Arid and semi arid development through water augmentation

13-16 December, 2010

Valparaíso, Chile

The use of roof catchments and cisterns for domestic supply in Brazil

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Arid and semi arid development through water augmentation

1. Introduction
2. Minas Gerais semi arid region
3. Material and methods
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1. Introduction

Around 90% of the Brazilian population have access to clean and safe drinking water

A great part of the almost 20 million people with no access live in the rural areas of the Brazilian semi-arid region

The domestic roof water harvesting technique has been used as a water supply alternative for human consumption in the country

One Million Cisterns Program (P1MC): working since 2001 to build around 295,000 cisterns

2009 SEED award for Entrepreneurship in Sustainable Development (United Nations)

1. Introduction

Local NGOs and local community associations + national government and international agencies

Order of attendance: families living in rural areas with low HDI and the presence of children living in risk situations

(Cisterns dimensions) x (precipitation data, roof area and number of residents in each house)

The cisterns usually have nominal standardized volumes, even though the rainfall regimes and the lengths of the dry seasons are heterogeneous

1. Introduction

The P1MC is mainly financed by the Federal Government, which acts to provide the infra-structure (the construction of the cisterns)

Even with the great efforts there are further difficulties to be overcome, especially related to water quality, water quantity and costs issues

Is not rare that cisterns become empty far before the end of the dry season and the beneficiaries fill them using water with dubious quality

As in other developing countries, the stored rainwater is potentially the cleanest available for people in semi-arid rural regions

The water stored in the cisterns is normally used untreated for drinking, although not always meeting the national drinking-water standards

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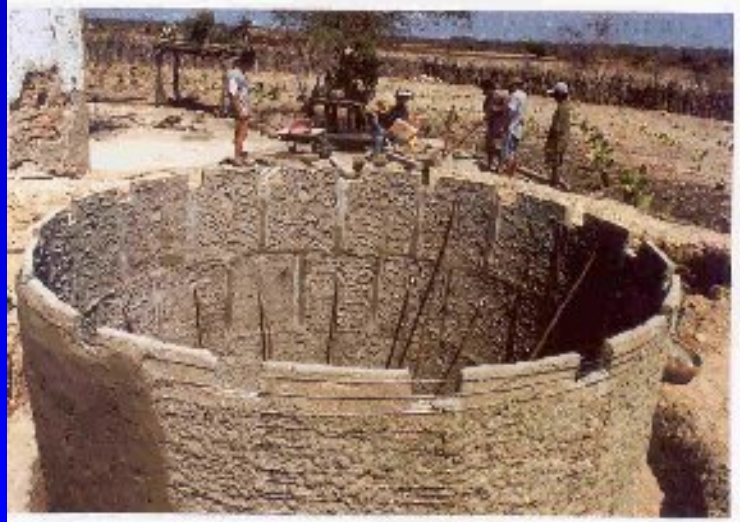

TERMO DE RECEBIMENTO DA CISTERNA

Convênio ANA/DIACONIA Nº 019/2001 UF PI Nº 42.775 da cisterna

Entidade Executora: Cáritas Brasileira Regional do Piauí

Localização do Projeto Demonstrativo: S. 07° 41. 995 ' /W 040° 48. 247 '

Município: Curidade Estado: Piauí

Localidade: Cabaceira

Nome do Beneficiário: Francisco Mariano Novais

Número de Pessoas na Família: 9 Adultos: 5 Crianças: 4

Custo Financeiro – R$: 600,00

Custo Não Financeiro - MÃO DE OBRA FAMILIAR - R$ 120,00

Período de Construção - Início: 09/Jev Término: 12/Jev

Declaro que recebi do Projeto Demonstrativo de 01 (uma) Cisterna de Placa de 16.000 litros na localidade acima referida.

Curidade – PI, 28 de fevereiro de 2.002

Francisco Mariano Novais

Assinatura do Beneficiário

CPF Nº: 749 613 864 - 04

Arid and semi arid development through water augmentation

1. Introduction

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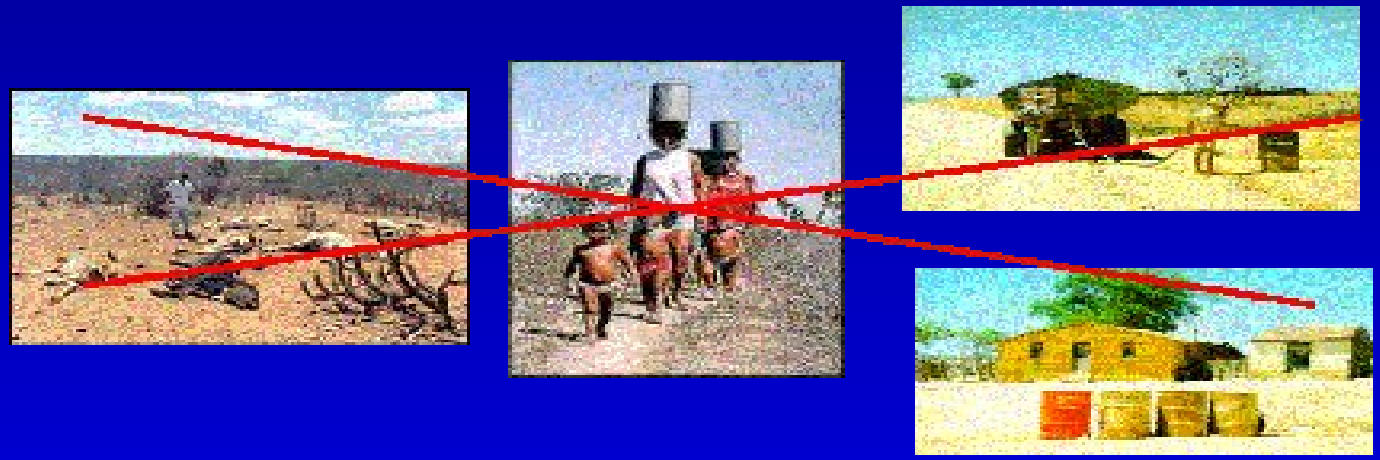
Ceará – drought in 1877: 900,000 died (50% of the population)



Water transported by trucks:

1) the most expensive option
2) generally the water is not potable
3) several times it is used with political aims
4) it is a temporary solution

1. Introduction

A simple mass balance model was used to estimate the performance of cisterns and roofs of different sizes

Due to the great number of years with failures proposals are described so that to make the cisterns a more secure alternative for water supply

The absence of a systematic maintenance of the cisterns may result in their partial or total abandon

One obstacle for the wide use of cisterns in the Brazilian rural areas is the lack of a specific legislation

A cistern management and operational plan is then proposed in order to try to overcome some of those problems

2. Minas Gerais semi-arid region

Brazilian semi-arid region

Area: 969,589 km^2

Population: almost 21 million people (43% living in rural areas)

This region comprises part of nine Brazilian States, including a great part of the State of Minas Gerais

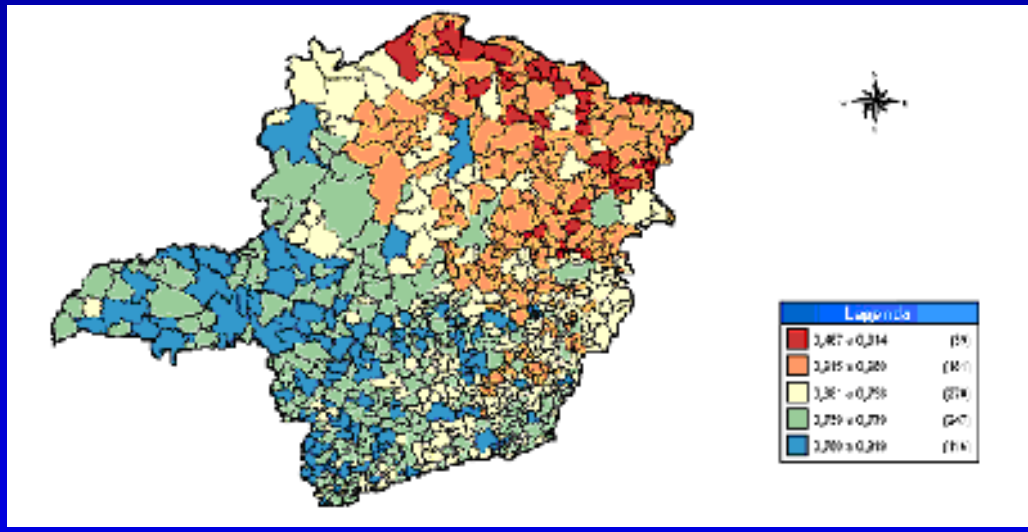
The water resources distribution is quite irregular in time and space in the State of Minas Gerais with a strong reflect on the HDI values of its municipalities

The middle part of the Jequitinhonha basin (mean annual precipitation of 800mm concentrated in 4 months) is considered to be one of the poorest of the country

Arid and semi arid development through water augmentation

2. Minas Gerais semi-arid region

Brazilian semi-arid region



HDI values in Minas Gerais

3. Material and methods

The P1MC cisterns usually have nominal standardized volumes of 16,000 litres

- family of 4 to 5 people
- entire dry season (up to eight months in some locations)
- roof area: 40m^2
- minimum mean annual precipitation: 400mm
- average daily water consumption per person: 13 litres (water for drinking, cooking and hygiene purpose)

In the semi-arid region of the State of Minas Gerais (mean annual precipitation of 800 mm), greater daily water consumption per person can be specified (even the minimum value preconized by the World Health Organization, which is 20 L/person/day) by considering changes in the cistern volume and/or the roof area

3. Material and methods

Water balance model

-It estimates the volume of the water available inside a cistern in a daily basis considering as input the rainwater and as output the water consumed (if available) and potential overflows

$$V_i = VCIS_{i-1} + VENT_i - COME_i \quad (1)$$

in which:

- V_i is an auxiliary value that represents the potential volume of water stored inside the cistern on day i (in L);
- $VENT_i$ is the volume of water that enters in the cistern on day i (in L);
- $COME_i$ is the mean daily water consumption (in L); and
- $VCIS_{i-1}$ is the volume of water stored in the cistern on day i-1 (in L)

3. Material and methods

The volume $VENT_i$ is calculated (in L) by the following product:

$$VENT_i = P_i \, C_r \, A \qquad (2)$$

in which:

- P_i is the rainfall on day i (in mm);
- C_r is the water runoff coefficient; and
- A is the catchment area (in m^2) – in the case of the P1MC cisterns, this is the roof area of a house

The effective volume of water stored inside the cistern on day i ($VCIS_i$)

$$VCIS_i = VMAX, \quad \text{if } V_i > VMAX \qquad (3)$$

$$VCIS_i = Vi, \quad \text{if } 0 < V_i \leq VMAX \qquad (4)$$

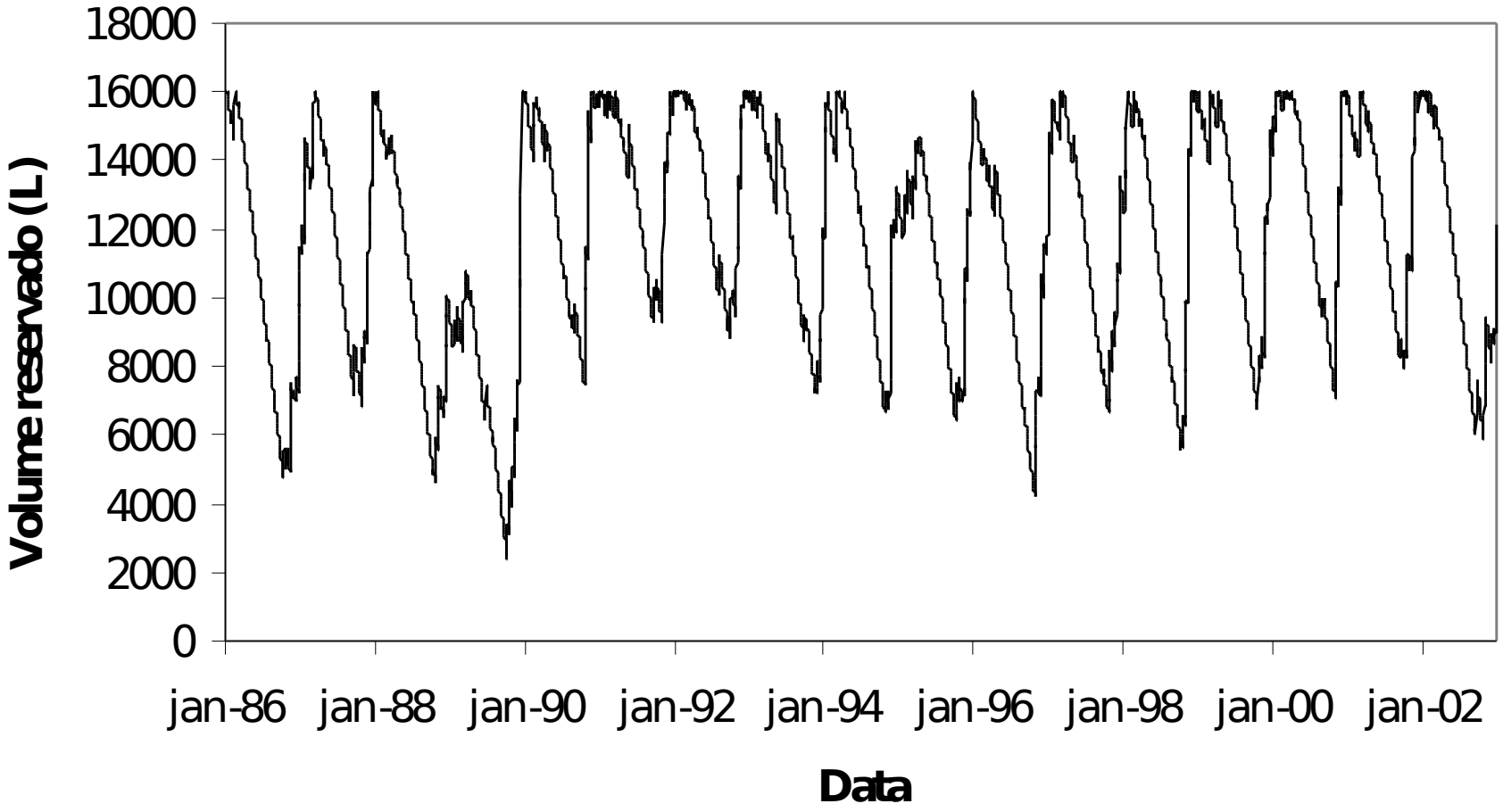
$$VCIS_i = 0 \text{ (“failure”)}, \quad \text{if } V_i \leq 0 \qquad (5)$$

4. Results

In order to verify the possibility to provide water to a family all over the years with the use of a cistern and just rainfall as water source, the model was used with daily rainfall data from a station located in the middle part of the Jequitinhonha basin (6,208 days, from 01 January 1986 to 31 December 2002)

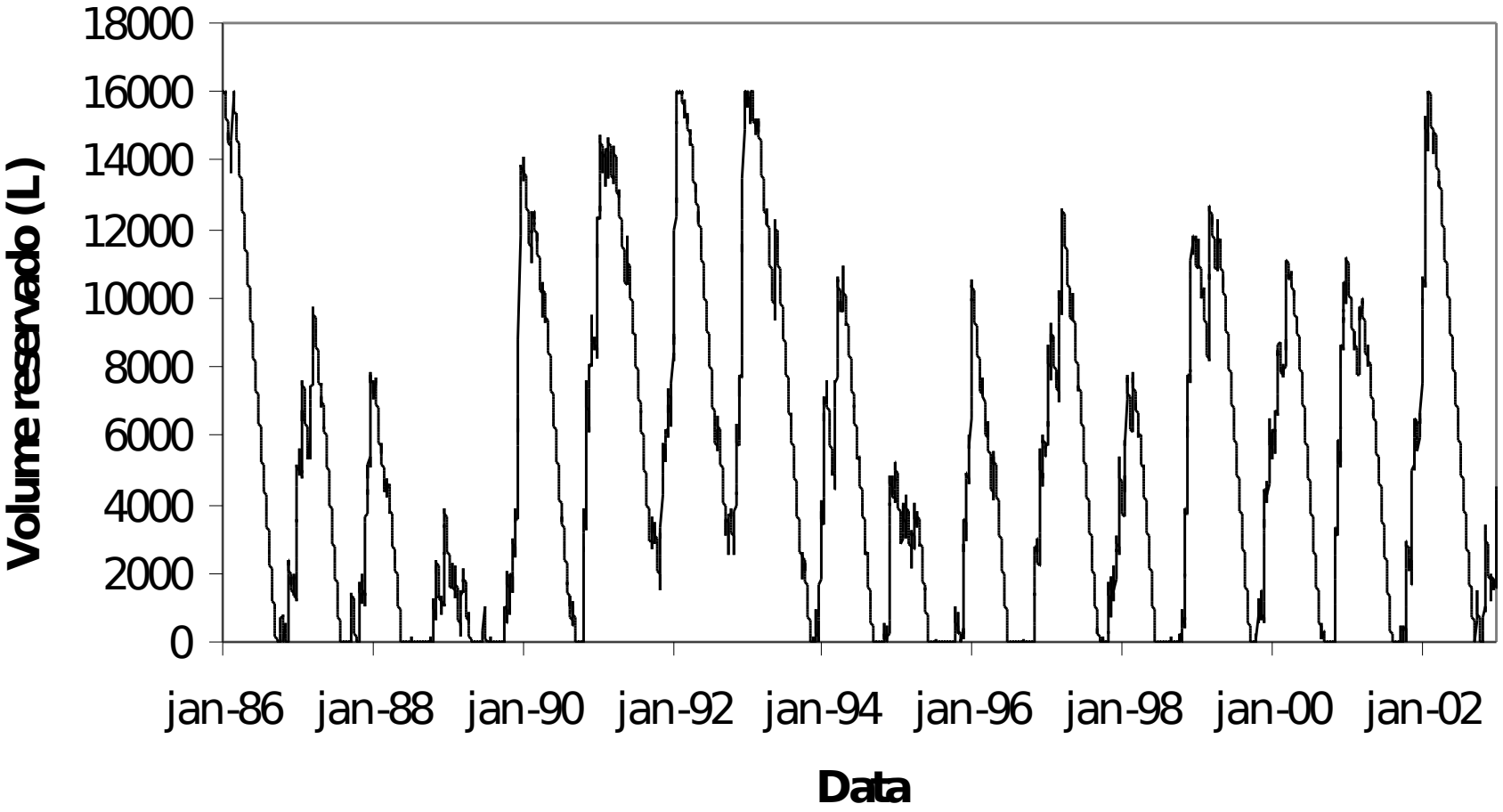
The model was first run considering the following default values:
1 - VMAX = 16,000 litres (value adopted in the P1MC);
2 - Volume of water inside the cistern on day 0 ($VCIS_o$) = 16,000 litres;
3 - A = 40 m^2 (value adopted in the P1MC);
4 - COME = 52 litres (value adopted in the P1MC: four people and a daily consumption by person of 13 litres); and
5 - Cr = 0.80

4. Results



mean daily water consumption of 52 L and roof area of 40m^2

4. Results



mean daily water consumption of 80 L (WHO minimum for four people) and roof area of 40m^2

4. Results

Minimum daily consumption of 13 litres per person

- the cistern would never be empty during the 14 years of simulation

Minimum daily consumption of 20 litres per person

- the cistern would be empty on 1081 days, which is 17% of the total simulated period (mainly in consecutive days)

With the standardized dimensions of the cisterns they could not be considered a secure alternative to provide water if a daily consumption per person of 20 litres is adopted even in an area with one of the greatest mean annual rainfall of the Brazilian semi-arid region

4. Results

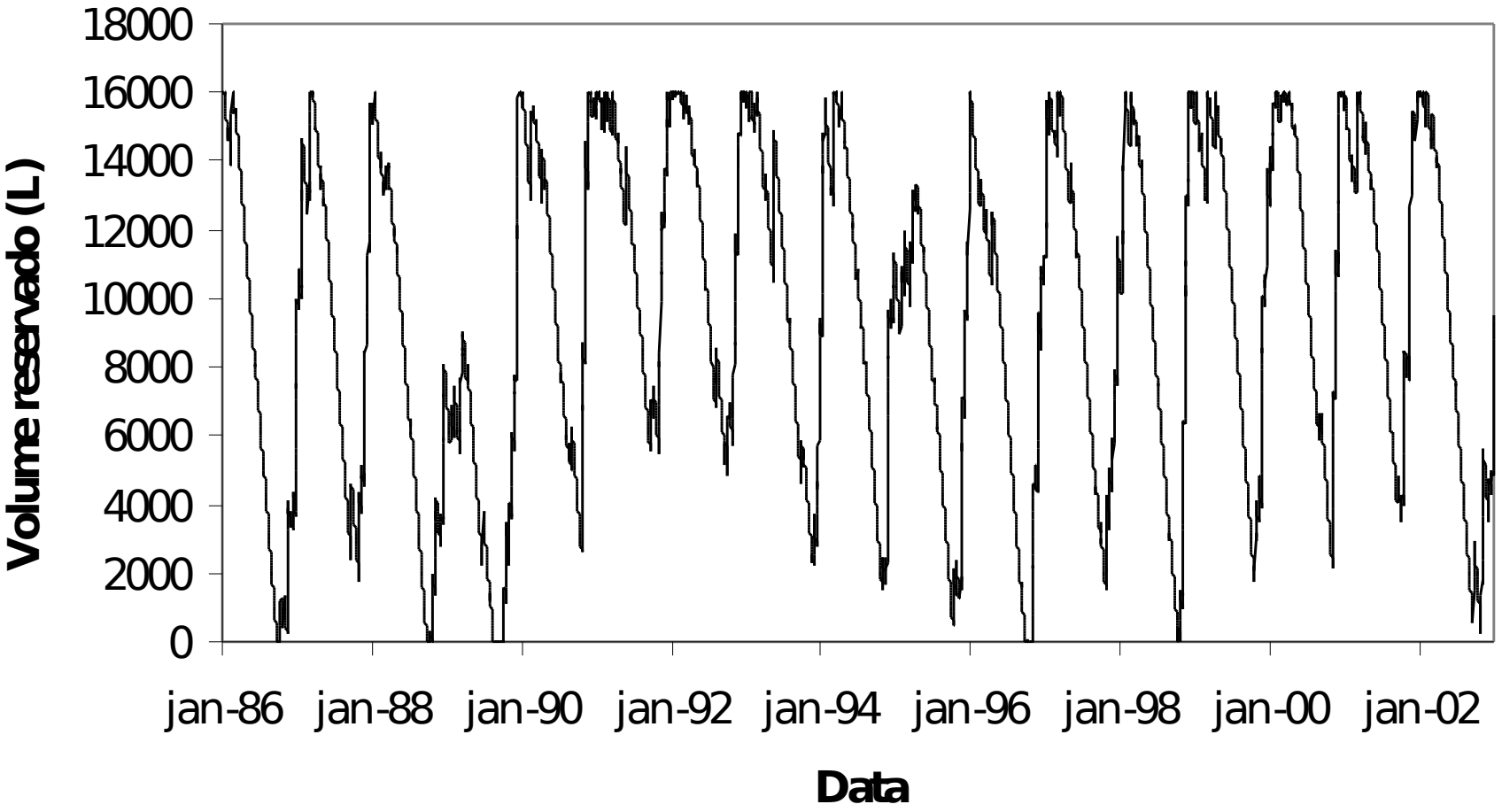
In order to guarantee the availability of water for that daily consumption one can consider an increase of the cistern volume and/or of the catchment area

An increase of the cistern volume alone does not change the amount of the source water (although it can diminish the overflow quantity), since the quantity of diverted rainwater would be the same

It is possible to improve the supply of water by using the standard cistern and considering an increase of the roof area from 40m^2 to 60m^2

The number of days with an empty cistern decreases considerably – from 1081 to 126 but even though this could represent a great problem for the beneficiaries if another source of water is not easily available

4. Results



mean daily water consumption of 80 L (WHO minimum for four people) and roof area of 60m^2

4. Results

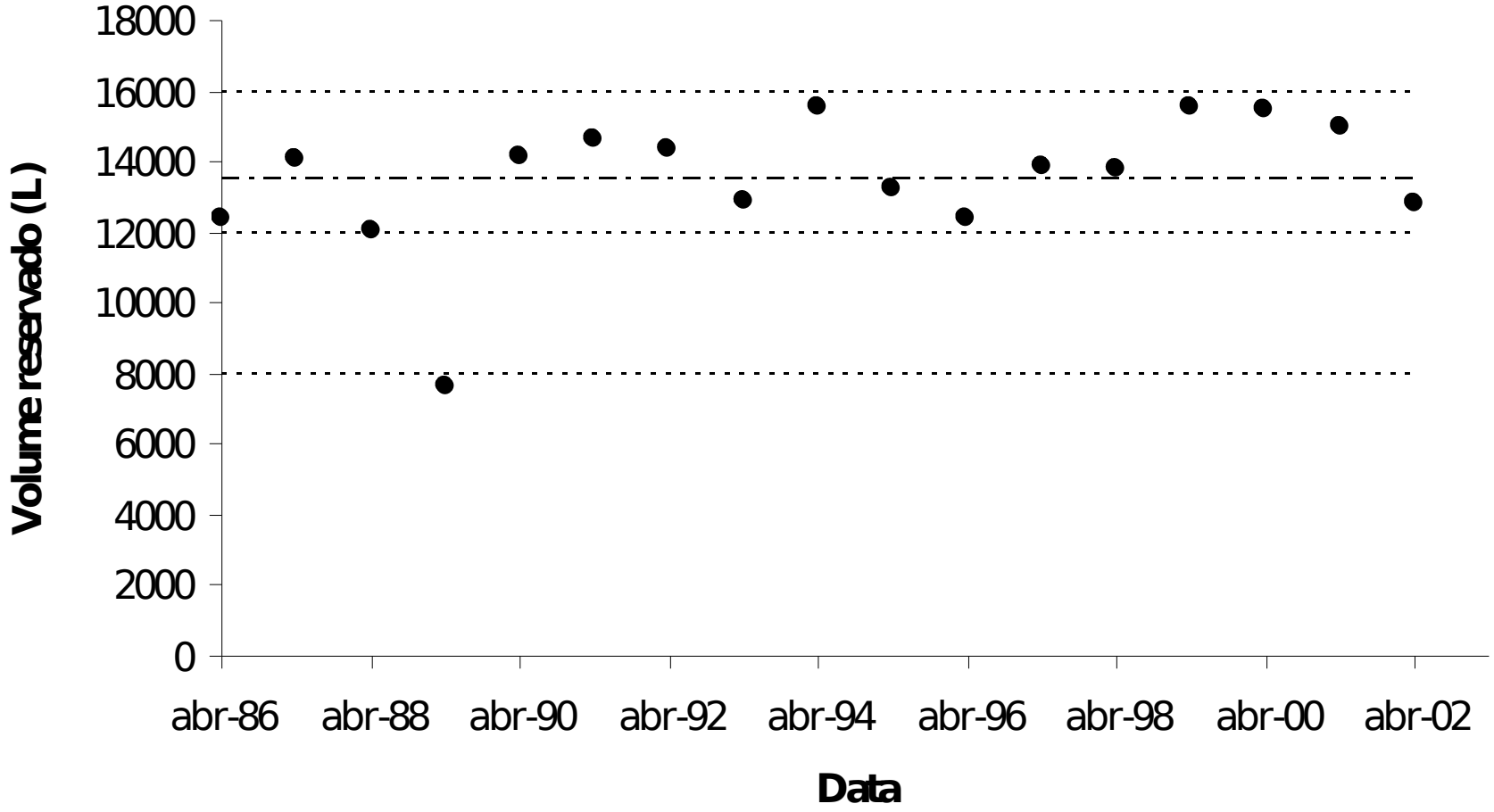
The potential occurrence of failures indicates the necessity, in the driest years, to administrate the daily water consumption in order to get water from the cistern during the whole dry season

It is necessary to have an almost full cistern in the end of the rainy season (end of March) to guarantee a 80 L/day consumption all over a 6 month dry season

In this manner, if one verifies the volume of the stored water inside the cistern on, for example, 15 April, it is possible to decide whether the daily consumption must be decreased for the rest of the dry season

By considering the runs with the roof area of 60m^2, the mean water volume inside the cistern on that day would be equal to 13,492 litres

4. Results



Water volume inside the cistern on 15 April

4. Results

This volume (13,492 litres) would be basically enough to maintain the 20 litre daily water consumption until the start of the rainy season; in the worst year (1989) the water volume available on 15 April would not be enough even if a reduction to 13 litres per person is considered

To avoid this reduction the local public authorities can be early informed about the problem as to schedule a gradually supply of potable water using trunks (this water could come from the treatment plants available in a near urban area)

This proposal is not against the directives of the P1MC due to the guaranteed high quality of the provided water (nowadays, when there is an extreme water shortage, the population has no alternative than to pay high prices for poor water quality of the water truck trading)

5. Proposal of a management and operational plan

Besides the 295,000 cisterns from the P1MC, thousands more have been recently constructed in private initiatives and with financial support from several NGOs

The results of the P1MC are quite impressive by the number of cisterns already constructed and by the change of paradigm in terms of water supply as the beneficiaries are now responsible for their own system

For the management of water supplies, water demands and water quality in alternative systems, especially those in the current stage of the P1MC, the implementation of a Management and Operational Plan can represent a solution to the problems already observed and a basis to allow the sustainable expansion of the number of cisterns

5. Proposal of a management and operational plan

In a simplified manner, the establishment of a Management and Operational Plan for the around 300 cisterns already constructed in the municipality of Araçuaí would be consisted by the follow steps:

i) an organism in charge of the cistern maintenance would register all constructed cisterns;

ii) all cisterns would be visited at least twice per year (in April, after the end of the rainy season and in October, after the end of the dry season) by two technicians responsible for the physical inspection of the cisterns and for the cistern water sample collections;

iii) the water sample collected would be analyzed in the laboratories of the company responsible for water supply of the nearest city;

5. Proposal of a management and operational plan

iv) in April, it would be verified the necessity to fill the cisterns with water from the treatment plant of the nearest city by using trucks;

v) costs of those visits for inspection would be paid by the beneficiaries (this is a point of intense debate); the costs per cistern would be relatively low especially considering the expected benefits;

vi) typical drinking water analysis would be established in specific programs for alternative water supply systems to be proposed in the Municipal Master Plan; and

vii) costs of cistern repairs (natural depreciation) could be subsidized by public funding, with the benefit of increasing the cistern useful life (repairs due to incorrect utilization would be paid by the cisterns users)

6. Concluding remarks

In Brazil the spread of the roofwater harvesting using cisterns to provide water for human consumption could be achieved by their legitimation

Only for great urban areas, municipal laws concerning the use of rainwater harvesting systems have been recently approved (the great motivation was to reduce peak flood storms instead of creating an alternative to diminish the pressure on conventional water supply systems)

With the inclusion of the water harvesting systems in legal texts, it would be possible to guarantee the supplying of public funds for them in the Water Resources Plan for basins

6. Concluding remarks

As for the case of the P1MC, this inclusion may enable the formal monitoring of the cisterns and potential advances in the development of the program

There is a strong need to integrate the water resources and the sanitation policies

This must be done considering the already acquired partnership between grassroots organizations and governmental institutions in the context of the P1MC

It is believed that the implementation of the proposed Plan would bring elements to avoid the pulverization of resources and the superimposition of actions, effectively contributing to the water scarcity mitigation in the Brazilian semi-arid region

GRACIAS

THANK YOU

OBRIGADO