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Measuring the invisible: Analysis of the Sustainable Development Goals in relation to populations exposed to drought

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Abstract *Brazil, together with all the member countries of the United Nations, is in a process of adoption of a group of Sustainable Development Goals, including targets and indicators. This article considers the implications of these goals and their proposed targets, for the Semi-Arid region of Brazil. This region has recurring droughts which may worsen with climate change, further weakening the situation of access of water for human consumption in sufficient quantity and quality, and as a result, the health conditions of the exposed populations. This study identifies the relationship between drought and health, in an effort to measure progress in this region (1,135 municipalities), comparing relevant indicators with the other 4,430 municipalities in Brazil, based on census data from 1991, 2000 and 2010. Important inequalities between the municipalities of this region and the municipalities of the rest of Brazil are identified, and discussed in the context of what is necessary for achieving the Sustainable Development Goals in the Semi-arid Region, principally in relation to the measures for adaptation to achieve universal and equitable access to drinking water.*

Key words *Post-2015 development agenda, Sustainable Development Goals, Drought, Water, The Brazilian Semi-arid Region*

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Introduction

The risks emerging from environmental changes arising from processes related to the model adopted for economic development – destruction of ecosystems, loss of biodiversity, land use, occupation and deforestation – constitute threats to the environment and the social and economic structure, especially at local level. These processes affect the environment and its relationship with society, changing populations' conditions of life and health. In spite of this, the health sector in many countries still shows a certain apathy in relation to these changes, which can, directly or indirectly, alter the state of health of the populations affected[1-3].

Among the conditions or situations of risk that relate to the combination of environmental, climatic and social changes, at local and regional level, is drought. Drought is a type of phenomenon that is simultaneously environmental and climatic, related to a prolonged reduction of the water reserves existing in a region, as well as lower than usual rainfall[4]. Its nature is complex, due the difficulty of its delimitation in space (it can affect anything from extremely large areas, due to the global distribution of humidity, to much smaller areas), and in time (it can last for months or years)[5]. The effects of the process of drought on economic, social and environmental development influence factors that determine health, principally in relation to access to quantity and quality of potable water and foods, thus adversely affecting living conditions, especially for the poorer and more vulnerable social groups. The effects of drought on health, over the medium and longterm, are still little recognized and difficult to measure, especially in areas where drought is commonly recurrent[3,6-8].

At global and national level, drought presents itself as a great threat, principally affecting the poorest populations. According to data from EM-DAT, globally between 1970 and 2014, drought was responsible for 5.4% of natural disasters, 31% of the total of people adversely affected, and 21% of deaths[9]. In Brazil, according to the *Brazilian Atlas of Natural Disasters,* in the period between 1991 and 2010, of the 31,909 records of natural disasters and 96 million persons affected, more than 50% were by reason of drought, negatively affecting mainly the Semi-arid Region, which includes eight states of Brazil's Northeast and the northern part of the state of Minas Gerais, of the Southeast Region[10].

In the Semi-arid Region of Brazil, drought is recurrent and long-lasting, and the effects on the conditions of life and health of people are dealt with by economic and social policies and decisions that can reduce, or worsen, the vulnerability of the populations and of the territory[8]. Climate changes that are in progress can alter the magnitude and frequency of drought events, which will probably mean greater environmental, economic and social damage, with serious consequences for the populations' health[11].

The concerns about water, drought and health are important parts of the post-2015 development agenda, and are included in the Sustainable Development Goals (SDGs). The idea of the SDGs originated at the Rio+20Conference in 2012, based on a proposal from Colombia and Guatemala[12]. In September 2014 a proposal with 17 objectives and 169 targets[13] was presented at a meeting of the General Assembly of the United Nations, and these objectives and targets will be the principal basis for a new agenda for development post-2015[14]. Brazil has an important contribution in these discussions[15].

This article seeks to understand the relationships between the SDGsand the situation of the Brazilian Semi-arid Region, and emphasizes the relationship between drought, water and health. It also presents a quantitative analysis of the years 1991, 2000 and 2010 of specific indicators at municipal level.

Methods

For this article, the 17 objectives and their 169 targets were reviewed, classifying them under three dimensions of sustainable development (social, environmental and economic), highlight the relationship that exists between the targets on water, drought (desertification) and health. We have prepared a conceptual framework that shows the interrelationships between the 17 SDGs, identifying with a greater or smaller degree of intensity those that are key for understanding and acting on the subject of drought, from the point of view of health and human wellbeing.

We have also analyzed the differencesin social, economic and environmental indicators related to the conditions of drought, between the1,135 municipalities of the Brazilian Semi-arid Region – which is the region most affected by drought in the country (more than 70% of the drought events recorded in Brazil are concentrated in this region) – and the other 4,430municipalities of the rest of Brazil, using data from the censuses of 1991, 2000 and 2010. We make comparisons of

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medians, and the first and third quartiles, of the indicators selected.

We provide a graphic expression of four indicators corresponding to health (child mortality rate per thousand live births) and to the dimensions of sustainable development: social (percentageliteracy), environmental (percent with access to piped water) andeconomic(percent of people who are not poor), developed in the *Brazilian Atlas of Sustainable Development and Health*[16,17]. These graphics demonstrate the performance of the municipalities of Brazil in terms of progress in these indicators, in the periods of 1991, 2000 and 2010, comparing the municipalities that have drought (the Brazilian Semi-arid Region) with the other municipalities of Brazil. The child mortality rate (CMR), is represented by a circle, the thickness of which shows 50% of the distribution (inter-quartile interval); the other three variables are represented in each one of the three angles of the triangle, with an interval of distance between the two lines that represent the first and third quartile denoting the central 50% of the distribution (inter-quartile interval) of each one of these variables. It is important to point out that the ideal condition of the graphic would be to achieve the circle (TMI = 0) at a point in the center of the triangle, and the quartiles getting closer to each other and reaching the extreme of the triangle (value =100%).

Results and discussion

Comparing the SDGs with focus on the populations of the Brazilian Semi-arid Region

In reviewing the SDGs we find that all the objectives are related to health, to a greater or lesser degree, and that all are related to the question of water. Figure 1 shows the relationships between these goals, grouped so as to understand their relationships from the point of view of the social, economic and environmental dimensions, and in particular the relationship between water, drought (desertification) and health.

To better understand the relationship between the *Health and Wellbeing* SDG and the other SDGs, it is placed in the center. Certain determi-

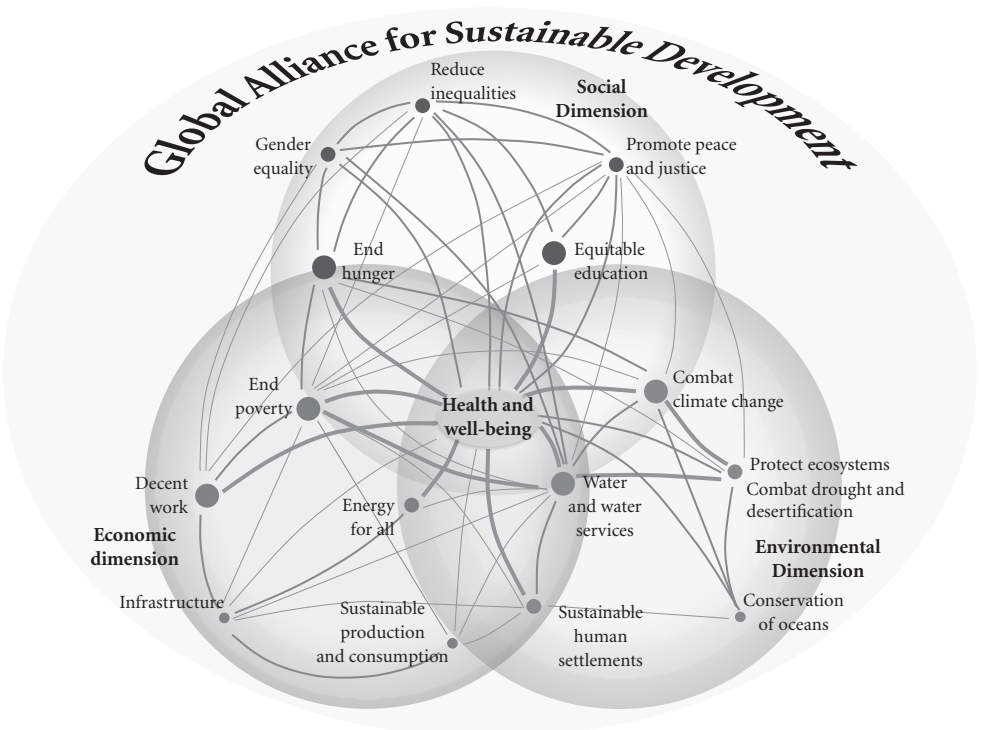


Figure 1. Relationships between the 17 Sustainable Development Goals.

nant factors (targets) of health are highlighted in this figure, such as *poverty* and *work* in the economic dimension; *water* and *climate change* in the environmental dimension; and *hunger* and *education* in the social dimension. The thickness of the lines indicates, qualitatively, the importance of the relationships between the SDGs and Health and Wellbeing, highlight the relationship with the target *water*. The size of the bubbles indicates, qualitatively, the relation of each SDG with Health and Wellbeing. The SDG on a *Global alliance for sustainable development* was placed outside the three dimensions because it is wide-ranging, in general overall covering all the SDGs.

The Sustainable Development Goals

The review of the 169 targets proposed in the 17 objectives resulted in 41 targets that can be aligned with the relationship between drought and health. Below we highlight some of these relationships, taking into consideration data that compare social, economic and environmental inequalities between Brazil's Semi-arid Region and all the other municipalities of the country, as detailed in Table 1.

The selected indicators represent some of the targets established within the SDGs. For each one of these indicators, a comparison is presented between the Semi-arid Region and the rest of the country, shown by the differences observed between the first and third quartiles, and the medians. In this case we highlight an important fall in the median of the TMIn in the Semi-arid Region, from 94.2 to 27.2 per thousand live births, and also an approximation to the median of the rest of the country. This approximation also takes place with the TMI and life expectancy at birth. There are also important differences in the indicators of poverty, illiteracy and access to piped water, but even so the differences are diminishing, similarly to those in the other indicators assessed. For the IDHM, in 2010 the median in the Semi-arid Region was 0.591, that is to say 50% of the municipalities had an IDHM less than or equal to 0.591, which translates as 'low' or 'very low'. This advance is an important contrast when compared with the year 1991, when 50% of the municipalities had an IDHM of 0.291 (very low), or less. The other municipalities of Brazil had better levels in 2010 (0.688 considered average, low and very low), an important increase compared to 1991 (0.414 considered very low).

Figure 2 is a summary chart of health and three other indicators representing the three dimensions of sustainable development. These are: *health*, measured by the infant mortality rate per thousand live births; the *social* dimension, measured by the proportion of the population that is literate; the *environmental* dimension, measured by access to piped water; and the *economic* dimension, measured by the proportion of the population that is not poor.

In a more detailed analysis of these charts we can see a significant improvement in the four variables corresponding both to the Semi-arid Region, and also to the rest of the municipalities of Brazil, in the three periods analyzed, and principally in the last 10 years. When we compare the medians of the years 1991 and 2010, we see in the municipalities of the Semi-arid Region a great reduction in child mortality (TMI) from 72.7 in 1991 to 25.2 per thousand live births in 2010, and also a reduction in inequality, seen in the movement of the central circle that has become thinner and moved in direction of the central axis of the triangle. As for the other three variables, we also see great advances, evidenced by the lines that represent the first and the third quartiles (distance between quartiles), which move closer towards the vertices of the triangles. We can see in the charts the indicators of: the *environmental* dimension (proportion of the population with access to piped water), with an increase in the median from 21.1% (1991) to 74.6% (2010);the *economic* dimension (non-poor percentage of the population) from 18.6% in 1991 to 58.9% in 2010; and in the *social*dimension – in the proportion of the population that is literate, which increased from 49.5% in 1991 to 70.1% in 2010.

Summing up, these indicators show improvement throughout the country, and an approximation between the municipalities of the Semi -arid Region and the other municipalities of the country. If this progress continues without interruption and with greater prioritization of actions for some municipalities of the Semi-arid Region, it will be possible to achieve several of the targets established in the SDGs.

SDG-1.End poverty in all its forms everywhere: The relationship between poverty and health is well established[19]. Currently, the Brazilian Semi-arid Region shows significantly higher levels of poverty than the rest of the country (Table 1), hence the targets proposed by the SDG are of functional importance – including, for example, adequate systems of social protection for all, with special attention to the poorer and vulnerable populations, guaranteeing them equal rights to the economic resources, and also access to basic

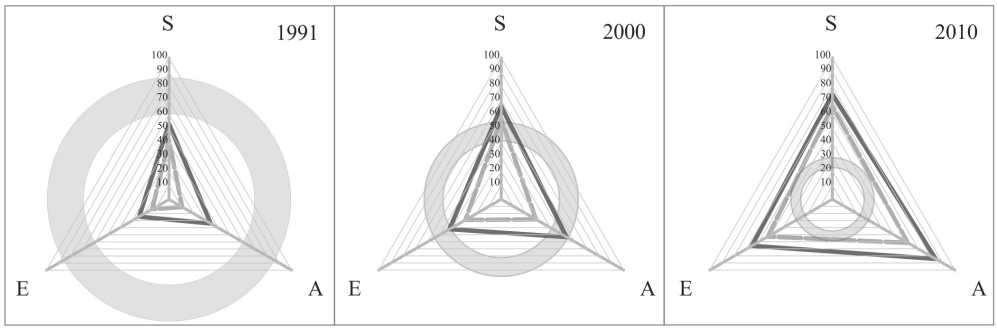
Table 1. Social, economic, environmental and health indicators for municipalities of Brazil's Semi-arid Region (1,135), and municipalities of the rest of Brazil (4,430); and difference between medians (M), quartile 1 (Q1) and quartile 3 (Q3),in the years 1991, 2000 and 2010.

Indicator	Year	Municipalities of Brazil's Semi-arid Region(n = 1135)			Other municipalities of Brazil (excluding the Semi-arid Region) (n = 4430)			Simple differences between the municipalities of the Semi-arid Region and the other municipalities of Brazil		
		Q 1	M	Q 3	Q 1	M	Q 3	Q 1	M	Q 3
TMI										
	1991	60.4	72.7	86.1	27.4	33.8	49.6	33.1	38.9	36.5
	2000	41.1	47.8	54.5	19.6	24.6	35.1	21.6	23.2	19.4
	2010	22.4	25.2	29.4	13.2	15.5	19.3	9.2	9.7	10.1
TMIn										
	1991	78.9	94.2	110.7	31.9	40.3	62.7	47.0	53.9	48.0
	2000	52.2	61.0	68.3	22.5	28.2	39.7	29.7	32.8	28.6
	2010	24.3	27.2	31.7	15.4	18.0	22.0	8.9	9.3	9.6
Life expectancy										
	1991	56.3	59.0	61.5	62.7	65.9	68.1	-6.3	-6.9	-6.6
	2000	62.8	64.4	66.5	67.4	70.1	72.1	-4.6	-5.7	-5.6
	2010	69.3	70.6	71.6	72.5	74.2	75.5	-3.2	-3.6	-3.9
Poverty										
	1991	75.7	81.4	86.2	33.5	50.2	69.5	42.2	31.2	16.8
	2000	57.8	64.8	70.8	17.6	29.9	52.3	40.2	34.9	18.5
	2010	34.3	41.1	47.3	5.8	11.9	28.5	28.5	29.1	18.8
Illiteracy										
	1991	45.2	51.5	57.5	15.7	22.7	34.9	29.5	28.8	22.6
	2000	32.7	37.4	42.6	10.5	15.5	24.0	22.2	21.9	18.7
	2010	25.7	29.9	34.3	7.6	11.6	18.4	18.2	18.3	15.9
Water										
	1991	10.8	21.1	34.0	36.0	69.7	87.0	-25.2	- 48.6	-53.0
	2000	28.5	40.8	53.5	55.1	86.1	95.1	-26.6	- 45.3	- 41.7
	2010	61.6	74.6	84.3	85.0	92.9	97.1	-23.5	-18.3	-12.8
Electricity										
	1991	30.2	48.3	65.4	0.5	2.0	9.6	29.7	46.3	55.7
	2000	9.1	16.4	26.9	1.9	6.3	17.0	7.3	10.1	9.9
	2010	8.4	14.4	22.3	0.5	1.9	8.9	7.9	12.5	13.4
IDHM										
	1991	34.1	50.1	63.3	59.8	83.4	95.6	-25.7	-33.3	-32.2
	2000	64.9	81.7	91.7	85.8	96.6	99.3	-21.0	-14.9	-7.6
	2010	95.8	98.5	99.4	98.2	99.6	99.9	-2.4	-1.1	-0.6

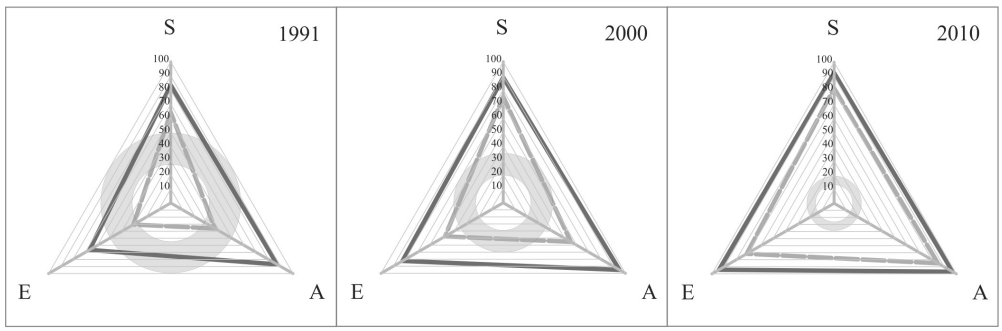
Indicators: TMI: Child Mortality Rate per thousand live births; TMIn: Infant Mortality Rate per thousand live births; Life expectancy: at birth; Proportion of the population in poverty conditions (%); Proportion of population that is illiterate (%); Proportion of the population without access to piped water (%); Proportion of the population living in households with electricity (%); IDHM – Municipal Human Development Index.
Source: IBGE, based on data available in UNDP (United Nations Development Program)[19].

services, principally water. Brazil has made efforts to eradicate extreme poverty, and it is possible to achieve this target by 2030. However, the target of reducing the proportion of people who live in a situation of poverty to half its present level, or less, will call for more efforts, principally in the Semi-arid Region. More than 50% of the beneficiaries, and of the total value of the benefits, of Brazil's '*Family Subsidy*' (*BolsaFamília*) program in 2012 were in Brazil's Northeastern Region – where a large proportion of the Semi-arid Region is located[20]. In the Semi-arid Region, the challenge that remains is that the compensatory policies of reduction of poverty should be accompanied simultaneously by emancipatory policies, including the economic, environment and social development that results in improvement of education, access to water, generation of work and

Municipalities of the Semi-arid Region (n=1,135)



Municipalities of Brazil excluding the Semi-arid Region (n=4,430)



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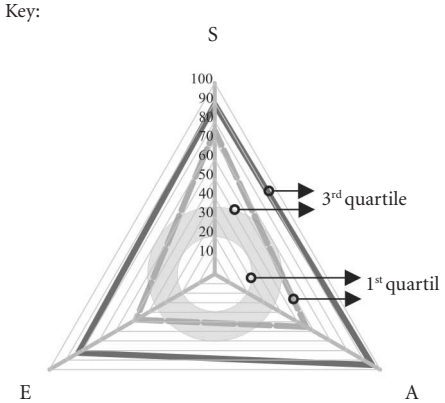

Triangle:

S: Social dimension (% of people literate)
E: Economic dimension (% of people "not poor")
A: Environmental dimension (% of people who have access to piped water supply)

Circle:

Infant mortality rate (per 1,000 live births)

Figure 2. Progress of the municipalities of the Brazilian Semi-arid Region, and of the other municipalities of Brazil, according to selected indicators in four dimensions of analysis.

Source: IBGE, based on data available in theUNDP (United Nations Development Program)[19]. Chart design based on the Brazilian Atlas of Sustainable Development and Health[16,17].

income and expansion of sustainable production and consumption. These improvements can strengthen the autonomy and citizenship of the population that was previously adversely affected by poverty, and promote health.

SDG-2. End hunger, achieve food security and improved nutrition and promote sustainable agriculture: The conditions of drought mean both scarcity and contamination of water and, consequently, scarcity and contamination of

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foods, with the capacity to cause absence of food security, malnutrition and other effects on health[5]. At the same time, nutritional deficiency is a central determining factor in child deaths associated with diarrhea, pneumonia, malaria and measles[21]. The targets of eliminating all the forms of malnutrition, including the targets that have been agreed internationally (by 2025) on chronic malnutrition, malnutrition in children less than five years old, and nutritional needs of adolescents, pregnant women, nursing mothers and the elderly, are fundamental for improving the health situation of the Semi-arid Region. Thus, it is necessary to establish strategies to guarantee access to water, for the purpose of doubling agricultural productivity, and the income of small food producers, so as to guarantee sustainable food production systems. These strategies can be supported with the implementation of resilient farming practices that are able to increase the capacity for adaptation to the climatic conditions, including extreme situations of drought. Climatic changes and other environmental changes are new factors causing food insecurity[22,23]. With the subsistence conditions in which the Semi-arid Region lives, it is also important that there should be recognition of family agriculture as a social and political space strategy for production and reproduction of life, and also adaptation to climate change[24].

SDG-3. Ensure healthy lives and promote well-being for all at all ages: In the Semi-arid Region, indicators such as infant mortality rate, access to potable water, level of illiteracy and life expectancy, as well as other indicators, show worse conditions than the rest of the country[8] (Table 1). Thus, the targets relating to this objective are directly related to the health conditions of this region. Proposals such as to end avoidable births of newborns and children aged less than five (by 2030) eradicate the neglected illnesses that are endemic to the region, reduce the incidence of transmissible and non-transmissible diseases, and promote mental health, are fundamental for ensuring a healthy life and wellbeing of the populations that live in the Semi-arid Region. For most of these targets to be achieved, access to potable water is functional – it is a basic good that makes it possible to promote various conditions of human health and wellbeing[25], in which it is also an indicator of progress.

SDG-4. Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all: The relationship between education and child mortality and other causes of illness/death, including waterborne diseases, is well established, and it is important to highlight that in recent decades progress has taken place in Brazil[26]. This goalinvolves targets to ensure that all children complete equitable qualityprimary and secondary education, that leads to relevant and effective learning results, and also to eliminate gender disparities, and provide a quality of access at all levels of education and professional training, including to the most vulnerable. A high level of illiteracy still persists in the Brazilian Semi-arid Region (Table 1), which could be eliminated through an adequate policy of access to education for young people and adults. The guarantee that people will acquire the knowledge and abilities necessary to promote sustainable development and sustainable lifestyles, human rights, gender equality, promotion of a culture of peace and non-violence, global citizenship and recognition of the value of cultural diversity could contribute to the improvement of the region's social and economic indicators. It is important that the promotion of learning for the populations of the Semi-arid Region should not be based only on reception of technological knowledge, but should also benefit from being guided, in its development and the potential of local production, by an exchange of knowledge with other communities.

SDG-5. Achieve gender equality and empower all women and girls: A great part of the burden of work, and management of the local economy in the Semi-arid Region is under the responsibility of women, who at various periods of history have been called 'widows of the drought', when they stayed in their homes taking care of the life of the family while the men migrated in search of work and income, due to the effects of lack of supply of water for irrigation of farming. At present women are the heads of 93% of the families benefited by the *Bolsa Família* program[27]. The participation of women in taking of decisions, whether political or economic, in the public sphere or in the family, with rights of equality to leadership, at all levels, constitutesa target for action with great potential effect on the sustainability of the development of the Semi-arid Region. Undertaking reforms to recognize the equal rights of women to economic resources, access to property and control and management of land, and other forms of property and natural resources, could contribute to improvement of the conditions of life of women and empowerment of their management and participation in family structures.

SDG-6. Ensure availability and sustainable management of water and sanitation for all: There

is an extensive literature on the relationship between water, water treatment and services, and health[25,28,29]. Access to water with security and quality is still a major challenge for the Brazilian Semi-arid Region. Universalization of service of supply of water and water treatment for all is not a reality in the region (Table 1). Thus, measures identified in the SDG, such as promoting universal and equitable access to potable water that is secure and accessible; providing access to adequate and equitable water treatment and hygiene for all; reducing pollution; reducing the proportion of untreated waste water by half; increasing recycling and safe reuse of water; increasing the efficiency and sustainability of the use of water in all sectors; and ensuring supply of fresh water to deal with scarcity of water, are important and indispensable for improving the quality of human life and wellbeing of the populations that live in the region. The local patterns of rainfall, types of soil and social conditions should be taken into account in preparation of technologies for supply and storage of water for the population, since drought in the region is recurrent and prolonged. Achieving the targets proposed for this goal by 2030 would result in significant progress in improvement of the economic, social and health indicators in the region, because of the important relationship between access to water (whether for agriculture, industry or domestic use) and these dimensions of sustainable development. The participation of the local communities in discussions to improve policies, technologies and means of management relating to water and water treatment is also essential for meeting these targets.

SDG-7. Ensure access to affordable, reliable, sustainable and modern energy for all: Lack of clean and safe energy is a risk for health[30]. The increased participation of renewable sources in global energy supply, by 2030, is a target that will continue to call for great effort by Brazil. The availability of some types of renewable energy for the Brazilian Semi-arid Region (where access is less than in the rest of the country, Table 1), such as, for example, solar and wind energy, would be a significant step in improvement of environmental management in a sustainable and decentralized way, ensuring electricity at prices that are accessible for the populations. This measure, preferably constructed with community participation, could have a beneficial effect on some factors that determine health, such as services for health, production, education, economic development and other goods and services.

SDG-8. Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all: The Brazilian Semi-arid Region is a socially and economically vulnerable area. Thus, the targets identified in the SDG, such as improving the efficiency of global resources in consumption and in production, with efforts to dissociate economic growth from environmental degradation by 2030, and to reduce the proportion of young people without employment, education or qualification by 2020, are essential for strengthening of the population's capacity for adaptation and resilience, and that of the economy of the region. Achieving this objective is a difficult task and calls for a considerable effort from governments and society. Some initiatives of the government for strengthening of local economies have been undertaken in the region. Highlights are public policies related to land ownership, development, reduction of social and economic inequalities in the region (pointed out by Celso Furtado in the 1950s), stimulus and dissemination of productive systems to strengthen family agriculture and ecology (which has been stimulated by the 'Living with Drought' program, anchored on the group of organizations that have been promoting and organizing the region since the 1990s), and other forms of generation of sustainable work and income[24,31].

SDG-9. Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation: The production chains of goods and services in the Brazilian Semi-arid Region are very sensitive to situations of prolonged drought, which affect the installed infrastructure, and also the economically active population. In spite of the adaptation to seasonal droughts, the persistence of long, multi-year periods of drought can rupture important links in this chain, reducing production, consumption and investment capacity. The targets proposed for developing a local and regional infrastructure of quality, that is reliable, sustainable and resilient, with focus on equitable access and accessible prices for all are, thus, fundamental for the economic development and human wellbeing of the populations that live in the region. This dimension of sustainability and development in the region should take into account some essential factors such as: combating degradation of the soil; reform in the management of water resources; guarantee of the production of family subsistence through sustainable agriculture; production of clean energy; and other investments, in access to scientific information technologies and the Internet.

SDG-10. Reduce inequality within and among countries: In the Brazilian Semi-arid Region, there are significant inequalities between the indicators of municipalities and those of the rest of Brazil (Table 1), and also between them. Thus, the target proposed in this SDG, of reducing inequalities by 2030, will call for strategies, from the government, of empowering and promoting social economic and political inclusion of all. The measures proposed for this objective, principally the target to achieve and maintain faster growth in the income of the 40% poorest of the population than the nationwide growth rate, would make it possible to reduce the social effects and inequalities in the region that arise from the conditions of drought, also reducing families' vulnerabilities. It is emphasized that the government of Brazil has important policies for reducing social inequalities such as, for example, programs of transfer of income, which have positive effects on the Semi-arid Region, but it is necessary to make progress in programs for reduction of regional and local inequalities through a model of inclusive and sustainable development.

SDG-11. Make cities and human settlements inclusive, safe, resilient and sustainable: The environment where people live has measurable effects on health[32]. To ensure that by 2030 the targets of this objective are reached requires a large coordinated effort of the governments at all their levels, principally in the municipalities of the Brazilian Semi-arid Region. Targets such as planning, with participative management, of human settlements, that are integrated, inclusive, safe and sustainable, with access to safe housing and adequate and safe basic services, principally water in quantity, and quality, is a foundation for achieving other targets, such as, for example, reduction in the number of deaths and people affected by disasters (in this case, situations of drought), and economic losses caused by drought, in relation to GDP. These targets are fundamental for protecting the poor and vulnerable populations that live with drought. Implementation of integrated policies and plans scheduled to be complied with by 2020, such as inclusion, efficiency in the use of resources, measures of mitigation and adaptation to climate changes, resilience of the populations and the government to disasters, and sustainable integration between the countryside and the city, can strengthen the Semi-arid Region and improve its socioeconomic profile.

SDG-12. Ensure sustainable consumption and production patterns: To achieve sustainable patterns of production and consumption in the Brazilian Semi-arid Region, it is necessary that there should be appropriate management and use of the natural resources, especially the water resources, based on other values that express a solidarity economy, such as, for example, alternatives based on agroecology, co-existence with the Semi-arid Region, management of the *Caatinga* biome, maintenance of herds and adapted cultures, and the associative and cooperative projects existing in the region. For this target to be reached by 2030 it is possible that a technological development would be required that has participative forms of management, including sustainable techniques of irrigation, storage and distribution of water, to make it possible to guarantee that these resources are appropriated by all, not only by minorities that are politically and economically dominant.

SDG-13. Take urgent action to combat climate change and its impacts: According to a study by the World Health Organization, it is estimated that between 2030 and 2050 there will be approximately 250,000 additional deaths per year as a consequence of climate change[33]. According to estimates by the Brazilian Climate Change Panel, the forecasts for the Semi-arid Region up to 2021 will be an increase of temperature of between 3.5°C and 4.5°C, and a reduction of between 40% and 50% in average annual rainfall[11]. In the Brazilian Semi-arid Region, the vulnerability of the Caatinga biome to the effects of climate change represents a strong factor of pressure for desertification in the region. To avoid greater impacts of this possible situation it is important to increase the capacity of resilience and adaptation of institutions and populations through national and, principally, local strategies and plans. Thus, as well as the integration of these measures, it is important to strengthen people's capacity for new economic, environmental and social conditions, and implement programs of sustainable development, with the aim of reducing the vulnerabilities that already exist in the region and avoiding possible greater impacts.

SDG-14. Conserve and sustainably use the oceans, seas and marine resources for sustainable development: Taking this SDG as a basis for policies related to collections of water (rivers, lakes and reservoirs), it is important to observe that these are subject to a high variability in their quantity and quality. The low coverage of systems of collection and treatment of sewerage, combined with the predatory use of farming land and employment of weed killers has contributed to salinization, silting and eutrophication of land-ba-

sed waters. Contamination of these waters puts at risk the populations that use these resources for supply for human consumption and irrigation of farming. Part of the total of sediment, organic matter and contaminants produced on the continent can reach the ocean in periods of rain. Thus, measures for conservation and sustainable use of the collections of water and of the soil, and measures for water treatment in the Semi-arid Region are extremely important to minimize the environmental and social impacts, and this will require a significant effort by governments, especially local governments.

SDG-15. Protect, restore and promote sustainable use of terrestrial ecosystems, sustainability manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss: According to the Brazilian Climate Change Panel (*Painel Brasileiro de Mudanças Climáticas*, or PBMC), the Brazilian Semi-arid Region has tendencies to desertification and loss of native forests, which would result in an increase in the scarcity of water and loss of biodiversity[11]. The measures for combat of desertification and restoration of the soil and of water should be inserted into programs of sustainable socioeconomic development of the areas affected by drought. However, it is difficult to guarantee that targets aligned with this objective will be reached by 2020, since this will demand a series of integrated strategies of sustainable management of the territory, including integrated participation of the populations and their cultural values in all the stages of the processes of development to promote sustainability in this region.

SDG-16. Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels: Conditions resulting from situations of drought, particularly in prolonged periods, can contribute to increase of physical and social violence, which are potentialized by processes of migration, urbanization, economic and human losses, and driving of more vulnerable portions of a population that live in the region out of their territory. Some (non-sustainable) measures used in the attempt to promote economic development and reduce the impacts of drought, such as agribusiness, are altering the communities' way of life, contributing to increase in violence, introduction of drugs to schools, prostitution, and migration, and also expulsion of farmers from certain regions[34]. Measures for empowerment of local populations and strengthening of institutions of justice should be included in the regional and local plans, with a view to prevention of the factors that make populations vulnerable that are associated with drought, and also with economically-excluding development projects.

SDG-17. Strengthen the means of implementation and revitalize the global partnership for sustainable development: The group of environmental, economic and social problems existing in the Brazilian Semi-Arid Region, added to the low concentration of investments in health and education, produces various impacts that have a feedback effect on the poverty and vulnerabilities of this region, such as diseases, unemployment, illiteracy, and migration. Thus, the following factors, in conditions that are favorable for this region, become fundamental targets for development with equity, and improvement of the quality of life of these populations: sustainable promotion of environmental, economic and social development; reduction of local and regional social inequalities; education; development of knowledge; and dissemination of environmentally sustainable technologies, especially those related to the infrastructure of storage, management and distribution of water. Civil society of the region, through ASA (*Articulação do Semiárido*), has brought together various entities to discuss proposals for an appropriate policy for sustainable development for the region, taking into consideration, as well as its differences, the economic and human, environmental and cultural, scientific and technological dimensions. This partnership rural workers' unions, environmental entities, NGOs, Christian churches, international cooperation agencies, associations and cooperatives, women's movements, universities, researchers and the community of the Semi-arid Region itself. The support of the United Nations in the Conferences of Parties (COP),through the United Nations Convention to Combat Desertification (UNCCD)has also been important for the global partnership and discussion of sustainable measures for the regions of drought[35]. Thus, the strengthening of the implementation of this SDG calls for expansion and strengthening of the participation of civil society in this process, involving both its needs and its propositions.

Conclusion

The implications of environmental and climate change on public health are multiple, and often are not being recognized, making it more diffi-

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cult to identify and act upon the various factors determinant of health. In cases of municipalities that are vulnerable to situations of drought this invisibility, together with the weak social and environmental conditions normally observed in the region, make it even more difficult to take action to reduce risks and promote health. These challenges, added to the already existing environmental conditions, and their impacts on the populations' conditions of life, especially in relation to access to water in quantity and quality, demand a greater integration of the health sector with other sectors, in planning of actions.

To establish better management of drought situations and its relationship with the reach of the targets proposed by the SDGs, it becomes necessary to build alliances that can work with the information taking into account the territorial bases, where the social production of the health -illness process manifests itself. The purpose is to support planning, prioritization and assessment of actions. Traditionally, in situations of drought, concerns are more directed to determinant environmental and economic factors, specifically in terms of agriculture, such as use of the land, absence of water for irrigation, and economic losses, with emphasis limited to certain social determinants that have long-term impacts on health, such as precarious access to quality education, scarcity of foods and profound social and economic inequalities. It is important to remember that the vulnerabilities in the Semi-arid Region express the interaction and the cumulative character of the risk situations in relation to environmental degradation and climatic conditions, combined with precarious conditions of life and social and economic inequalities.

Planning of action, principally, in health, needs to be sustained on articulation and integration of public policies oriented to the pillars of sustainable development: environmental, social and economic. An important strategy for analyzing the health situation and showing the inequalities is the construction of indicators of the proximal social, economic and environmental determinants using the SDGs, as a basis, as shown in Figure 1. These indicators would make it possible to show up situations that today are invisible, supporting the establishment of measures that can achieve universal and equitable access to the promotion of health wellbeing, and reduction of social inequalities.

It is important also to consider values and cultures of the territory to be worked on, amply and transparently incorporating the participation of society. This strategy is essential for a better engagement of the community in the planning of actions and in the decision processes for reduction of risks, and it would also help in social control and qualification of management in health[36].

It is concluded that, although the data show great advances from 1991 to 2010 both in the municipalities of the Semi-arid Region and also in the other municipalities of Brazil, efforts, investments and prioritization of actions are still necessary that can result in reduction of social and health inequalities. For a better understanding of the implications of the SDGs and their proposed targets, and to make it possible to act on the situation of each municipality of the Semi-arid Region, to strengthen the actions for control, co-existence and adaptation at all levels, and reduce social inequalities, it is important to be aware of the particular vulnerabilities of each one. Thus, a more detailed analysis of the determinant factors that act on health and which have relationship with the SDGs, would be a support for prioritization and implementation of actions, and formulation of public policies for better sustainable development in this area. These determining factors include: poverty; hunger; low levels of education; lack of access to employment and social inclusion; precarious dwellings; fast and disorganized population growth; and, principally, lack of access to water in appropriate quantity and quality.

Collaborations

A Sena worked on the conception and outlining of the first version of this article. A Sena, CM Freitas, C Barcellos, W Ramalho and C Corvalan contributed equally in the preparation and revision, and approved the final version of the article.

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p. 674

Where it reads:
In this case we highlight an important fall in the median of the TMIn in the Semi-arid Region, from 94.2 to 27.2 per thousand live births, and also an approximation to the median of the rest of the country. This approximation also takes place with the TMI and life expectancy at birth. There are also important differences in the indicators of poverty, illiteracy and access to piped water, but even so the differences are diminishing, similarly to those in the other indicators assessed. For the IDHM, in 2010 the median in the Semi-arid Region was 0.591, that is to say 50% of the municipalities had an IDHM less than or equal to 0.591, which translates as 'low' or 'very low'. This advance is an important contrast when compared with the year 1991, when 50% of the municipalities had an IDHM of 0.291 (very low), or less. The other municipalities of Brazil had better levels in 2010 (0.688 considered average, low and very low), an important increase compared to 1991 (0.414 considered very low).

When we compare the medians of the years 1991 and 2010, we see in the municipalities of the Semi-arid Region a great reduction in child mortality (TMI) from 72.7 in 1991 to 25.2 per thousand live births in 2010, and also a reduction in inequality, seen in the movement of the central circle that has become thinner and moved in direction of the central axis of the triangle.

It should read:
In this case we highlight an important fall in the median of the Under 5 MR in the Semi-arid Region, from 94.2 to 27.2 per thousand live births, and also an approximation to the median of the rest of the country. This approximation also takes place with the IMR and life expectancy at birth. There are also important differences in the indicators of poverty, illiteracy and access to piped water, but even so the differences are diminishing, similarly to those in the other indicators assessed. For the Municipal HDI in 2010 the median in the Semi-arid Region was 0.591, that is to say 50% of the municipalities had a Municipal HDI less than or equal to 0.591, which translates as 'low' or 'very low'. This advance is an important contrast when compared with the year 1991, when 50% of the municipalities had an IDHM of 0.291 (very low), or less. The other municipalities of Brazil had higher levels in 2010 (Municipal HDI of 0.688 which includes municipalities with medium, low and very low HDI), an important increase compared to 1991 (0.414 considered very low).

When we compare the medians of the years 1991 and 2010, we see in the municipalities of the Semi-arid Region a great reduction in infant mortality rate (IMR) from 72.7 in 1991 to 25.2 per thousand live births in 2010, and also a reduction in inequality, seen in the movement of the central circle that has become thinner and moved in direction of the central axis of the triangle.

p. 675, Table 1 - Indicator

Where it reads:
TMI
TMIn
Electricity
Municipal HDI

It should read:
Table 1
IMR
Under 5 MR
Sewerage
Electricity

p. 675, Table 1 - legend

Where it reads:
Indicators: TMI: Child Mortality Rate per thousand live births; TMIn: Infant Mortality Rate per thousand live births; Life expectancy: at birth; Proportion of the population in poverty conditions (%); Proportion of population that is illiterate (%); Proportion of the population without access to piped water (%); Proportion of the population living in households with electricity (%); IDHM – Municipal Human Development Index.

It should read:
Indicators: IMR: Infant Mortality Rate per thousand live births; Under 5 MR: Under 5 Mortality Rate per thousand live births; Life expectancy at birth; Proportion of the population situation of poverty (%); Proportion of illiterate population (%); Proportion of the population without access to piped water (%); Proportion of the population living in households without sewerage (%); Proportion of the population living in households with electricity (%).