ACADEMIA DE CIENCIAS FÍSICAS, MATEMÁTICAS Y NATURALES

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Instituto de Biología Experimental

Improving Access to Safe Water: Perspectives from Africa and the Americas

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Introduction

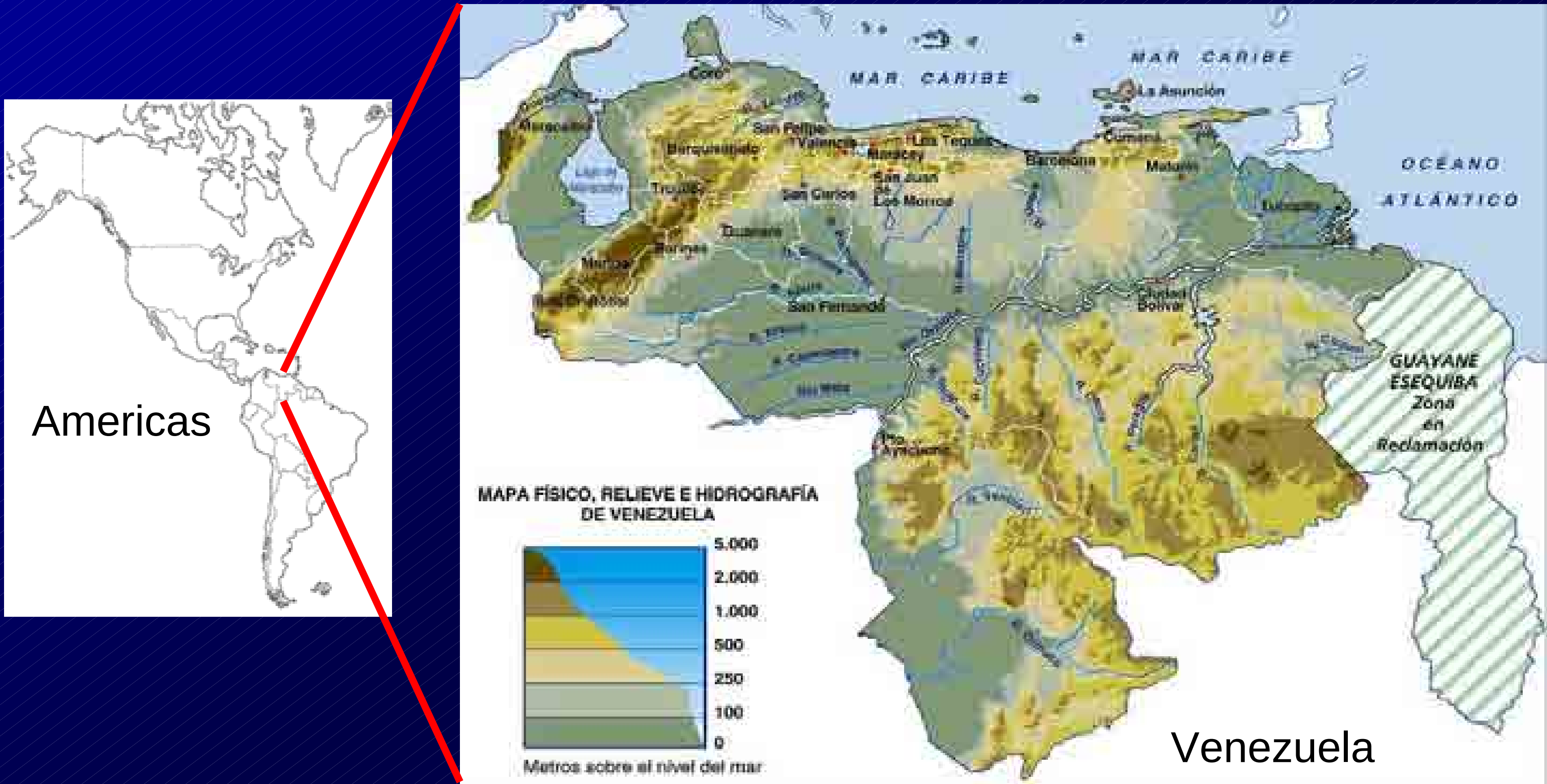
Venezuela has more than 100 reservoirs, which were built for diverse purposes: drinking and industrial water supplies, irrigation, flood control, recreation and hydroelectric power production.

However, human activities in their basins have generated eutrophication problems.

Some remedial measures have been suggested, as well as the creation of protected areas and regulatory of standards for nutrient control in sewages, in order to protect the water bodies.

The aim of this presentation is to show some Venezuelan practices that helped to improve the access of population to water resources and to improve the water quality. Some problems related with these processes are also showed.

Venezuela in the World



Venezuela is located in the Northern region of South America, between 00° 38’ 53” and 12° 11’ 46” latitude N and between 58° 10’ 00” and 73° 25’ 00” longitude W.

Venezuelan State has a relevant concern about water resources, and issued many regulatory standards in order to assure the protection of natural (water) resources and the good water quality that is supplied for diverse purposes.

Elsewhere, Ministry of the Environment has invested high amounts of money to recover the water quality in some reservoirs, and has invested a lot of time to organize communities in order to capacitate them for solving their problems and protect their natural resources.

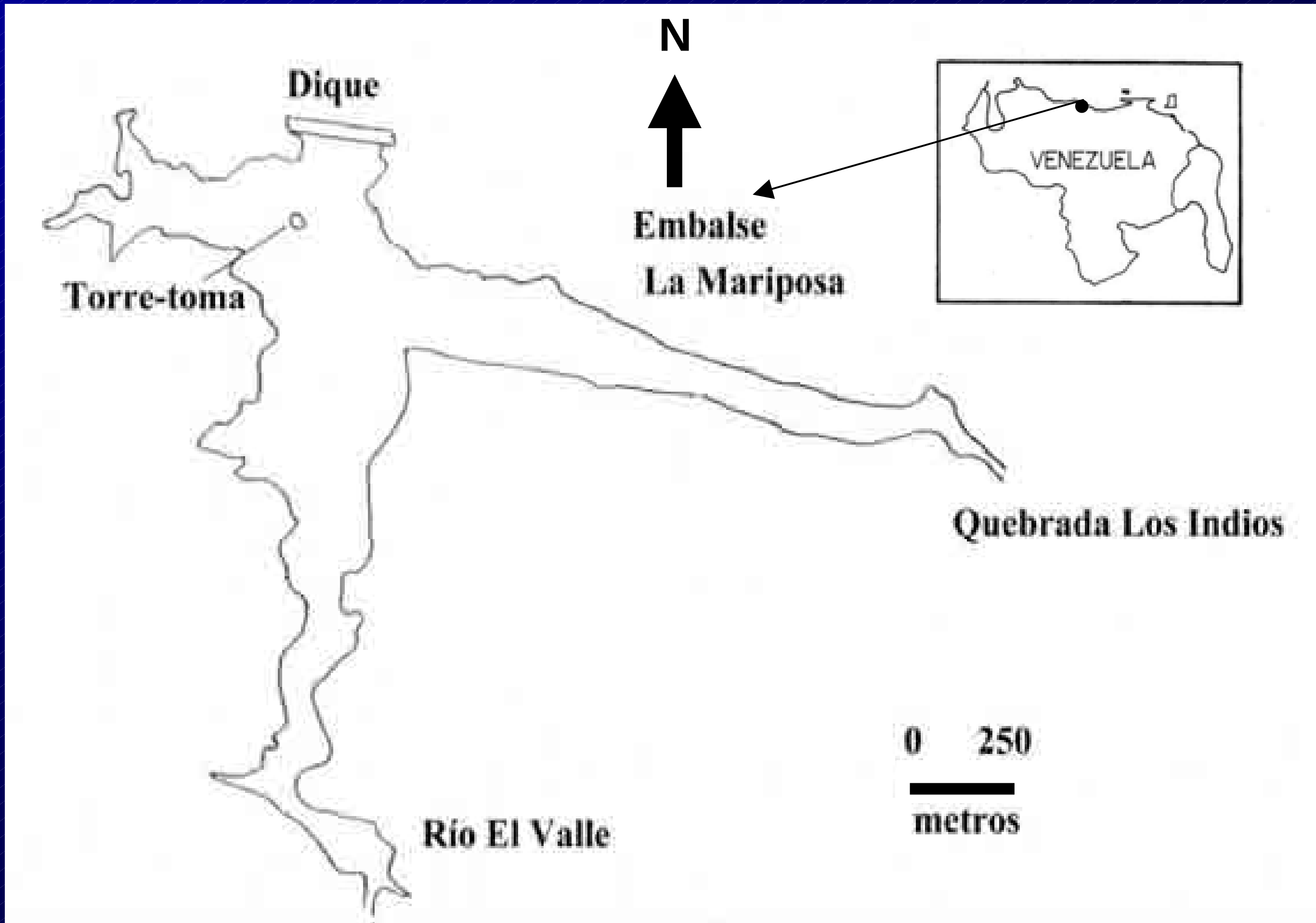
Some examples will be depicted as follow.

Study areas

Image from Google Earth

Reservoirs location in Venezuela

Study case: La Mariposa reservoir



- Location: 10º 24'N-66º 33'W
Reservoir area: 540,000 m^2
- Volume: 7,000,000 m^3
- Altitude: 980 m.a.s.l.
- Mean depth: 13.0 m
- Discharge: 4.00 m^3/s
- Residence time: 20 days

Purpose: Supply of drinking water to the City of Caracas (>4 million of inhabitants), and recreation. Trophic state: Hypertrophic.

La Mariposa reservoir

Image from Google Earth

Reservoir suffers high and frequent level fluctuations due to the high water demand of the city of Caracas, and water pumping from Camatagua and Lagartijo reservoirs. Its basin is highly impacted and eroded, which directly contribute with a lot of nutrients and sediments to the water body.

October 2005: The water hyacinth *Eichhornia crassipes* began to cover the reservoir surface, affecting even more its water quality.

January to May 2007: Irregular macrophyte removal was made, without success; macrophyte covered up to 85% of reservoir surface.

May 2007: Ministry of the Environment ordered the removal of the macrophyte. The population of *E. crassipes* was almost entirely removed in few days, using mechanical harvesting. However, water quality was affected.

Water quality

	Jan. 2001	Jan. 2007	Jan. 2008
Transparency (m)	0.7	1.3	0.3
Temperature (°C)	24.9	24.6	25.2
Dissolved oxygen (mg/l)	7.0	3.79	2.7
Conductivity (μS/cm)	302	347	416
pH	8.05	7.6	8.13
Total P (μg/l)	123	153	308
Total N (μg/l)	1383	844	2261
Condition	Without *E. crassipes*	Covered with *E. crassipes*	*E. crassipes* removed

Removal of water hyacinth was the right action, but this macrophyte increased their population densities again at the end of 2008, because of the lack of a systematical and periodical removal of plants.

February 2009 – March 2010: Plants covered more than 50% of water surface, and a new removal plan was applied. Eutrophication sources are still present around the reservoir, and therefore, if not controlled, *E. crassipes* will increase in numbers once again, and again, and again...

May 2006: ~10% covered

February 2007: ~85% covered

Mechanical harvesting was used to control this macrophyte

January 2008: Macrophyte removed

January 2009: ~ 50% covered

April 2009: Macrophyte removed

November 2009: Never ending story

More than 90% of reservoir surface was covered by *E. crassipes…* again…

March 2010

What to do? – Some suggestions:

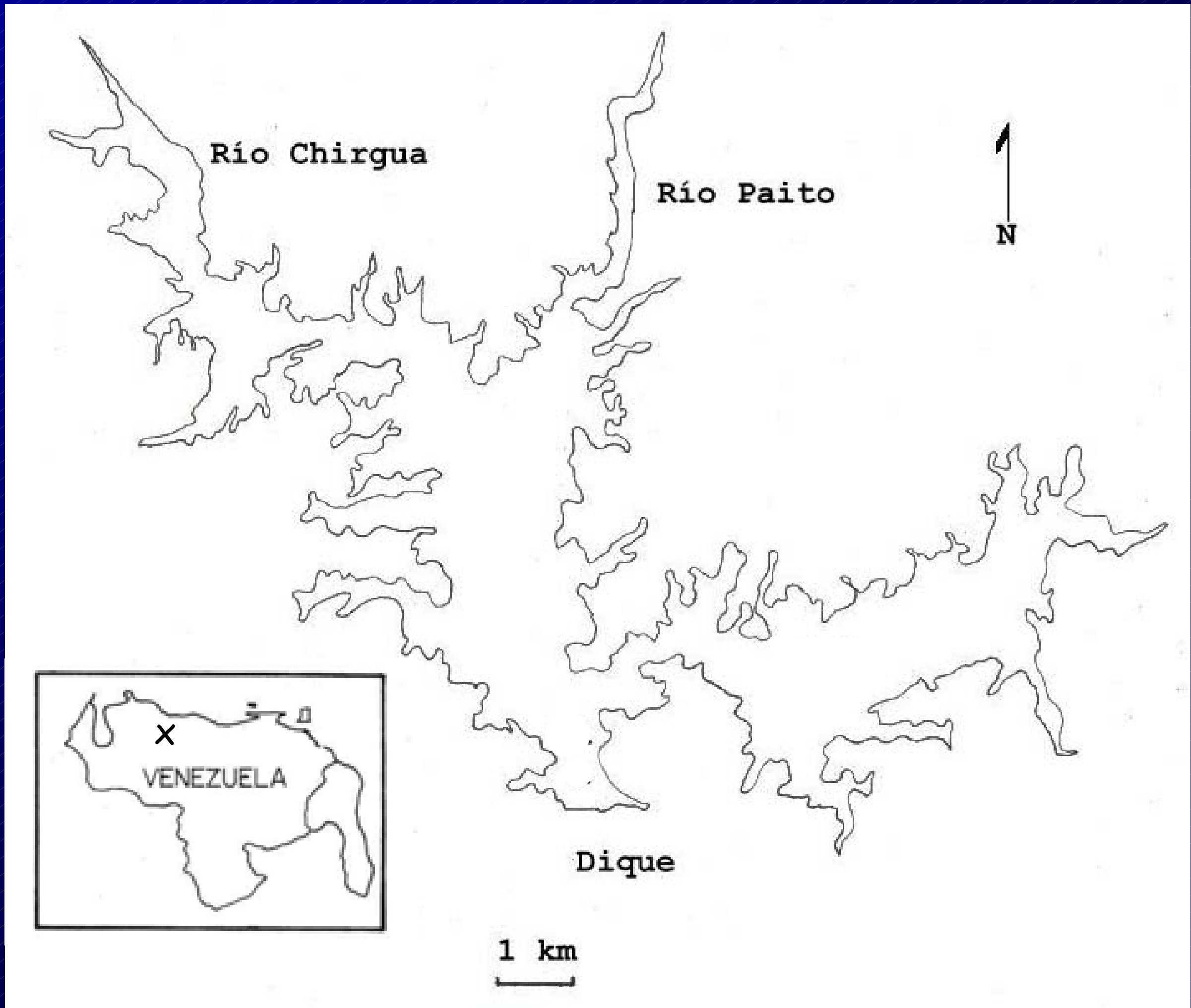
- Protection of reservoir basin: Forestry; forbid direct waste water disposal to their tributaries and into the water body.

- Systematical removal of machrophytes.

- Systematical monitoring of water quality.

- Incorporation of populations in water resource conservation programs.

Study case: Pao-Cachinche reservoir



- Location: 9º53'N-68º08'W
- Basin area: 940 km^2
- Reservoir area: 16,100,000 m^2
- Volume: 170,000,000 m^3
- Altitude: 353 m.a.s.l.
- Mean depth: 10.6 m
- Discharge: 7.00 m^3/s
- Residence time: 281 days

Purposes: Supply of drinking water to the Cities of Valencia, Maracay and San Carlos (2 million of inhabitants), and irrigation. Trophic state: Hypertrophic.

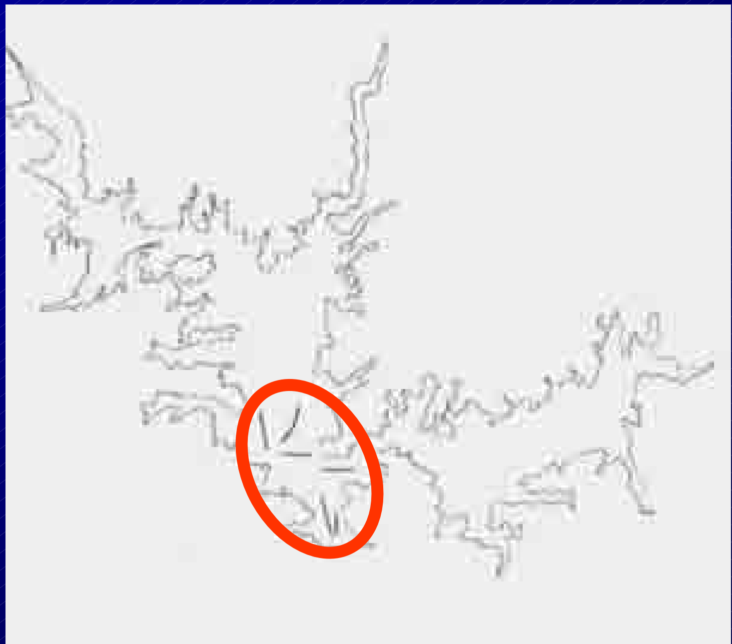
Pao-Cachinche reservoir

Image from Google Earth

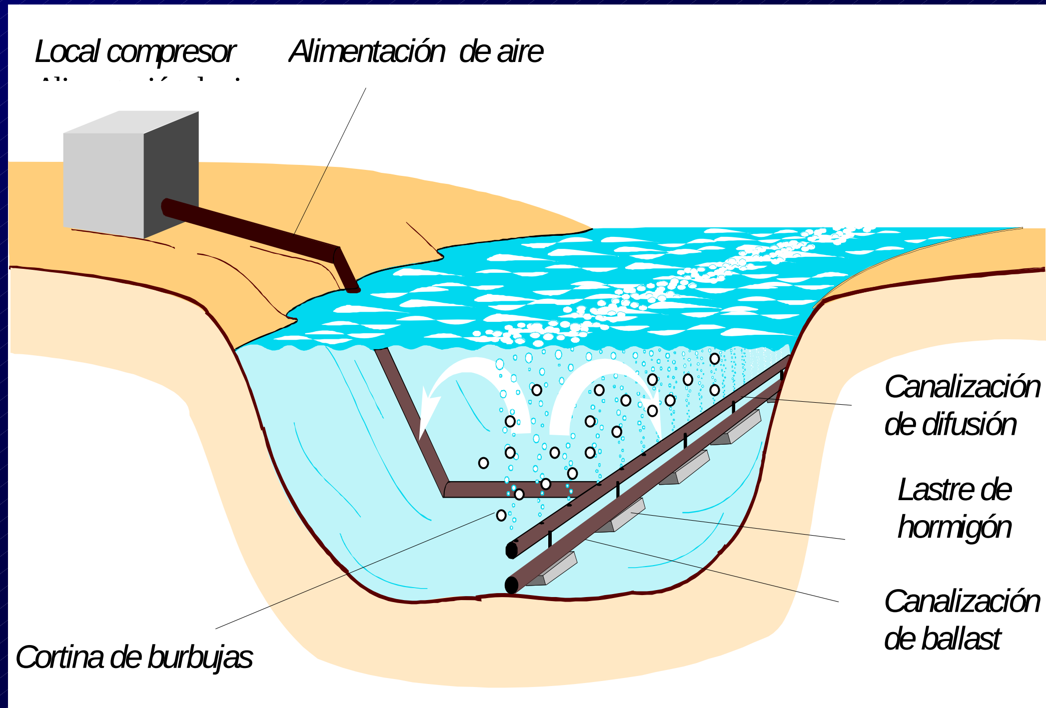
After limnological characterization, which was carried out by our laboratory, remedial measure was suggested to the hydrological companies.

In November 2001 the process of artificial destratification of the reservoir started, which effectively controlled the eutrophication effects after one year of continuous operation, representing the first and successful case of water quality enhancement in Venezuela.

Artificial aeration mechanism



Aeration pipelines
(~30% of the reservoir)

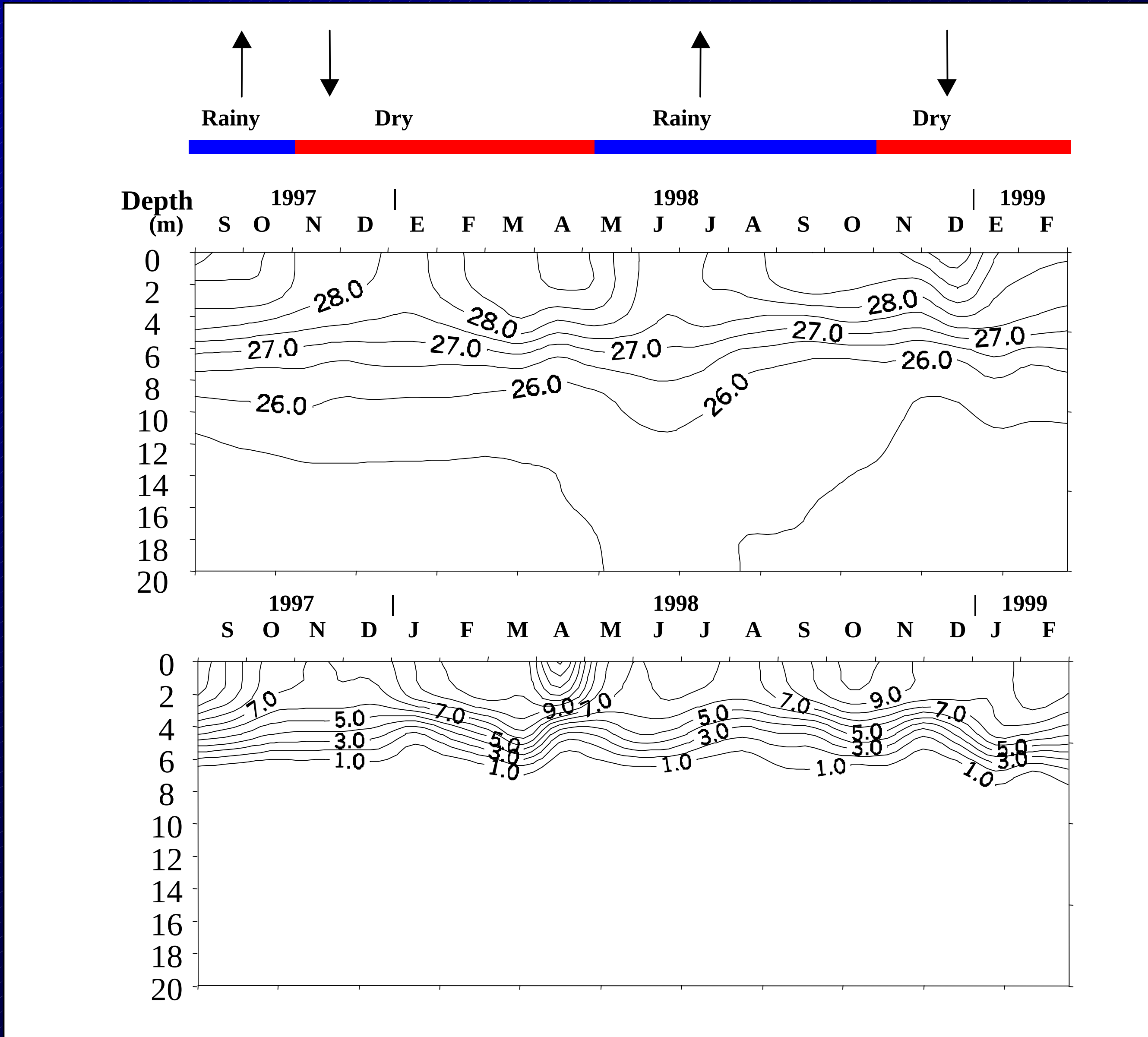


Aeration system

Compressor: Atlas Copco, model GA 250; 7.4 bars; 300 HP

Images from Hidrocentro

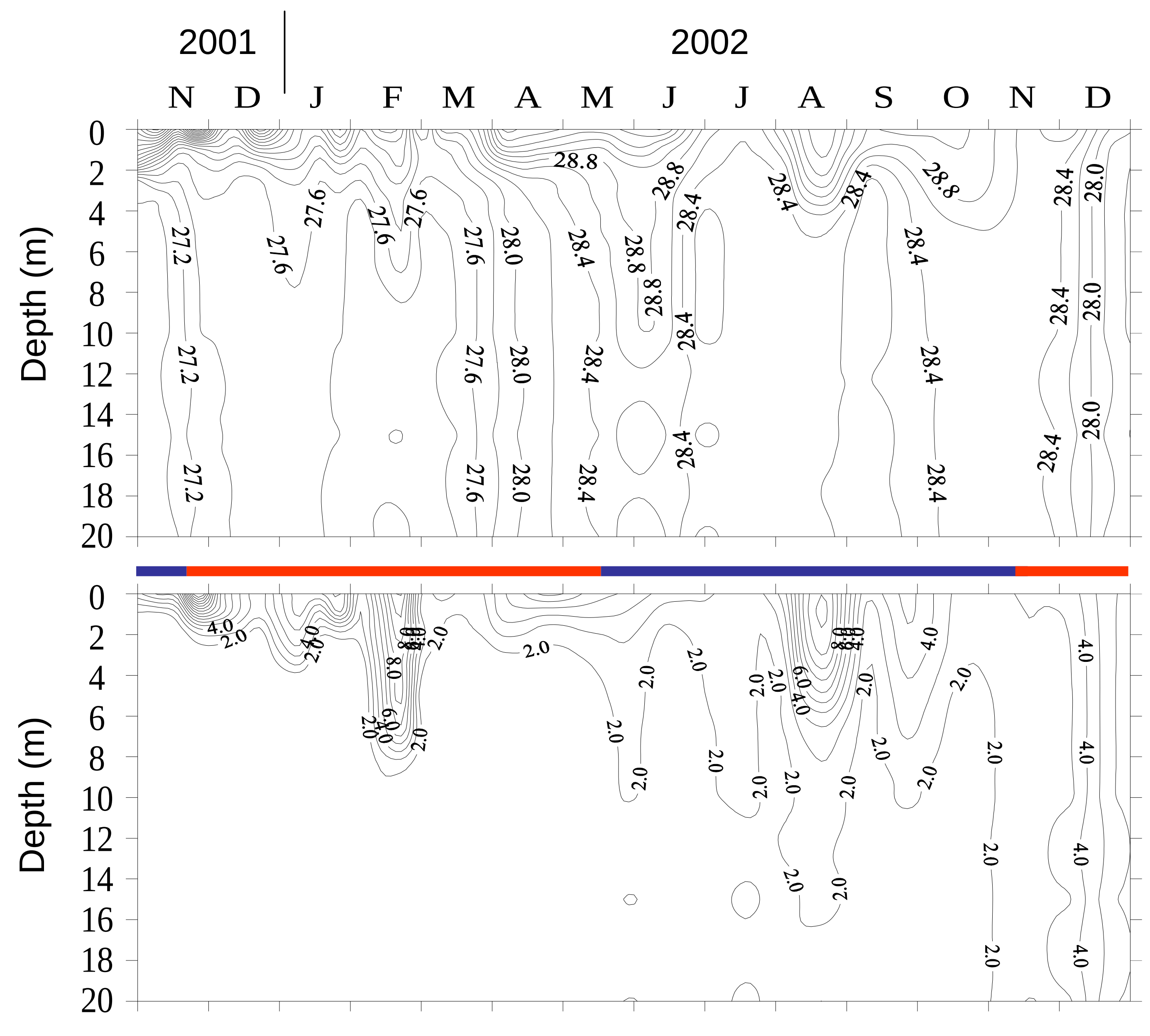
Before aeration



Temperature (ºC)

Dissolved oxygen (mg/l)

After aeration



Temperature (ºC)

Dissolved oxygen (mg/l)

Results of artificial destratification in Pao-Cachinche reservoir

• Increase of water transparency.

• Gradual loss of thermal stratification.

• Decrease of epilimnetic dissolved oxygen concentrations as compared with the previous supersaturated values, and hypolimnetic oxygenation.

• Decrease of surface values of pH.

• Decrease of ammonia, N-Kjeldahl y total P concentrations.

• Homogenization of physical and chemical conditions.

• Decrease of relative proportions of bluegreen algae.

• Loss of cyanobacterial “blooms”.

• Increase of relative proportions of green algae.

Results of artificial destratification

View of “aerated” (above) and “non-aerated” (below) regions of the reservoir

Image from Hidrocentro

This case represented a good example of interaction between scientists and planners, hydrological companies and universities, which achieved the water quality enhancement that is supplied to population for drinking purposes.

However, Pao-Cachinche reservoir was after affected due to the rise of water level of Lake Valencia.

Lake Valencia waters flooded agricultural and urban areas. Because of this, some of its tributaries were deviated to the Paito stream, one of the main Pao-Cachinche tributary.

The high organic load contained in these streams had again caused the oxygen depletion in the water column of the reservoir, and all the benefits obtained after the artificial destratification were reverted.

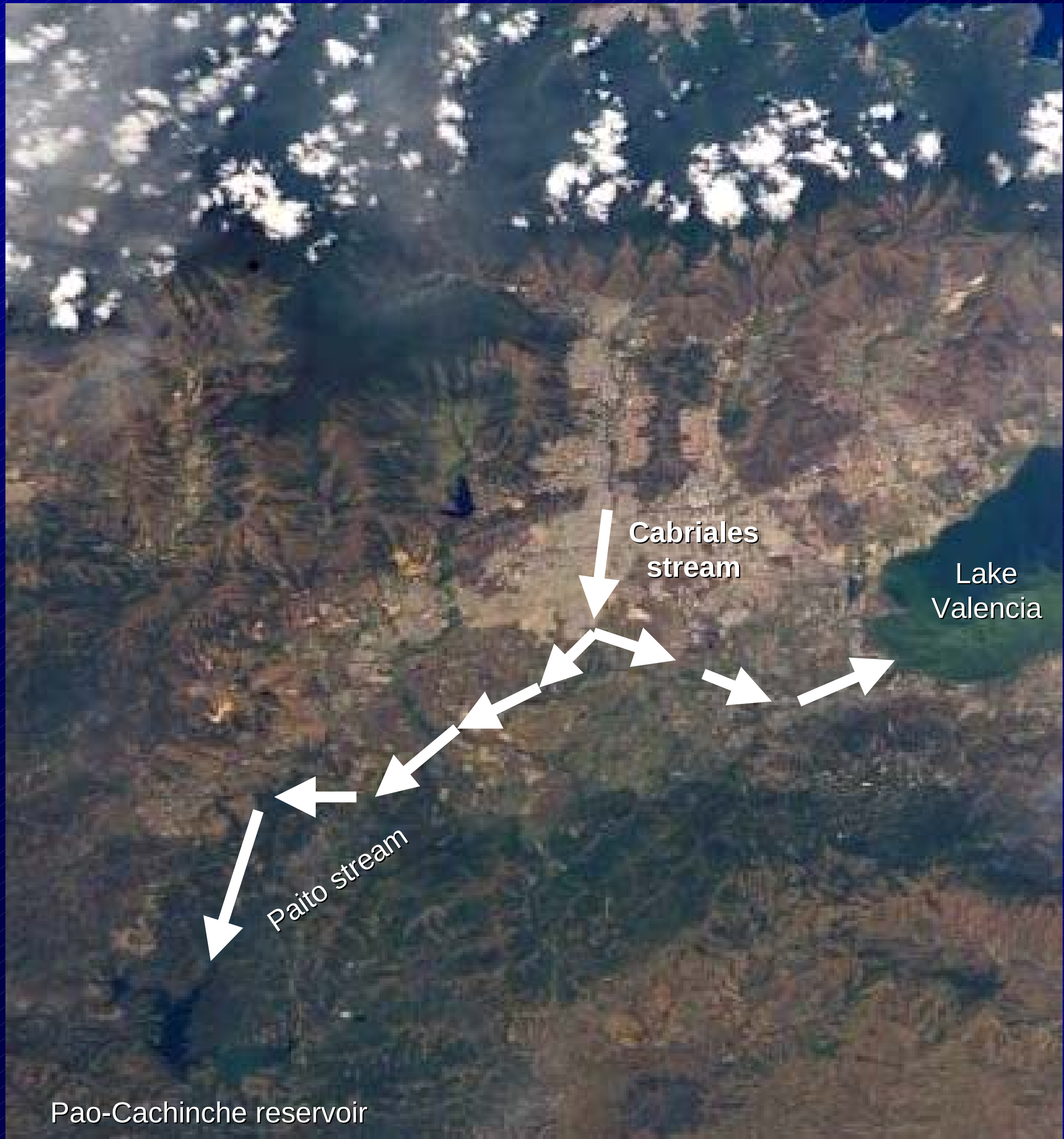


Image from NASA

What to do? – Some suggestions:

- Adequate water treatment before its disposal to the reservoir tributaries.
- Improvement of water treatment plants.
- Enhancement of destratification system.
- Systematical monitoring of water quality.
- Incorporation of populations in water resource conservation programs, excluding politics from discussion.

Regulatory Standards

One of the main regulatory standards is represented by the Decree 883, promulgated in 1995.

Among other regulations, established maximal limits allowed for phosphorus and nitrogen concentrations in the waste waters:

10,000 µg/l for total phosphorus

40,000 µg/l for total nitrogen

10,000 µg/l for nitrates + nitrites.

These limits are high in extreme and therefore, do not contribute to enhance or protect the water quality of the reservoirs.

Actually, this decree must be submitted to revision.

Population participation:
Technical Roundtables for Water Problems

Venezuelan Government encourages communities to get involved in improving their quality of life.

Technical Roundtables for Water Problems (TRWP) emerged as an alternative for solving problems related to drinking water and environmental sanitation in Venezuela, in a participatory way.

Venezuelan Government is also creating structures called Community Water Councils, where all the TRWP converge to present their problems and offer their ideas.

Based in the National Constitution of the Bolivarian Republic of Venezuela, the hydrological company HIDROVEN and its filial enterprises, promote the conformation of these TRWP.

Distribution of TRWP by hydrological company

17 COMPANIES	N° TRWP
HIDROANDES	377
HIDROCAPITAL	756
HIDROCARIBE	355
HIDROCENTRO	450
HIDROFALCON	675
HIDROLAGO	1518
HIDROLLANOS	186
HIDROPAEZ	170
HIDROSUROESTE	404
AGUAS DE EJIDO	64
AGUAS DE MERIDA	191
AGUAS DE MONAGAS	229
AGUAS DE PORTUGUESA	205
AGUAS DE YARACUY	241
CVG- GOSH	66
HIDROBOLIVAR	261
HIDROLARA	314
TOTAL OF TRWP	**6.462**

From HIDROVEN (2008)

From 1999, communal organizations have been conformed in urban and rural areas, which have been called Technical Roundtables for Water Problems (TRWP), with the aim of enhancing the maintenance of drinking water supply and sanity services.

These TRWP have been become a fundamental mechanism for the community organization, and helping in the development of a new culture for water conservation.

Functioning of TRWP is as follows:

1. Communities meet.

2. They present their problems and devise their projects.

3. When the financing comes through, they carry out the work.

Actually, more than 6500 TRWP are operating in Venezuela. Some of their achievements are:

1. More than 1,200,000 of inhabitants have been benefited.

2. More than 1000 projects have been executed, with an investment of more than US$ 100,000,000.

3. Inclusion of more than 600,000 inhabitants to the national water system.

Community projects devised by the TRWP

FINISHED **641**

IN COURSE **454**

TOTAL **1095**

From HIDROVEN (2008)

This strategy of participation has decisively contributed to the main objective of extending the population access to drinking water supply and sanity.

Moreover, communities have progressively widened the range of their interests: initially concerned with the immediate problems of access to drinking water and its quality, they have moved on to consider broader problems, including the environmental problems of the river basins.

In conclusion, there is a growing number of Venezuelan communities that deal with their own problems related with water supply and sanity, increasing the national coverage for these services.

Increase of national coverage of drinking water and sanity services in Venezuela (1998-2003). Modified from Arconada (2005).

Year	Drinking water supply (% of population)	Residual waters collection (% of population)
1998	81.57	63.77
1999	83.66	64.38
2000	85.15	66.96
2001	86.37	68.15
2002	87.65	71.27
2003	89.27	71.69

Final considerations

Venezuela has abundant water resources and valuable experiences in their management. However, numerous problems still persist, and they have to be confronted.

Some actions still have to be applied, in order to enhance the access of populations to “safe water” and to improve the water quality:

• Adequate waste water treatment and its disposal.

• Protection of water bodies basins.

• Systematical monitoring of water quality.

• Stimulation of communities to participate in resolution of their problems related with water supply and sanity.

• Submission of regulatory standards for revision.

• Others…

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