



# Sanitary barriers for cisterns for drinking water supply

Sylvana Melo dos Santos

Prof. Dr. Ing.

# Northeastern Brazil's semi-arid region

Semi-arid area:

- covers 974,700 square kilometers,
- 86.4% of the northeast and 9 States:
  - Maranhão,
  - Piauí,
  - Ceará,
  - Rio Grande do Norte,
  - Paraíba,
  - Pernambuco,
  - Alagoas,
  - Sergipe and
  - Bahia.

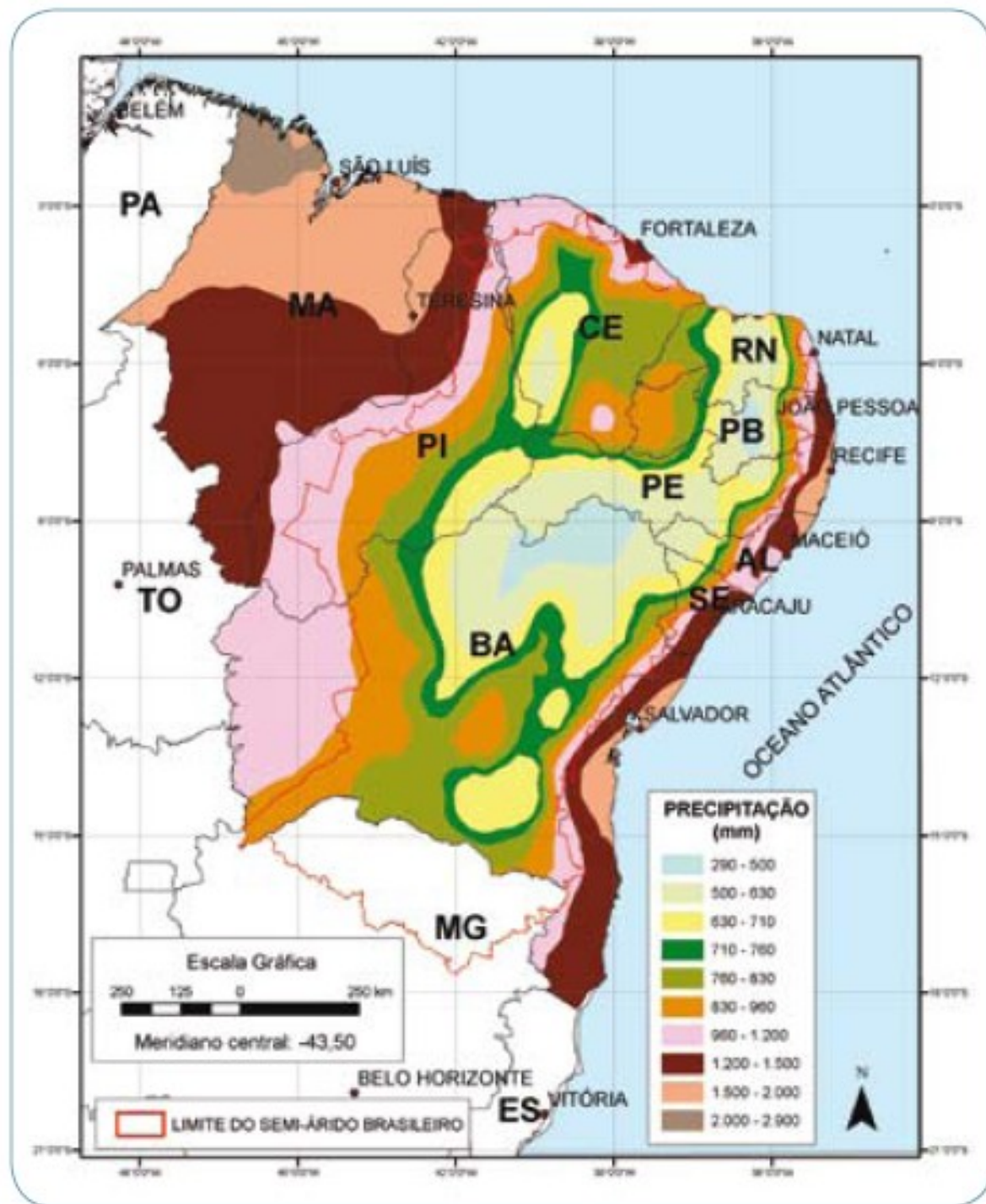
as well as northern Minas Gerais.



# Northeastern Brazil's semi- arid region

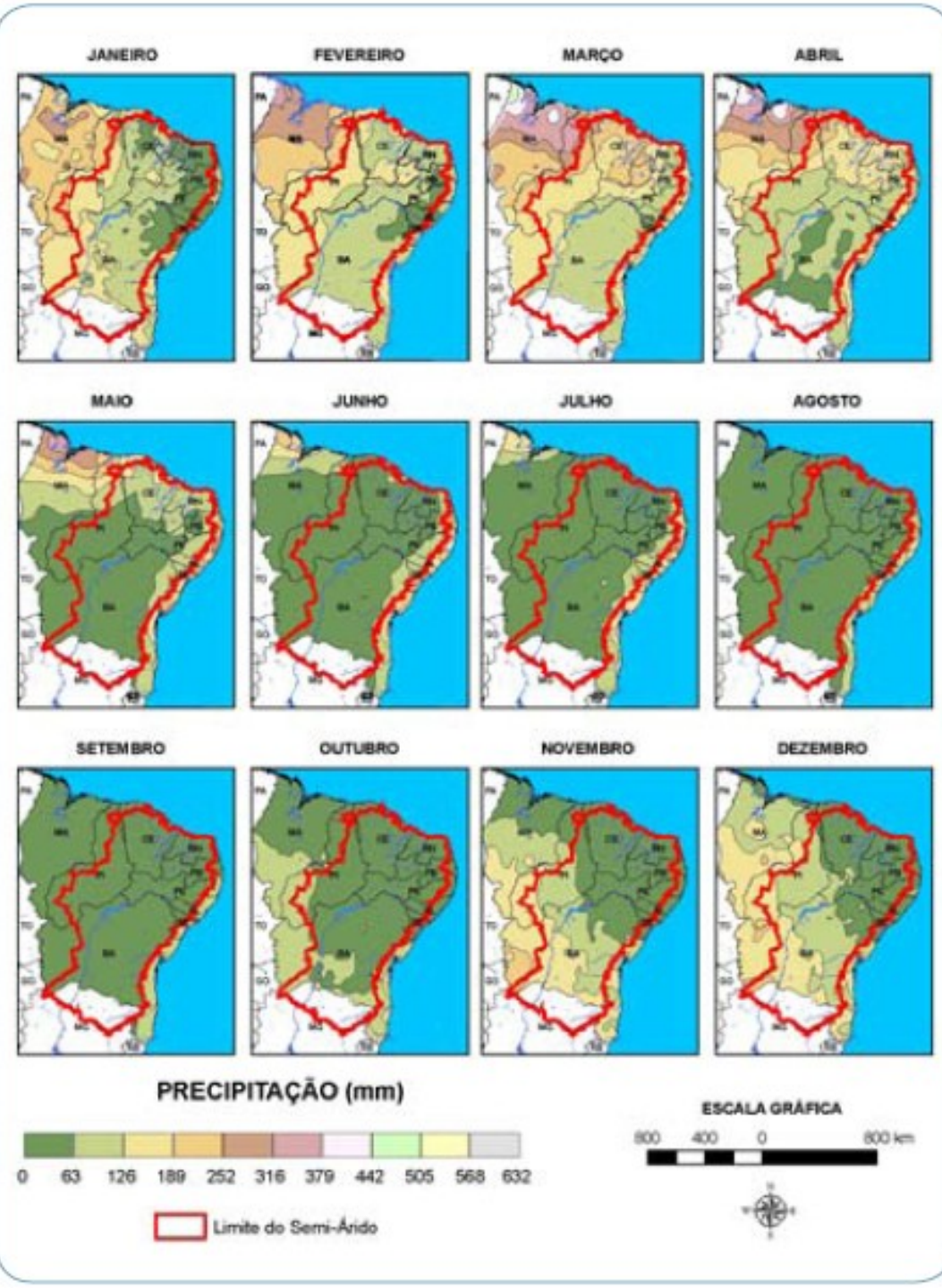
What is happening in  
this region?

... the average rainfall  
varies from 400  
millimeters to 800  
millimeters a year.

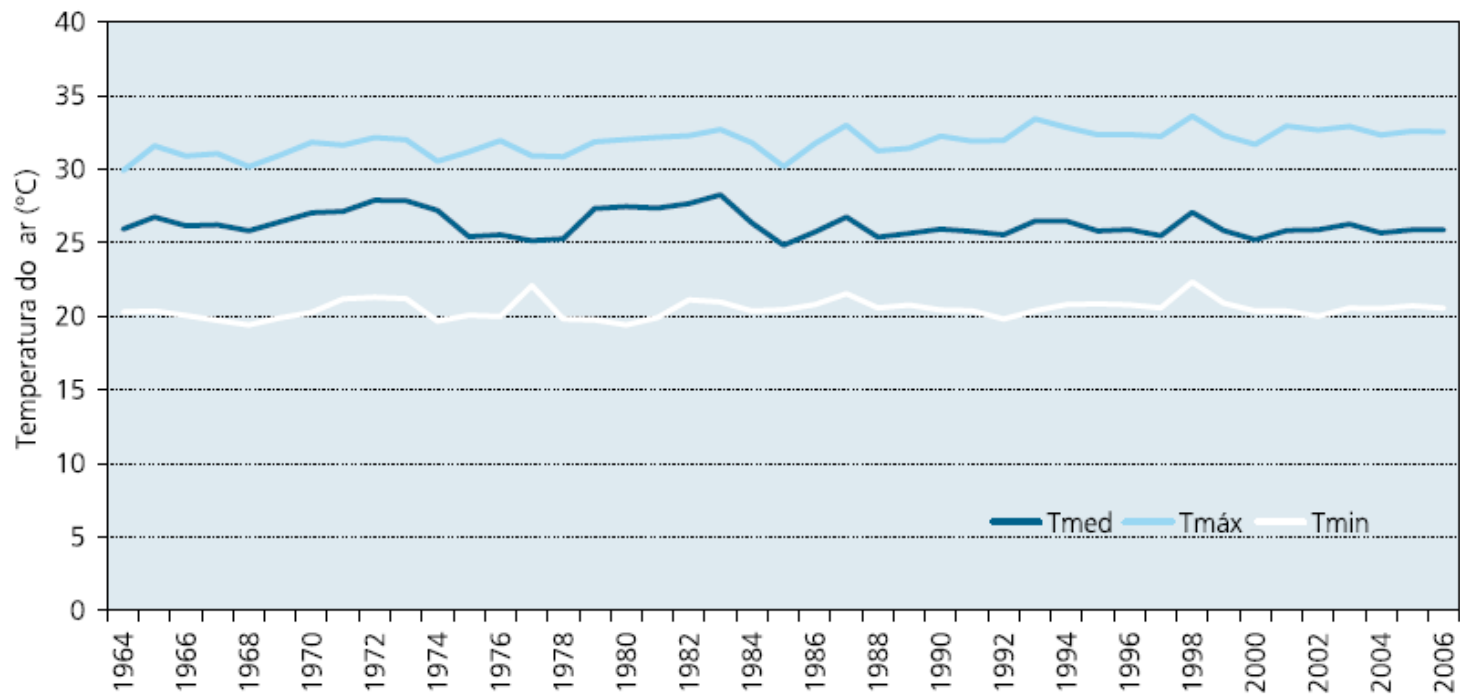


# Northeastern Brazil's semi-arid region

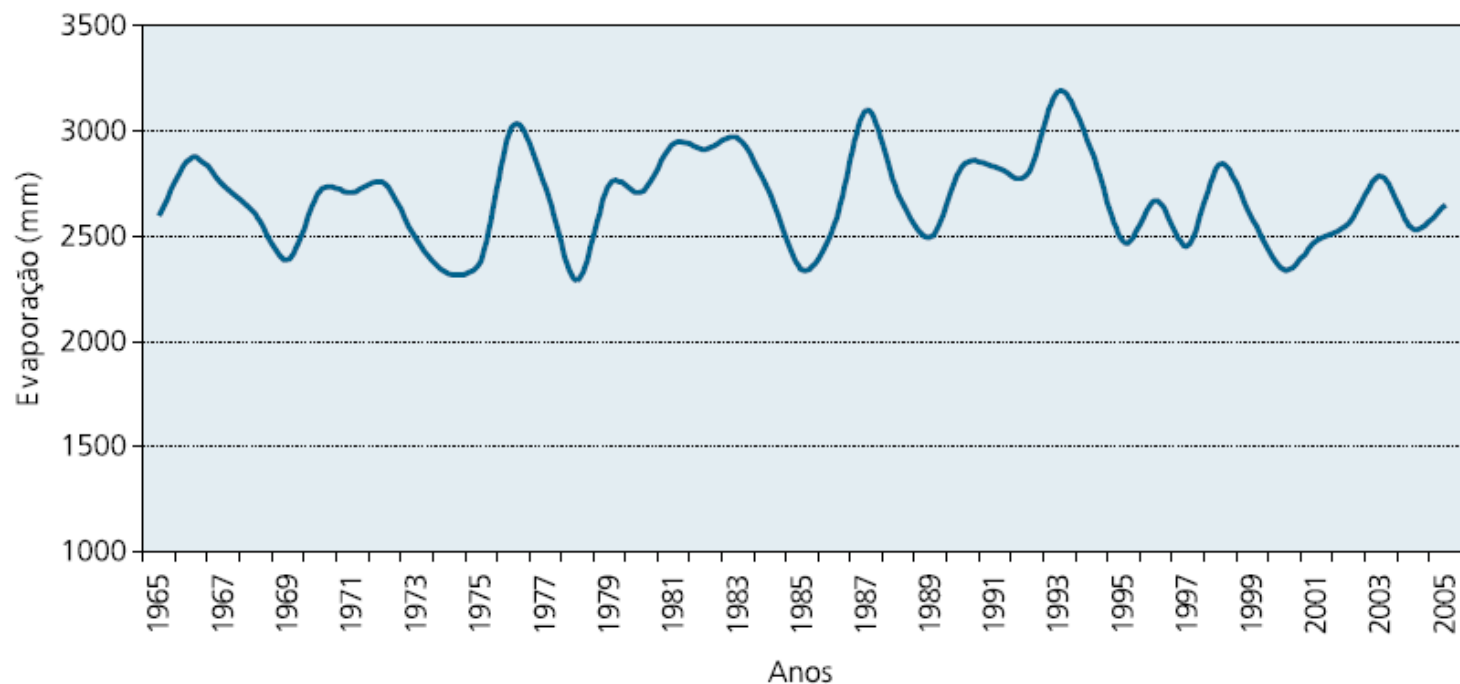
While in a drought year you could receive only 185 mm of rainfall, in another year one could receive 974 mm.



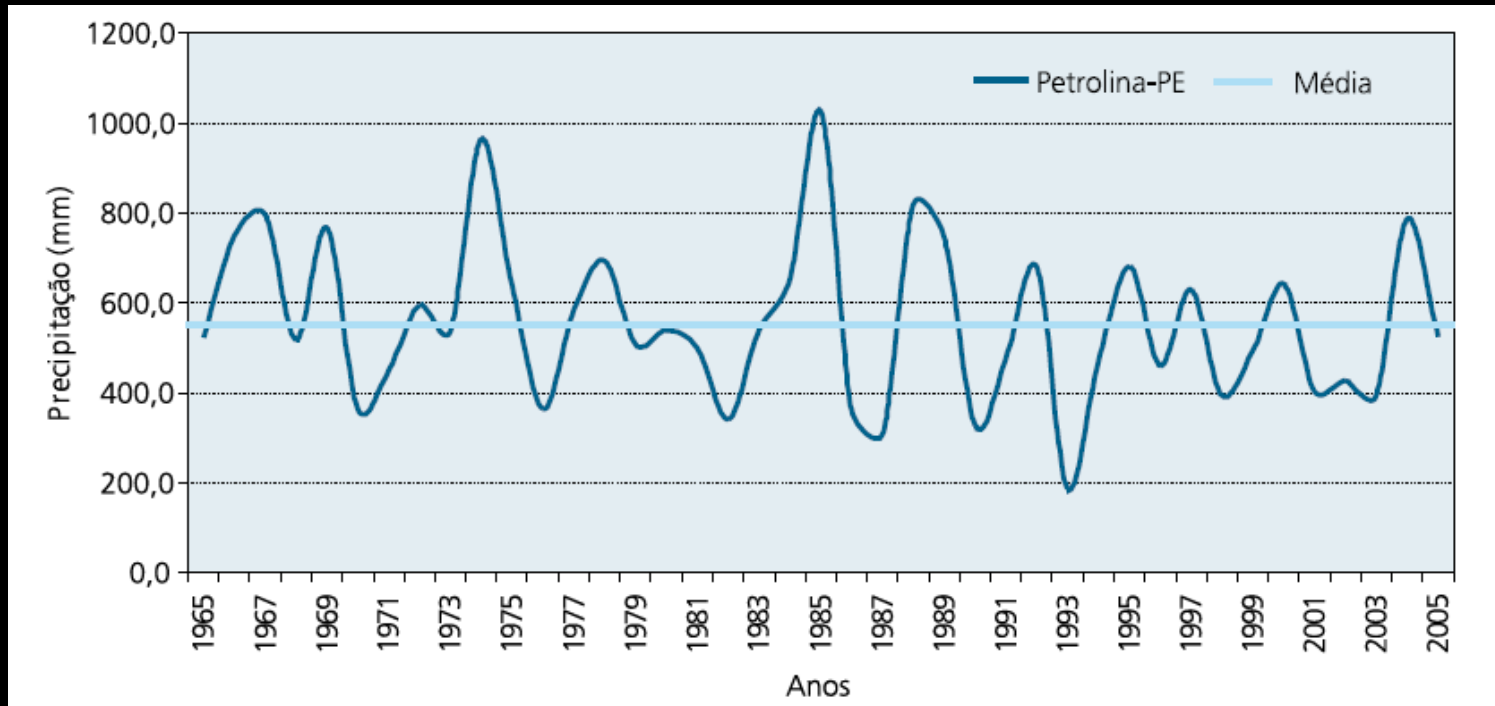
- Continuous high temperatures.



- High evaporation rate.



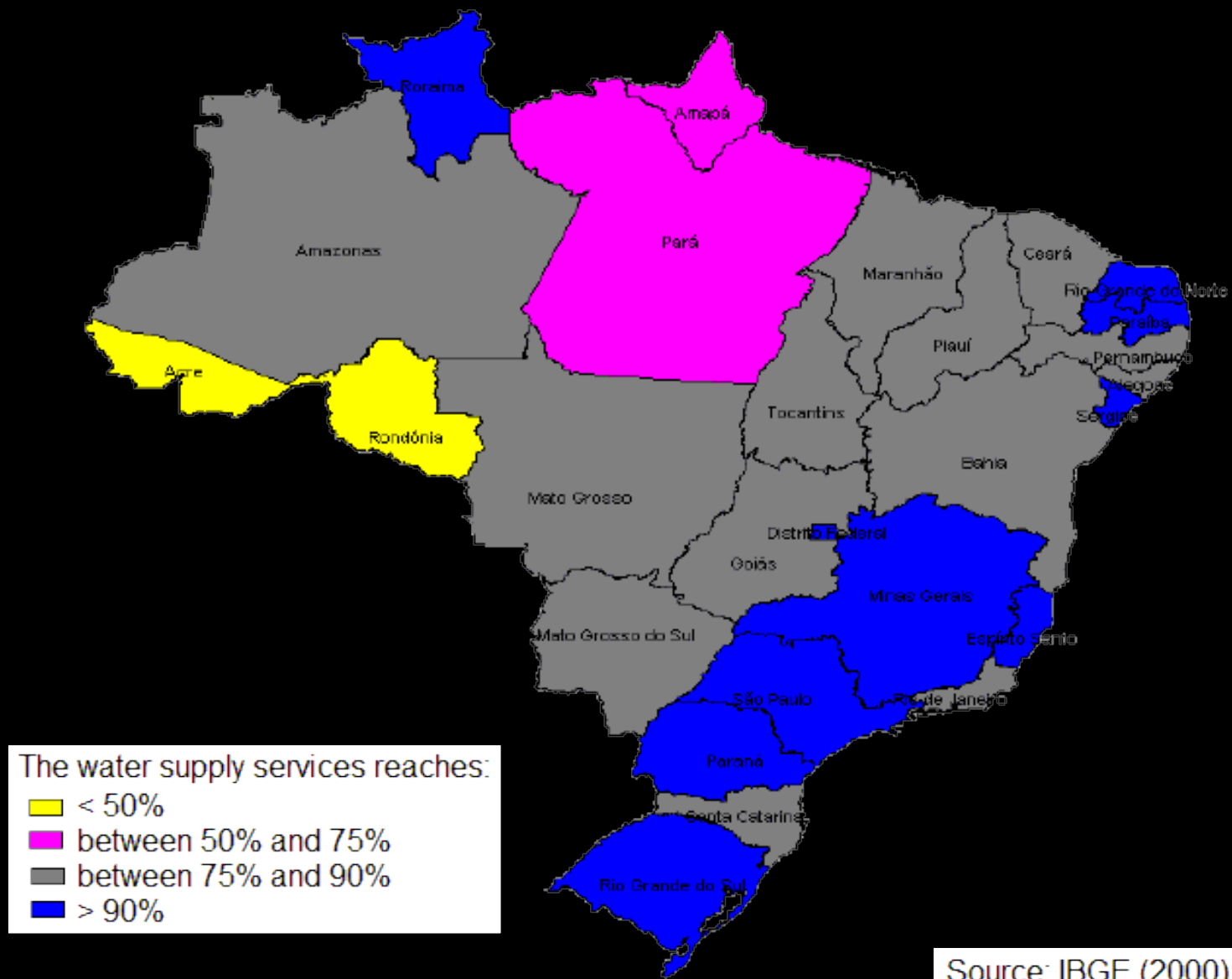
- The region is affected by periodic droughts.



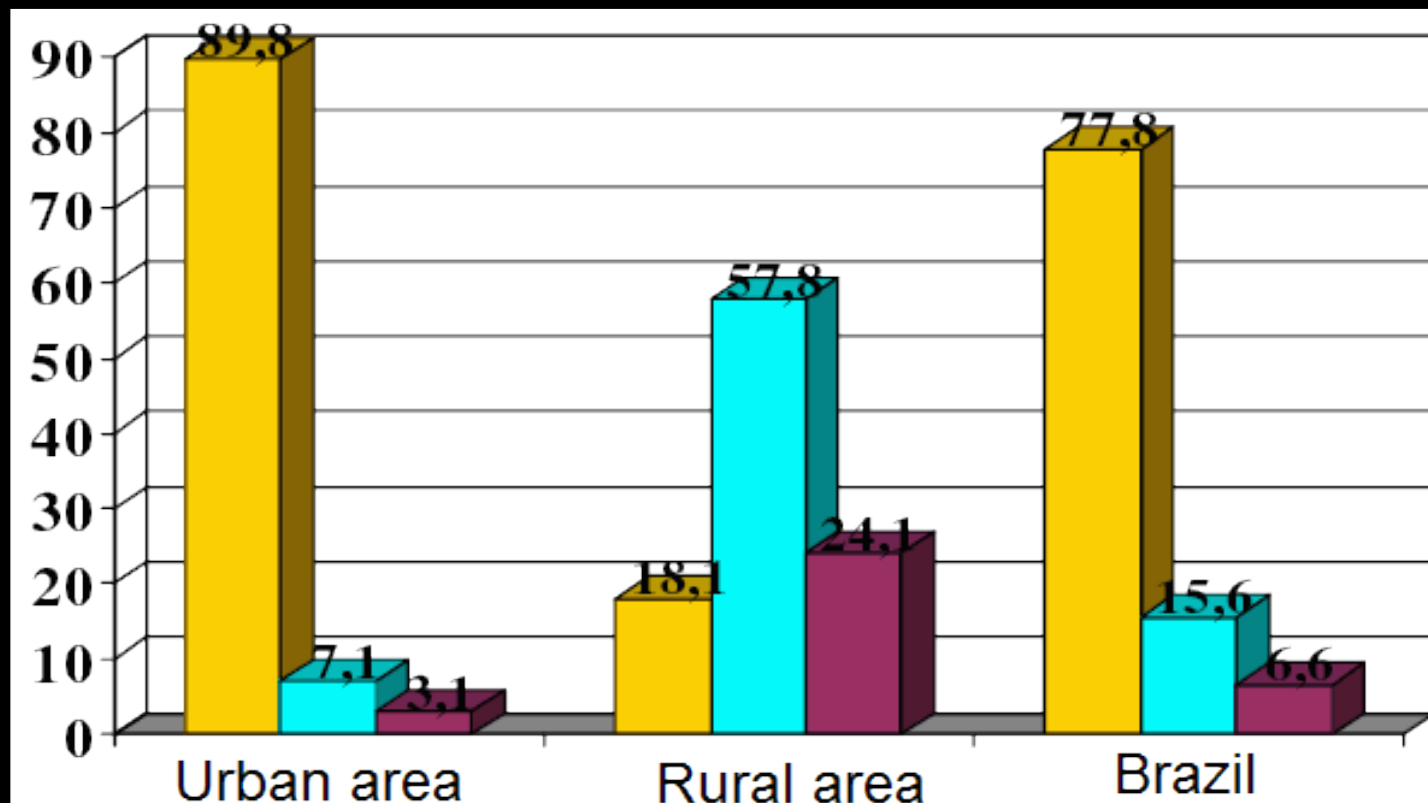
# And about...

1. Water supply
2. Sanitation
3. Waste
4. Health

# Water supply services in Brazil



# Water supply services in Brazil: Urban area x Rural area

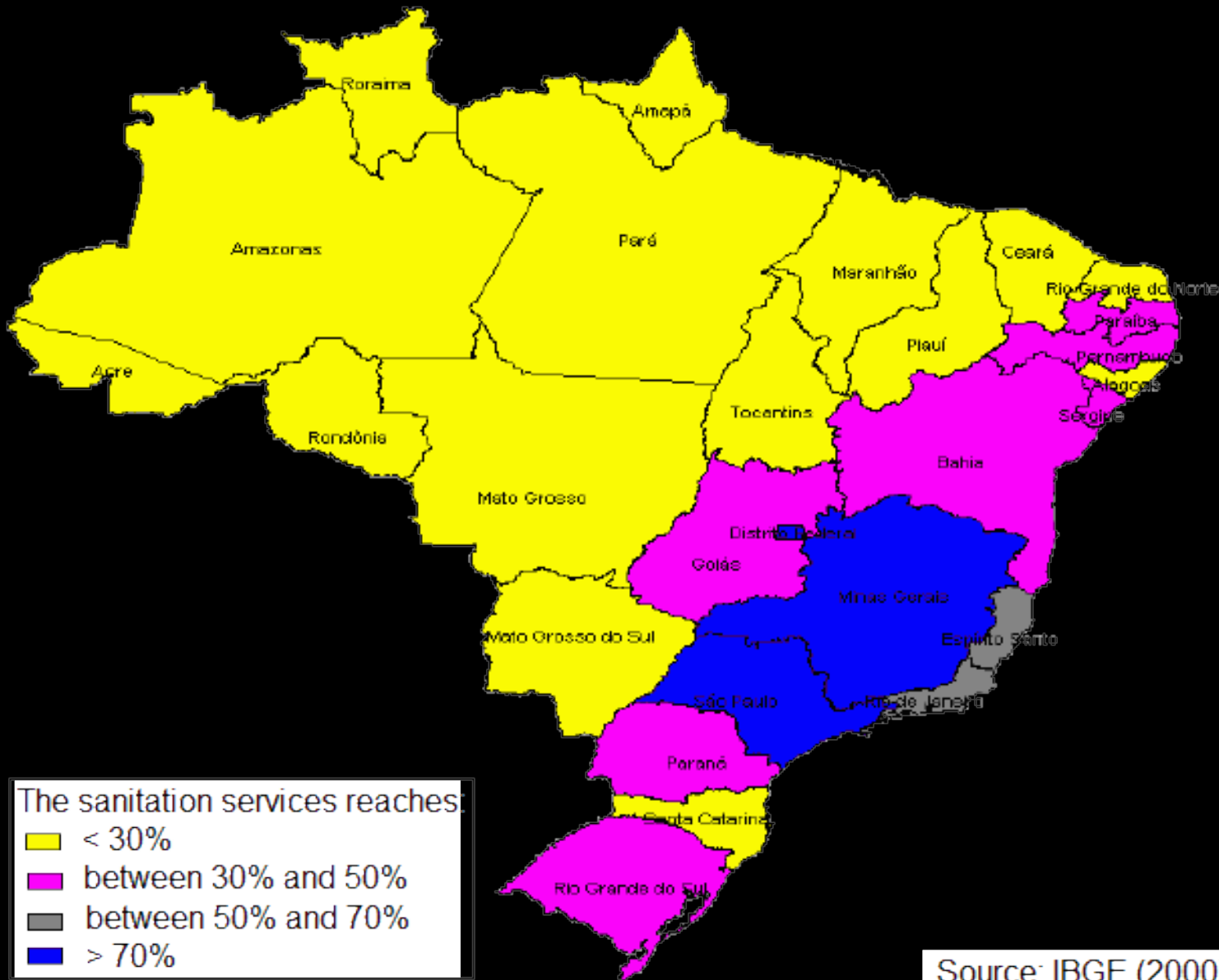


Public Service

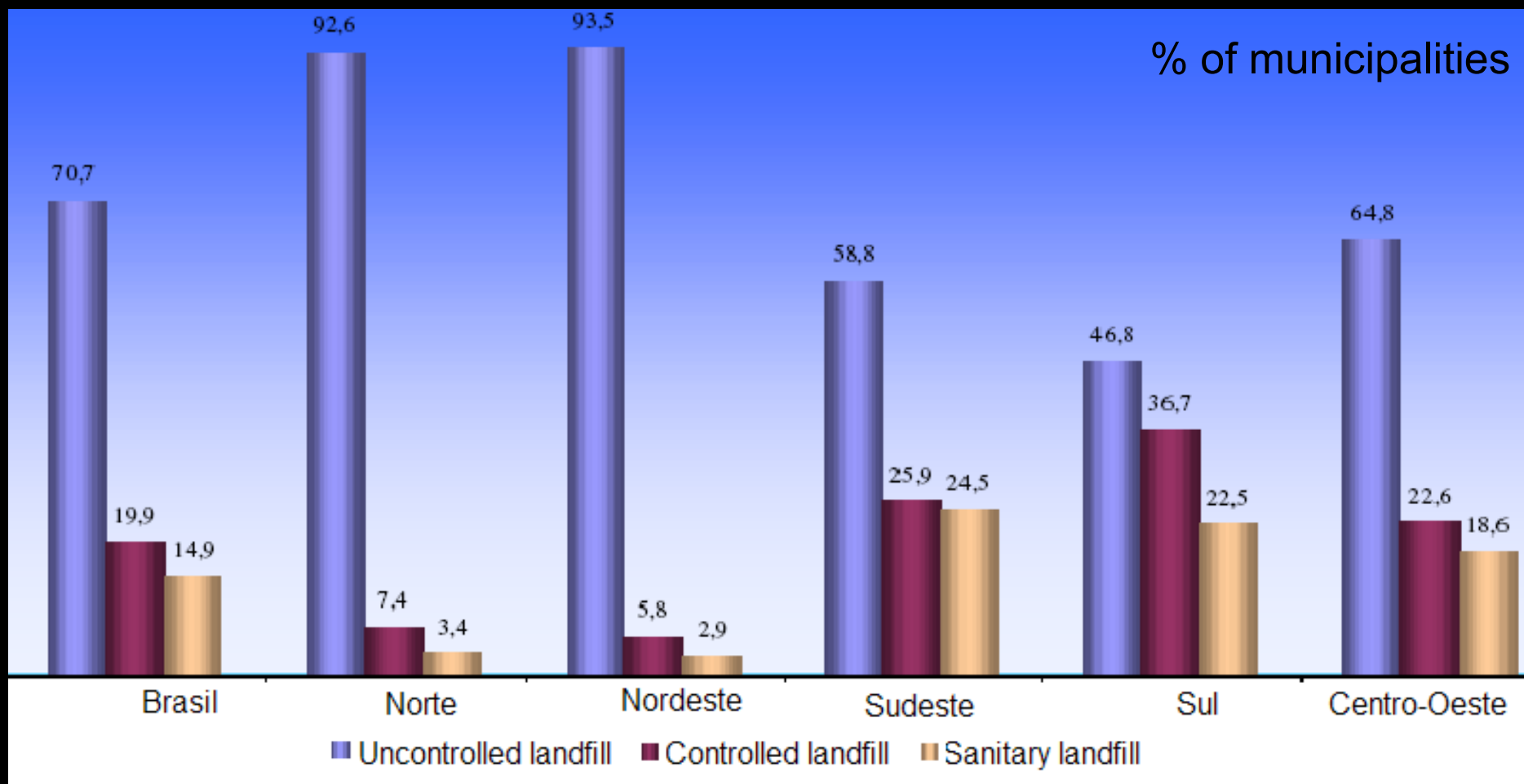
Wells

Other way

# Sanitation services in Brazil

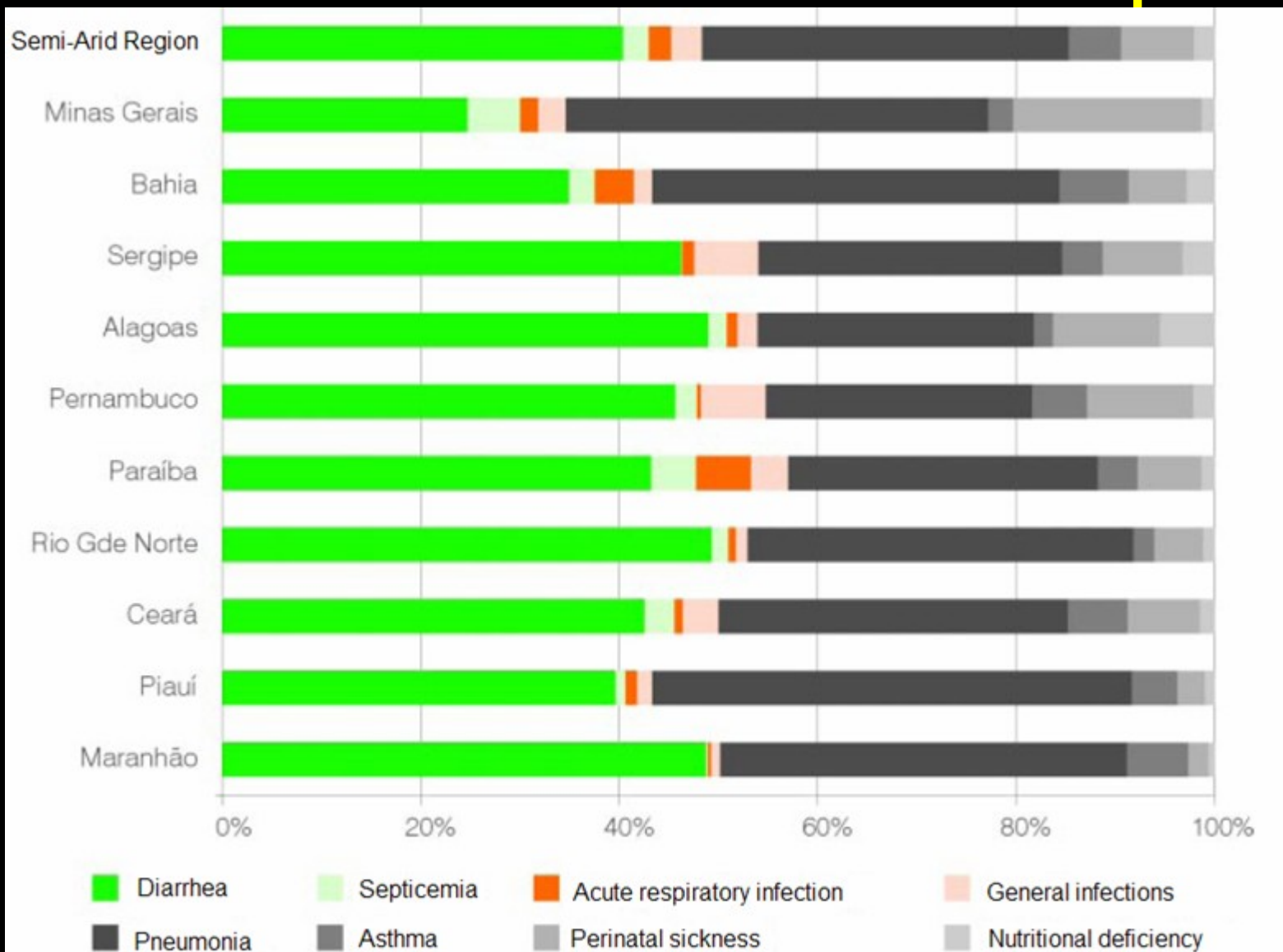


# Waste services in Brazil



Source: IBGE (2000)

# Reason of entrance in hospital



Source: Datasus, Ministério da Saúde, SIH-SUS, 2001 (Brazilian Ministry of Health)

# What is the solution?

- Managing water in and for the environment
- Taking care of community water
- Supplying emergency water
- Providing drinking water for every household
  - supplied by **cisterns**, shallow wells, etc.
- Elaborating decentralized and participative plans of water supply
  - ASA – the Brazilian Semi-Arid ONG Network
  - **P1MC – the Program of 1 Million Cisterns**

# What is a CISTERN?

A Cistern is a receptacle for holding liquids, usually water like that collected from a roof or some other catchment area.

For thousands of farming families in northeastern Brazil's semi-arid region... CISTERN IS...

...a simple, low cost water storage system that dates back thousands of years has made life much easier...

# P1MC – The Program of 1 Million Cisterns

- It was been executed by the civilian society in a decentralized manner.
- It receives funding from governmental organizations and the private sector.
- The goal is to supply safe and drought proof drinking water for 1 million rural households.
- Positive aspects:
  - improving health of the population through better drinking water quality
  - time saving for women, who no longer need to fetch water long distances from their homes.

# How are this Cisterns?



# Who are using cisterns in semi-arid region?

- 68,5% of people are adults.
- 26% of people are children, who are less than 14 years old.
- 5,5% of people are adults, who are more than 60 years old.

About the head of the family:

56,4% of people are men,

43,6% of people are women,

57,1% of people are adults, who are more than 40

years old,

55,9% of people are illiterate (they can't write and

read),

38,6% of people can write and read.

Economic activity main: agriculture.

# Who are using cisterns in semi-arid region?

- 17,9% of people are retired.
- 13,1% of people work without a constant job.
- 89,8% of people say that always they take care water.
- 21,3% of family filter water and put chlorine into water for better water quality.



# Who are using cisterns in semi-arid region?

- 94,7% of family has a person who carry heavy buckets of water on his head before the P1MC, about 3,6 km from his house.
- 8,5% of people walk between 5 and 10 km.



The water from muddy water holes are used by family to drink, to cook, to shower and others domestic activities.

# So... The Cistern is the solution?

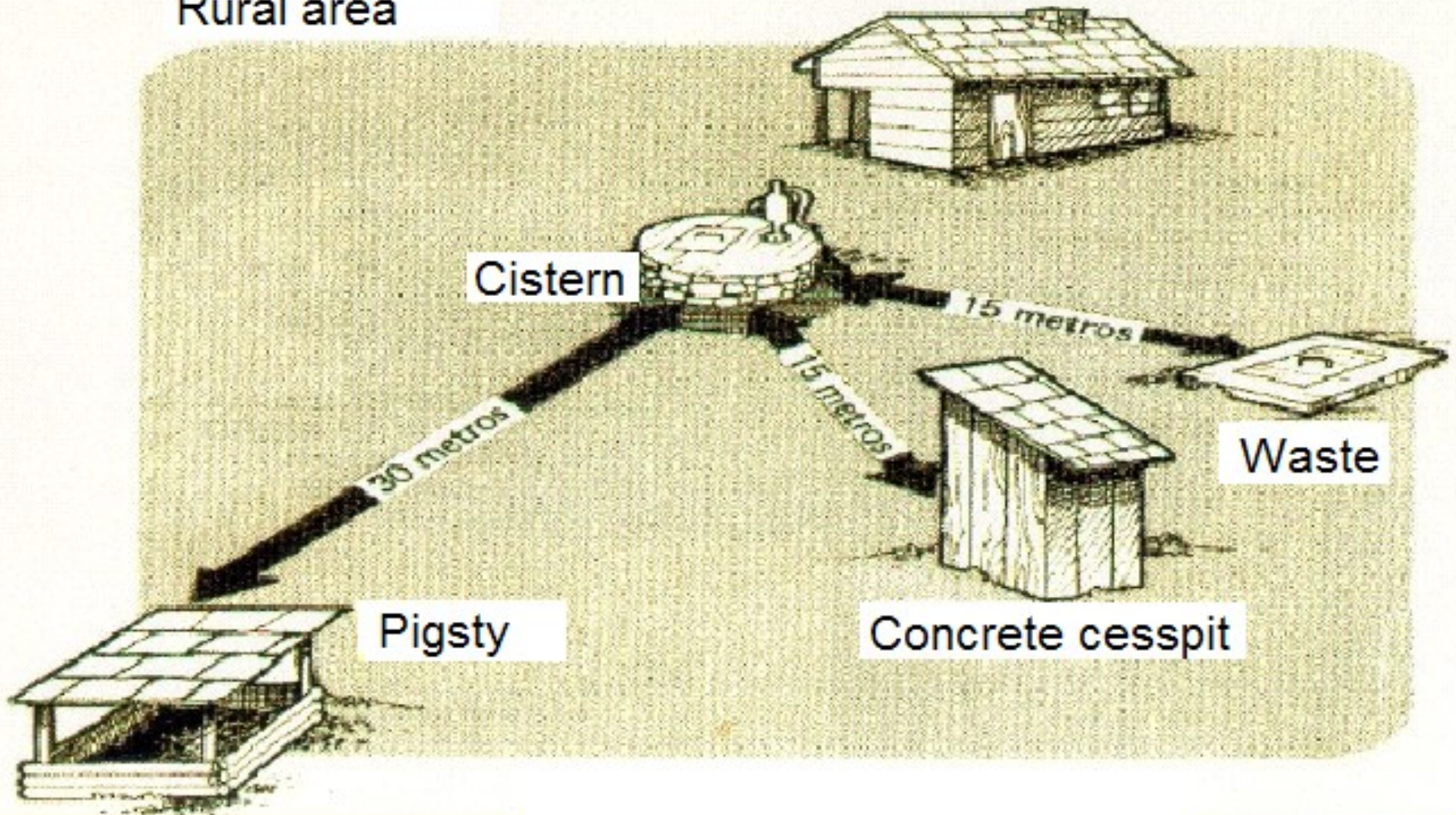
... When we analyze the water quality from cistern...

# How is the quality of water from cisterns?

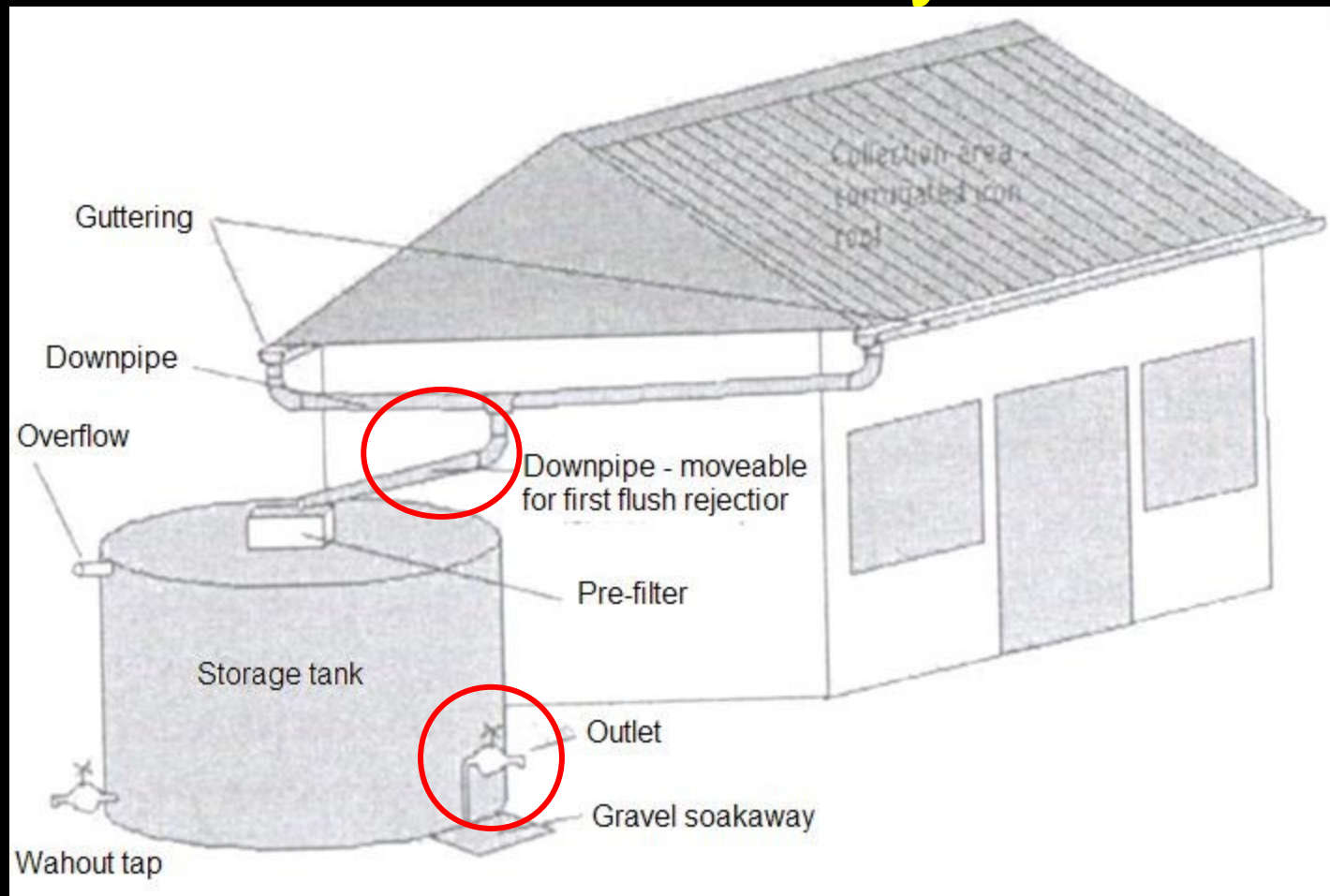
Código	Σ Cátions ----- (mmol <sub>e</sub> L <sup>-1</sup> ) -----	Σ Anions	pH	S.D.T. (mg L <sup>-1</sup> )	Coliformes (NMP)		Código	Σ Cátions ----- (mmol <sub>e</sub> L <sup>-1</sup> ) -----	Σ Anions	pH	S.D.T. (mg L <sup>-1</sup> )	Coliformes (NMP)	
					Totais	Fecais						Totais	Fecais
Ouricuri, PE						Petrolina, PE							
Q1C	1,40	1,33	7,2	64,0	14,0	7,20 <sup>+</sup>	Q2C	3,58	3,47	7,6	179,2	< 3,0	< 3,0
Q2C	2,42	2,35	7,5	57,6	1100,0	20,0 <sup>+</sup>	Q4C	3,77	3,64	7,6	192,0	93,0	7,4 <sup>+</sup>
Q3C	2,30	2,10	7,5	108,8	150,0	15,0 <sup>+</sup>	Q5C	4,00	3,80	8,1	204,8	6,10	< 3,0
Q4C	1,71	1,71	7,1	70,4	75,0	9,2 <sup>+</sup>	Q6C	4,00	3,77	7,7	211,2	>1100,0	20,0 <sup>+</sup>
Q5C	2,08	1,93	7,8	102,4	460,0	15,0 <sup>+</sup>	Q7C	3,57	3,22	7,6	198,4	93,0	11,0 <sup>+</sup>
Q6C	1,81	1,67	7,2	96,0	460,0	20,0 <sup>+</sup>	Q10C	3,98	3,67	8,1	204,8	23,0	< 3,0
Q7C	3,49	3,56	7,2	236,8	93,0	21,0 <sup>+</sup>	Q11C	4,45	4,26	7,2	230,4	23,0	3,6 <sup>+</sup>
Q8C	2,45	1,90	7,1	140,8	36,0	11,0 <sup>+</sup>	Q18C	4,06	3,67	7,7	224,0	460,0	15,0 <sup>+</sup>
Q9C	2,35	2,25	7,3	128,0	460,0	7,4 <sup>+</sup>	Q19C	4,13	3,90	7,8	224,0	9,2	9,2 <sup>+</sup>
Q10C	1,49	1,31	6,9	76,8	28,0	7,4 <sup>+</sup>	Q22C	3,48	3,21	7,8	179,2	6,2	< 3,0
Canudos, BA						Uauá, BA							
Q14C	5,59	5,88	7,2	364,8	9,2	< 3,0	Q6C	2,66	2,58	7,6	153,6	43,0	9,20
Q20C	5,74	5,60	7,4	371,2	11,0	< 3,0	Q7C	2,16	1,71	8,0	115,2	43,0	7,40
Q27C	6,07	6,26	7,1	422,4	15,0	3,60	Q9C	2,09	1,88	7,3	108,8	7,4	< 3,0
Q28C	7,07	7,69	7,6	518,4	< 3,0	< 3,0	Q10C	2,46	2,27	7,5	134,4	3,6	< 3,0
Q30C	2,57	2,12	7,4	147,2	38,0	14,00	Q16C	2,52	2,29	7,1	134,4	15,0	3,60
Q31C	2,29	1,91	6,8	121,6	***	***	Q17C	2,39	2,23	7,5	121,6	< 3,0	< 3,0
Q32C	2,35	1,98	7,8	121,6	36,0	7,20	Q18C	2,35	2,11	7,6	121,6	< 3,0	< 3,0
Q50C	2,21	1,91	8,2	115,2	7,4	< 3,0	Q19C	2,04	1,77	7,2	89,6	43,0	< 3,0
Q51C	2,83	2,38	7,9	160,0	15,0	< 3,6	Q20C	1,56	1,43	7,1	76,8	< 3,0	< 3,0
Q52C	3,56	3,47	7,5	198,4	15,0	< 3,0	Q21C	2,41	1,98	8,1	134,4	23,0	23,00
						Juazeiro, BA**							
VC1					7,4	< 3,0	VC4					< 3,0	< 3,0
VC2					3,6	< 3,0	VC5					< 3,0	< 3,0
VC3					15,0	< 3,0	VC6					< 3,0	< 3,0

# Why do we study alternatives sanitary barriers?

Rural area



# Where are the sanitary barriers?

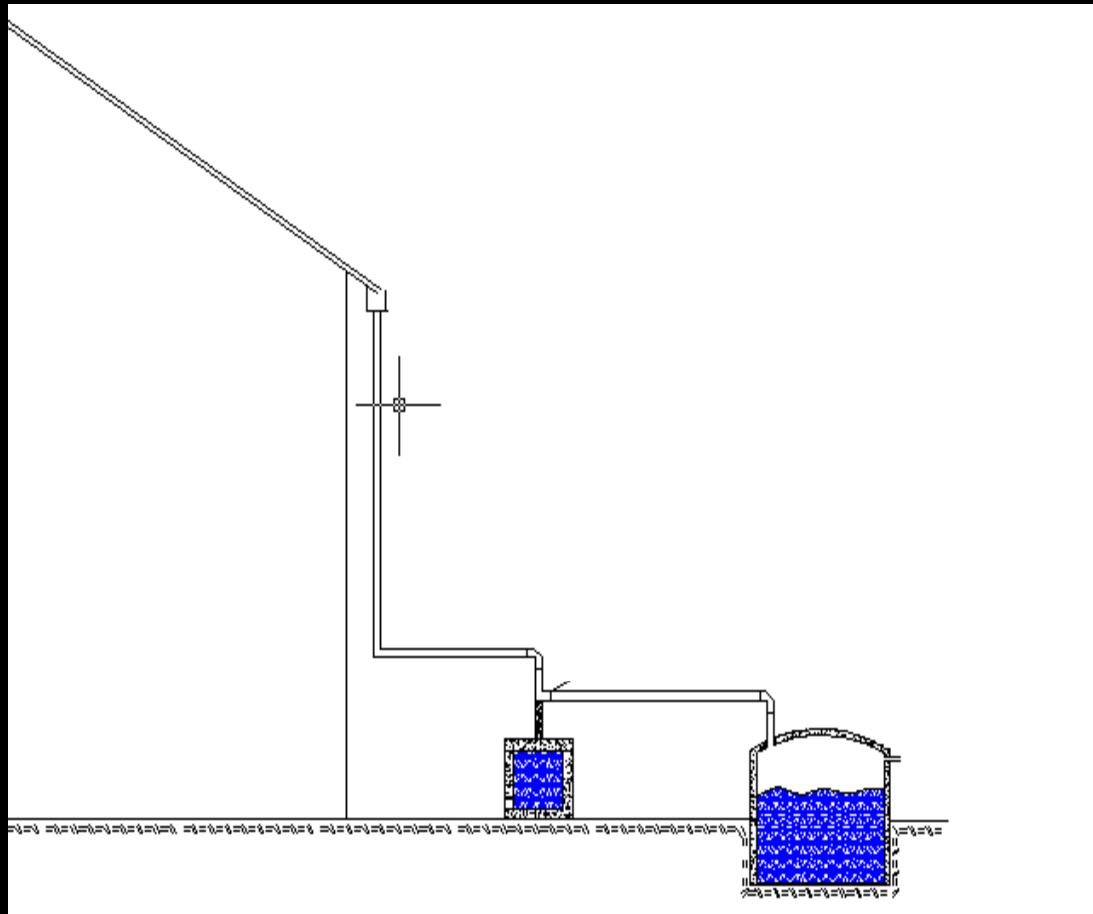


Common way:

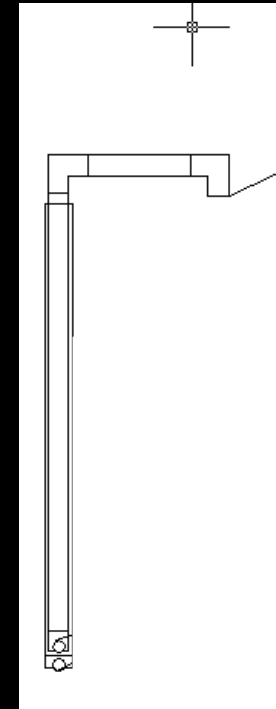
- The first flush rejection is done disconnecting the downpipe.
- The water is collected with a bucket.

# Sanitary barriers – possibilities:

First flush rejection automatic devices



Handpump



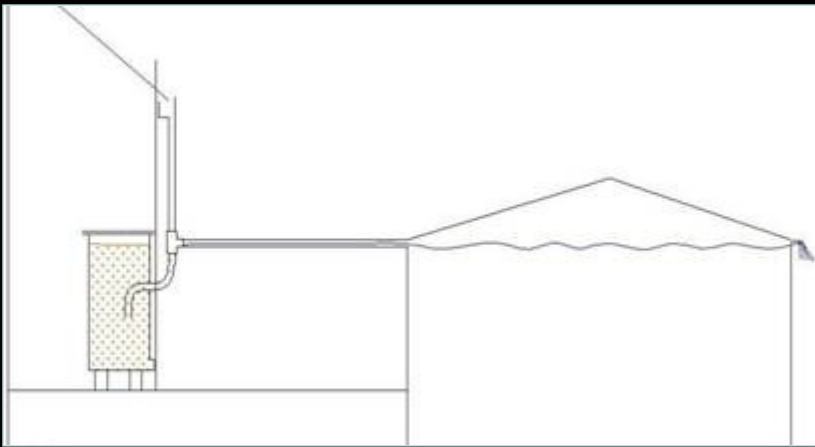
# What is the problem with the common first flush rejection way?

The procedure is appropriate to remove solid pollutants, debris and animals excrements that is carried from the catchment surface during the first few minutes of a rain event.

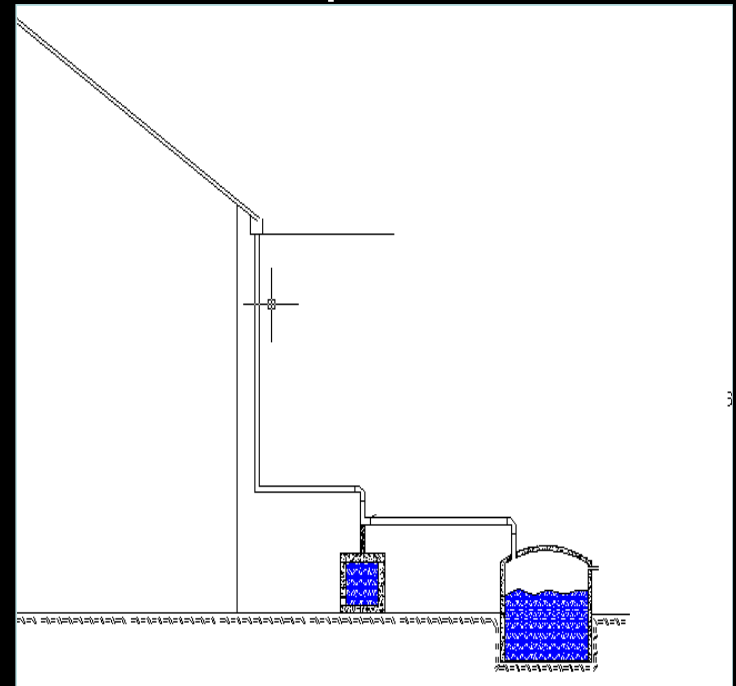
- The people forget to do it.
- It is necessary to use the hands and sometimes the people don't have sanitary conditions, hygiene habits, and level of knowledge about it.

# Sanitary barriers - First flush rejection automatic devices

Communicant vases principle



Siphon



What are the goals?

- Research a efficient device to apply to communities.
- The people don't use the hands to use the first flush rejection.
- The device has to be simple and cheap (material and labour).

# First flush rejection automatic devices

Communicant vases principle

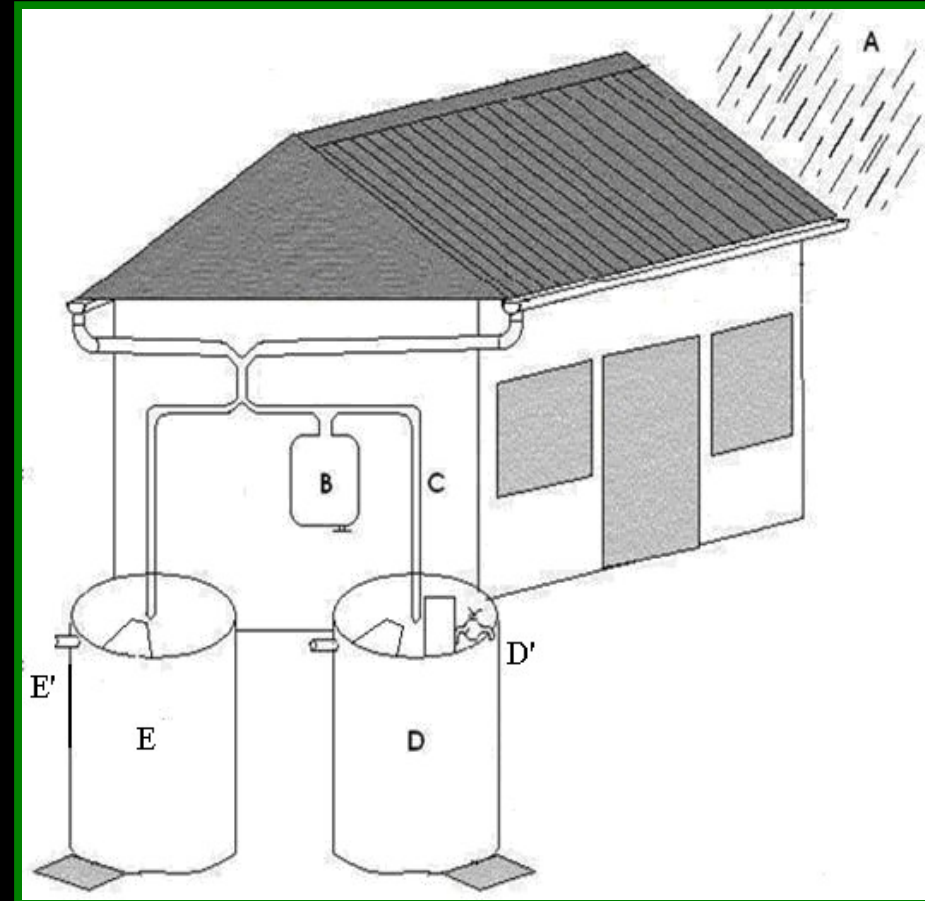


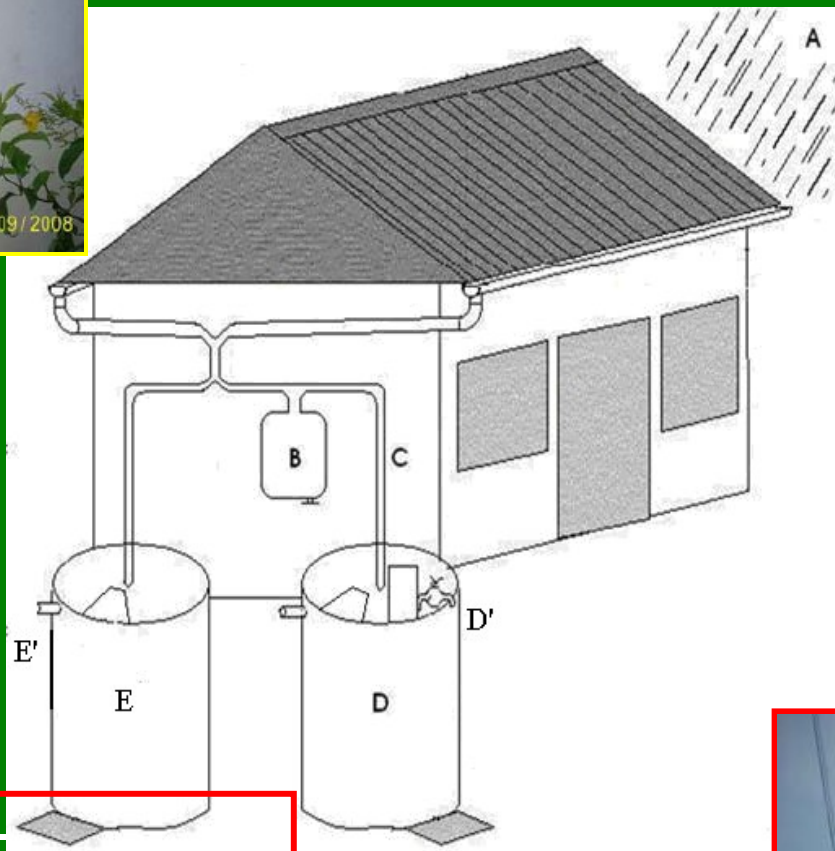
Siphon



# The procedure to analyze the first flush rejection automatic device

- Collecting the water sample.
- Transporting the sample to the lab.
- Analyzing the sample at lab.
- Comparing the results.





Sampling location:

A → before the roof

B → inside the first flush device

C → inside the cistern

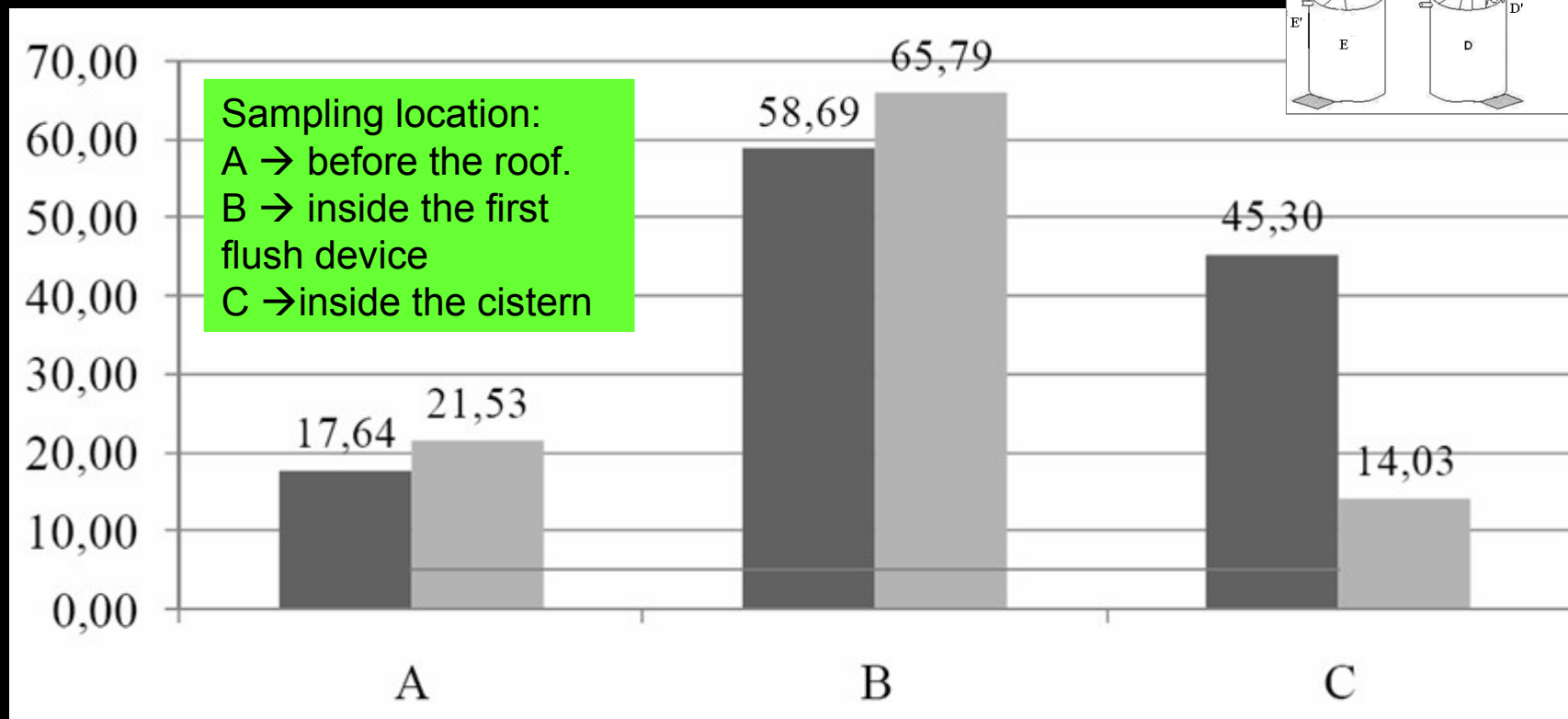
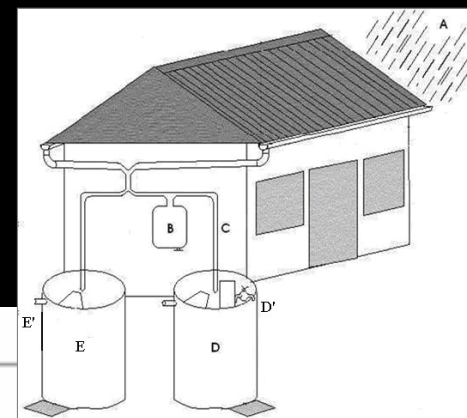
D → outlet – cistern 1

E → outlet – cistern 2



# Water quality parameters

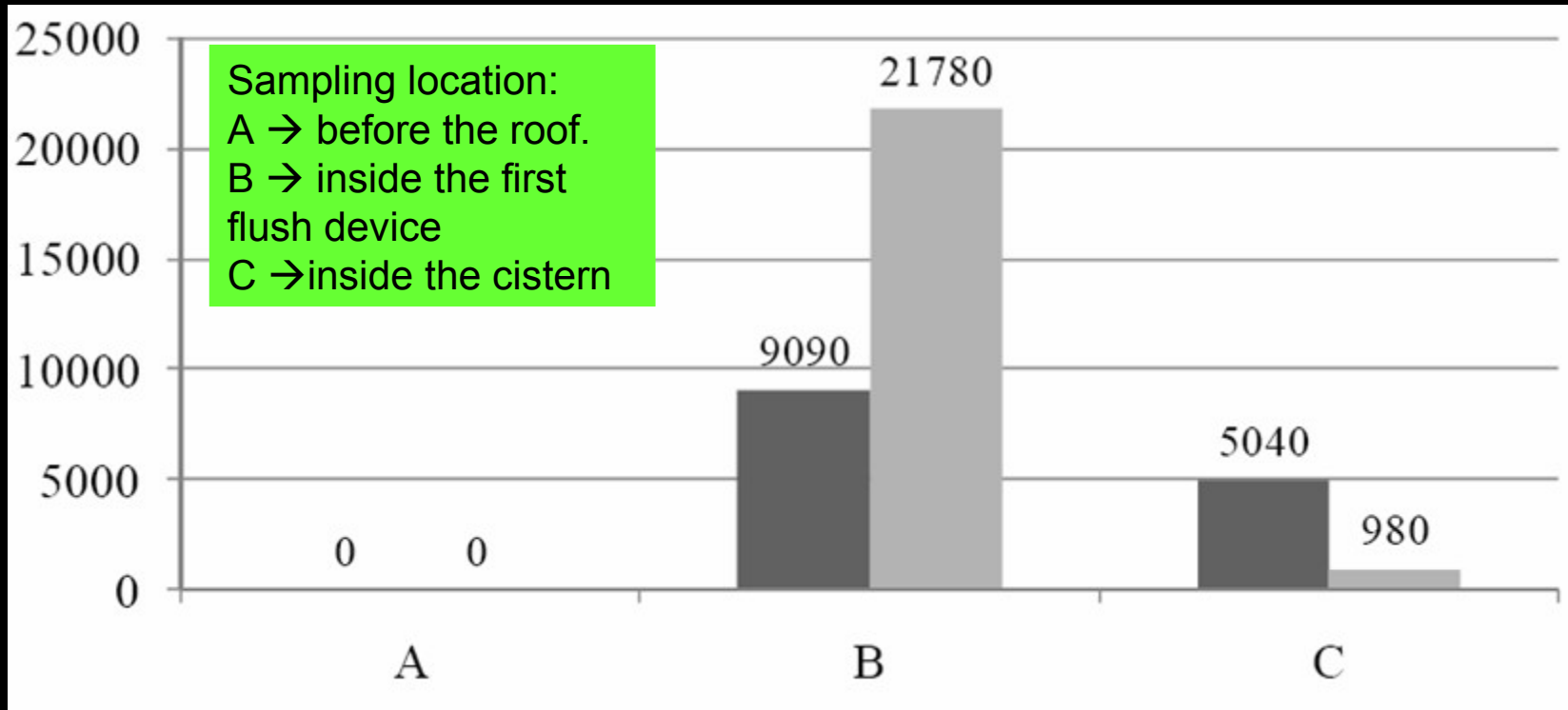
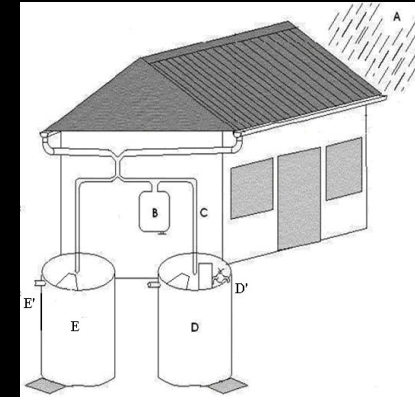
**Turbidity:** measure of the amount of particulate matter that is suspended in water.



- Device based on communicant vases principle.
- Device based on siphon.

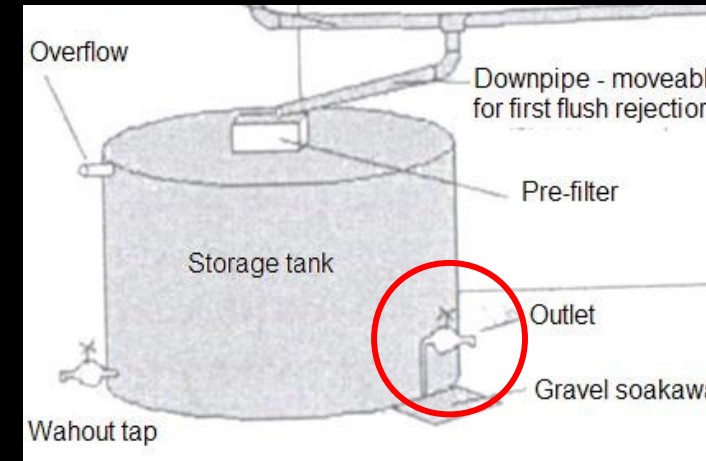
# Water quality parameters

**Coliform:** bacteria that are always present in the digestive tracts of animals, including humans, and are found in their wastes, they are also found in plant and soil material.



- Device based on communicant vases principle.
- Device based on siphon.

# What is the problem with the bucket?



- Near the cistern there are domestic animals: chicken, pig, dog,...
- Sometimes the people don't have sanitary conditions, hygiene habits, and level of knowledge about it.

# The problem is not the bucket!

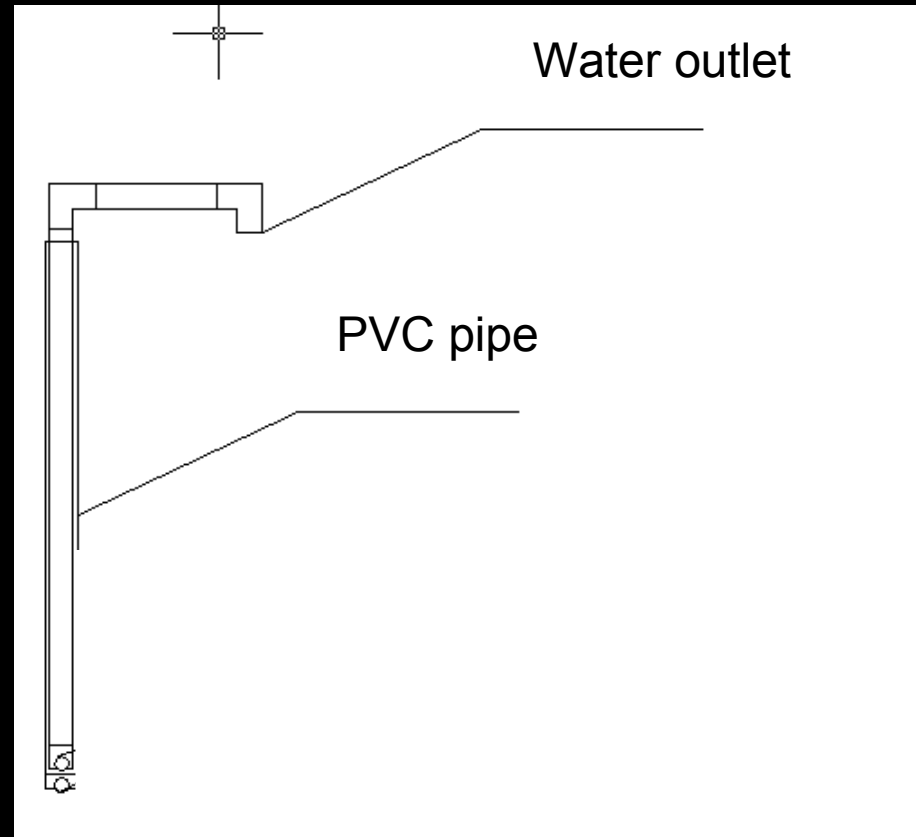
Characteristics	n	%
Indoor water plumbing	166	18.1
Bathroom facilities	162	45.7
Familiarity with cysticercosis	165	93.9
Familiarity with tapeworm	131	26.7
Has raised hogs	155	77.4
Raises hogs presently	155	30.3
Boils drinking water	159	8.8
Throws out faeces outside the home	165	47.3
Washes hands prior to eating or when going to bathroom	165	63.6
Washes food products	164	84.1
The hogs consume excrement	119	72.3
Has eaten or eats pork contaminated by cysticercosis	153	45.8

Source: Gomes et al. (2002)

# Sanitary barriers - Handpump

What are the goals?

- The people substitute the bucket by the handpump.
- The device has to be simple and cheap (building material and labour).
- The device has to be a popular device for the people want to use it.



# Sanitary barriers - Handpump



Preliminary conclusions:

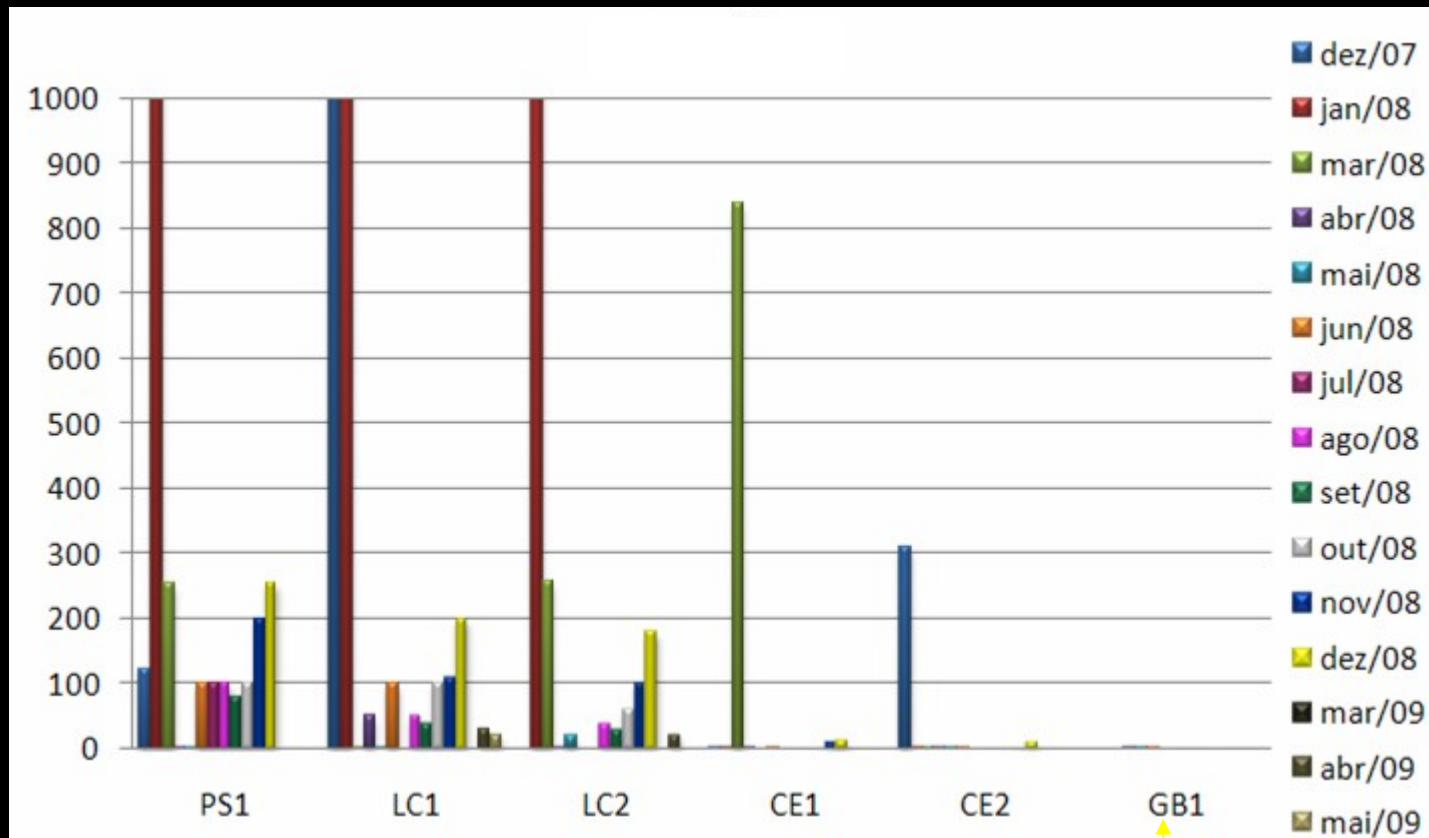
- the actual device is easy breakable;
- the people prefer to use the bucket: more simple and faster.

# Bucket x Handpump



# Bucket x Handpump

**Coliform:** bacteria that are always present in the digestive tracts of animals, including humans, and are found in their wastes, they are also found in plant and soil material.



↑ Handpump

## Other actions

- Compare the water parameters analyze results with values of the Governmental Decree 518/04 (Health Department).
- Water quality monitoring of the other cisterns.
- Development of the other sanitary barriers.
- Environmental Education for the rural communities.



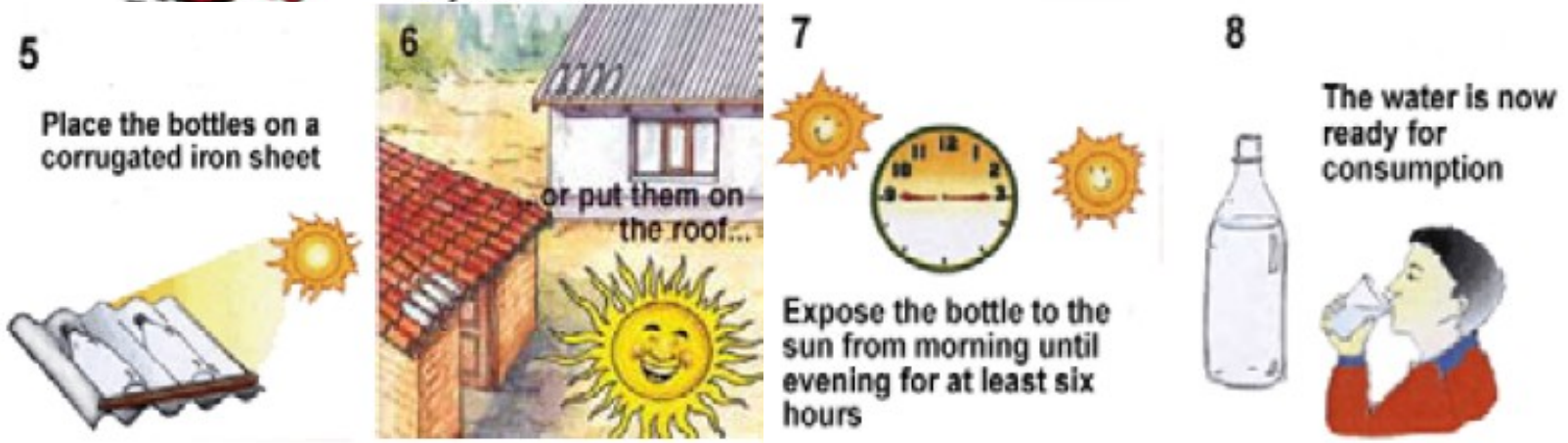
# Other actions

- Application of the SODIS method.

## SODIS (Solar water disinfection) :

to improve the quality of drinking water by using sunlight to inactivate pathogens causing diarrhea.

Source: <http://www.sodis.ch/>



# Other actions

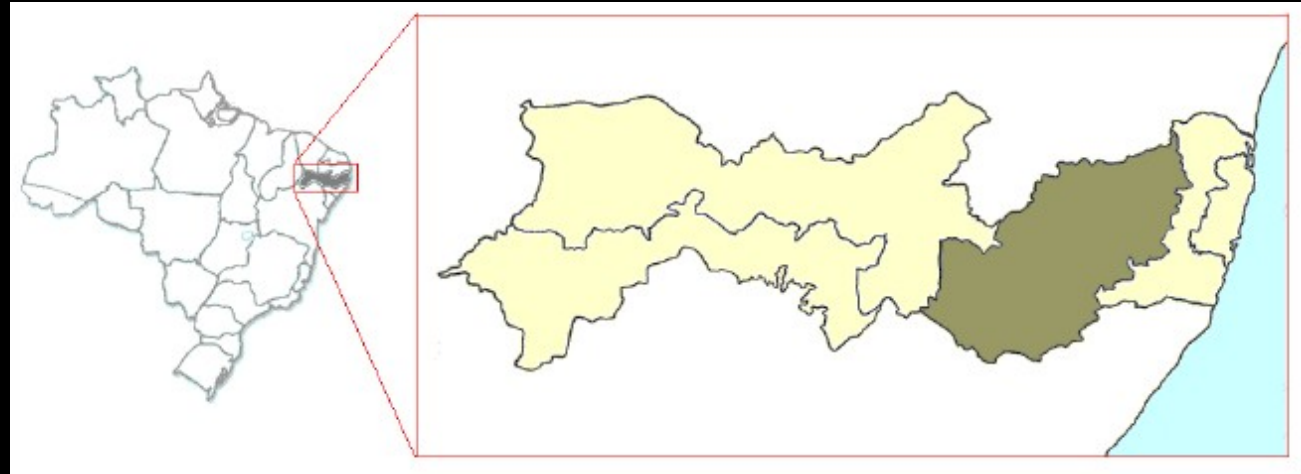
**Working in a multidisciplinary team:**

Researchers: Civil Engineers, Chemists, Biologists, Educators.

Scientific researchers: graduation students and master students.



# The location of study area



Pesqueira

# Conclusions

- At this moment:
  - First flush rejection automatic devices can be a good option.
  - Handpump is necessary for all cisterns.
  - Environmental Education is very important if we want good water quality results in semi-arid region.
- There is so much to study about sanitary barriers.

# Financial support and partnerships

## Financial support:

- CNPq - National Counsel of Technological and Scientific Development
- FINEP - Research and Projects Financing



## Partnerships:

- Federal Rural University of Pernambuco
- Federal University of Campina Grande
- State University of Paraíba
- Brazilian Agricultural Research Corporation



# The reality for many families in northeastern Brazil's semi-arid region



<http://noticias.uol.com.br/ultnot/especial/2007/seca/faltadagua.jhtm>

*"I spent my whole life carrying water in the drought season. If I counted the hours spent coming and going it would be days, weeks, and months of my life. Coming and going with a can of water in my arms, stealing my time, wasting my energy, my youth, breaking down many dreams, undermining our hope. But I never gave in,"*  
*Josefa Cabral\**

*\*age 56, from the community of Rangel in the municipality of Jassanã-RN, the mother of four, had a cistern built in the patio of her home*

# Thank you for your attention!



Prof. Dr. Ing. Sylvana Melo dos Santos  
Federal University of Pernambuco  
Water Resources Group  
[sylvana@ufpe.br](mailto:sylvana@ufpe.br)