# How can rainwater harvesting contribute to living with droughts and climate change in semi-arid Brazil?

*JOHANN GNADLINGER*

*In the last 20 years, in semi-arid Brazil, rural communities have begun to use water management technologies for households, in agriculture, livestock raising, and the environment, such as cisterns, subsurface dams, conservation methods of soil humidity, and aquifer recharge. These communities were also prepared to deal successfully with the severe drought from 2011 to 2013. To contribute to living with the challenge of droughts and climate change in the future, these experiences are multiplied all over semi-arid Brazil and included in an overall management programme with a sustainable comprehensive structure. The so-called principles of living with the semi-arid climate are summarized into different guidelines for sustainable livelihood and production: access to water and sufficient land area; rainwater harvesting to provide water security to households and communities; preservation, recovering, and management of drought-resistant vegetation; emphases on raising of small and medium-sized livestock and water and forage storage; appropriate crop selection and sustainable extraction, processing and marketing of crop products; and capacity building of the people. All these initiatives should contribute to bringing the discussion about the 'National Policy on Living with the Semi-arid Conditions' to the National Congress of Brazil.*

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SAB (SEMI-ARID BRAZIL) IN the north-east of the country (Figure 1), extending over 980,133 km$^2$ and 1,135 municipalities, is inhabited by 22 million people, 8.5 million of them in rural areas (National Institute of the Semiarid Region, 2012). It is not little, but irregular rainfall, which characterizes SAB. The city of Juazeiro in the centre of SAB has an average yearly rainfall of 510 mm. In a drought year there may be only 174 mm rainfall, whereas in another year there could be 974 mm (Figure 2). The evaporation rate is high, due to continuous high temperatures (open surface evaporation of about 3,000 mm a year).

Droughts are part of the semi-arid climate and occur in a cycle of 25 to 30 years. In 2012 and 2013 a severe drought event occurred with only 30 per cent of average rainfall. The last similar drought happened from 1979 to 1983 with devastating

*Johann Gnadlinger (johanng@terra.com.br), environmental and water manager, has been working since 1991 at IRPAA (Regional Institute for Appropriate Small Scale Agriculture), a leading non-governmental organization in semi-arid Brazil, and is a former president of ABCMAC (Brazilian Rainwater Catchment and Management Association) and a former vice-president of IRCSA (International Rainwater Catchment Systems Association).*


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**Figure 1** Map of Brazil

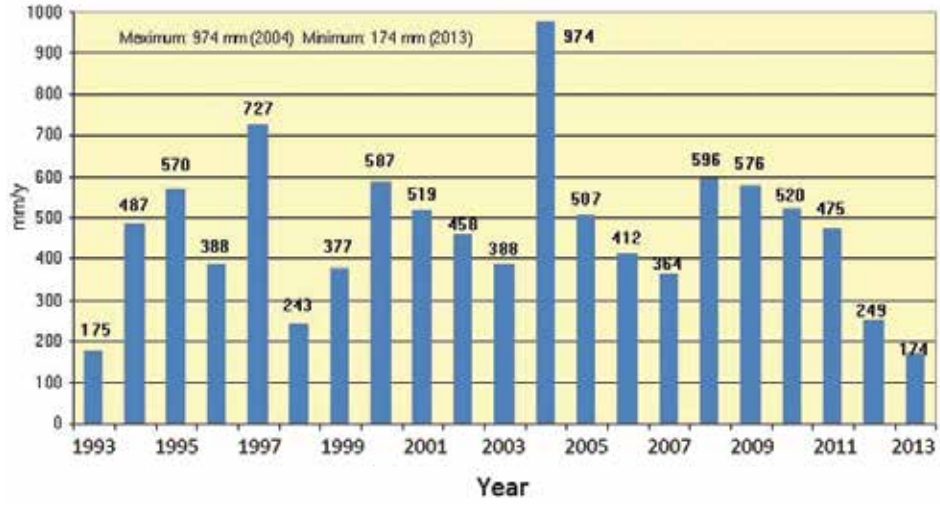


**Figure 2** Annual rainfall in semi-arid Brazil, Juazeiro (1993–2013)

consequences for the rural population: a high mortality rate among the elderly and children and an increased migration of young people to cities. Although these effects have not been repeated for the affected people this time, the challenge now is: How do the people, the civil society and the government deal with the actual drought? What is the contribution of rainwater harvesting? What lessons can be learned for living successfully in the semi-arid region notwithstanding droughts and climate change?

## Approach

### *Droughts happen regularly, but are we prepared?*

When one or two or three years of low rainfall happen, it is not a catastrophe for the semi-arid region's plants and animals. Over a period of thousands of years nature has been able to adapt to droughts and build resilience. A catastrophe is rather the lack of preparation of the people and especially the government. The federal and state governments have had a period of three decades since the last severe drought to prepare and not be caught by surprise. But, once again, the governments needed to take emergency measures, spending enormous sums of money to avoid major economic losses and deaths in the population. Since the beginning of 2012, a government emergency drought-relief programme has been trucking water to rural households and supporting families with money. We watch a parade of water trucks, the resurgence in full force of the so-called drought industry and lament the lost time, in which SAB could have been endowed with infrastructure and courageous policies. As an example of a lack of preparation: in March 2013, Brazil's central region exported 20 million tonnes of its super corn harvest to China and the USA, but CONAB, the National Food Supply Company, was unable to send 500,000 tonnes of corn to the drought-ridden SAB where it was needed as livestock feed. There was no corn available in the SAB during that period (Globo Rural, 2013).

### *The right livelihood is to live in harmony with the semi-arid climate*

On several occasions, farmers, livestock raisers, community representatives, and even policymakers have shown how it is possible to live with the drought (Gnadlinger, 2011). Some of the rural population were already prepared through awareness building in previous years when they studied the real reasons for suffering from drought. Droughts are longer than normal dry periods with less than average rainfall, but the consequences of droughts are human made: little or no water management, deforestation, climatically inappropriate farming practices, lack of access to land, and social and political exploitation. Native plants of the Caatinga vegetation accumulate water and nutrient reserves, having tuberous roots and thick trunks to store water or deep roots to fetch it; they avoid unnecessary evaporation; they produce and reproduce less in drier years, but do not die. The lesson from nature is that human activities must also meet the concept of multiple-year preparation, similar to nature: the water supply needs to be planned, not for eight months, but for two years or more. Forage must not be exhausted within a few months or a year

and must be produced on location. Bank credit for crop and livestock production needs to be rethought according to multiple years.

### *Five steps of water supply*

The semi-arid region needs to diversify the sources of water according to its end use. In many parts of SAB where there is crystalline bedrock it is not viable to drill wells since no groundwater exists. But, despite the problems of uneven rainfall distribution, high evaporation, and unfavourable subsoil, it is always possible to catch water when and where it rains, store it, and, therefore, have a safe source of water during the dry season, not only for drinking but also for other uses. Thus a new idea is emerging: the integrated management of rainwater, surface water, soil and groundwater, respecting the water cycle (Gnadlinger, 2006).

The struggle for access to water must also be accompanied by a concern for structural problems such as sufficient land area suitable for raising animals and producing in semi-arid climate conditions. With infrastructure and good management, it will be possible to have sufficient water for different uses in the local communities under semi-arid conditions and also during drought periods, especially if the following five steps are considered:

*Drinking water.* Drinking water should come preferably from cisterns, constructed near the house, large enough to store rainwater caught during the rainy season for

**Figure 3** A drinking water cistern constructed by ASA

use during the long dry season, and giving residents comfortable access to water. In Brazil, access to drinking water is a priority in the case of water scarcity (Presidency of Brazil, 1997); 750,000 cisterns of 16,000 L for drinking water have already been constructed by the private sector with funding from the federal government during the past 12 years; 519,772 alone by ASA (the Semi Arid Network) (see Figure 3; ASA, 2013). Furthermore, since 2012, the Ministry of National Integration has been distributing PVC cisterns, provided by a multinational company, but has been criticized because of the lack of community involvement.

*Water for the community.* Water for household use such as bathing, washing dishes and clothes, and livestock consumption, is provided by narrow trench-like ponds, dug into the rock and at least 4 m deep, and by wells. More than 1,000 manual water pumps (called Volanta pumps) were installed by ASA, especially in low-volume wells in crystalline subsoil (see Figure 4), providing water for sheep and goats.

**Figure 4** A manual water pump provides water for animals

*Water for agriculture.* Water is supplied through sub-surface dams (Figure 5), cisterns or ponds for supplemental irrigation, road catchments to irrigate fruit trees, contour level ploughing, rainwater stored *in situ* for fruit trees or sorghum, use of manure and dry mulch (straw) to retain soil moisture for plants, and seeding of crop species adapted to the climatic conditions. ASA constructed 14,343 cisterns of 52,000 l for irrigation of vegetables and fruit trees.

**Figure 5** Building a sub-surface dam

*Water for emergency situations.* During a long drought period, emergency water is provided by deep wells and small dams, strategically distributed. This point is an interim solution where the three previous points are not fully achieved.

*Water for the environment.* This is ensured through protection of springs and riparian vegetation, prevention of water source contamination, and refraining from burning the Caatinga vegetation and the fields. Knowledge of the water cycle and water balance are conditions for harmonious living with the climate and the environment. The environment provides water for the needs of humans but part of this should

be available for conservation and proper functioning of the ecosystem. A variety of watershed management programmes in temporary rivers and of natural vegetation recovery programmes, called 'recaatingamento', are under way. The intact Caatinga and the lumpy soil provide good infiltration of rainwater, preventing erosion.

These five water management steps are the result of concrete discussions with rural communities and make possible the elaboration of decentralized and participative Municipal Water Plans in the municipalities of SAB, prepared and implemented by the public sector and non-governmental organizations. At this point the São Francisco River diversion and other big irrigation projects must be mentioned, projects that aim to benefit large companies and enterprises, supplying mostly coastal cities, and having nothing to do with 'quenching the thirst of the semi-arid Northeast' as informed by official propaganda.

### *Towards a policy of sustainable livelihood in SAB*

Rainwater harvesting alone is not capable of solving the problems of droughts and climate change. It must be included in an overall management programme. The requirement for a sustainable comprehensive structure in SAB means to multiply successful experiences all over SAB. For this reason the principles of Living in Harmony with the Semi-arid Climate can be summarized in the following guidelines (IRPAA, 2012):

1. Guarantee access to water and sufficient land area to raise livestock and produce in the semi-arid conditions. The SAB Agro-ecological Land Zoning (EMBRAPA, 2000), conducted by Embrapa Semiarido, the Brazilian Agricultural Research Agency, shows the correct use of the land, according to climate and soil, but also indicates the minimum property area. This data should be the basis for land titling, land reform projects, bank loans, etc.
2. Prioritize decentralized water supply systems and local rainwater harvesting solutions to provide water security.
3. Prevent desertification: avoid large livestock unfit for SAB such as cattle, deforestation of large areas, and production of crops that are not adapted to the semi-arid climate.
4. Preserve, recover, and manage the native Caatinga vegetation which resists drought and, probably, climate change (Figure 6). The Caatinga is the natural heritage of SAB and a guarantee for a sustainable life of the people.
5. Prioritize the raising of small and medium-sized livestock (goats and sheep), because SAB is, par excellence, a region for livestock.
6. Store fodder for the months without rain and even longer than a year, preserving the richness of the Caatinga vegetation through its rational use for breeding and harvesting.
7. Select crops that are able to get along with the irregular rainfall in those parts of SAB with microclimates, where crop production can be indicated. State agencies should also support marketing in order to guarantee the farmers' success.

8. Harvest, process, and market products of native fruits such as umbu (Spatodia), passion fruit, and others, which have a good economic potential and contribute to the preservation of the biome. The inclusion of these products in the local school food programmes must be a government priority.
9. Focus efforts on skills and capacity building in rainfed agriculture in SAB's agricultural universities and technical schools because of the great potential of the Caatinga. Irrigated areas are of little significance – only about 4 per cent of SAB is economically suitable for irrigation.
10. Discuss these points with communities and their social organizations, in different forums, networks, and coalitions to propose and construct a National Policy on Living in Harmony with Climate in the Semi-arid Region at the municipal, state, regional, and federal levels.

## Outlook

At the end of 2013 the rain returned to many parts of the region bringing some relief from almost three years of drought, but the opportunities to rethink and plan after a major drought should not be lost (Fishman, 2012), especially in the context of climate change, when more severe drought events are predicted for the SAB region (Nobre et al., 2004).

A 'Survey of the situation of rural small-scale family farming communities', an initiative of ASA and INSA (the National Institute of the Semiarid Region), is under way, especially on the situation of water for humans and fodder for livestock (goats and sheep). This survey also includes a 'list of positive experiences': how some farmers and rural communities have been able to live successfully with the recent drought situation.

In March 2013, the SAB non-governmental sector published in Recife 'Guidelines for living with semi-arid conditions' as its contribution to build public policies on this topic. At the same time, the Pernambuco state government promulgated the 'Living in Harmony with Semi-arid Conditions' law (Assembleia Legislativa de Pernambuco, 2013). Different municipalities are elaborating a 'Water program for the rural area'; Bahian municipalities discussed a 'Municipal policy of living in harmony with semi-arid conditions'.

Additionally, in October 2013, the EMBRAPA Semiarido and IRPAA organized the Semi-arid Show, 'How to live with drought conditions' in Petrolina, Pernambuco state.

Looking further afield, the SAB has previously received useful ideas from abroad for its development programmes, for example, from the rainwater harvesting programme of the semi-arid region in Gansu Province, China. Also, there now exists an initiative to exchange experiences between SAB and semi-arid regions in sub-Saharan Africa.

All these initiatives should contribute to bringing the discussion about the 'National Policy on Living with the Semi-arid Conditions' to the National Congress.

To conclude, we recall the visionary words of Father Cicero Romão Batista, famous in the semi-arid region, who 80 years ago, on the occasion of the 1932 drought, said:

'The people of the Brazilian Northeast should be prepared to endure three years of drought one after the other!'

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