“PROYECTO GRANDE”

CHALLENGES IN THE ASSESMENT OF SEDIMENTATION AND MORPHOLOGICAL CHANGES OF THE RESERVOIRS IN THE ALTIPLANO DUE TO CLIMATE ACCELERATION, BOLIVIA

By

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- Reservoirs in the Altiplano
- Sedimentation processes of shallow Poopo lake
- Erosion pattern and sedimentation of Tuni glacier reservoir, preliminary interpretations

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Reservoirs in the Altiplano

- In the Bolivian Altiplano are placed two big lakes and two dry lakes (*salares*). In short and long time they are very sensible to climate.
- Titicaca lake has 8000 km^2, Poopo lake has 3000 km^2. The first one is deep and the second very shallow, with average deep only of 1.5 m.
- The Poopo lake according to the last modern climate period should be considered as terminal lake and very dependent.

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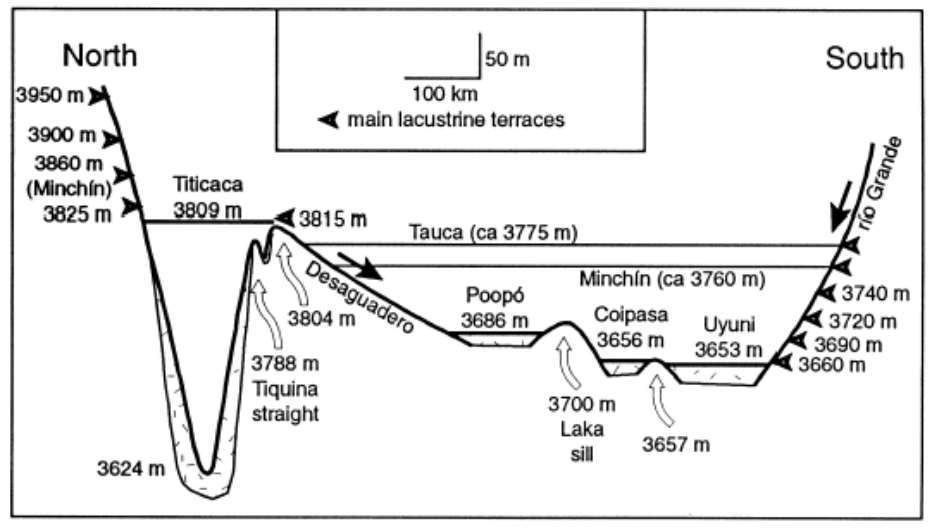
Reservoirs in the Altiplano



- Successive limnological studies have been carried out in the Titicaca lake and has been identified different lake paleo-levels.
- The water levels oscillation at least for the last 170 000 years has been registered by several researchers . One thousand years ago Titicaca was divided in two lakes.
- Thus the Titicaca lake studies were priorized not only the hydrological issue.

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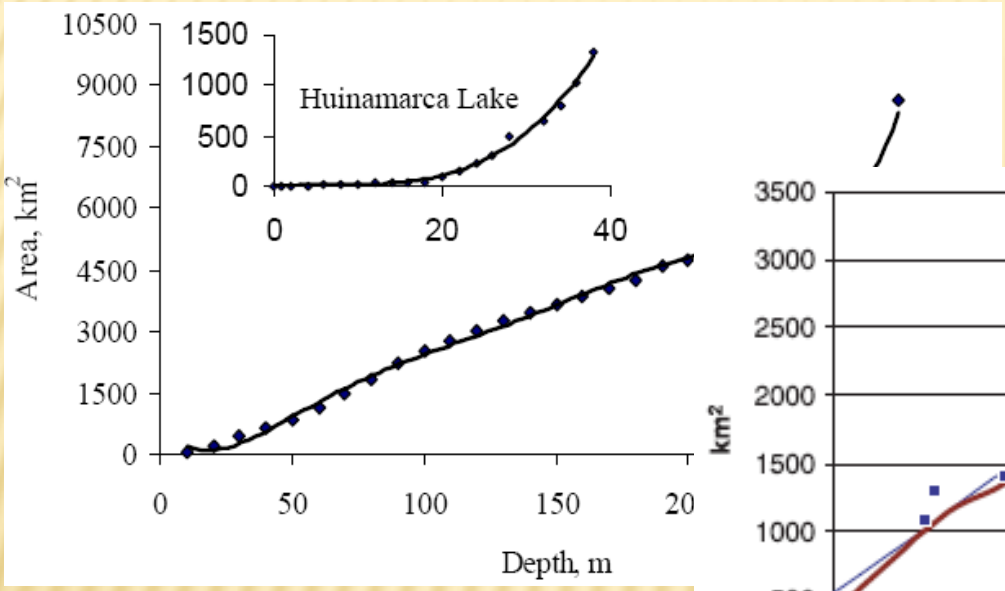
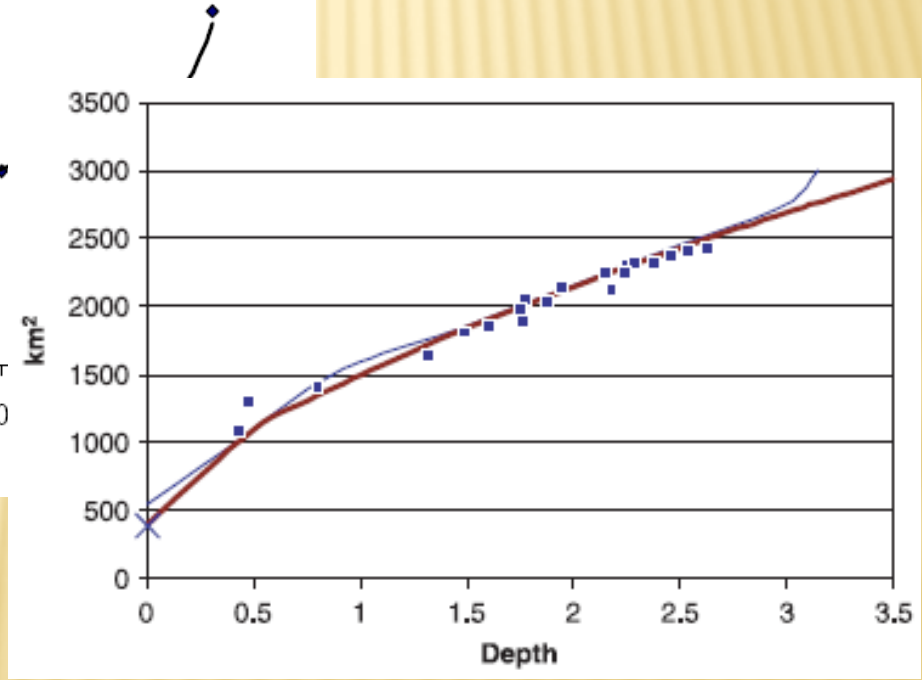
Reservoirs in the Altiplano

- The modern hypsographic curve of the Altiplano lakes (Titicaca and Poopo)





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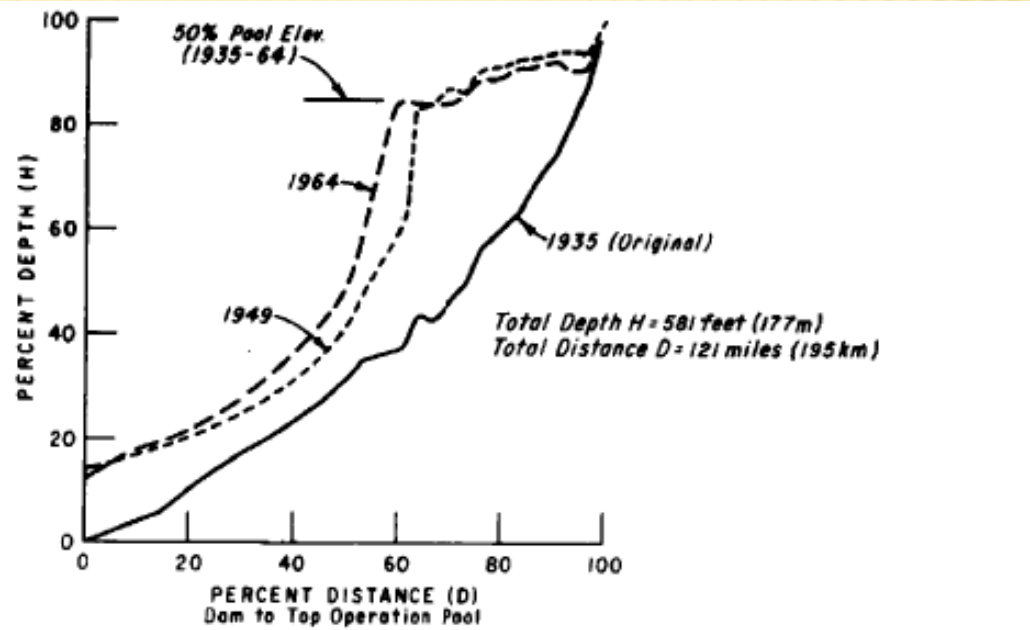
Reservoirs in the Altiplano

- Typical morphological changes of the reservoirs (Lake Mead, USA)



Sediment distribution from reservoir surveys of Lake Mead (Bureau of Reclamation, 1987)

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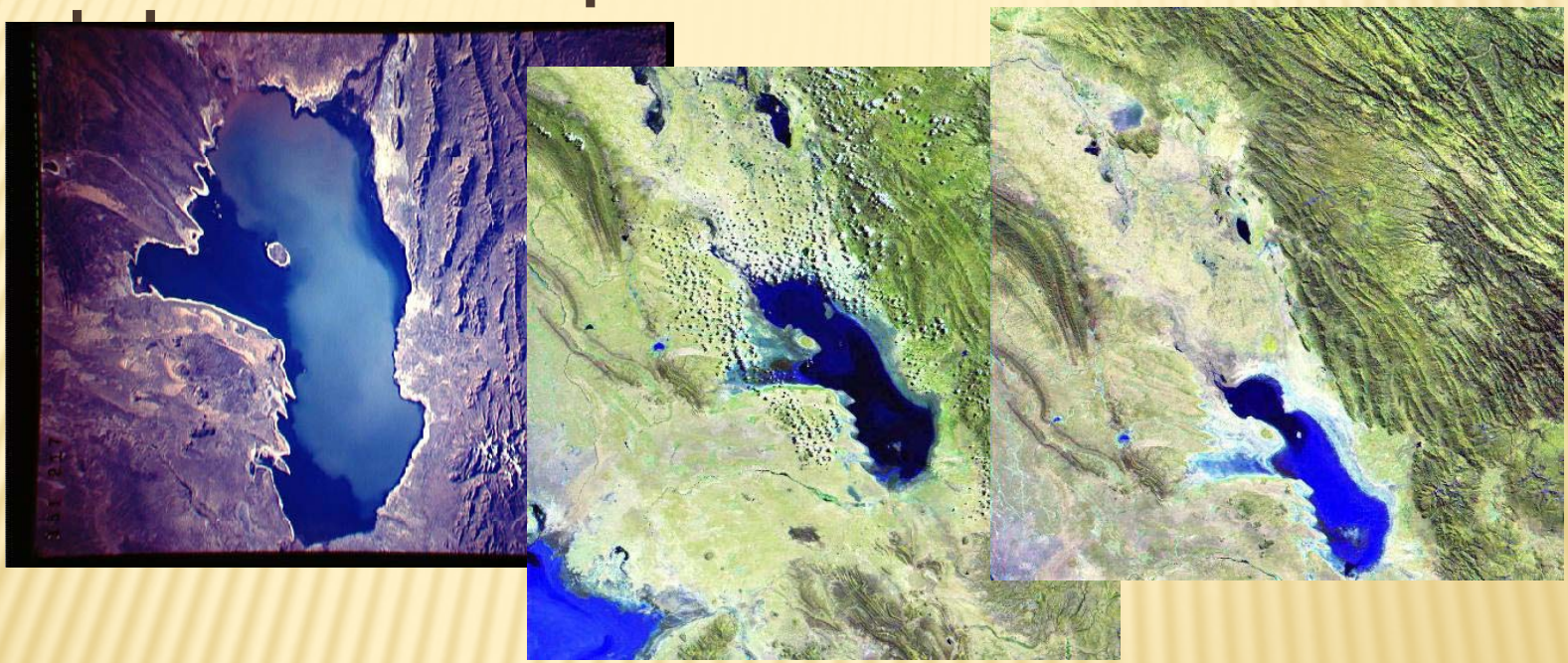
Sedimentation processes of shallow Poopo



- The water level oscillation is extreme with surface area changing from 2500 to 1000 km^2 . If water depth is less than 1 m at the end of the rainy season, the lake disappears.
- The shores are very shallow and wind force easily could move up the shores hundred of meters.

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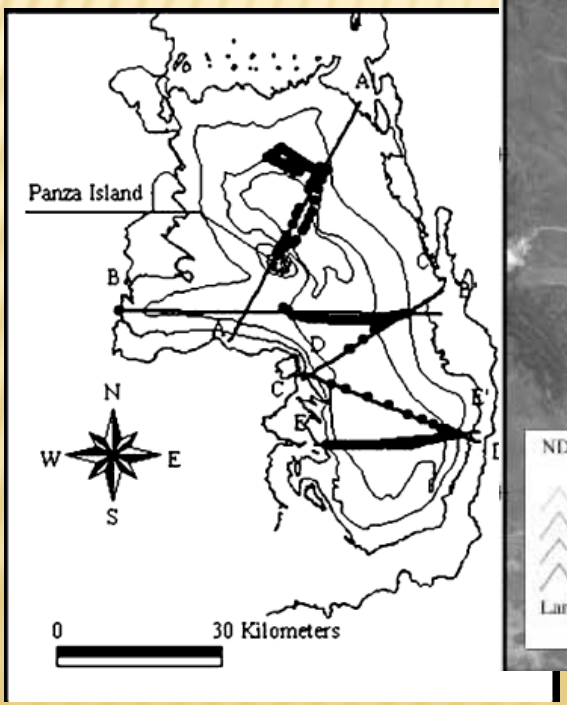
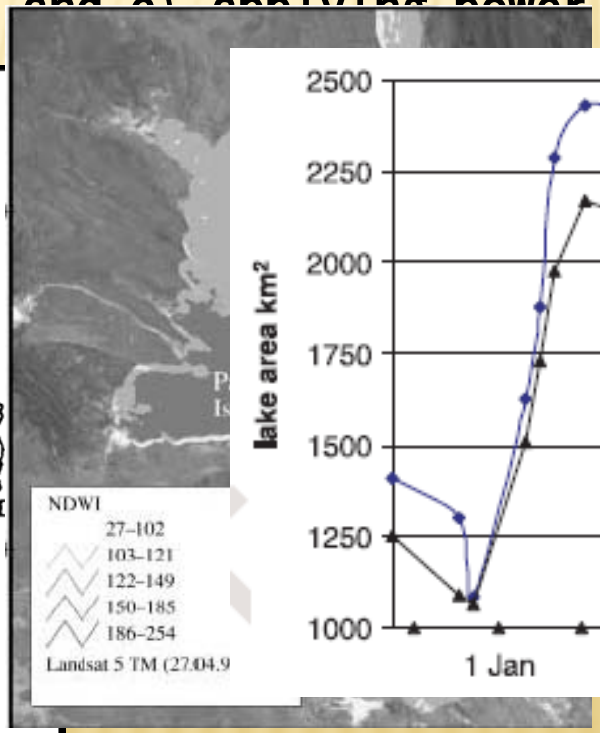
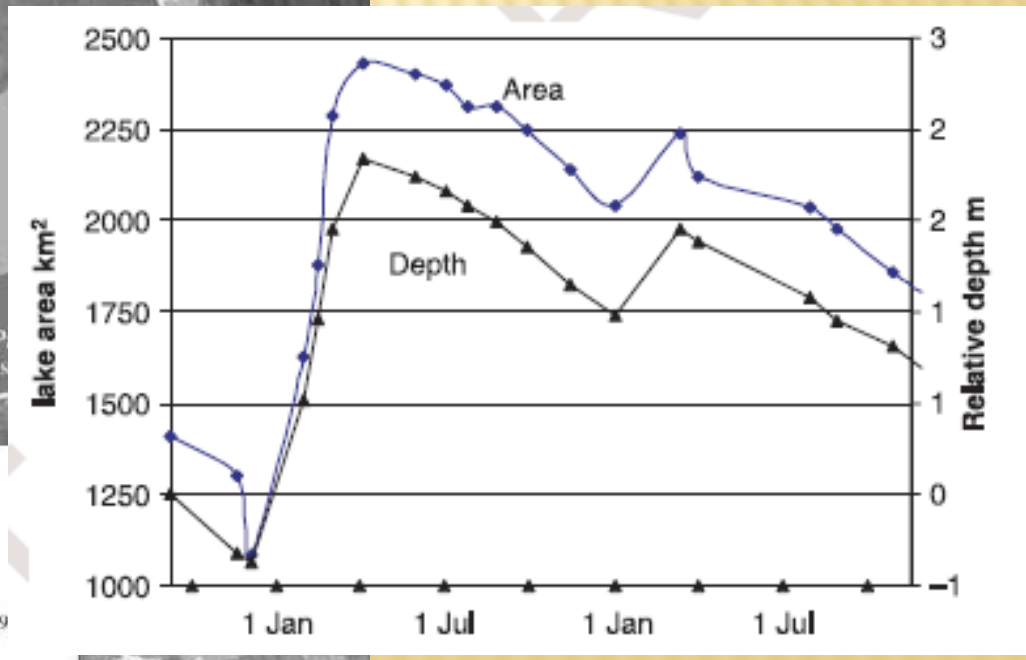
Sedimentation processes of shallow Poopo lake

- There was defined and analyzed first the hypsographic curve of the lake trough different methods: a) Bathymetry consisting in lake leveling , measuring single deep point and analyzing satellite images and computing water index, b) computing water balance for the lake and c) applying power equation.







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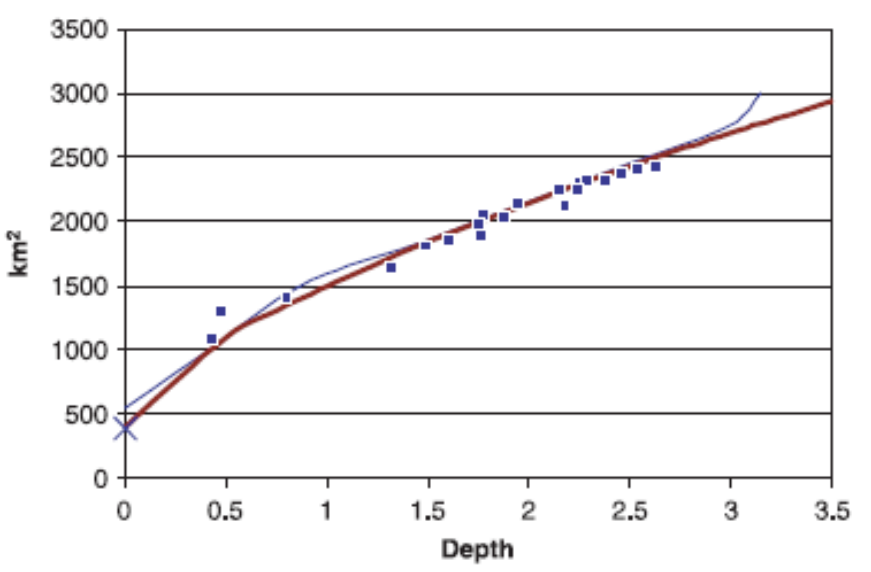
Sedimentation processes of shallow Poopo lake



$$A = A_{base} + A_0 \, (h/h_0)^{2/P}$$

- Thin line come from lake leveling and satellite image analysis; the isolated squares corresponds to water balance computation; and the thick line to power equation.

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Sedimentation processes of shallow Poopo lake

- The hypsographic curve of the Poopo lake could change due to of re-suspension within the lake, and sediment transport from the 24 regional rivers and one big river.

- The annual sediment transport in the Desaguadero big river during 1992-1993 was estimated at $6*10^6$ tn/year, which corresponds to a sedimentation rate of the lake of 2 mm/year, or 4 cm in 20 years.

- The concentration of suspended solids was found to be changes from 250-180 mg/L.

- Redistribution on the bottom sediments could change the bathymetry of the shallow lake.

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Sedimentation processes of shallow Poopo lake

- There is more sediment to settle in a deep water than in shallow one, but waves erode bottom material more in very shallow water and the deeper parts would tend to become more shallower also.

- The resuspension and resettling can take over the whole lake bottom of Poopo lake.

- Since there is no banks around the lake, the water processes probable change the morphology very slowly, but there is no information to verify this conclusion.

- Is more likely that morphological changes could occur because o single events, rather than continuously over time, such as the wind event, which moves the water hundred of meters up the shores.

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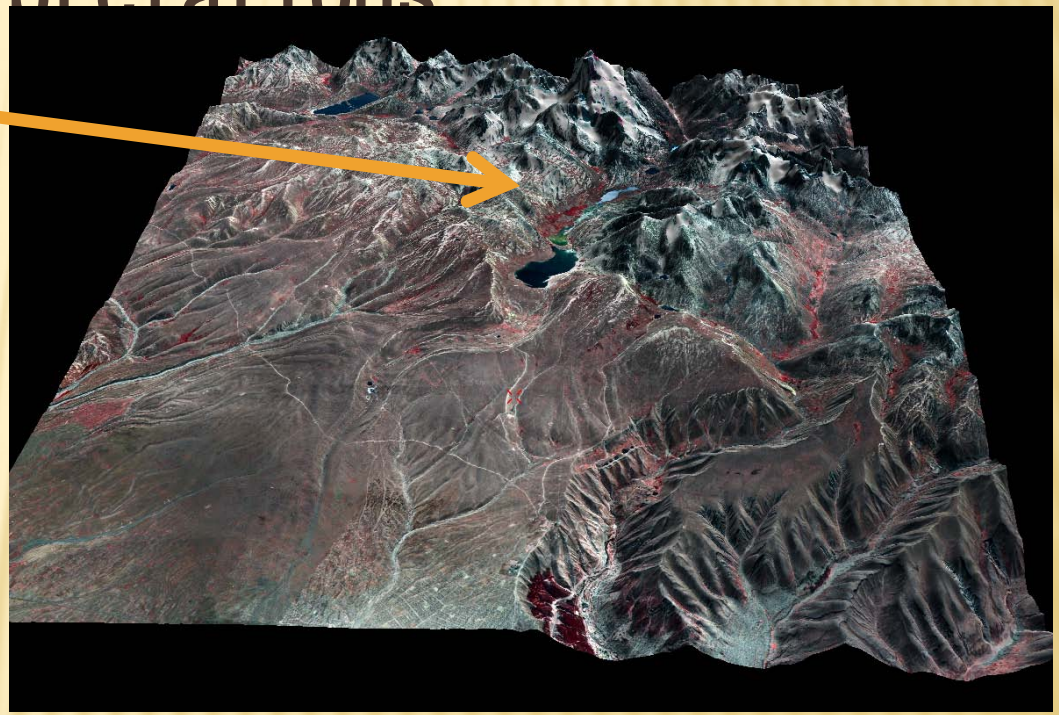
Sediment transport pattern and sedimentation in Tuni glacier reservoir, preliminary interpretations



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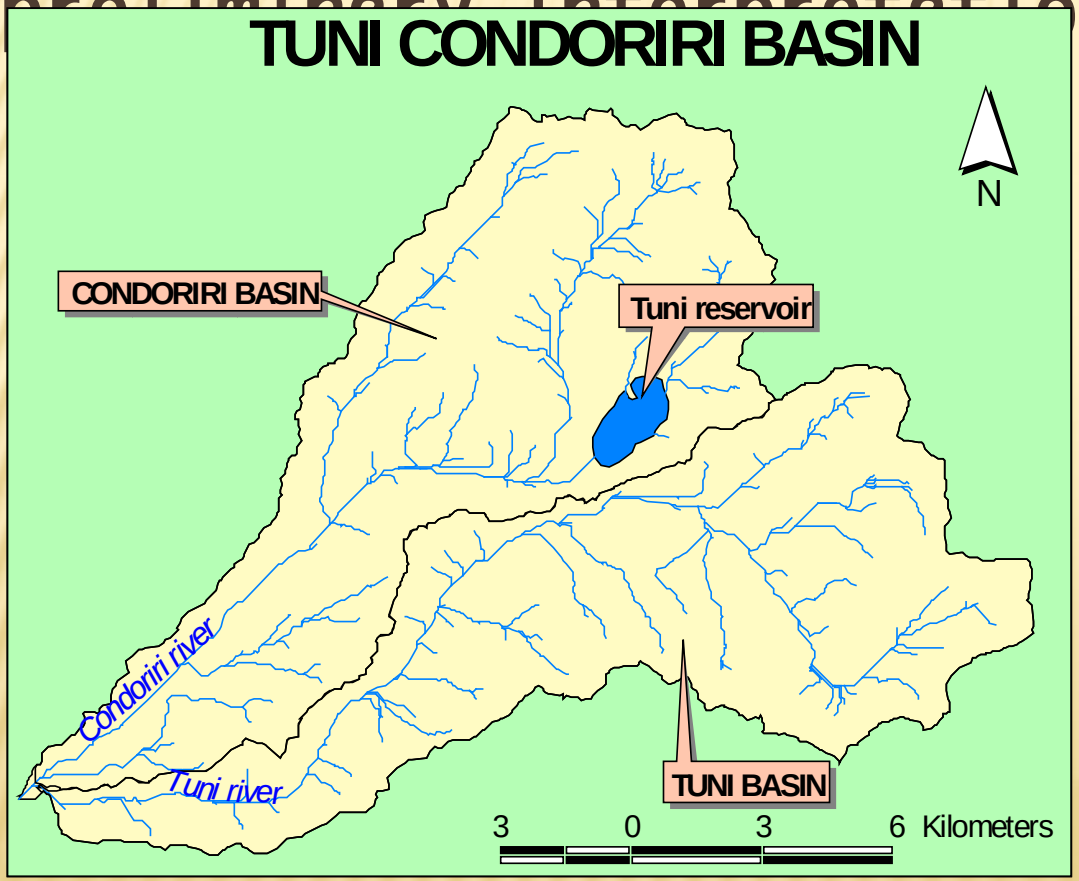

- Whole Tuni basin area= 195 km^2.

- Tuni glacier watershed surface area = 25 km^2

- Tuni water surface area = 2 km^2

- Maximum water depth = 30 m
- Average water depth = 15 m

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Sediment transport pattern and sedimentation in Tuni glacier reservoir, prelim

Parameters	Value
Area of the basin (Km^2)	195.7
Perimeter of the basin(Km)	77.9
Compactness ratio	1.57
Average elevation (msnm)	4947
Drenaje density (Km/km^2)	1.13

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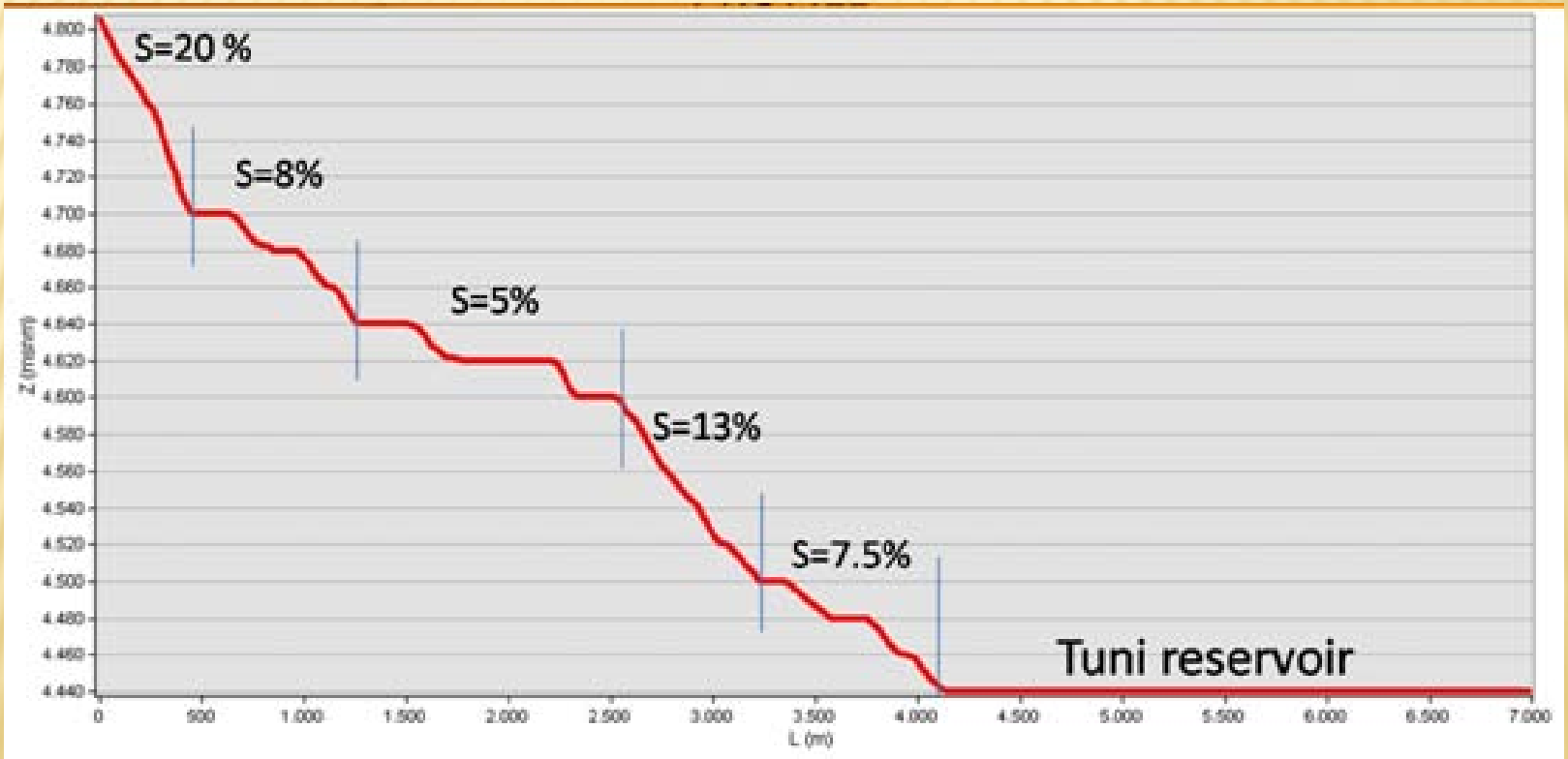
Sediment transport pattern and sedimentation in Tuni glacier reservoir, preliminary interpretations

- Tuni reservoir glacier watershed profile



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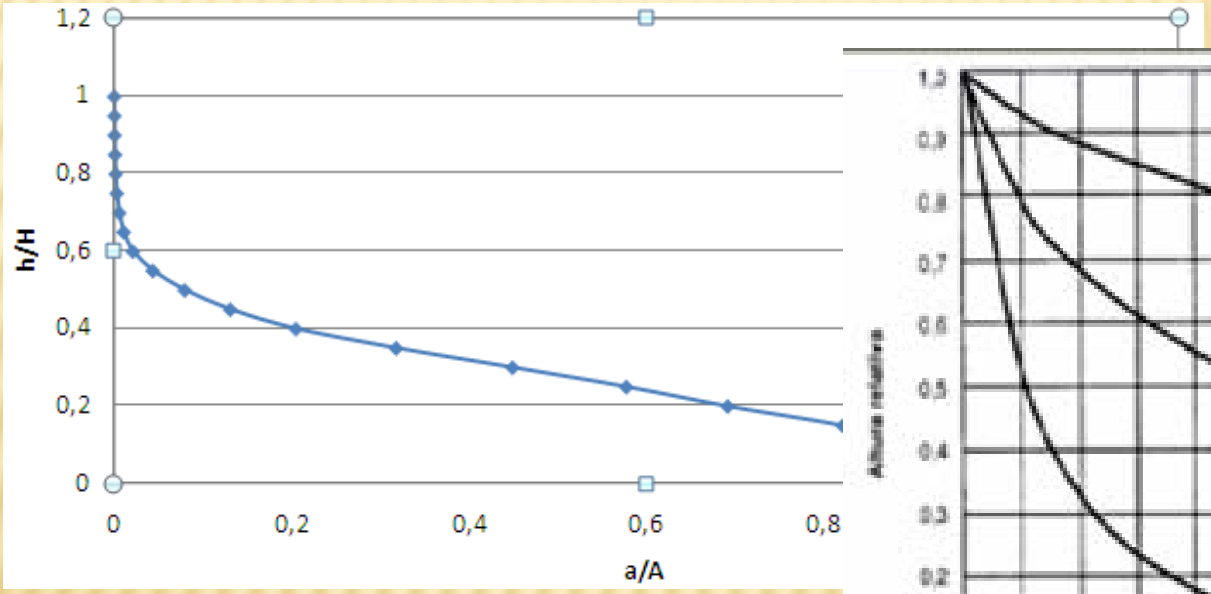
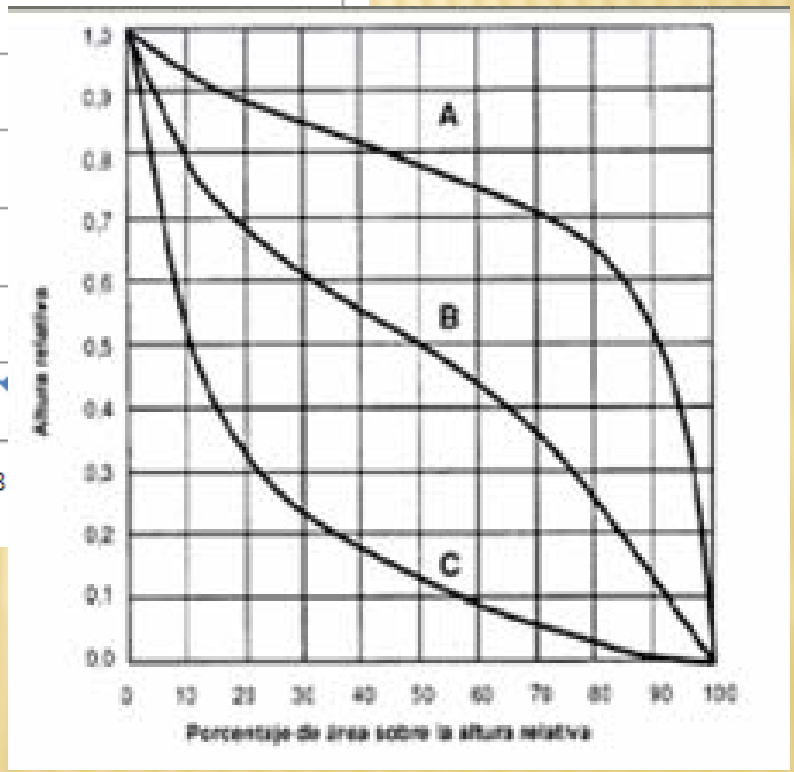
Sediment transport pattern and sedimentation in Tuni glacier reservoir, preliminary interpretations

- Hypsographic curve of whole Tuni river basin





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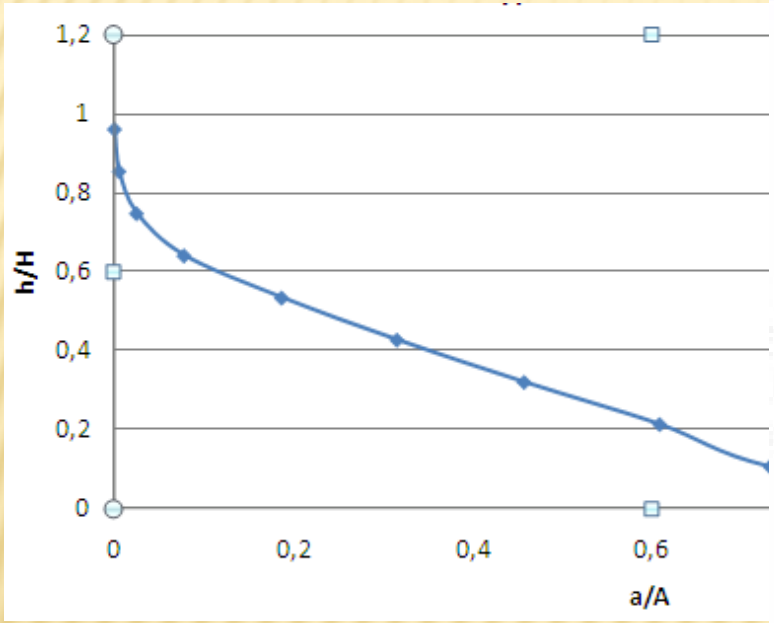
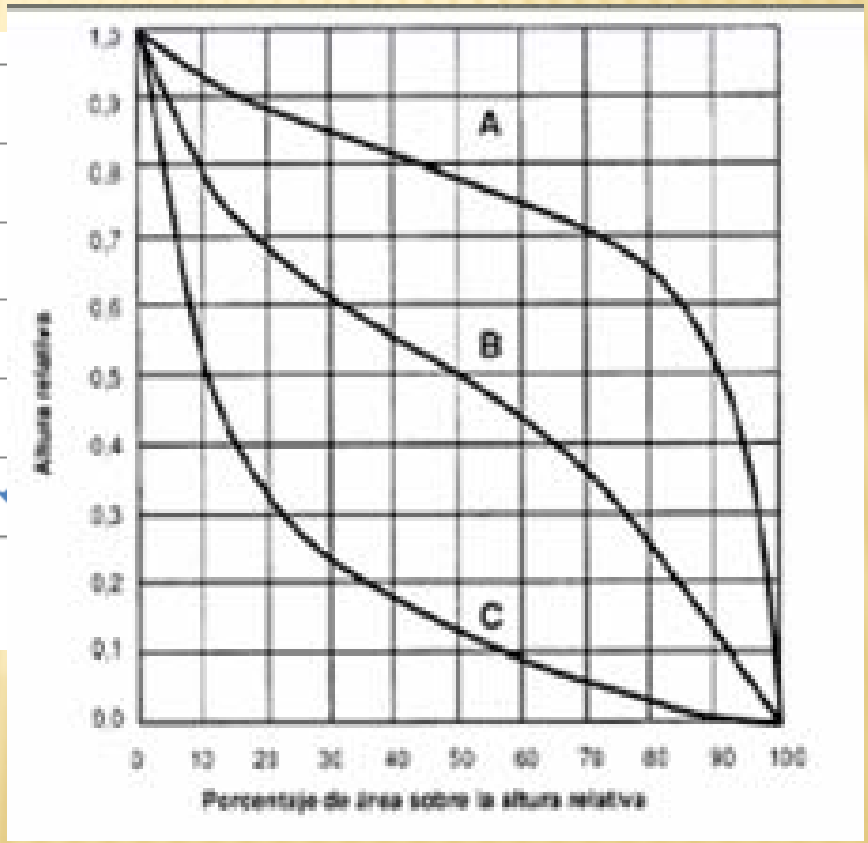
Sediment transport pattern and sedimentation in Tuni glacier reservoir, preliminary interpretations

- Hypsographic curve of Tuni glacier watershed





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Sediment transport pattern and sedimentation in Tuni glacier reservoir, preliminary interpretations

- **To raise the issue and hypothesis of research are the followings:**

- **The generation of erosion and sediment transportation data.**
- **Production and sedimentation models.**

- **Sedimentation model under climate changes of the reservoirs.**

Also could be then:

- **The sediment trap along Tuni river and regulation capacity of the watershed**
- **Analysis of the practices for sediment transport control**
- **Re-suspension of the sediment in the Tuni glacier basin**
- **Morphological changes prediction of the Tuni reservoir**

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