Interreg Ivc – Sharp

>> 1st SHARP International Conference & 5th SHARP Partners Meeting

>>North Aegean Region Water Resource Management on Chios Municipality.

Kozani , May 22nd to 24th, 2012

North Aegean Region

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External expertise

Water resources management

What everybody of us can think about water resources management ?

1. *Reduce water use ?*
2. *Creation of new water facilities (e.g. more drillings, dams, wells)?*
3. *Crop specific uses?*

> *Management is the use of natural resources to the greatest extent, to meet possible needs and last longer. Gifford Pinchot (1947)*

Pinchot defined two aims for management-conservation.

1. *Proper use, protect, maintenance and renewal of natural resources.*
2. *Monitoring and controlling water resources for the common good.*

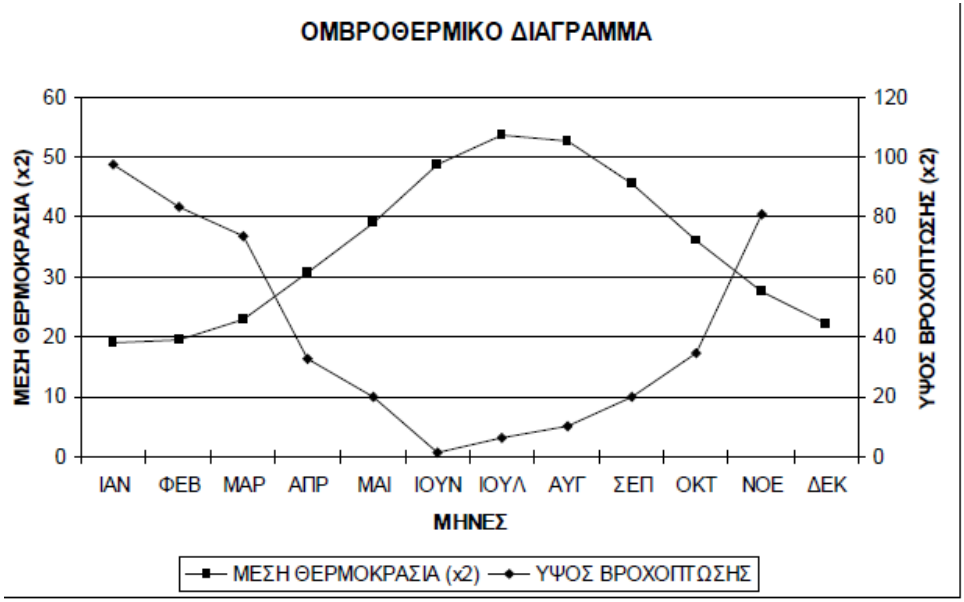
Chios city and Korakaris basin

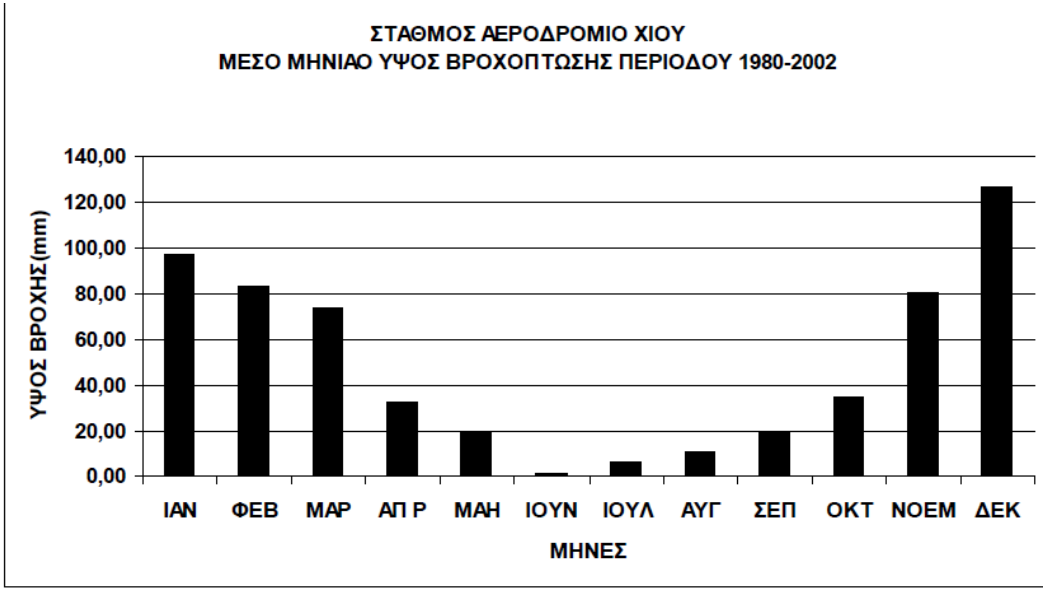
Study area's facts

- **Geography- Adminstrative**: Chios city is the capital of Chios Island and it is located in the east cost of the Island.
- **Demography** : 37.000 , 70% of the total population habits within Korakaris Basin.
- **Korakaris basin:** serves the need for water for about 37.000 habitants in an area of 23 km².
- **Climate :** Mediterranean, characterized by a rainy winter, a cool spring and a dry summer.
- **Geology :** Complex geological formations , limestone and dolomite prevails.
- **Tectonic:** Faults orientation NE-SW & NW-SE
- **Hydrogeology:** Karstic formation

Climate

According to ombrothermic diagram it is assumed that the dry period appears between the months of April and September. The peak of the dry period occurs in July. High temperatures has as a consequence more water losses by perspiration and evaporation.





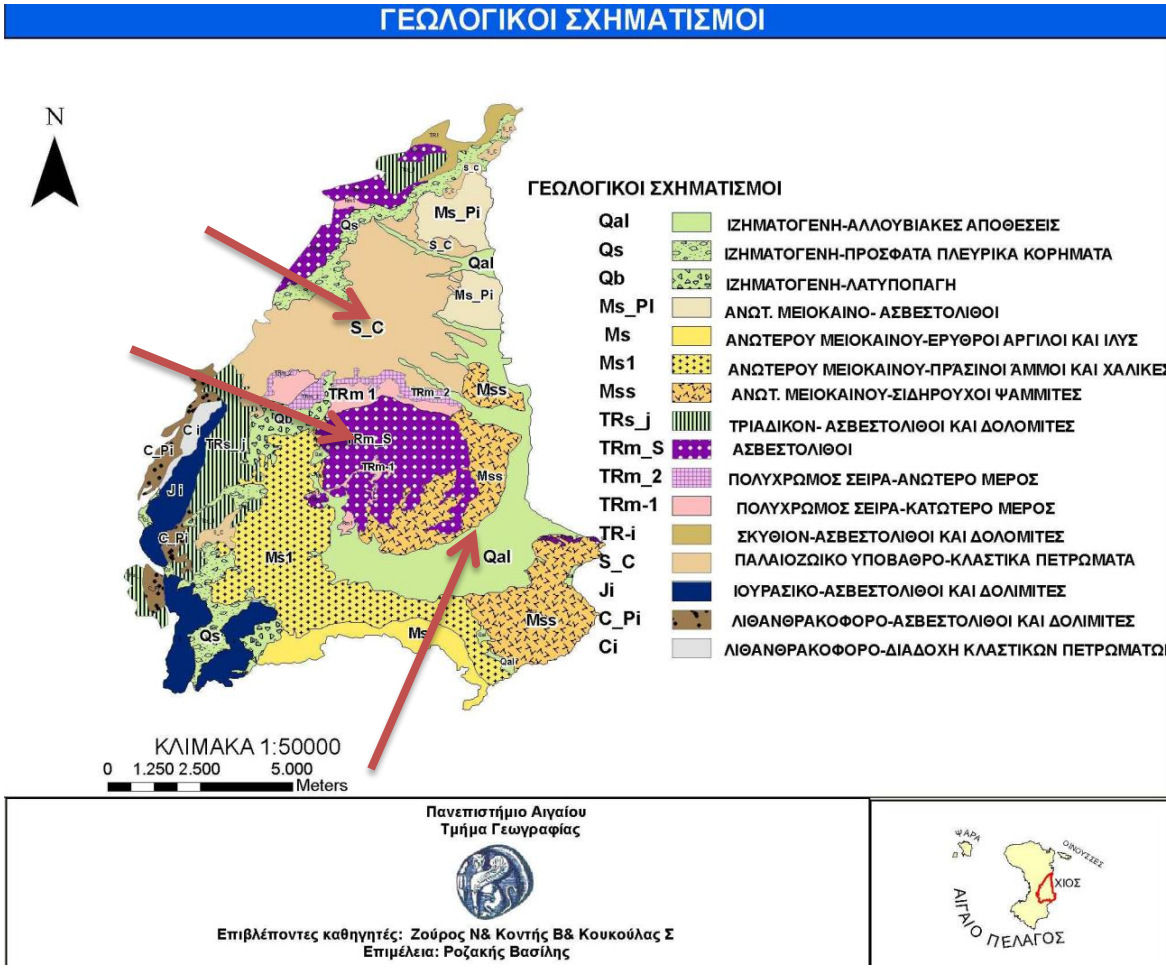
Korakaris Geology

The geological formations that exist in Korakaris area according to the maps of the Greek Geological Institute are:

- Paleozoic Sedimentary Bedrock: *Psammite, Slate S-C, GrW.*

- Limestones and Dolomites formations: *TRm-I , TRm-S, Kd-t .*

- Alluvial deposits: gravels, sands, silts -Qal. Deposits appear within Kokalas and Parthenis torrents.

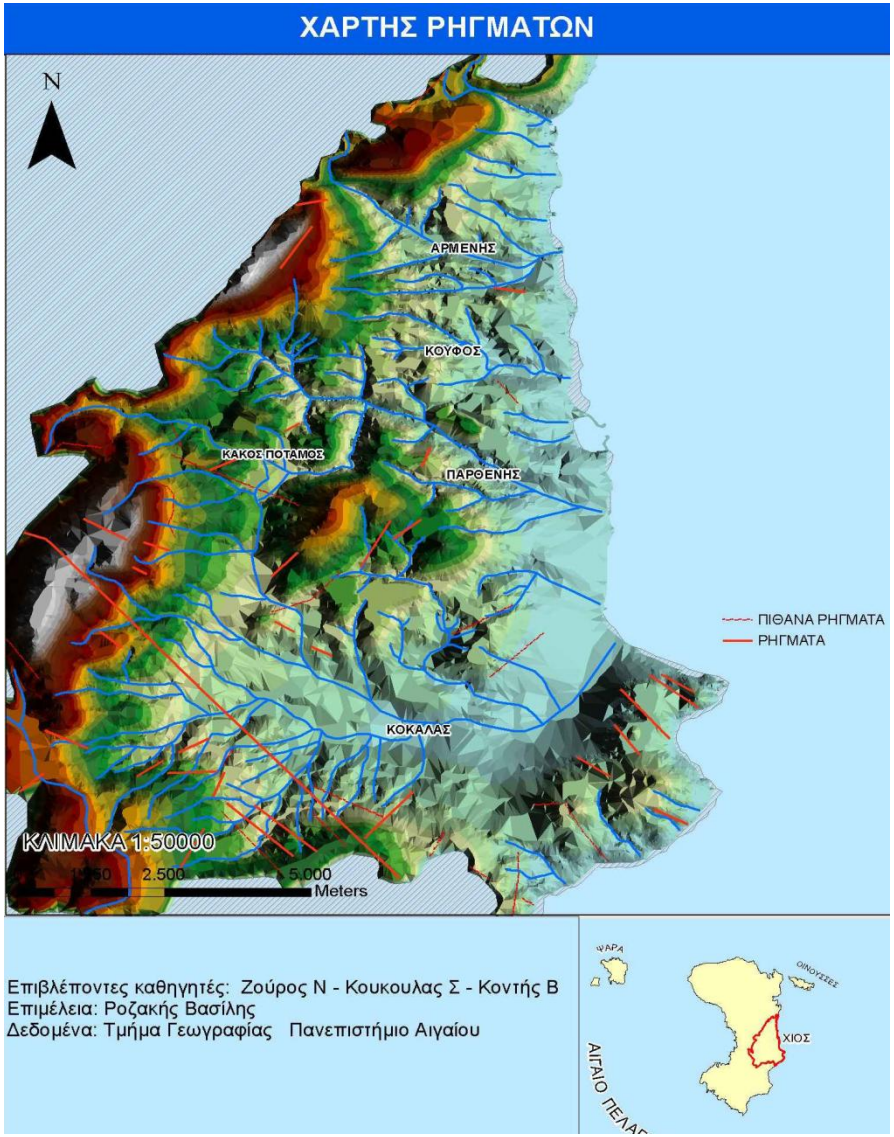


Region's Tectonic

Tectonic has played important role in in creating <u>both relief</u> and the <u>formation of hydrogeological conditions.</u>

There are two main directions of the faults in the region.

- NE-SW and NW-SE.



Hydrogeology

The geological formations encountered in the area of Korakaris can be divided into the following categories based on their Hydrogeology behavior:

- ✓ **Karstic formations:** limestones and dolomites regardless water permeability.
  - ➢ Limestones medium to high permeability.
  - ➢ Limestones low to medium permeability.(little or no flow)
  - ➢ Porous formations (fed by rainwater infiltration).
- ✓ **Sedimentary clastic rocks of the Paleozoic :**
  - ➢ Psammite, shales and chert (the entire formation is non permeable.

Remarkable aquifers

According to the above, and on the basis of the existing drilling and wells locations in Chios area, the remarkable aquifers locate in **the limestones and dolomites** of Korakari and in the **recent alluvial deposits** of the lowland.

- **Korakaris Karst system:** In Southern and Eastern parts of Korakaris area drillings are operating since ’50s. The water which is drilling is coming from Korakaris limestone aquifer. This aquifer is fed mostly from rainwater. Initially, it was consider that the presence of a relatively impermeable formations between korakaris aquifer and the sea, would protect the water aquifer from salination.

Water Balance

P=E+A+I

P is for the volume of precipitation (m^3) **, E** for evaporotranspiration**, A** for Runoff and **I** for infiltration (mm)

✓ **Precipitation**=E(m^2) * h(m)

E=10 Km2

Precipitation 1980-2002 is 512 mm

P= 5.100.000 m3

✓ **Evaporespiration**.

On the basis of the average annual rainfall and average monthly temperature we can estimate the amount of precipitation infiltrating water in the karst limestone an the rate of **evaporespiration**.

Burdon – Papakis Method

If Annual Precipitation is 250<P<1000m, as it occurs on Chios, as evaporespiration is taken the 50% of the precipitation period November-March and the remaining months rainfall , ie *E = (0.5 + RNOE RAPR-MAR-OCT) / P annual.*

For period 1980-2002 **E=0,58 ή E=2.700.000 m3**

✓ **Runoff**

Assuming that there is not great loss of surface water in the area of limestone it is encountered equal to 2%, **100.000 m^3**

✓ **Inflitration**

In conclusion, considering the evapotranspiration is equal to **2.700.000 m3** and runoff is **100.000 m^3** the infiltration is **2,000,000 m^3** . The average annual supply of korakaris limestone for the period 1980-2002 amounts to 2.000.00 m3 and therefore these are the average annual renewable potential the system.

Chios water drilling works

Korakaris reservoir covers much of the city's water supply with the following drilling works:

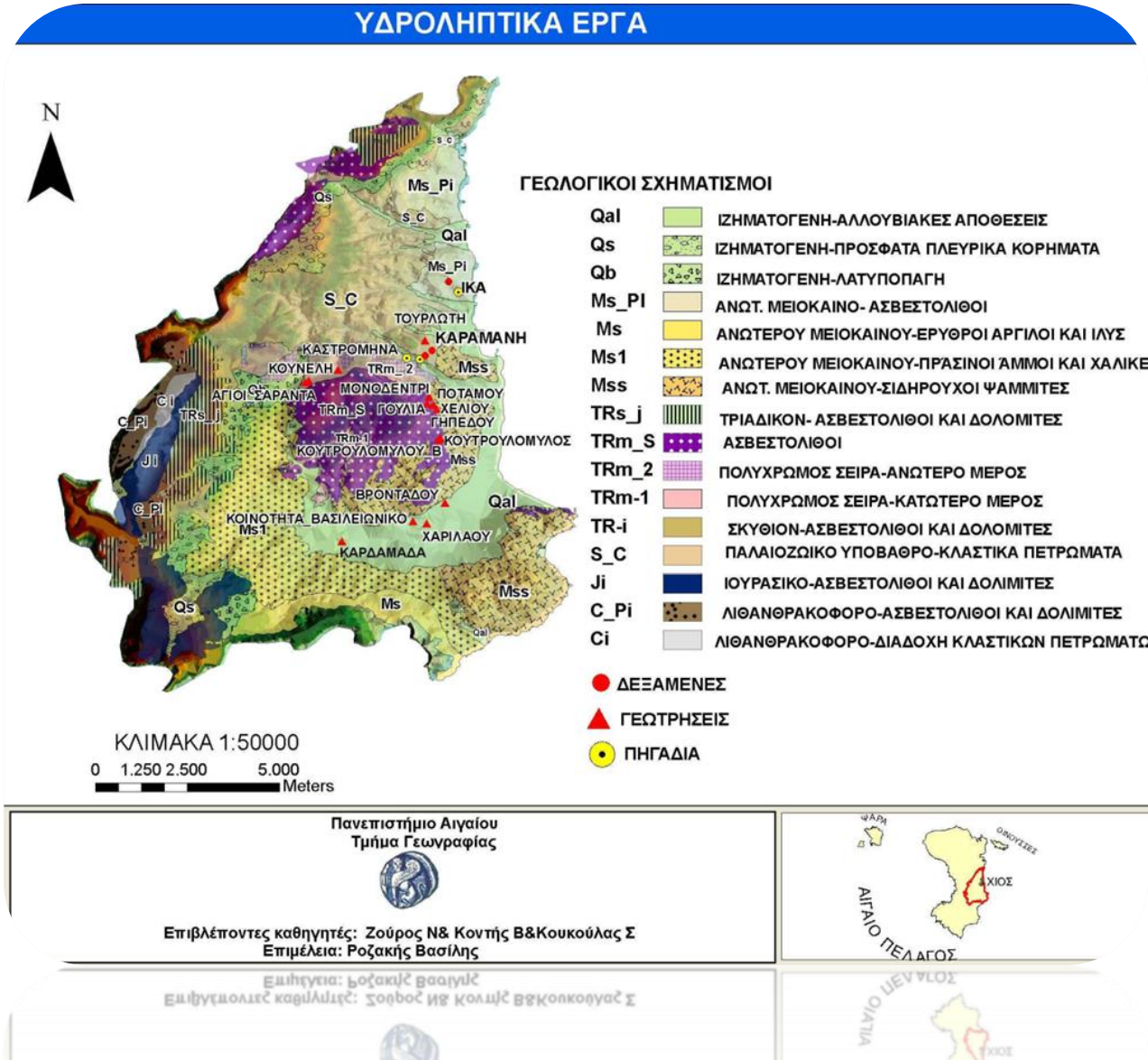
- 16 Drillings
- 3 Wells
- 3 Springs
- 1 Dam

The pumped water from korakaris aquifer serves the need of Chios and the irrigation of Kampos area.

- Main water drill between June-September <u>20hours daily,</u>

  <u>monthly supply</u> ≥200.000 m^3.

✓Pump is limited in <u>5 hours daily</u> during the winter.



Water quality problems

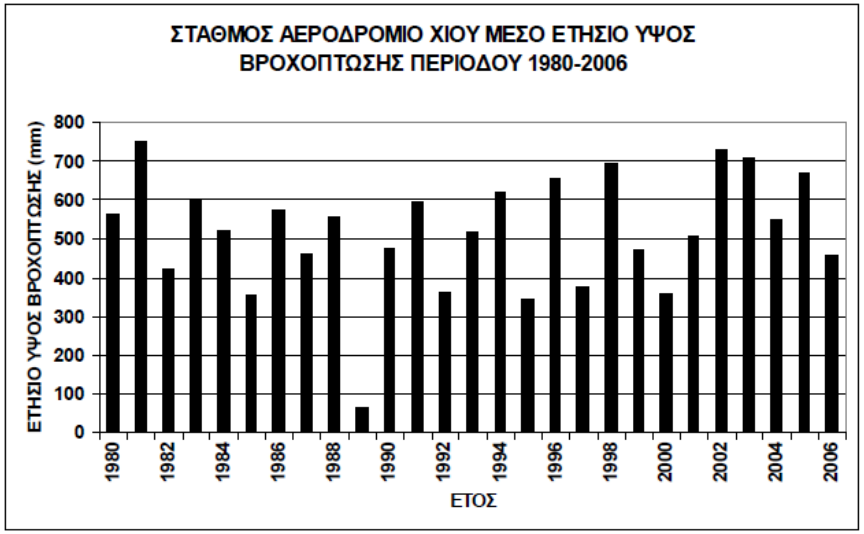
- Insufficient water resources,
- the poor quality of the supplied drinking water, mainly due salination and to over-pumping,
- imbalance in population and irrigated areas mainly in Chios area,
- the climate conditions the last years(extended arid periods) and
- the geological formations of the area are the main factors which contribute to the two main problems of water degradation:

Salination & appearance of Mercury

Salination

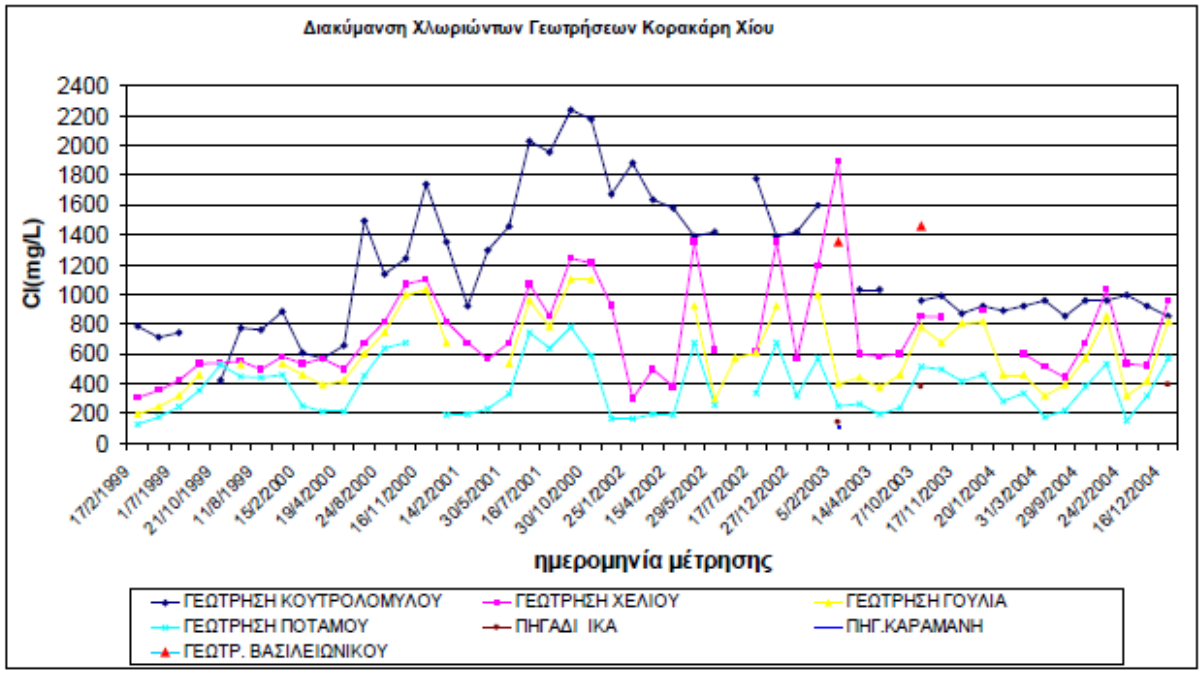
The biggest problem that Chios faces as it was mentioned also above is the salination. The water supply and the irrigation is made mostly from water drill works in Korakaris basin. Korakaris limestone mass extends in an area of 8-10 km² and it is open to the sea through the psamitte bedrock. **Every basin has a capacity of water extraction and the exploitation must not exceed this**. Unfortunately, Chios authorities in early 50's, in order to cover the population increasing demand on water , were proceeded in the **construction of a numerous wells and drills.**

➢The irrational exploitation of water combined with the increased demands for water created serious quality problems and allowed the sea to enter the aquifer. The situation became worse after the arid period of 1989.



Salination

Proof of all the above are the results of analyzes **where concentrations of chloride and sodium ions exceed drinkable limits(250mg/l) ,**which certifies the encroachments of the sea and the mixing of seawater with the sweet water of the aquifer.



Διάγραμμα-20 : Διακύμανση των χλωριόντων Γεωτρήσεων και φρεάτων στη λεκάνη του Κορακάρη

Mercury

However, salination aquifer creates an extra problem. **The charge of water aquifer with Mercury (Hg)at rates higher than the permissible.**

In the bedrock of Korakaris Basin exists the rock cinnabar (HgS). When cinnabar come in contact with salty water a chemical reaction occurs and quantites of mercury are released in the underground water . This makes water extremely dangerous for human health.

In our survey we used Pearson coefficient to test the dependence of mercury on chloride.

The results showed that there **is a strong and positive dependence** between the Mercury and Chloride.

Proposals

- Mapping the water supply network with GIS.
- Locate and repair the water supply network losses.
- Restrictive measures on both the pumping and consumptions for private use, re-pricing of water (graduated rates).
- Eliminate or reduce contamination by mercury is practically impossible. The only possible action is to reduce pumping at a rate of about20% to slightly lower amounts deducted from the reserve.
- It also highlight the need for well organized control

✓ Imposition of fines to those who use illegal water.

✓ Financial support of private initiative to built inhouse water tanks to colect rainwater.

✓ Complete the construction of the new projects that will enhance the water potential of the area (under construction projects koris gefiri, Sarapio & Piges Rinas of providing up to 300m3/ h and 250m3 / h respectively, and the sources of dolphins with 100m3 / h

✓ Enhance the aquifer with small dams

✓ Collect surface water in small and big dams so that there will be the possibility to cover the future needs of water.

Conclusions

- The estimation that the aquifer was not in communicate with the sea lead to the public authorities to overdrill water to cover the increasing demands and cause the salination problem.

- The volume of precipitation in korakaris limestone is 5.100.000 m3 and only 2.000.000 m3 infiltrating.

- The water exploitation is more than 1.015.415m ^{3} per year and it is estimates that the exploitation is also made from the reserve.

- Overdrilling and wells in the area are the main factor of salination.

- Every area of the karstic aquifer shows a significant increase of the chloride after 1990 as consequence of the arid year of 1989.

Thank you for your attention!