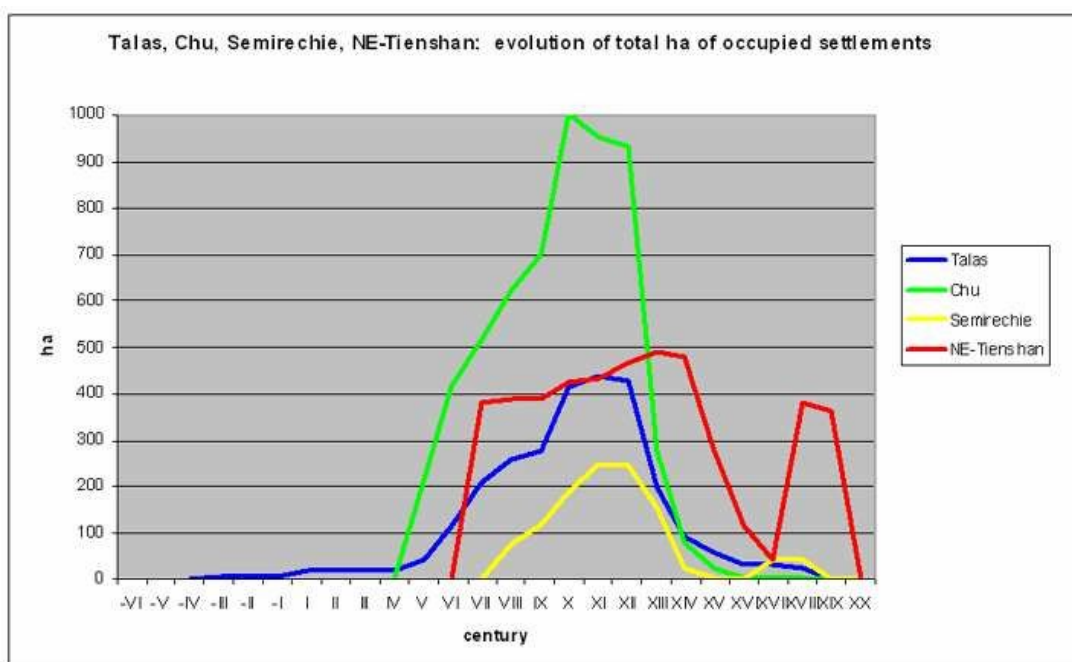


Fig 06 -Syrdarya-NTianshan: evolution of total ha of occupied settlements between VI BC and XX AD



**Fig 07 -Syrdarya: evolution of total ha of occupied settlements per region between VI BC and XX AD**



**Fig 08 -N-Tianshan: evolution of total ha of occupied settlements per region between III BC and XX AD**

- 1- The urban process starts around the V BC on the Syrdarya delta (Chirik-Rabat culture, following by 2-3 centuries the first urbanization of Khorezm) and possibly also in the Karatau piedmonts. From these early centers it diffuses all along the Middle Syrdarya, with a big growth during the I AD and then a continuous development, under the successive rule of Kangju, Early Turks and Karluk tribes, that reaches a peak in VI-VIII AD. The VI-VIII AD represents a maturity stage for the urban complexes of the Syrdarya, followed by a long period of stability until the XII AD, with the left bank and the delta ruled by immigrant Oguz tri-bes and the Mid-Syrdarya by the Karluk-Karakhanid. The active urban expansion switches to the Northern piedmonts of Tianshan.



- 2- Actually, the first urban structures of Northern Tianshan appeared quite early but at a very slow pace, dif-fusing together with Sogdian-Kangju communities from the Middle Syrdarya to the northern Karatau pied-monts as early as the III BC, and then to the Talas delta around the I AD. It is between the VI-VII AD (un-der the Early Turks) that the urban process accelerates in the Talas delta and suddenly starts as a new agri-cultural and commercial colonization in the Middle Chu valley, with the two regions finally joined into a common Turko-Sogdian urban complex, with urban units established at oases 10-12 km far from each other. During the VII AD, following by 1000 years the Saka-Tocharian urbanization of Tarim, the NE-Tianshan urban complex is quickly built under Turko-Tang rule, but with rich families of Sogdian immigrants having a near-monopoly of trade (Deom, Sala 2010; De La Vaissiere 2005). In VIII AD the first “colonial” towns appear in Issykul and Semirechie under Karluk rule (Sala 2010). In that way, by the VIII AD, through the cooperation of Sogdian merchants, nomadic Turkic tribes and the expansionist politics of the Tang, an uninterrupted urban front was established from the Aral to Mongolia, a kind of new and by far more effective “great wall” facing directly the large expanses and pastoralist groups of the northern steppes. At the beginning of the VIII century the urban development reaches a peak every-where, but at the end of the century it is temporarily decelerated by the Arab invasion and by the struggle between Arabs, Turks and Chinese, ending with the defeat of the last ones.
- 3- In the X-XII AD (under Karakhanid rule, which means islamization of the Turks and expulsion of Arabs and Samanids), the urban park reaches a second peak in all regions (on the Mid-Syrdarya and in Northern Tianshan), with the exception of the Syrdarya delta (still under the Oguz) where it contracts, possibly by lack of water. The main complexes are by far Chach, Chu and NE-Tianshan. After the X AD all urban re-gions enter a stage of stable equilibrium, with the exception of the youngest complex of Semirechie that still expands during the XI AD. The XII AD shows the first signs of urban contraction, due to the exhaustion of the Tianshan silver mines, the establishment of a very arid phase, and growing internal conflicts.
- 4- In the XIII AD the urban front of northwestern Central Asia breaks. The Mongols invasion, at the difference of the Turkic one, provokes the quick dismantlement of the urban complexes of Semirechie, Chu, Talas and Chach (and Arys), which is accomplished during the XIV AD under Chagatai rule. Instead the NE-Tianshan urban park, still under Uighur management, will have a later decay, in the XV AD. Similarly, during the XIII-XV AD (under Mongol, Timurid and Ak-Orda rule), the westernmost regions of Turkestan, Syrdarya-Left and Syrdarya-Delta see an expanding phase, Otrar slightly reduces but restruc-tures, and few new walled units are built along commercial roads in Central KZ.
- 5- The XVI AD (under Kazakh rule) sees the dismantlement of the Left-Syrdarya complex. The XVIII AD sees the fading of the Arys and Otrar complexes, and the ephemeral development of the Janadarya region in the Syrdarya delta thanks to the immigration of some Karakalpak tribes. Most longstanding are eight towns of the Turkestan region, which survive until the Russian period (XIX AD).
- 6- A very peculiar second wave of urbanization concerns E-Kazakhstan (Tarbagatai, Irtysh), Semirechie and its peripheries (Upper-Ili, Issykul, Low-Chu) between 1600 and 1750 AD (under Jungars rule), and just NE-Tianshan between 1750 and 1860 (under Manchu rule). It is much shorter and smaller than the first, counting only 121 total ha under the Jungars but 446 ha under the Manchu, i.e. more or less equivalent to the settlement park of NE-Tianshan during the X AD and to the one left along the Syrdarya in the XVIII AD.

#### **4 . Economical and environmental factors of urbanization**

The initial impulse of the urbanization of Syrdarya and Northern Tianshan comes on the west from the Sogdian

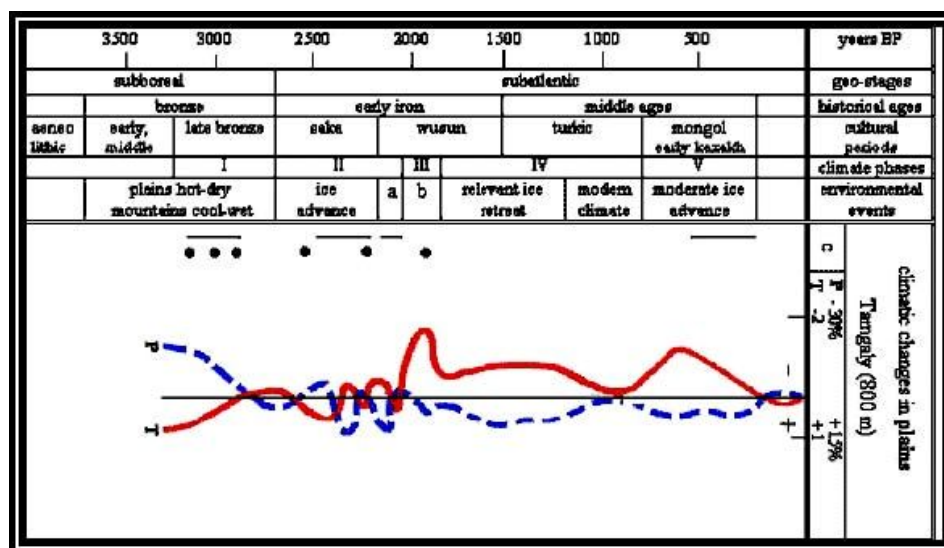
urbanization of Transoxiana and on the east from the Saka-Tocharian urbanization of Tarim. But, with its northern expansion supported by Sogdian merchants and Chinese dynasties, the urban process entered in contact with powerful nomadic confederations that played a major role in its further development or destruction: Kangju, Early Turks, Oguz, Karluk-Karakhanids, Uighurs, Mongols, Jungars.

The urbanization of the Syrdarya, with its gradual development accompanied by the implementation of large irrigation systems, shows quite clearly agricultural and commercial economical foundations. More intriguing is the extreme urban concentration in Chach, and the sudden development and abandonment of the N-Tianshan urban complexes, which evidently happened under the impulse of more complex and different factors.

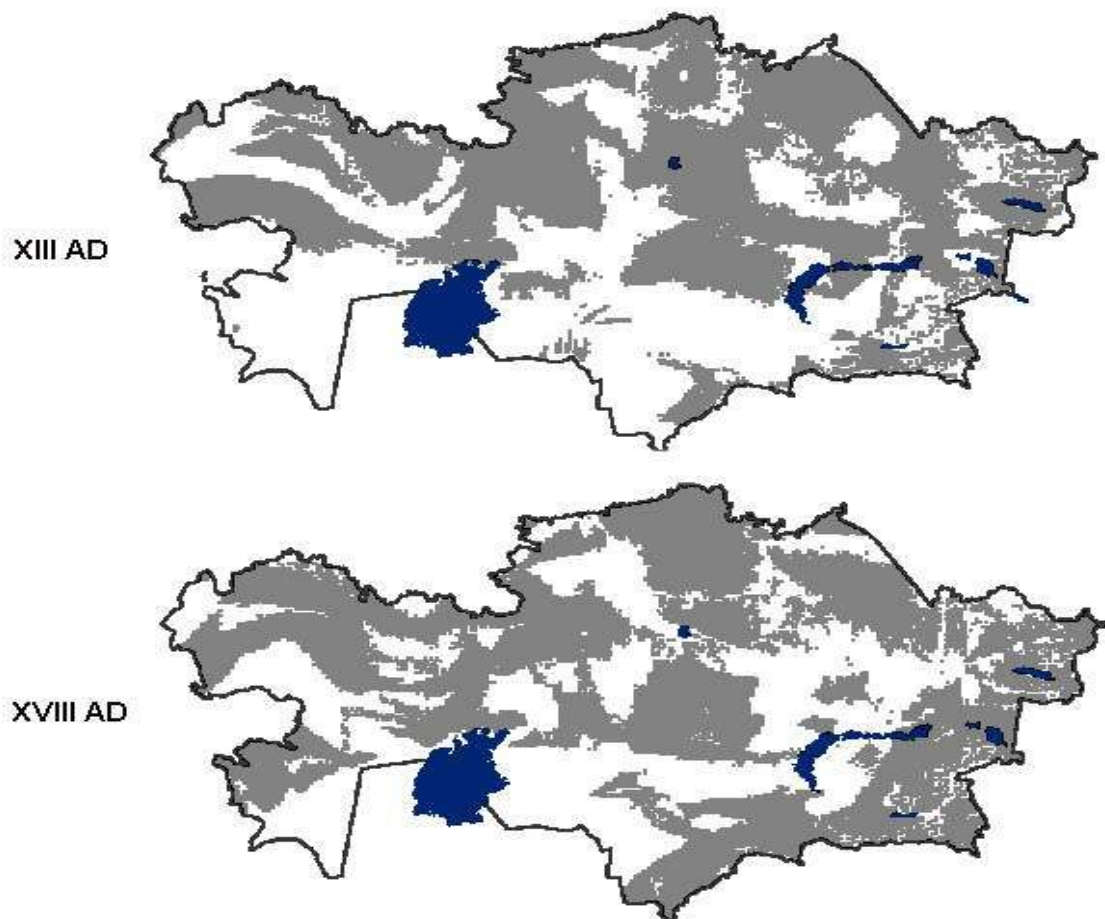
The start of the urbanization of N-Tianshan coincides with the urban peak of the Syrdarya, which evidently, together with the establishment of the Western Turkic empire, constitutes its socio-economical substratum. But few other concomitant factors of socio-economical and environmental character supported and enhanced the process.

Concerning the socio-economical factors, the relative political stability of the region made that, from the VI to the XIII AD, the long range interregional trade across central Asia privileged the northern branches of the Silk Road. Moreover, the discovery and exploitation of the polymetal deposits of Western Tianshan (Chach VI-X AD, Talas XI-XII AD) gave to the region the Eurasian monopoly of silver production, which deeply contributed to the urban blossoming of Chach, Talas and Chu. (Sala 2011)

Concerning the environmental factors, it must be underlined the coincidence between the period of urban development of N-Tianshan and the establishment of an arid phase, with dry peaks in VI-VII and X-XIII AD. Under such climatic conditions the grasslands expanded in Central Kazakhstan but contracted in the piedmont areas (Narama 2012), favoring the displacement and concentration of people and economical activities along the ice-fed streams of N-Tianshan and a large conversion from pastoralism to agriculture (Fig 09, 10)



**Fig 09 -Reconstruction of average fluctuations of temperature and precipitation in the Semirechie plains during the last 3200 yrs based on palynological analyses (150 yrs temporal resolution). Temperature (T) in continuous lines; Precipitation (P) in sequenced lines; (a) fires; (b) cryolitic formations; (c) chronological attribution provided by EPR and Canalyses (dots) and archaeological correlation (segments) (Aubekero, Sala, Nigmatova 2003)**



**Fig. 10 - Opposite changes of Poaceae grass cover (grey color) in Central and South KZ during the dry phase of XIII AD and the pluvial phase of XVIII AD (Horikawa et al., 2012)**

## **5 . Environmental impact of the urban process**

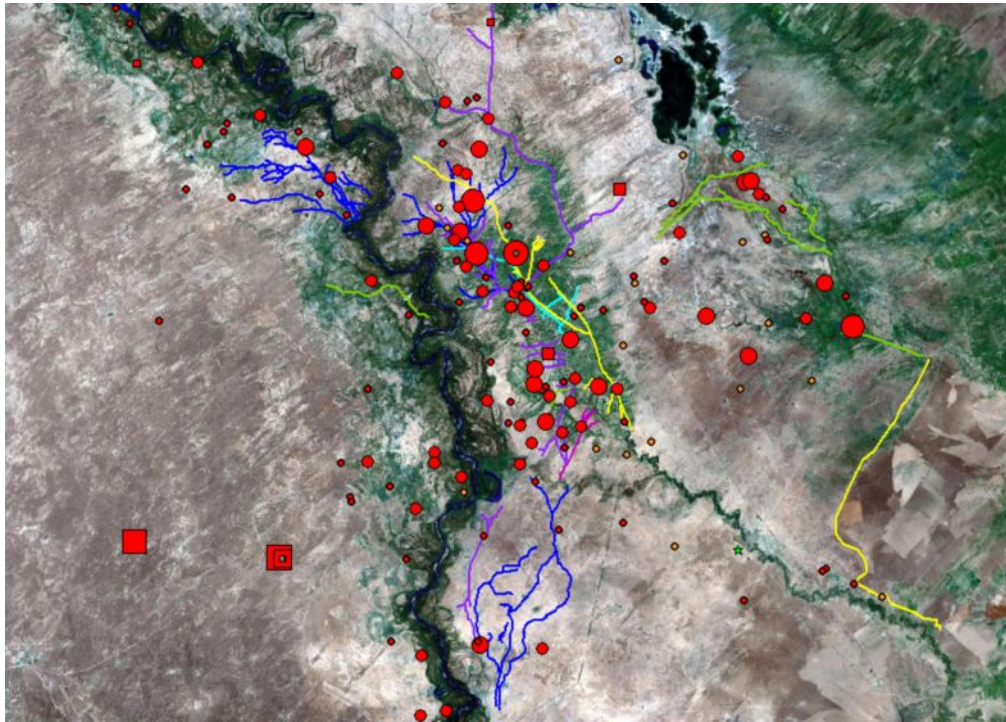
The realization of an urban complex of such large dimensions and largely based on irrigation agriculture surely induced geomorphological and hydrological changes and disturbed the environment in several ways, like soil depletion and water overuse.

### **5.1. Soil depletion**

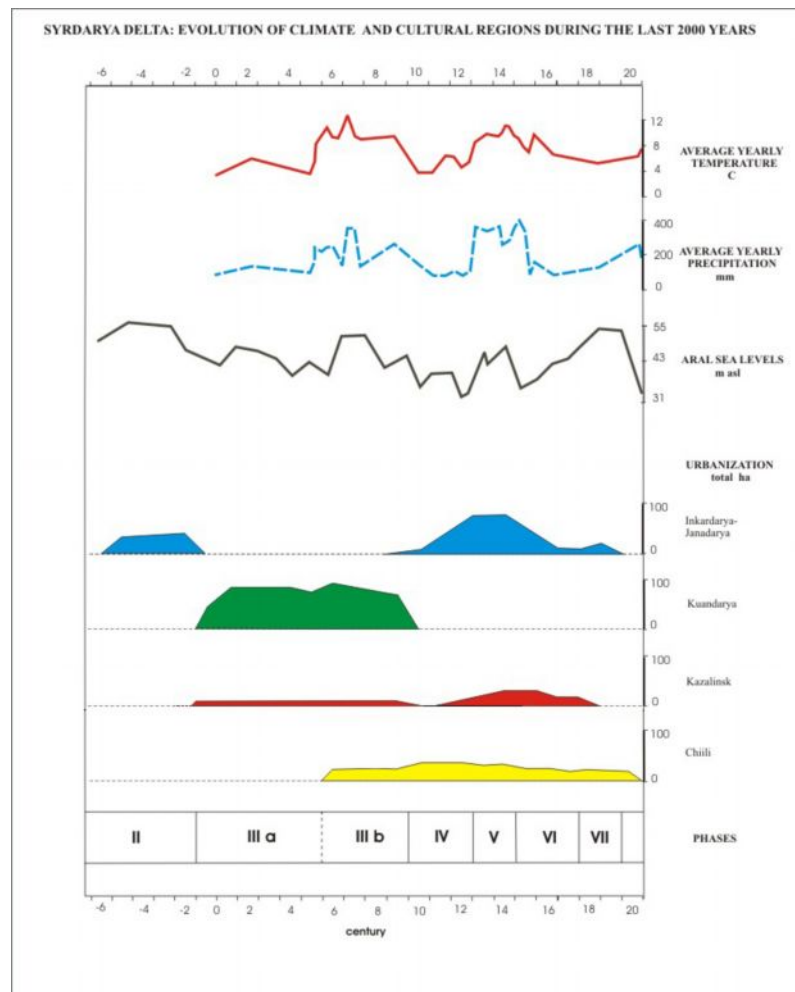
In the hydraulic history of the Otrar oasis, the six generations of canal systems that have been applied to the Arys river had an average endurance of 3.5 centuries, and have never been rebuilt along former itineraries. Evidently the original relief had been filled by sediments and the soils had been depleted. Exceptional is the superposition of the Altyn canal (X-XIII AD, blue central in Figure 11) and the western branch of the Sangyl canal (VII-IX, violet central), of which the reason could be the fact that both of them are following a main paleo-distributary of the Arys delta very crowded by early settlements of I AD, i.e. before the building of large canals, and so were possibly functional to pre-existing towns. Anyhow, the large towns of this area start to be abandoned in the XII AD and today the territory is desertic and totally abandoned. Also the modern irrigation system of Otrar is reproducing the XV century one (Temir-Aryk, yellow central), and in fact is crossing quite depleted soils. (Fig 11)

On the Syrdarya delta we face the same phenomenon. Succeeding cultures are switching distributaries. And the central segments of the Janadarya, which have been used by the Chirik-Rabat culture during the V-I BC, have been avoided by the following Medieval agro-irrigational establishments along the same stream. (Fig 12)





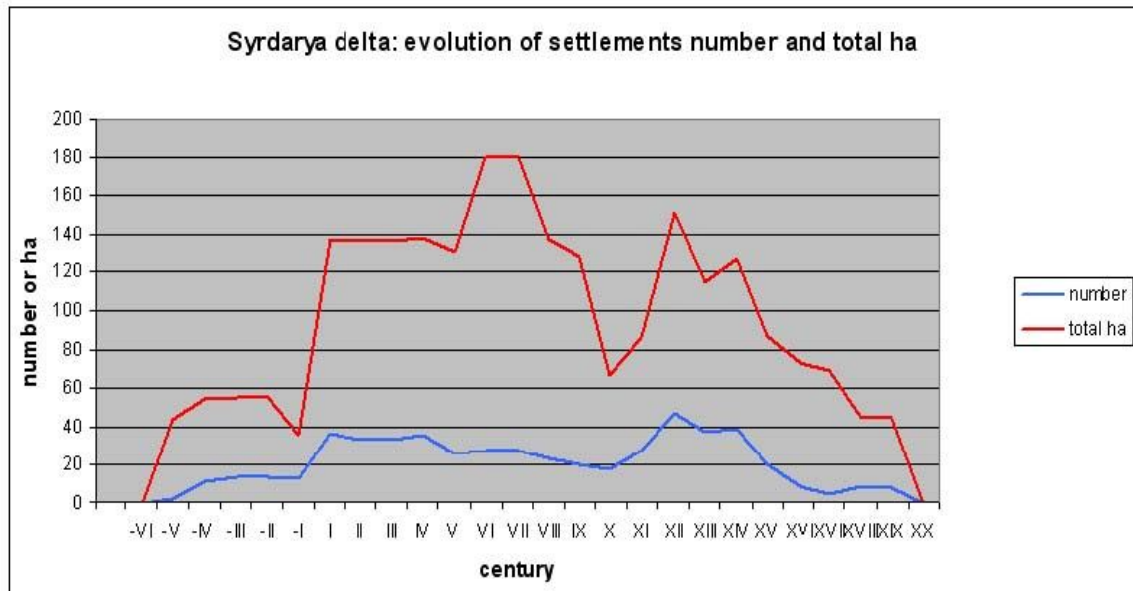
**Fig. 11** Otrar: 6 generations of irrigation canals (III-XIX AD). The line's color indicates the starting century of the canal: crimson (III AD), violet (VI-VII), blue (X), azur (XIII), orange-yellow (XIV-XV), green (XVIII-XIX). Red spots: all walled towns of the urban complex.



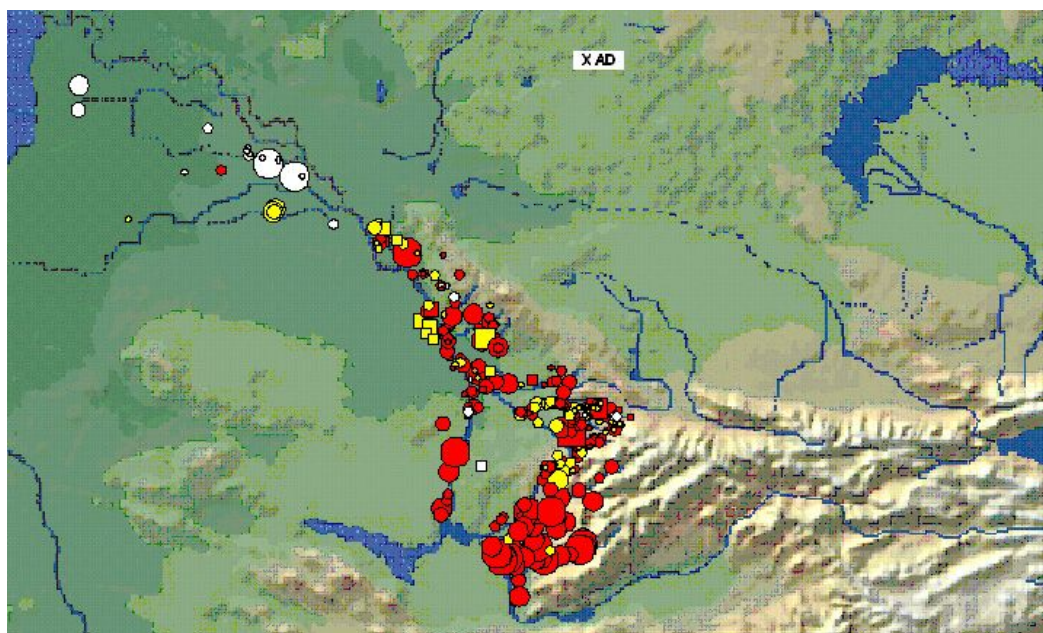
**Fig. 12** Syrdarya delta: evolution of climate and cultural regions during the last 2000 years

## 5.2. Medieval non-sustainable water use and Aral sea levels

From the VIII to the X AD, on the Syrdarya delta, it is detected a progressive anomalous contraction by more than 70% of the urban park, representing the end of the longstanding Jety-Asar culture. The irrigation activity was first displaced at the head of the delta (Chiili, X AD) and then, only after the XII AD, along the upper course of the Janadarya distributary (Fig 13, 14). In quite strict synchronicity, the Aral water level falls between the VIII and XIII AD.



**Fig. 13 Syrdarya delta: evolution of settlements number and total ha (VI BC - XIX AD)**



**Fig. 14 Map of the total urban park of the Middle-Low Syrdarya during the X AD.**  
Dots: Yellow: newly built; Red: still occupied; White: just abandoned

What are the reasons of such events? Water scarcity? Did something happen upstream? In fact the two phenomena coincides with the max plateau of urbanization on the Syrdarya river (VI-XII), and with the establishment of a dry phase (X-XIII) that further reduced the river discharge and induced a further increase of water catchment for irrigation.

In order to find an answer to such questions, few data and coefficients must be collected and elaborated: the water balance of the Aral sea and the water levels under different hydrological scenarios; the modern natural yearly discharge of the Syrdarya river and anthropogenic subtraction of water; the medieval coefficient of water subtraction by unit of

urban ha; and the tentative extrapolation of such calculations valid for the Syrdarya to the other tributary of the Aral sea, the Amudarya river.

**5.2.1** – The water surface and level (wl) of the Aral sea are function of the ratio between water input (river input plus local precipitation) and evaporation [  $wl = f(ri+p) / e$  ], with ri, p and e depending from the given climate. Under the present climatic conditions, the natural water input would be of 56000 km<sup>3</sup> (of which 47 due to river discharge and 9 to local precipitation), corresponding to a water surface of 67000 km<sup>2</sup> at +53 m asl, which was the case just before the 1960.

A long regression of Aral sea levels happened between 800-1300 AD, with a min peak at less than 31 m asl around 1230. This event is detected in different extent also in the Balkhash, Issykul and Bosten lakes. The causes of the phenomenon must be preliminarily attributed to both environmental and anthropogenic factors.

**5.2.2** – The average virtual (natural) yearly regime of the Mid-Low Syrdarya is of 17.84 km<sup>3</sup>/year in Chardara and of 13.82 km<sup>3</sup>/year in Kazalinsk, i.e. between the 2 stations 4.02 km<sup>3</sup>/year are lost in evaporation and infiltration. But a consistent reduction of the water stock is caused by irrigation, today as well as during Medieval times. Estimates of the modern and Medieval water use along the Middle-Low Syrdarya are the following ones.

Today (1974-1994) the anthropogenic water use along the Syrdarya is of:

- in the Fergana valley until Chardara 6.06 km<sup>3</sup>/year
- from Chardara to the mouth (Kazalinsk) 8.56 km<sup>3</sup>/year
- total 14.62 km<sup>3</sup>/year, i.e. the **81% of the river stock**

At the mouth are left only 3.22 km<sup>3</sup>/year

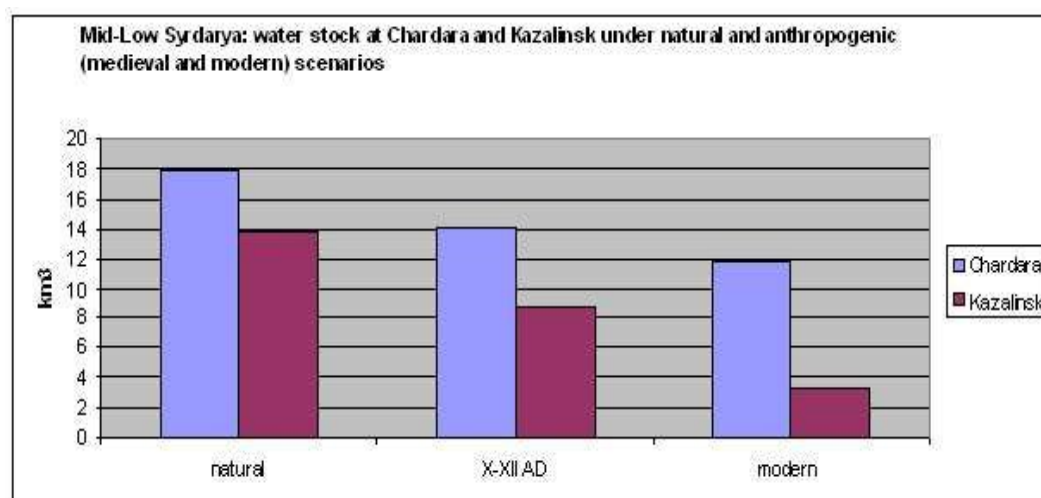
In 2000-2002, within a project INTAS, has been calculated the coefficient of yearly water use during the X-XII AD for the central part of the Otrar oasis. It amounts to 0.0039 km<sup>3</sup>/year per hectare of walled town. (Clarke and alia, 2010)

Such esteem, when applied to the entire urban park of the Syrdarya during the X AD (1364 ha), suggests a water consumption of:

- in the Fergana valley until Chardara 3.81 km<sup>3</sup>/year
- from Chardara to the mouth (Kazalinsk) 5.39 km<sup>3</sup>/year
- Total 9.20 km<sup>3</sup>/year, i.e. the **51% of the river stock**

At the mouth were left only 8.64 km<sup>3</sup>/year

This means that, in X-XII AD, the water catchment from the Syrdarya amounted to the 63% of modern water use (Fig 15). At least the same ratio must be suspected for the Amudarya.



**Fig. 15** Mid-Low Syrdarya: water stock at Chardara and Kazalinsk under natural and anthropogenic medieval and modern scenarios



**5.2.3** –The modern water catchment along the Syrdarya, coupled with an even bigger catchment's ratio from the Amudarya, has induced the total depletion of the Aral sea.

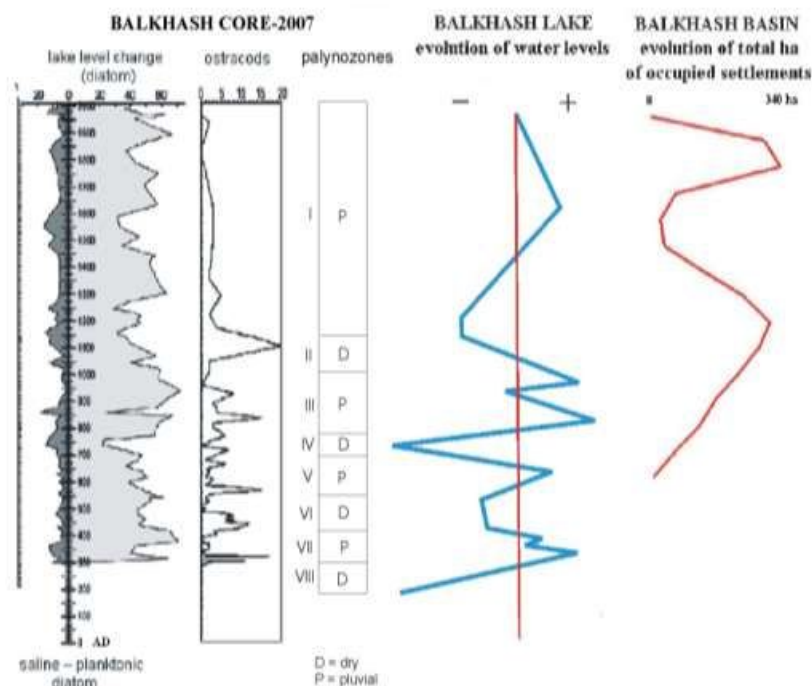
If the water use of the X-XII AD represented the 51% of the virtual yearly stock along both the Syrdarya and the Amudarya rivers, this would mean a diminution of the total river input into the Aral from 47 to 23.5 km<sup>3</sup>, determining a new equilibrium of the sea with a surface of 281 16 km<sup>2</sup> at +35 m asl. The Kerderi settlement of the XII-XIII AD, by being located at 31 m asl<sub>3</sub>, points to a water surface of less than 16500 km<sup>2</sup>, i.e. an additional reduction of the total river input to less than 14 km<sup>3</sup>. This means, at least, a further reduction of the river input by 20.2%, which must be totally attributed to climatic impact (increased evaporation and/or decreased precipitation) or to a XIII-XIV century diversion of part of the Amudarya flow into the Sarykamysh lake. (Abu al-Ghazi 1665; Tolstov 2005).

On the basis of this model, the 60% of the Aral regression of the XII-XIII AD must be attributed to human water catchment, and the 40% to climatic-environmental changes. The question now is: Are our coefficients correct? How much lower than 31 m asl went the Medieval regression of the Aral sea? What have been, eventually, the relative weights of the anthropogenic irrigation activity and of the natural climatic and environmental forcing?

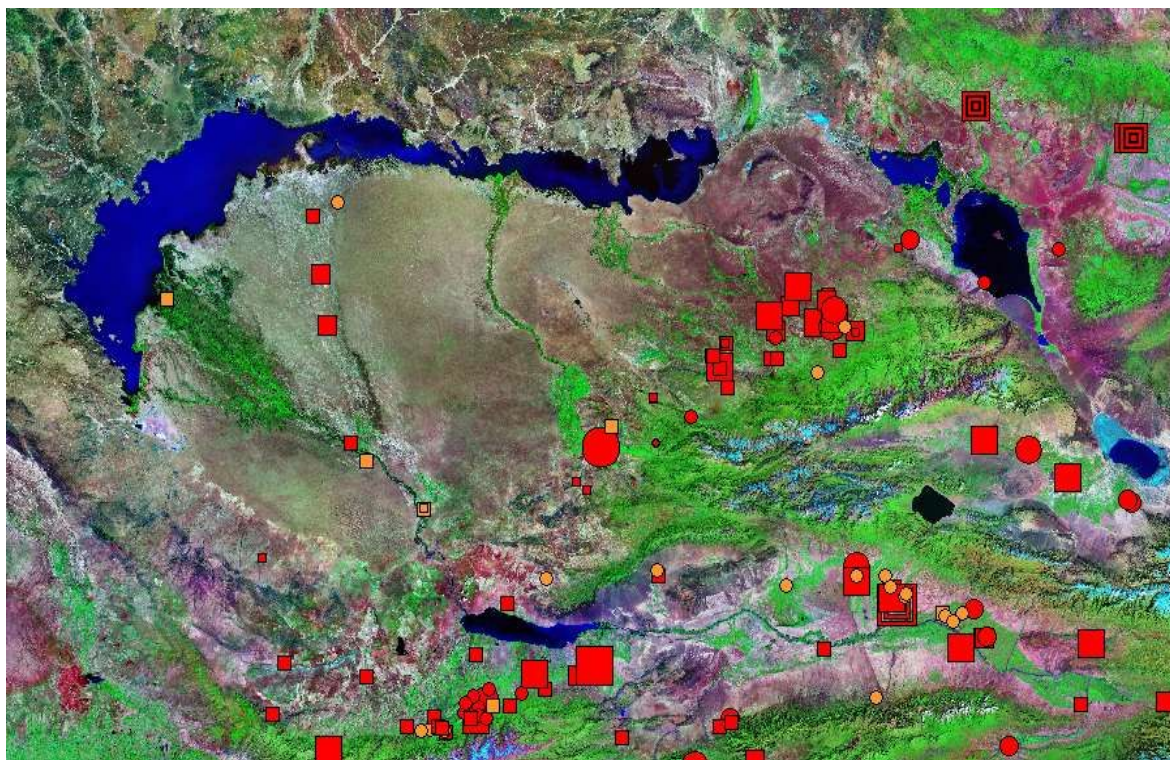
### 5.3 – The problem of the Medieval regression of the Balkhash lake

The same explanation is not valid for the Balkhash regressions of the VIII and XII AD (the first very strong and abrupt, the second less pronounced but longer). It is a question of proportions. In fact, on the basis of the Otrar coefficient of water use per settlements ha, the entire urban park of the Ili valley during the X AD (165 ha) could only use the 5.4% of the modern average yearly water regime of the Ili (at the mouth: 11.85 km<sup>3</sup>/year). And the total urban park of the Karatal and Lepsy rivers (82.53 ha) used just the 6.0% of the average yearly stock of both these streams (5.26 km<sup>3</sup>/year).

Anyhow, a correlation is clearly existing between the Medieval regressions of Balkhash water levels and the Early Medieval period of urban development of the Balkhash basin between the VIII-XIII AD (Fig 16). But the cause seems acting in the opposite direction than in the Aral case, in the sense that, like all along the N-Tianshan piedmonts so in the Balkhash basin, the establishment of a dry climatic phase favored the conversion from pastoralism to urbanized piedmont irrigated agriculture and mix-farming; and the following start of the pluvial phase at the end of the XIII AD would support the opposite trend.



**Fig. 16** Ili-Balkhash basin: evolution of water levels of the Balkhash lake and of total ha of occupied settlements in the basin (diatom and ostracod by Endo; palynozones by Aubekarov; water levels and urban evolution by Sala)



**Fig. 17 Ili-Balkhash basin: map of the Medieval urban complex (VIII-XII AD)**

As last consideration, we will underline the existence of an alignment of ruins of caravanserais pointing to a caravan road evidently active during the VIII-XIII AD along an eastern paleo-distributary of the Ili delta and across the Uzunaral straight (Fig 17). Was at that time the straight transformed into a dry road, which would mean an exceptional drop by 6 meters of Balkhash water levels and the split of the western and eastern parts of the lake? Actually paleosoils have been found buried in the area of the Uzunaral straight, but their age has not been attributed yet.

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