CBS
Central Bureau of Statistics

CURAÇAO ENVIRONMENTAL STATISTICS COMPENDIUM 2015

Curaçao Environmental Statistics Compendium 2015

Centraal Bureau of Statistics

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Preface

After a few years of preparation, the Central Bureau of Statistics (CBS) of Curaçao is very pleased to release the first edition of the Environment Statistics Compendium. This is in alignment with the CBS business plan, the Plan of Action on Environment Statistics ("Plan van Aanpak Milieustatistieken"), and it's very essential goal of compiling and disseminating statistics for both government and general-use purposes.

A compendium is a collection of information in which a brief summary on a certain topic is given. In the case of environmental statistics, the Plan of Action on Environmental Statistics focuses on the methodology, planning and adaption of the Core Set of the FDES, the Framework for the Development of Environmental Statistics of the U.N., into a Curaçaoan version. The Core Set contains the most important environment statistics to describe statistical topics, thus providing guidance to environmental programs and policies.

In this publication, data from existing CBS data sources, administrative sources and from both government and non-government entities are compiled. Although it was not possible to receive all the data needed, and that the CBS still has data gaps to deal with, the Bureau gratefully acknowledges the support of all the experts and stakeholders who were committed to provide the statistical data and information needed. Our aim is to issue this publication annually. In principle, the data presented cover the years 2010 to 2015.

This publication is written by Mr. Chris Jager, senior statistician Business Statistics and Environmental Statistics.

The Director
Drs. Sean de Boer

Introduction

The demand for environment statistics is increasing in tandem with the ongoing environmental challenges faced by modern societies, such as population pressure, energy issues, sustainable development and climate change. The environment is ever more present in public policies and development plans. With its many islands and Small Island Developing States (SIDS), the Caribbean is no exception, and neither is Curaçao.

The realization that human wellbeing and development depends on the environment has led to an increasing emphasis on environmental and sustainability concerns (e.g. the 2013 report on Strategies for Sustainable Long Term Economic Development[1] and the National Development Plan Curaçao 2015) on which decisions and actions need to be taken. Of paramount importance to these actions is the regular production of environment statistics of the highest quality. These statistics portray key information about the state of the environment and its changes through time. Furthermore, they give information to organizations, students and the public, and can be used as input and support for fact-based policymaking. As in other developing countries and SIDS, environment statistics represent a new and emerging domain which is typically endowed with limited (technical, financial and human) resources and is challenged by an institutional setup and inter-institutional coordination that are still in development.

The Compendium is structured in 7 sections:

1. Environmental conditions and quality
2. Environmental resources and their use
3. Residuals and waste
4. Extreme events and disasters
5. Human settlements and environmental health
6. Environment protection and management
7. Tourism

[1] Strategies for Sustainable Long-Term Economic Development in Curaçao, May 2013, also called the "T.A.C. Report"

Methodology

Environment statistics give us information about the state of as well as changes in environmental conditions, the quality and availability of environmental resources, the impact of human activities and natural events on the environment, the impact of changing environmental conditions, as well as the societal actions and economic measures taken by societies to avoid or mitigate these impacts and restore and maintain the environment's capacity to provide the services that are essential for life and human wellbeing. Environment statistics thus cover a wide range of information. Their sources are spread out over a variety of organizations and data producers, and numerous methods are applied for their compilation. To effectively produce environment statistics, specific statistical and environmental expertise, knowledge, institutional development and adequate resources are necessary. Similar to many other countries, Curaçao is limited in its organizational, technical and financial capacity and is challenged by a lack of cooperation and by data-gaps. Therefore, the development of environment statistics require a proper framework, which is why the FDES and especially the Core Set were chosen as useful tools to be used by the CBS to set up and enhance these statistics.

The FDES, developed by the Statistical Department of the United Nations (UNSD), is a multi-purpose statistical framework that is comprehensive in nature and marks out the scope of environment statistics. It was first published in 1984 and revised in 2013. It provides a structure to guide the collection and compilation of environment statistics, and brings together data from various relevant areas and sources. It is broad and holistic in nature, covering the issues and aspects of the environment that are relevant for policy analysis and decision making.

Its primary objective is to guide countries like Curaçao, which are at early stages in the development of their environment statistics programs. The FDES organizes environment statistics into six components which are broken down into topics and individual statistics.

The objective of the Core Set of environment statistics of the FDES is to serve as a limited set of environment statistics that are of high priority and relevance to countries. This Core Set is actually the first level ("Tier 1") of a greater Basic Set of environment statistics, composed of three levels, according to the relevance, availability and methodological development of these statistics.

The Core Set consists of six fundamental components that follow the FDES's conceptual framework. The first component, **Environmental conditions and quality**, brings together statistics related to the conditions and quality of the natural environment and their changes. The second component,

Environmental Resources and their use, groups together statistics related to availability and use of environmental resources. The third component**, Residuals**, includes statistics related to the discharge of residuals from production and consumption processes, like emissions and waste. Statistics related to both natural and technological **Disasters and extreme events** and their impacts are covered by the fourth component. The fifth component brings together statistics related to **Human settlements and environmental health**. The sixth component, **Environment protection, management and engagement**, groups statistics relevant to societal responses and economic measures aimed at protecting the environment and managing environmental resources.

Environmental conditions and quality (component 1) are at the center of the FDES. As depicted in Figure 1, all six components are intrinsically related to each other. The dotted lines separating the components are an indication of the continuous interactions among them. These interactions are between and among all the components of the FDES.

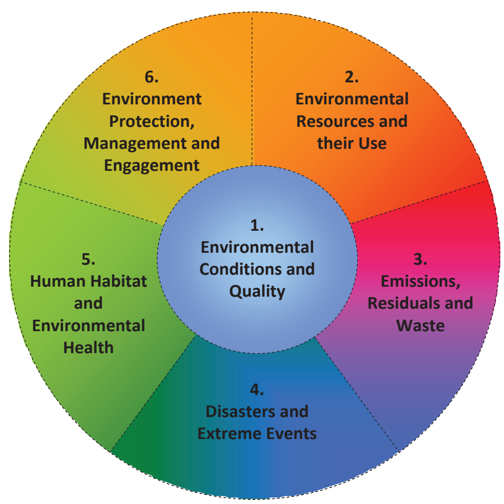

Figure 1. The FDES components

The Core Set is designed to be flexible so that it can be adapted to individual countries' environmental concerns, priorities, possibilities and available resources. The Core Set of environment statistics is of high priority and relevance to most countries and has a sound and clear methodological foundation. It is well-suited to provide guidance in determining priorities.

During a CARICOM workshop in April 2014, it became clear that it is necessary for Curaçao as well as other Caribbean countries to add **Tourism** as a 7th component to the Core Set of the FDES framework, in accordance with the CARICOM indicators and in view of the high social and economic importance of tourism in Caribbean countries.

As the information about the environment keeps developing, the availability of environmental information will continue increasing in the near future. The dissemination of information and the regular publication of this compendium will eventually enhance the needed cooperation, quality and completeness of environmental statistics in Curaçao.

1. Environmental Conditions and Quality

Component 1 of the Core Set of the FDES includes statistics about meteorological, geographical, biological as well as physical and chemical characteristics of the environment and their change over time. Many of these natural conditions change very slowly as a result of natural processes of Earth's atmosphere or human influence. On the other hand, other natural conditions can show immediate and dramatic effects. Importantly, changes in environmental conditions and quality are the result of combined and accumulated impacts of natural and human processes and activities.

Photo: C. Jager

Topic 1.1.1. Atmosphere, climate and weather

This topic covers data on atmospheric and climatic conditions over time. Information on weather describes the short-term behavior of the atmosphere on the island and is recorded by the Meteorological Department. Climate is determined by long-term weather conditions and includes aspects such as temperature and precipitation. Curaçao has a semi-arid climate with irregular and sometimes heavy rainfall, with distinct dry and rainy seasons. The dry season runs from February through June, whereas the rainy season starts in September and ends in January. The months of July and August can be considered as transitional months. During the rainy season, rain showers occur usually during the early morning or early to late evening hours.

The island is characterized by warm tropical temperatures with the highest mean temperatures occurring in September, sometimes exceeding 33°C. Mean minimum temperatures can be as low as 23-24°C in December and January. The seawater around the islands averages around 27°C and are coldest (average 25.9°C) around February-March, and warmest (average 28.2°C) around September-October. In general, the skies are mostly clear to partly cloudy.

Temperature in degrees centigrade

Curaçao Int. Airport

Table 1: Average temperature[1)]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
1981-2010[2)]	26.5	26.6	27.1	27.6	28.2	28.5	28.4	28.7	28.9	28.5	27.9	27.0	**27.8**
2010	27.4	27.1	28.1	28.4	29.2	28.6	29.1	29.6	28.5	28.4	27.1	26.6	**28.2**
2011	26.7	26.5	25.5	26.8	27.6	28.4	28.1	28.8	28.6	28.0	27.9	27.0	**27.5**
2012	26.1	26.3	26.6	27.4	28.3	28.3	28.6	28.8	29.0	27.8	26.8	26.1	**27.5**
2013	26.6	27.1	27.6	27.9	28.5	28.8	28.8	29.1	29.5	29.1	27.7	26.6	**28.1**
2014	25.7	26.7	27.1	27.6	27.8	28.5	28.5	29.0	29.2	29.0	28.2	27.8	**27.9**
2015	27.1	27.4	27.2	27.8	27.9	28.2	28.4	29.1	29.8	29.3	28.3	27.7	**28.2**
5-year mean	26.4	26.8	26.8	27.5	28.0	28.4	28.5	29.0	29.2	28.6	27.8	27.0	**27.8**

Table 2: Average maximum temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
1981-2010[2)]	29.9	30.1	30.7	31.4	32.0	32.1	32.1	32.7	32.8	32.1	31.1	30.3	**31.4**
2010	31.2	30.7	31.7	31.8	32.6	30.4	32.3	32.8	31.7	31.4	29.8	29.4	**31.3**
2011	29.6	29.8	28.2	29.8	30.4	31.8	31.4	32.3	32.0	31.1	30.8	29.4	**30.6**
2012	29.1	29.7	29.5	30.9	31.4	32.0	31.9	32.0	32.6	31.2	29.8	29.0	**30.8**
2013	29.8	30.7	30.9	31.3	31.8	32.1	32.2	32.6	33.0	32.4	30.7	29.7	**31.4**
2014	29.5	30.2	30.5	30.7	30.8	31.4	31.9	32.7	32.7	32.5	31.2	31.0	**31.3**
2015	30.6	31.2	30.7	31.3	31.2	31.3	31.9	32.6	33.6	33.1	31.4	30.4	**31.6**

5-year mean	29.7	30.3	30.0	30.8	31.1	31.7	31.9	32.4	32.8	32.1	30.8	29.9	**31.1**

Table 3: Average minimum temperature

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
1981-2010[2)]	24.4	24.5	24.9	25.6	26.3	26.5	26.1	26.5	26.6	26.2	25.6	24.9	**25.7**
2010	25.3	25.2	26.3	26.3	27.0	27.1	26.8	27.4	25.7	25.7	24.5	24.2	**26.0**
2011	24.4	24.4	23.5	24.9	25.5	26.2	26.1	26.2	26.2	25.6	25.2	24.6	**25.2**
2012	23.7	23.9	24.9	25.2	26.3	26.4	26.4	26.6	26.6	26.3	24.4	23.5	**25.4**
2013	24.3	24.9	25.8	25.9	26.3	26.8	26.8	26.8	26.9	27.0	25.2	24.1	**25.9**
2014	23.4	24.9	25.1	25.9	26.0	26.8	26.5	26.7	27.0	26.7	24.7	25.6	**25.8**
2015	24.6	25.3	24.9	25.9	26.2	26.5	26.4	27.0	27.7	27.2	26.2	26.1	**26.2**
5-year mean	24.1	24.7	24.8	25.6	26.1	26.5	26.4	26.7	26.9	26.6	25.1	24.8	**25.7**

1) Average of daily 24-hourly observations

Rainfall

Curaçao Int. Airport

Average monthly rainfall (in mm)

	Jan	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**	**YEAR**
1981-2010[1)]	46	29	14	19	21	22	41	40	49	102	122	96	**601**
2010	142	0	1	22	12	75	44	5	122	154	298	217	**1092**
2011	105	15	47	9	53	18	17	7	26	68	168	96	**629**
2012	58	44	32	15	19	4	18	19	7	79	65	80	**440**
2013	19.4	4.2	1.3	12.2	12.9	15.0	13.1	40.7	124.6	18.7	181.3	85.7	**529**
2014	29.0	11.0	0.4	0.6	5.9	7.1	15.3	36.3	17.3	55.2	146.0	60.2	**384**
2015	37.7	15.4	62.4	15.7	3.4	2.1	16.1	6.3	10.2	28.2	131.1	11.8	**340**
5-year mean	49.8	17.9	28.6	10.5	18.8	9.2	15.9	21.9	37.0	49.8	138.3	66.7	**465**

Number of rain days

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	YEAR
1981-2010[1)]	8	5	3	7	2	3	6	4	5	8	11	11	**73**
2010	1	0	0	3	3	7	7	2	9	14	20	17	**83**
2011	9	6	4	2	7	5	1	1	4	14	11	17	**81**
2012	14	10	0	4	5	2	1	3	4	6	6	8	**63**
2013	5	2	1	2	3	4	4	5	7	5	10	12	**60**
2014	9	3	0	0	1	1	5	5	4	6	15	10	**59**
2015	10	3	8	1	1	1	3	2	3	4	10	3	**49**
5-year mean	9	5	3	2	3	3	3	3	4	7	10	10	**62**

Source: Meteorological Department Curaçao

Topic **1.1.3. Geological and geographical information**

This topic includes general geological and topographic information, presenting statistics that inform on the extent and characteristics of the territory and its relief. These characteristics typically change slowly over time and as such, are normally static. Because of their nature, these geological and geographical data are often presented in the form of maps.

Shown are two maps: a geological map of Carmabi (figure 2) and a vegetation map of C. E. Beers et al[2] (figure 3).

Concerning geographical information it can be said that the country's territory is 444 km^2. The total surface of coral reefs is 16 km^2 (van Duyl, 1985) and the mangroves have a surface of less than 0.6 km^2. (http://www.unesco.org/csi/pub/papers/pors.htm)

The geological history of Curaçao began in the late Cretaceous period, about 90 million years ago, still within the age of the dinosaurs[3]. Since then, a multitude of processes have shaped and reshaped the foundations beneath our feet, processes that are continuously ongoing. The island as we know it is basically a snapshot in geological time. Four distinct rock groups represent the geological structure of the island: lava formation, the Knip Group, the Middle Curaçao Formation and Limestone (source: Carmabi).

The Lava Formation consists of volcanic rocks or basalt and represents the oldest geological feature on the island. This formation was formed below sea level during the Cretaceous Period. The basalt is locally at least 5 km thick, suggesting the island's origin started at this depth below the ocean surface and is geologically "younger" towards the West.

The Knip Group overlies the volcanic sequence and hence is somewhat younger. Its significant difference in appearance with the older volcanic rocks is the distinct layering. This is a characteristic of sedimentary rocks.

The Mid-Curaçao Formation originated through a reorganization of the geological features that had formed thus far some 65 million years ago. A series of endogenous forces, likely earthquakes, but also the slow rising of the island (0.25-0.50mm per year) associated with tectonic movements, resulted in

[2] C.E. Beers, J. de Freitas, P. Ketner, "Landscape ecological vegetation map of the island of Curaçao, Netherlands Antilles," 1997.

[3] No fossil remains of these giants can be found on Curaçao today, because at that time a 5 kilometer deep ocean marked the position of the Island to be.

sequential sand and rock deposits in trenches or valleys on the island or on the slopes of the island below the ocean's surface.

Limestone Formations, consisting of the Ser'i Domi Formation and the limestone Terraces, were formed 5 million years ago. Except for sporadic rock formation in the Eocene, no significant rock formation occurred on Curaçao between the Mid Curaçao Formation and the recent Limestone Formations. Five million years ago, the rising of Curaçao resulted in the birth of two islands "Banda'bou" and "Banda'riba," representing the West and East side of present-day Curaçao respectively. Coral reef formation occurred in the shallow waters around these islands. These oldest reef formations are still visible as the sloping limestone mountains along the Leeward shore. The Limestone Terraces then arose as coral growth tracked the variable sea levels associated with glacial and interglacial cycles. The oldest (or "highest") terrace was formed some 2 million years ago.
The subsequent glacial period caused sea levels to drop, resulting in a "lower" reef terrace (1 million year ago) on which Tera Kòrá is built. Two younger terraces were formed 0.5 million and 30,000 years ago, the latter now forming the Hato Plain. The most recent glacial period occurred 20.000 years ago when a reef was formed that "drowned" and can now be found underwater at depths 60-80m, referred to as the Second Drop-Off.

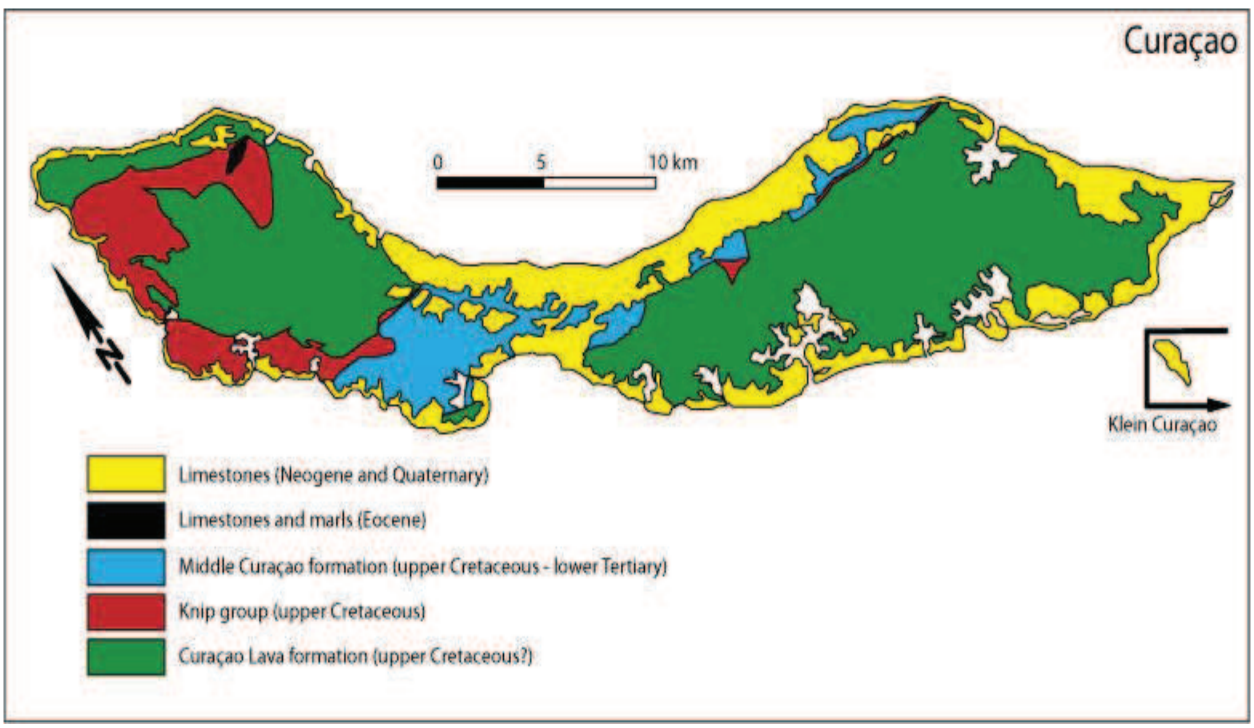

Figure 2: Geological map of Curaçao. Source: Carmabi

The vegetation of the island can be generally characterized as dry woodland vegetation. The vegetation map (figure 3) is based on a landscape and vegetation survey from 1988 to 1990, scale 1:50.000. It consisted of interpretations of aerial photographs and fieldwork. According to the Landscape Ecological Vegetation Map of Beers, de Freitas and Ketner, the island is subdivided into seven main landscapes. Each in turn is divided into sub-landscapes, which are characterized by terrain features and plant communities. The different landscapes comprise 21 different vegetation types, ranging from dry climatic evergreen types to seasonal desert-like scrublands and edaphic vegetation types, such as mangroves areas near saliñas.

Almost everywhere on Curaçao, the vegetation is (over)grazed, particularly around the villages. Grazing has a major impact on the natural vegetation, resulting in a reduction of the vegetation cover and dominance of weedy species.

A large area around Willemstad has hardly any spots left with natural vegetation sufficiently large to be mapped. The area has been mapped as urban/industrial/agricultural, which points to an enormous expansion of human activities, such as urbanization, industrialization and tourism development. In many parts of the island, these trends have been and are still destroying, fragmenting and polluting most of the remaining wilderness sites.

Curaçao has several sites which have an exceptional conservation value. Besides the Christoffel National Park, these include parts of the plantations Knip, Jeremi and St. Hironymus, the coastal terraces between Hato and Boca Ascension, the plantation of Malpais and surrounding properties, the fresh water basin of Muizenberg, the limestone terrace landscape and coastal zone stretching from Caracas Bay to Oostpunt, the saliñas of Jan Thiel and St. Marie, the main mangrove areas and the north coast reefs from Playa Canoa to Oostpunt, including St. Joris Bay.

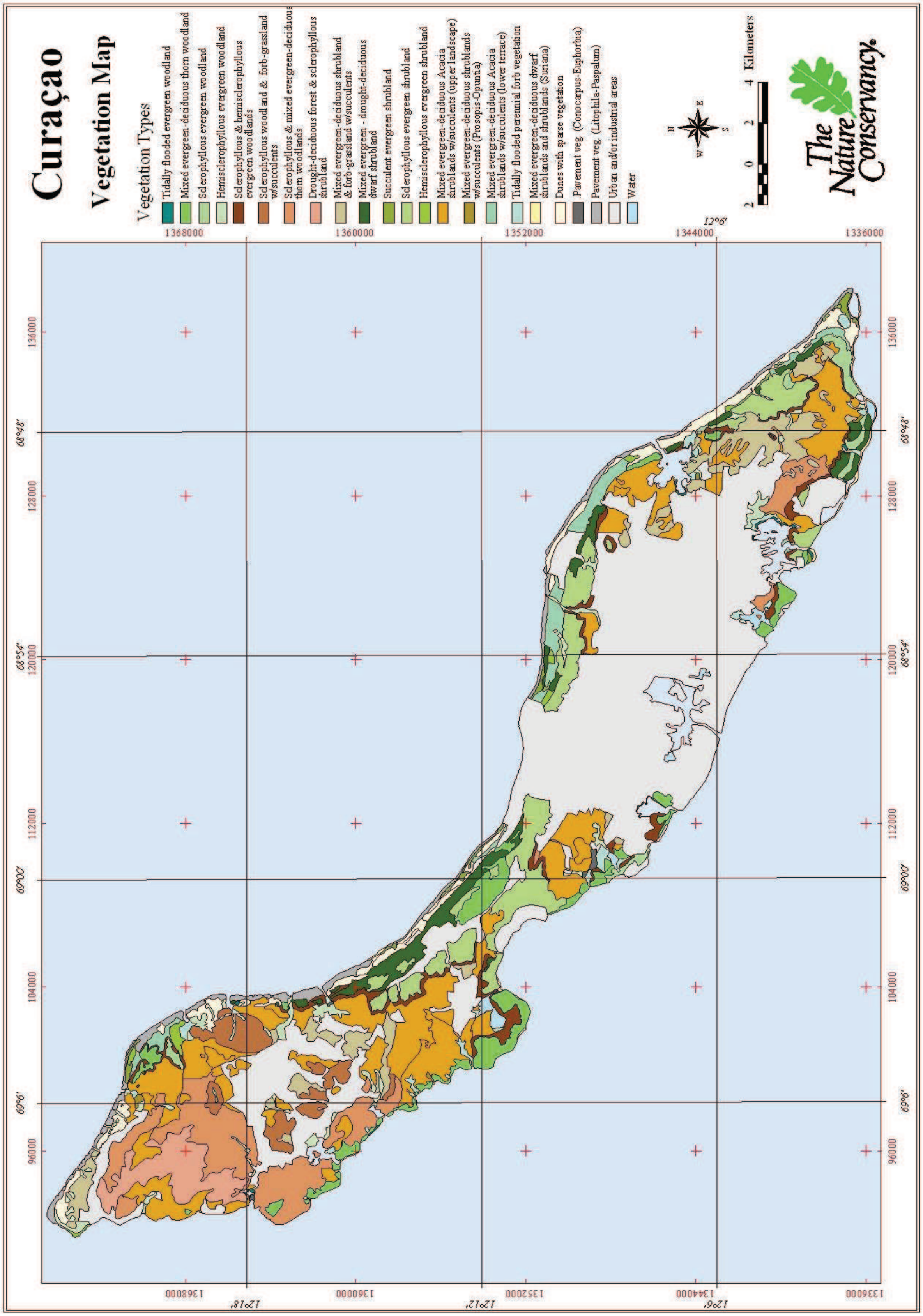

Figure 3: Curaçao Vegetation map

Topic **1.2.2. Ecosystems and Biodiversity**

The topic of ecosystems and biodiversity covers physical quantitative and qualitative information about the main ecosystems, including the extent, characteristics and biological components (biodiversity) of these ecosystems. The extent and conditions of the ecosystems determine their capacity to produce ecosystem services.

The reefs are an important ecosystem and are subjected to a variety of human-related stressors like overfishing, coastal development, (underground) sewage discharge, chemical pollution and artificial beach construction. Though threatened, the reefs Curaçao harbors are still among the best in the region. Especially the north shore and eastern and western sides of the south coast harbor healthy coral communities[4] (figure 4).

Statistics on the biological components of ecosystems provide information on the condition of plants, animals and living habitats, e.g. species at risk of extinction. Although information about ecosystems in Curaçao is in development and will therefore become increasingly available, using it for statistics describing ecosystems is still rather infrequent and non-systematic.

Ecosystems

Table 6: Threatened species

		Estimated numbers
Birds	Caribbean Coot (Fulica caribaea)	1000
	Scarlet ibis	
	West-Indian whistling duck	
	Fulvous whistling duck	
	American flamingo	
		Species
Invertebrates	Fire corals	4
	Lace corals	1
	Black corals	10
	Stony corals	69
	Queen conch	1
	Spiny lobster	1

[4] The current state of Curacao's Coral Reefs, Dr. Mark Vermeij, 2012

Reptiles	Sea Turtles	n.a.	
Plants	Endemic plants	2	
		Estimated numbers	
Mammals	Curacao White-tail Deer	250	estimate (2006)
Bats	Glossophaga longirostris elongata	2500	
	L. curasoe	n.a.	
	Mormoops megalophylla intermedia	n.a.	
	Natalis tumidirostris	n.a.	
	Myotis nesopolus	n.a.	
	Pteronotus davy	n.a.	
	Noctilio leporinus	n.a.	
Fish	Queen triggerfish	n.a.	
	Lancer dragonet	n.a.	
	Atlantic goliath grouper	n.a.	
	Nassau grouper	n.a.	
	Lined seahorse	n.a.	
	Yellowedge grouper	n.a.	
	Snowy grouper	n.a.	
	Atlantic white marlin	n.a.	
	Hogfish	n.a.	
	Mutton snapper	n.a.	
	Cubera snapper	n.a.	
	Blue marlin	n.a.	
	Giant manta	n.a.	
	Tarpon	n.a.	
	Yellowmouth grouper	n.a.	
	Red porgy	n.a.	
	Cano toadfish	n.a.	
	Bigeye tuna	n.a.	
	Atlantic Bluefin tuna	n.a.	
Sharks & rays	Bigeye thresher	n.a.	
	Smalltooth sawfish	n.a.	
	Whale shark	n.a.	

Scalloped hammerhead	n.a.
Great hammerhead	n.a.

Source: Carmabi 2014

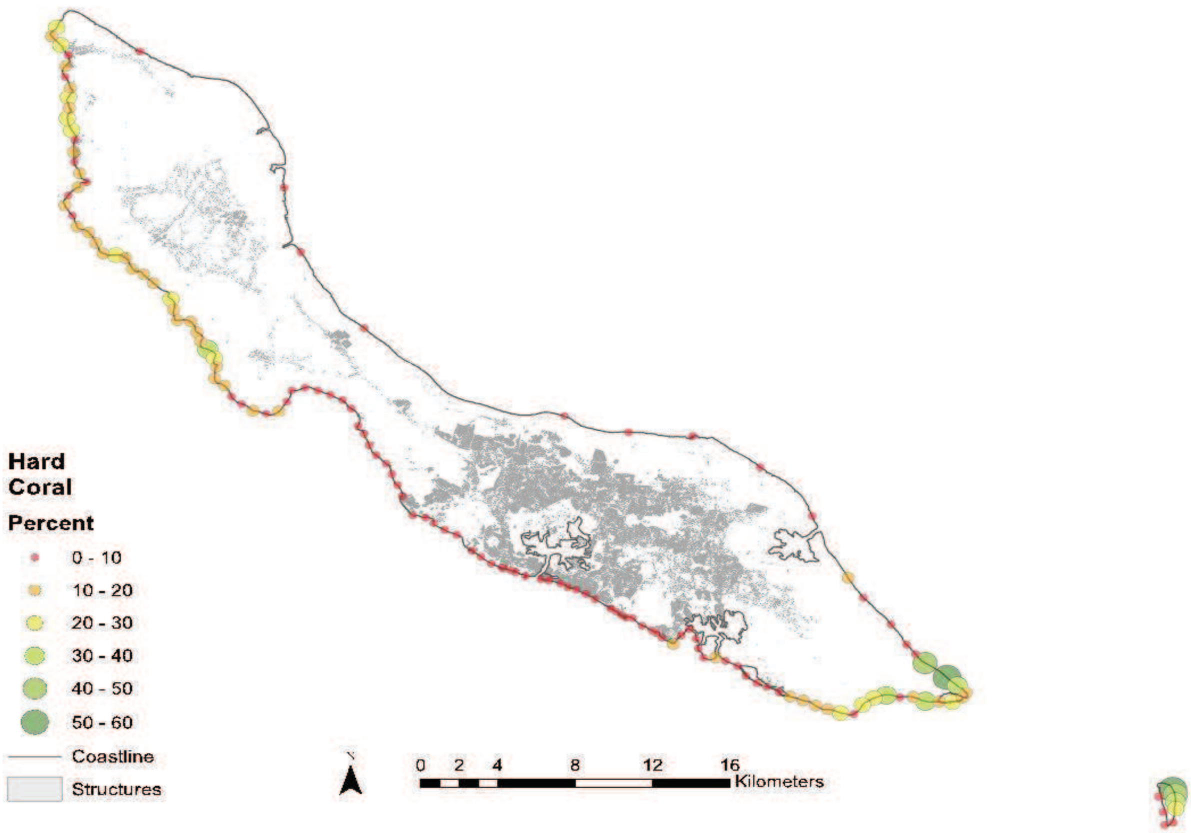

Figure 4: hard coral coverage, Carmabi 2015

Biodiversity is the variety of life, species and ecosystems. It boosts ecosystem productivity and is strongly related to e.g. health, agriculture and natural resources. In addition, the richer the diversity of life, the greater the opportunity for medical discoveries, economic development, and adaptive responses to challenges such as climate change.

The topic of biodiversity includes statistics on the diversity of flora and fauna species, on protected areas and on protected flora and fauna species. The typical themes here include the number and population trends of known species of flora and fauna, terrestrial as well as marine. The flora of Curaçao has 541 species of which 5 are endemic. This is comparable to other arid and semi-arid areas in the Caribbean (DCNA, 2013). Some of the species of foreign origin, imported or escaped from cultivation, have become invasive by turning into notorious weeds that outcompete other species and change the ecosystem.

Biodiversity

Table 7: Fauna species:	number:
Birds	223
scleractinian corals	69
sponges	88
marine polychaetes	132
marine amphipods	20
marine fishes	611
freshwater fishes	20
Mammals	3
Reptiles	3

Source: Carmabi, 2015.

Table 8: Protected areas, incl. marine area	km^2	Ramsar[5]; since 2013
Northwest Curacao*	24.4	
Muizenberg (wetland)	0.65	
Rif St. Marie (wetland)	6.7	
Malpais/St. Michiel (wetland)	11	

* Overlaps with Shete Boka and Christoffel Park

Table 9: Nature parks without formal legal protection	km^2
Curacao Marine Park (since 1983)	10.4
Christoffel Park (since 1978)	23
Shete Boka (since 1994)	4.7

[5] The Ramsar Convention, formally the Convention on Wetlands of International Importance, is an international treaty for the conservation and sustainable utilization of wetlands, recognizing the fundamental ecological functions of wetlands and their economic, cultural, scientific, and recreational value. It is named after the city of Ramsar in Iran, where the Convention was signed in 1971.

Topic 1.3.1. Air quality

Statistics on air quality include the ambient concentration of the most important pollutants, including solid particles, gases and other relevant pollutants that can have a negative effect on human and ecosystem health. Impact stations are located near major sources of pollution and measure the direct impact on air quality.

Air quality on Curaçao is measured by the Public Health Service ("GGD"), Amsterdam, Netherlands, at two monitoring stations near the oil refinery. One station is at Beth Chaim (which is an industrial area) and the other one at Kas Chikitu, a residential area, both located west of the refinery. The measurements are performed under ISO accreditation[6].

Monitoring stations Beth Chaim and Kas Chikitu photos: Government of Curacao

For guidelines on air quality, the CBS uses the Global Update 2005 of the World Health Organization (WHO)[7].

- For SO_2, the WHO maximum concentration is 20 μg/m^3 daily, i.e. 24-hour mean
- For PM_{10} this is 50 μg/m^3 daily, i.e. 24-hour mean

Particulate matter (PM) or atmospheric particulate matter, is microscopic solid or liquid matter suspended in the atmosphere. These affect both the climate and human health. Subtypes of atmospheric particle matter include respirable suspended particle (RSP), which are particles with a diameter of 10 micrometers or less, also known as PM_{10} and fine particles with a diameter of 2.5

[6] For more information, see www.luchtmetingencuracao.org.

[7] http://www.who.int/phe/health_topics/outdoorair/outdoorair_aqg/en/

micrometers or less, $PM_{2.5}$. Total Suspended Particulates (TSP or Total SP) are tiny particles of less than 100 micrometers.

Particulates are the deadliest form of air pollution due to their ability to penetrate deep into the lungs and blood streams unfiltered, causing permanent DNA mutations, heart attacks and premature death. In 2013, a study involving more than 300,000 people in nine European countries revealed that there is actually no safe level of particulates. For every increase of 10 $\mu g/m^3$ in PM_{10}, the lung cancer rate rose by 22 percent[8].

The levels for SO_2 and particulates are mainly, but not only, from the combustion of petroleum and other combustibles of the refinery and the utility plants at Dokweg. A limited contribution from transport (SO_2) and natural resources (particulates) cannot be fully excluded.

As can be seen in figures 5 and 6 (and tables 10 and 11 of the appendix), since 2010, the average concentration levels for SO_2 have exceeded the WHO levels (20 $\mu g/m^3$) almost every month. The low concentrations for 2010 are not representative due to the fact that the refinery was inactive for eight months. As can clearly be seen in figures 5 and 6, these high SO_2 levels have increased even further. Although the reason for this is not fully known, it is at least partly due to an increased production in the 2010-2015 period (as can be seen in table 14, Refining Index) and partly due to the extension of installed production capacity at the Dok power plant in 2014, from 48 to 84 MW (an increase of 75%).

The contribution of SO_2 concentrations from the utility plant at Dokweg in relation to the total measured concentrations at Beth Chaim is estimated at 33.2 percent and for Kas Chikitu, 36.6 percent, based on an analysis of the 24-hour mean levels in 2013 and 2014.

In the case of Beth Chaim (appendix, table 10), the levels increased to even more than 10 times the WHO maximum concentration. In 2015, this happened in six consecutive months (April till September), and in December, with a record (as in June) of almost 16 times the WHO limit. It goes without saying that this poses a serious and ongoing threat for the health of thousands of people in the region and vicinity of the refinery. Part of the intended solution to cope with this serious health problem is the use natural gas as fuel in the refinery and the CRU/BOO plant[9]. This could considerably help reduce the SO_2 air pollution in the future. At this moment, the execution of this project is on hold.

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8 The smaller $PM_{2.5}$ were particularly deadly, with a 36% increase in lung cancer per 10 $\mu g/m^3$, as these can penetrate deeper into the lungs (The Lancet Oncology 14, July 10, 2013).

9 The Curacao Refinery Utilities (CRU) manages the BOO power plant (Build, Own and Operate), of which the Refineria di Kòrsou (RdK) is the owner.

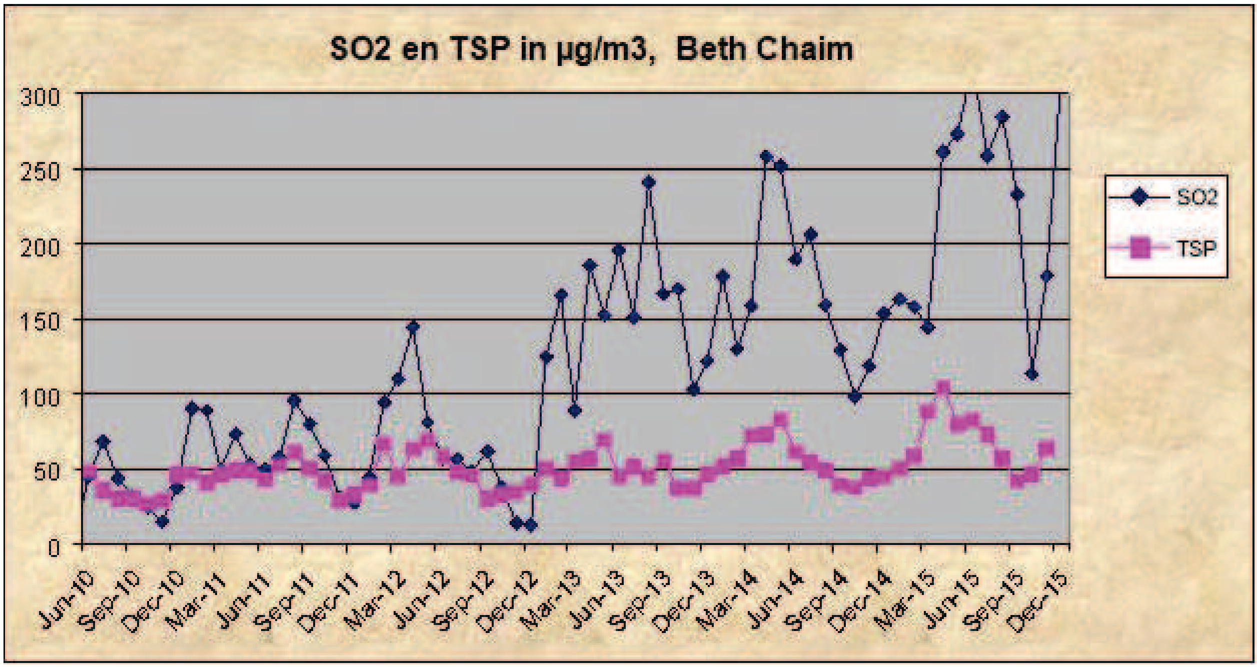


Figure 5: SO_2 and TSP, Beth Chaim

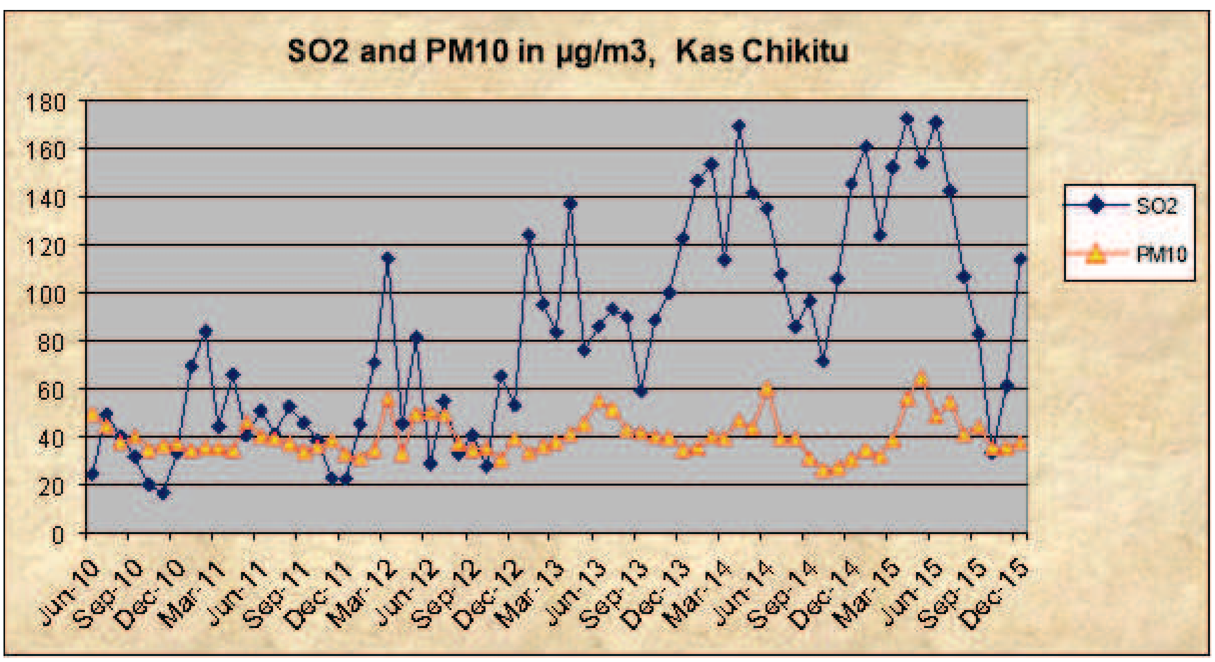


Figure 6: SO_2 and PM_{10}, Kas Chikitu

Topic 1.3.3. Marine water quality

Relevant statistics on marine and coastal water quality and pollutant concentrations can include (but are not restricted to) nutrients, chlorophyll, organic matter and contaminants, metals, as well as coral bleaching.

Unfortunately, no recent data are available. Standards are difficult to produce and for this reason are not available.

Table 12: Marine water quality		island wide average	concentration
Nutrients: nitrates in marine water	2007	PO4 (phosphate)	0.09 µM/ l
	2007	Total Dissolved P	0.27 µM/ l
	2007	NO_2 & NO_3 (nitrates)	0.65 µM/ l
	2007	NH_4 (ammonium)	0.66 µM/ l
	2007	Dissolved inorganic N	1.31 µM/ l
Chlorophyll in marine water	2007	Chlorophyll α	0.26µg/l
Organic matter, biochemical O_2 demand	2007		too variable
Coral bleaching (% corals affected)	1998		16.2
	2003		9.5
	2005		5
	2010		10

Source: Carmabi.

2. Environmental Resources and Their Use

Component 2 of the Core Set covers the living and non-living constituents of the Earth, which together comprise the environment that may provide benefits to humanity. Environmental resources include non-energy and energy minerals, land, soil resources, biological and water resources. They can be renewable (e.g. fish or water) or non-renewable (e.g. minerals) and are used as important inputs in production and consumption.

This component is closely related to the asset and physical flow account of the SEEA[10], the System of Environmental-Economic Accounting of the UN. This is partly due to the fact that statistics on environmental resources and their use are focused on measuring stocks and changes in stocks of these resources. In the case of non-renewable resources, continued extraction usually leads eventually to the depletion of the resource.

photo: C. Jager

[10] The System of Environmental-Economic Accounting (SEEA) contains the internationally agreed standard concepts, definitions, classifications, accounting rules and tables for producing internationally comparable statistics on the environment and its relationship with the economy. The SEEA framework follows a similar accounting structure as the System of National Accounts (SNA) in order to facilitate the integration of environmental and economic statistics.

Topic **2.1.1. Stocks and changes of non-energy mineral resources**

Stocks of non-energy mineral resources are defined as the amount of known deposits of mineral resources. The minerals in question vary from stone and sand to clay, chemical and fertilizer minerals, salt and various other minerals.

On Curaçao, there are mining activities for the extraction of limestone, a very pure Calcium Carbonate ($CaCO_3$), from the mountain called Tafelberg. This calcium marine deposit was formed in a very dry and clear seawater environment over millions of years. This non-energy mineral is not renewable, so its depletion reduces the availability in the environment over time. According to information of the Curaçao Mining Company, it is estimated that stocks will last till 2045. As can be seen in table 13, production of blocks and sand as well as the mining index are clearly diminishing.

Limestone from the Tafelberg is used for a number of applications such as asphalt, concrete, plaster work, paves, glass production and water purification.

Table 13: Stocks of mineral resources, limestone

	2010	2011	2012	2013	2014	2015
Production index blocks	275	252	242	242	189	194
Production index sand	146	145	144	140	117	125
Mining index CBS	174	164	159	157	126	132
Turnover index	100	82.8	75.2	105.1	90.5	90.5

Source: Curaçao Mining Company

Topic **2.2.2. Production and use of energy**

Energy production refers to the capture, extraction or manufacturing of fuels or energy in forms which are ready for general consumption (final use). Energy is produced for human consumption in a number of different ways, depending on its source. Energy production, transformation, distribution and consumption are made with different efficiency rates and these processes cause distinct environmental impacts, such as land use change, air pollution, GHG emissions (Greenhouse Gasses) and waste. That is why producing statistics to describe these activities is key to environmental sustainability policy (source: FDES 2013).

Total energy production originates from non-renewable and renewable sources. These constitute key environment statistics that can assist when analyzing the sustainability of the energy mix. Renewable energy (such and wind and solar) is transformed from sources that replenish this flow. It is also cleaner than non-renewable energy (such as gasoil and diesel oil) and its carbon footprint is substantially less than that of fossil fuel energies. The initial target for renewable production was set at 25 percent in 2015. In 2012, two wind parks became operational, supplying approximately 16 percent of the total installed capacity (table 15).

Since 2011, households and companies are allowed to produce their own renewable electricity up to their own usage, including a grid connection and feed-in compensation. Though a success, in the end of 2014, measures were taken by the utility companies and the government by introducing a service fee. This fee, called the "solar tax" by the general public, discouraged the use of solar panels. Users who install solar panels to generate renewable energy would have to pay ANG 16.00 per panel per month. For businesses, the rate is ANG 32.00 per panel per month.
The oil import in volumes has already been decreasing and will decrease further in the near future. Although many steps still need to be taken, the route is set towards a new era with less oil and more renewables.

Table 14: Production and use of energy

	2010	2011	2012	2013	2014	2015
Water production (1000 m³)						
	13,846	14,398	14,560	14,495	14,232	13,759
Connections*:						
	71,524	72,668	73,764	75,110	76,628	77,792
Electricity production (1000 kWh)						
	868,910	902,239	910,254	894,064	872,259	820,120
Refining Index:						
(1993 = 100)	41.8	78.5	81.4	83.4	89.6	81.6
Wind: installed capacity in MW per Dec.						
	8	8	30	30	30	30
Solar: official installed capacity in MW per Dec.						
	nil	nil	0.1	7.7	16.7	20**

Sources: Aqualectra (water and electricity), NuCapital (wind), BTP (solar), CBSC (Refinery)
* each January
** adapted projection (due to the introduction of the 2015 service fee) from 28.6 to 20 MW

Table 15: Product mix electricity, installed capacity

per end of 2015	MW	%
Old Dokweg plant (gasoil):	48	25.9
New Dokweg plant (gasoil):	35	18.9
Diesel generators, refinery (gasoil):	33	17.8
Wind turbines:	30	16.2
Solar panels:	17	9.2
CRU/BOO (pitch/IFO*):	22	11.9
Total:	185	100
Power requirement	120	
Reserve aggregate Mundu Nobo:	21	

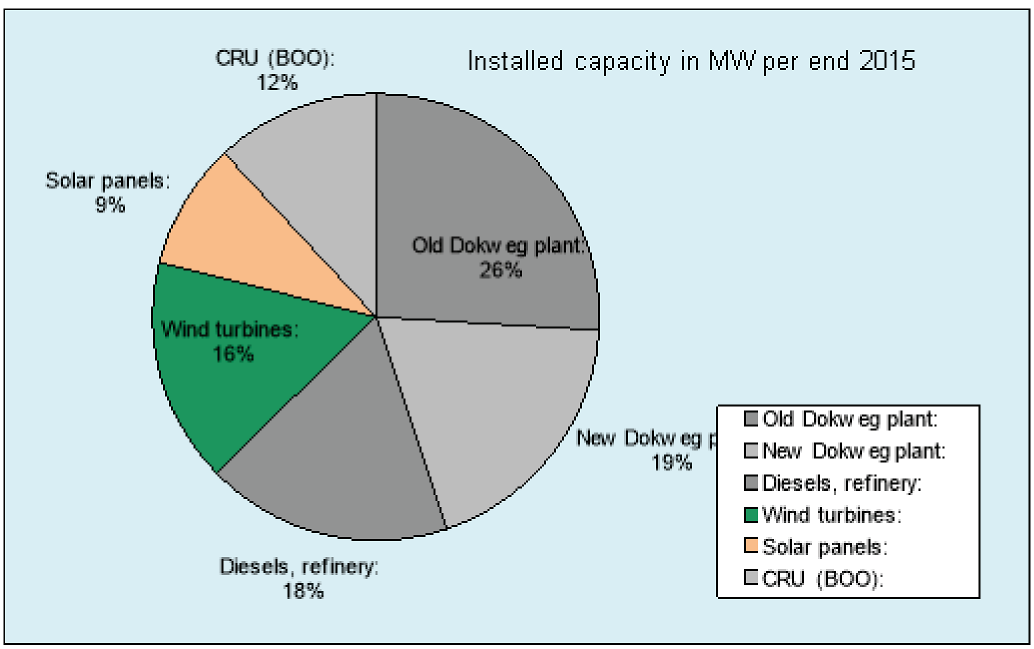


Figure 7: Installed capacity in MW

Sources: Aqualectra and NuCapital
*IFO = Industrial Fuel Oil

Topic 2.6.2. Abstraction and use of water

Water is abstracted from surface and groundwater resources for economic activities and households. It can be abstracted for direct own use or for distribution to other users. Surface water is very scarce in Curaçao and groundwater abstraction is widely practiced, mostly for agriculture. Potable water is produced via desalination of seawater using steam-driven flash evaporators and reverse osmosis.

Water losses can be significant. Unfortunately, that is the case in Curaçao. According to the production company (December 1989), “non-revenue water” (also called “unaccounted-for water”) at that time amounted to 30 percent of the distributed volume of water. Of this percentage, 13.5 percent was due to physical losses and 17.5 percent to so-called administrative losses, including water use through illegal connections. In 2006, the same percentage of 30 percent was mentioned in an advisory report by Drs. M. Karskens[11]. More recent figures of 2013, from the Bureau for Telecommunication, Post & Utilities (BTP&U), show that the losses due to non-revenue water were 24 to 28 percent of total production. According to the BTP&U (World Bank 2006[12]), a reasonable level of non-revenue water for developing countries is 17.5 percent.

Bearing in mind that in Curaçao potable water is equivalent to energy, as it is produced by desalinating sea water in conjunction with electricity production, the high levels of unaccounted-for water represent a serious economic cost. For 2014, this can be estimated at 24 percent of 24.2 mln. m^3, or 5.8 mln. m^3. For that reason, several actions and programs of reducing water losses have been initiated by the water production and distribution company. The most recent action plan is focused on reducing the water losses to 17 percent in 3 years, by 2018.

[11] Drs. M.W.R. Michiel Karskens, (September 2006). *Energieconsument op Curaçao*

[12] The challenge of reducing non-revenue water (NRW) in developing countries—how the private sector can help: a look at performance-based service contracting. World Bank, January 2006

Table 16: Abstraction of water

no. of households	2001	2011
A well with an electric pump	3846	5719
A well with a windmill	1194	1134
A well without a pump or windmill	830	982
No well	37048	46774
Not reported	243	327
Total:	43161	54936

Source: CBS Census 2001 and 2011

3. Residuals

This component is closely related to the physical flow accounts of the SEEA framework (chapter 2). Flow accounts contain flows from the economy to the environment. Their statistics give us information about the amount and characteristics of residuals generated by human production and consumption processes, their management and their final release to the environment. Residuals are solid, liquid and gaseous substances that are discarded, discharged or emitted directly to the environment, or captured, collected, treated or reused. The main groups of residuals are emissions, wastewater and waste.

photo: Stichting Uniek Curaçao

photo: C. Jager

Topic 3.1.1. **Emission of Greenhouse Gases (GHGs)**

A special category of air emissions is the emissions of GHGs. Emission inventories of GHGs are compiled according to the guidelines developed by the IPCC[13], under the auspices of the UN Framework Convention on Climate Change (UNFCCC). GHGs include both direct and indirect GHGs, such as sulphur dioxide (SO2) and nitrogen oxides (NOx). The most important GHGs are both direct and are carbon dioxide (CO_2) and methane (CH_4).

At the end of 2011, a first Greenhouse Gas Inventory or Carbon Footprint Study was executed for Curaçao for the year 2010 by the CBS in cooperation with Kool Caribe Consult. Such a footprint gives information about the contribution of Curaçao to emissions of GHGs, which are the most important and fundamental cause of the greenhouse effect and climate change. By the end of 2016, a second GHG inventory was in progress by the CBS, for the year 2015.

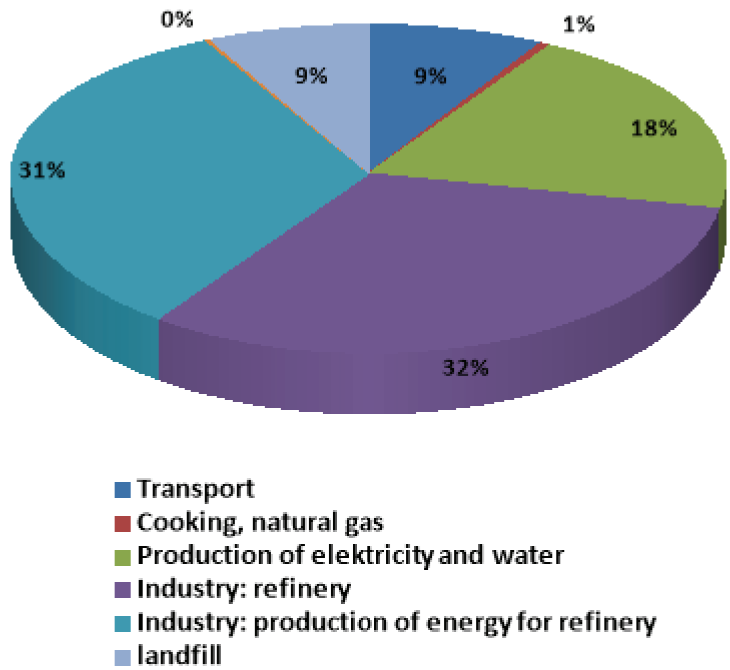
As can be seen in table 17, most of the emissions are related to the refinery and the utility industry. The production of energy for the refinery as well as the refinery itself contribute for more than 30 percent of total emissions. The utility industry's contribution is limited to a little over 18 percent. Landfill and transport account only for some 9 percent.

Tabel 17: GHG's 2010: CO2 and CH4

	kton	relative
Transport	420	9.3%
Cooking, natural gas	24	0.5%
Production of electricity and water	835	18.4%
Industry: refinery	1446	31.8%
Industry: production of energy for refinery	1419	31.2%
Industry: production of concrete	10	0.2%
landfill	388	8.5%
Total:	4542	100.0%

Source: Carbon Footprint Study

[13] The Intergovernmental Panel on Climate Change (IPCC) is a scientific intergovernmental body under the auspices of the United Nations. It was first established in 1988 by two United Nations organizations, the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP)



Fig

Table 18: Emissions and benchmarks

		capita: 149310	per capita in ton CO2
Total Curaçao	kton CO_2	4542	30.4
Total excl. refinery / CRU	kton CO_2	1676	11.2
	Aruba	2,396	21.7
	Colombia	63,387	1.5
	Kuwait	86,075	26.3
	Trinidad	37,006	37.3
	Netherlands	173,102	10.5
	Saudi Arabia	433,202	17.2
	Venezuela	165,415	6.0
	U.S.A.	5,832,194	19.7

Figures are 2008 emissions of CO_2, World Statistics UN July 2010.

Topic 3.2.2. **Collection and treatment of wastewater**

Generated wastewater can basically be discharged in two ways: directly to the environment by the generator, or by being collected in sewerage systems and being treated in wastewater treatment plants.

The collection and treatment of wastewater on Curaçao is very important, especially because of the fact that high concentrations of nutrients, such as ammonia and nitrates, can be a serious problem for our coral reefs and thus our (diving) tourism and fisheries (G.J. Gast 1998). While the nitrate norm for drinking water for human beings is 20 ppm, corals in a seawater aquarium will die at 2 ppm and corals on a coral reef are seriously stressed at much lower levels. The problem is that corals are naturally adapted to a low-nutrient environment and are thus extremely sensitive to quite low levels of nutrient pollution. There are indications that sewage waters are probably a major problem. A study by Bak & Nieuwland (R. Bak and G. Nieuwland,1995) indicates that coral cover at three transects in Curaçao and one at Karpata in Bonaire has declined considerably during a period of twenty years. The Karpata area is a fully protected area with no fishing or anchoring. This decline can thus be related to global causes, to a nutrient problem or possibly a synergistic effect between the two.

In Curaçao there is no large-scale agriculture. Use of pesticides is also very limited. Most pesticides are used in households. The calcareous zones are very porous and sewage nutrients will seep out to the sea almost unimpeded. In areas with impermeable volcanic soils or clays, this is much less of a problem, since the nutrients are unlikely to reach the sea. In the calcareous coastal zone in Curaçao, there has been quite some housing development (Jan Thiel, Blauwbaai, Boca St. Michiel, the Rif area, Cas Abou, Coral Cliff, Lagun, Westpunt-Playa Kalki). This has probably caused quite some seepage of sewage water directly to the sea via cracks in the porous limestone.

Wastewater collected at the sewage treatment plant at Klein Hofje in Curaçao typically contains about 83 ppm of N products, and this value is probably indicative of other local wastewater as well. There is also some seepage of sewage water via inner bays (Spanish Water, Schottegat, Piscadera Bay) and directly into the sea via groundwater (G.J. Gast, 1998). In some wells, nitrate concentrations as high as 100 ppm have been found. Curaçao has a large population, so there must have been considerable seepage of nutrients, especially via the Schottegat, and this could very well have been a factor in the decline of corals near the harbor entrance. This, however, did not affect areas further downstream, where the decline of coral cover set in much later.

Topic 3.3.2. Management of Waste

This topic includes statistics on the amount of waste collected and transported to treatment facilities or their final disposal. It also includes the amount treated by type of treatment or disposal, like recycling, incineration and landfilling. Waste covers discarded materials that are no longer required by the owner or user. It includes materials that are in solid or liquid state, but excludes wastewater and emissions.

The management of waste is one of the major challenges according to the National Report for Sustainable Development[14]. The problems that threaten environmental sustainability include pollution of marine areas from domestic sewage, inadequate sewage treatment facilities, industrial effluents and agricultural runoff, the management of toxic substances and ineffective regulations.

Recycled materials consist mainly (by more than 98%) of building materials.

Tabel 19: Municipal waste collected

	2010	2011	2012	2013	2014	2015
Deposited on Landfill	173907	176786	180874	143930	168743	176806
Recycled	18468	14728	29797	11729	53110	80357
Burned	63	155	70	147	94	81
Total:	192438	191669	210741	155806	221947	257244

In ton kg. Recycling at CRC: Curaçao Recycling Company

Burning at CIC; Caribbean Incineration Company

Source: Selikor

[14] National Report of Curaçao for the 3rd Conference on SIDS, September 2014

4. Extreme Events and Disasters

This component contains statistics regarding the occurrence and impact of extreme events and disasters on human wellbeing and the infrastructure. It consists of two subcomponents:

- Natural Extreme Events and Disasters: frequency and intensity of extreme events and disasters deriving from natural phenomena, as well as their impact on human lives and habitats and the environment as a whole.
- Technological Disasters: occurrence and impact of disasters arising as a result of human intent, negligence or error, or from faulty or failed technological applications.

photo: Hurricane Tomas, Wikipedia

Topic **4.1. Natural Extreme Events and Disasters**

An extreme event is an event that is rare within its statistical reference distribution at a particular location. An extreme event is normally as rare or rarer than the 10th or 90th percentile. A disaster is often described as a result of exposure to an extreme event. The Center for Research on the Epidemiology of Disasters (CRED) defines a disaster as an "unforeseen and often sudden event that causes great damage, destruction and human suffering." It often surpasses local capacities to respond to it and requires international assistance. For inclusion in this subcomponent, a disaster should be categorized using the CRED criteria. This means that at least one of the following criteria must be met:

- Ten or more people reported killed,
- One hundred or more people reported affected,
- Declaration of a state of emergency, or
- A call for international assistance has been made.

In recent decades, because of an increase in extreme events, natural disasters have become more frequent, more intensive and also more destructive (UN FDES, 2013). Climate change has been associated with the increasing frequency and severity of extreme weather events. It has resulted in increased global temperatures, rising sea levels, increased storms and precipitation, droughts, floods, hurricanes, tornadoes and other climatic disruptions in many places around the world. As the occurrence and intensity of natural extreme events and disasters have increased globally, countries have been facing and will continue to face increasing social and economic impacts.

November 1, 2010: Hurricane Tomas. The damage caused by this hurricane is estimated at ANG 200 mln. and it killed two people. This was the latest recorded tropical storm to strike the Windward Islands and Curaçao. Tomas developed from a tropical wave east of the Windward Islands, quickly intensifying into a hurricane, moving through the Windward Islands and past St. Lucia. After reaching Category 2 status on the Saffir-Simpson scale, Tomas quickly weakened to a tropical storm in the central Caribbean Sea. Tomas later regained hurricane status as it reorganized near the Windward passage.

photo: track of hurricane Tomas, Wikipedia

Although the storm did not directly strike the ABC islands, one of its outer rain bands stalled over the region and intensified during the night of November 1 to November 2. Curaçao experienced its most extreme rain event in 40 years; as much as 265 mm was recorded over a 24-hour period in the eastern part of the island. The majority of the rain fell overnight in a heavy downpour, accompanied by a severe thunderstorm that triggered large-scale power outages. Lightning strikes sparked three large fires in the oil refinery. The fires inflicted severe damage to several tanks, estimated at USD 10 million[15]. Flights from Curaçao International Airport were delayed due to the hazardous conditions.

Following hours of heavy rainfall, widespread floods made most roads in the region impassable, with dozens of cars swept away or stranded. The rains filled dams and overwhelmed drains, causing them to overflow. The neighborhoods of Saliña, Brievengat and Mahaai were among the hardest hit; hundreds of homes, gardens and businesses were inundated. Overall, Curaçao suffered some of its worst flooding in history; insured losses across the island exceeded ANG 110 million (USD 63mln), though total damage costs from Tomas were estimated at ANG 200 million (USD 115 million).[16]

[15] Sharlon Monart (November 3, 2010). "Miljoenenschade Tomas aan woningen, winkels en bedrijven"
[16] Sharlon Monart (November 25, 2010). "Helft schade Tomas niet te verhalen." Radio Netherlands Worldwide

photos: Curaçao Chronicle

Topic 4.2. Technological Disasters

Disasters may arise as a result of human intent, negligence or error, or from failed technological applications. Policy makers, analysts and civil society require statistics on technological disasters in order to understand who is ultimately responsible and what the immediate and potential impact may be, as well as to assess and mitigate future risks. To date, records of global technological disasters show increasing frequency and impact on humans, the infrastructure and the environment. This reinforces the relevance and necessity of statistics on these issues.

There are three types of technological disasters recognized by CRED. These are:

- Industrial accidents, which cover accidents associated with chemical spills, collapse, explosion, fire, gas leak, poisoning, radiation and other;
- Transport accidents, which cover accidents associated with air, road and water; and
- Miscellaneous accidents, which cover accidents associated with collapse, explosion, fire, and other disasters of varied origin.

All these types of disasters can impact large areas and affect both human safety and the environment in both the short and long term.

August 17, 2012: Oil spill Bullenbaai. A large amount of oil, thousands of barrels, leaked into Bullenbaai and caused a catastrophe in the 666 ha. natural reservoir Saliña St. Marie, a Ramsar wetland. It coated beaches, polluted mangrove swamps and glazed crabs, lizards and flamingos in petroleum tar. Initially, the oil refinery admitted that the oil came from their installations, but soon afterwards retracted their declarations and the case went to court. Almost two years after the spill, the court came to a settlement with the Refinery. The main points of the agreement consist of a package of technical measures, a tightening of procedures to reduce the risk of an oil leak in the future and a fine of ANG 10,000.

Just eight days later, there was a disaster at the Amuay refinery at nearby Punto Fijo (Venezuela) when a gas leak set off an explosion on August 25, killing 42 people and sending toxic black clouds of smoke into the air (source: Curaçao Chronicle).

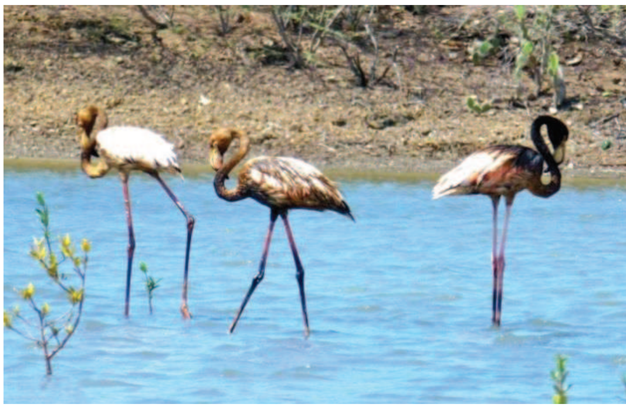


photo: Curaçao Chronicle photo: Uniek Curaçao

December 15, 2012: Firework Explosion. An explosion in a firework warehouse on an industrial estate killed four people. One died at the scene, the others later. Furthermore, it wounded another four, of which one seriously. The building and three cars were destroyed. The cause of the incident is still unknown (source: Curaçao Chronicle, December 17, 2012).

photos: Curaçao Chronicle

5. Human Settlements and Environmental Health

This component contains statistics on the environment in which humans live and work, particularly with regard to living conditions and environmental health. They are important for the management and improvement of conditions related to human settlements, safe water, sanitation, and health, particularly in the context of rapid urbanization, increasing pollution, environmental degradation, disasters, extreme events and climate change.

The wellbeing and health risks associated with the environment (and also those posed by extreme events and disasters) can be substantially mitigated or increased by several factors. These include the appropriate infrastructure for the provision of water and sanitation, adequate waste disposal, wise land use planning, clean and safe transportation, safe building design and good housing and ecosystem health. The existence of these conditions can improve a given human settlement and the wellbeing and health of humans. Conversely, vulnerable human settlements are often more impacted by the changing environment and recover more slowly from pollution, environmental degradation and extreme events and disasters.

photo: C. Jager

Topic 5.1.1. **Urban and rural population**

Humans live primarily in rural or urban communities[17], building their homes, shelters and institutions, while using environmental resources to satisfy their human needs. Depending on the carrying capacity of ecosystems, these settlements and their use of environmental resources will affect environmental conditions, as well as human wellbeing and health. Statistics on the location of human settlements can be mainly found in traditional demographic statistics. The potential for the use of population data in the field of environment statistics is ample. They can be used not only as a reference but also in combination with other environment statistics to construct indicators. For instance, in combination with housing, water and sanitation statistics, they can provide determinants of the environmental sustainability of human settlements and environmental health.

The main statistics pertaining to this topic are rural, urban and total population, including population density. These statistics are an important and pivotal element for our environment and its sustainability. Already in the 18th century, Thomas Malthus suggested that growing population rates would exceed resource growth, leading to catastrophic overpopulation[18]. This because population grew exponentially while food supply grew arithmetically. These Malthusian catastrophes have not taken place on a global scale due to progress in agricultural technology. However, nowadays many argue that future pressures on food production, combined with threats such as global warming, make overpopulation a still more serious threat in the future (source: Wikipedia).

In January 2015, the total population of Curaçao was 156,971 inhabitants, population density 354 people/km^2, which is high and comparable to Martinique, the Philippines and Japan. Benchmarks for population density: Caribbean; 182, Colombia; 42, Dominican Republic; 213, Japan; 336 and the Netherlands; 406[19]. The number of households in 2001 was 43,161. In 2011 this was 54,936 and in 2014, 56,499.

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[17] At present, there are no (separate) urban and rural population figures. However, the CBS is planning to arrange this in the future.

[18] Thomas Robert Malthus (1798) 'An Essay on the Principle of Population'. One immediate impact of Malthus's book was that it fueled the debate about the size of the population in Britain and led to (or at least greatly accelerated) the passing of the Census Act 1800. This Act enabled the holding of a national census in England starting in 1801 and continuing every ten years to the present.

[19] World Population Data Sheet 2014, Population Reference Bureau.

Curaçao Population 2000-2015

	Births	Deaths	Immigration	Emigration	Corrections	**Population**	**Pop./km²**	**Growth**
2000	2189	990	3833	10441	-738	136969	308	-3.5
2001	2047	1029	4198	8228	-514	130822	295	-4.5
2002	1842	1029	8441	6304	897	127296	287	-2.7
2003	1929	1152	7712	4804	-2173	131143	295	3.0
2004	1709	1175	5918	3952	592	132655	299	1.2
2005	1857	1088	6392	3742	430	135747	306	2.3
2006	1867	1105	6144	3551	-50	139596	314	2.8
2007	1868	1107	5726	4170	2	142902	322	2.4
2008	2001	1209	5212	4646	-35	145220	327	1.6
2009	1898	1114	4640	4698	-147	146543	330	0.9
2010	2032	1246	4910	4644	2110	147122	331	0.4
2011	1974	1276	5276	4900	20	150284	338	2.1
2012	2039	1246	4878	4121	-130	151378	341	0.7
2013	1959	1250	5392	4056	0	152798	344	0.9
2014						154843	349	1.4
2015						156971	354	1.3

CBS estimates compiled from various data sources and publications of the CBS.
All data in this file are the most recent estimations that have been calculated, deducted or found for these years.

Population date is January 1.

Topic 5.1.2. Access to water, sanitation and energy

This topic includes information about access to water, sanitation and energy. Access to these basic services can have a positive effect on human health and wellbeing, thereby contributing to improved environmental quality. Relevant statistics on this topic include "population using an improved drinking water source," as well as "population using an improved sanitation facility."

The metadata for MDG indicator 7.9[20] defines an improved sanitation facility as one that hygienically separates human excreta from human contact and includes flush or pour-flush toilets or latrines connected to a sewer, septic tank or pit, etc. The last group of statistics under this topic refer to households with access to electricity and its price. Access to electricity is a measure of modern energy services.

The percentages in the tables shown here refer to the number of households.

Table 21: Occupied living accommodations by type of water supply*

	2001	%	2011	%
Water supply line	42226	97.8	54295	98.8
Cistern or water well (groundwater)	47	0.1	2021	3.7
Water truck	15	0.0	36	0.1
Buying bottled water	187	0.4	184	0.3
Other water supply	184	0.4	420	0.8

* Multiple responses are possible per living accommodation

Source: CBS census

Table 22: Occupied living accommodations by type of sanitation

Drainage of the toilets via:	2001	%	2011	%
Cesspool ("beerput")	31123	72.1	42375	77.1
Septic tank	n.r.		1703	3.1
Sewer	9801	22.7	10209	18.6
Other	379	0.9	240	0.4
Not applicable	50		208	
Not reported	133		201	

Source: CBS census

[20] The Millennium Development Goal (MDG) indicator 7.9 is the proportion of the population using an improved sanitation facility. This is defined as the percentage of the population with access to an improved sanitation facility with respect to the total population.

Table 23: Type of electric supply*

	2001	%	2011	%
Electricity grid	42201	97.8	54219	98.7
Own generator	63**	0.1	286	0.5
Solar energy/wind energy			71	0.1
Other power supply	19	0.04	425	0.8
Not reported	143		126	

* Multiple responses are possible per living accommodation
** Including solar power
Source: CBS census

Topic 5.1.5. **Environmental concerns specific to urban settlements**

The topic of environmental concerns is intended to organize issues of specific relevance to urban areas. Depending on national and local conditions and priorities, additional environmentally relevant urban concerns should be included here.

With regard to transportation, statistics can include the number of private, public and commercial vehicles by engine type. Most importantly from the environment statistics perspective, additional statistics could include the number of passengers transported by public transportation systems.

Table 24: Number of motor vehicles

	2010	2011	2012	2013	2014	2015
Passenger cars	80973	61578	69035	67998	69062	69574
Number of cars/household		1.12			1.22	
Motor lorries and pick-ups	15878	12021	12908	12377	12079	12768
Motor buses	434	379	369	346	297	331
Taxis	193	179	159	138	141	138
Other cars	319	163	404	472	459	500
Motorcycles, incl. mopeds	1944	1117	1300	1689	1757	1758
Number of passenger cars:						
per km^2	182	139	155	153	156	157

Note: excluding motor vehicles owned by the government
Number of motor vehicles registered per Dec. 31
The relatively low number of cars in 2011 is due to an administrative cleanup of the data

Source: Collector's Office Curaçao ("Ontvanger")

Topic 5.2.1. **Airborne diseases and conditions**

This topic includes all airborne diseases and conditions that are caused or worsened by exposure to unhealthy levels of pollutants (such as PM, SO_2 or O_3). Airborne diseases and conditions include, but are not limited to, upper and lower respiratory disease, obstructive pulmonary disease, asthma, allergic rhinitis, lung cancer, coronary artery heart disease and stroke. This topic includes health statistics on morbidity (such as incidence and prevalence) and mortality of these diseases or conditions, as well as measurement of the associated impact on the labor force and on the economic costs. Although there are certainly reasons to believe that this topic is relevant to Curaçao, e.g. asthma and lung cancer caused by PM and SO_2 emissions from the refinery, there is no statistical information available on this topic.

Topic 5.2.2. **Water-related diseases and conditions**

This topic includes all water-related diseases and conditions that result from micro-organisms and chemicals in the water humans drink. Water-related diseases and conditions are still a considerable public-health problem in many countries. They include but are not limited to diseases caused by biological contamination, such as gastroenteritis infections caused by bacteria, viruses and protozoa, and water-borne parasite infections. Where available, this topic includes health statistics such as morbidity (incidence and prevalence) and mortality of these diseases or conditions, as well as measures of the associated impact on the labor force and on the economic costs. In Curaçao there are no recent known cases of legionella. The last legionella infections were in 1998 and 1999.

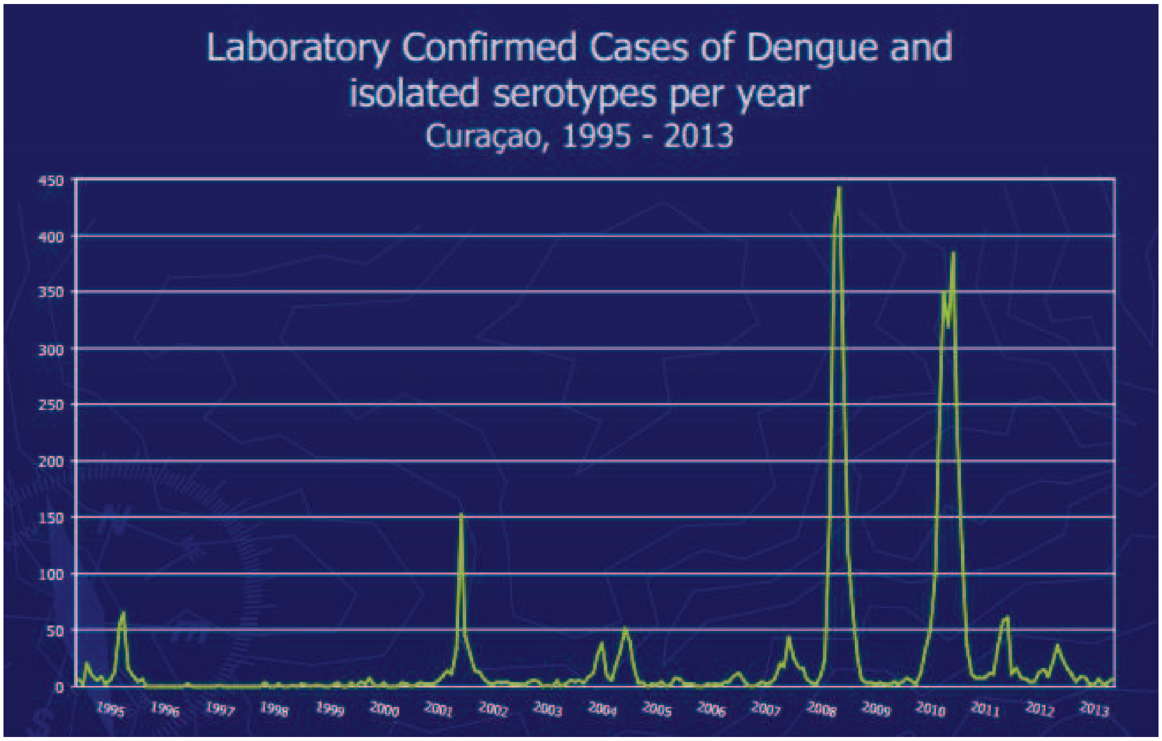
Topic 5.2.3. **Vector-borne diseases**

This topic includes vector-borne diseases that are transmitted by organisms, e.g. insects, that carry viruses and bacteria. Common vector-borne diseases include, but are not limited to, malaria, dengue fever, yellow fever, chikungunya and Lyme disease. Some vector-borne diseases are being directly affected by climate change, notably by the change in rain patterns and floods. This topic includes health statistics such as morbidity (incidence and prevalence) and mortality of these diseases or conditions, as well as measures of the associated impact on the labor force and on the economic costs.

Table 25: Vector-borne diseases	2010	2011	2012	2013	2014
Dengue*	2800	2654	720	680	159
Chikungunya					1847
Dengue and chikungunya**					3405

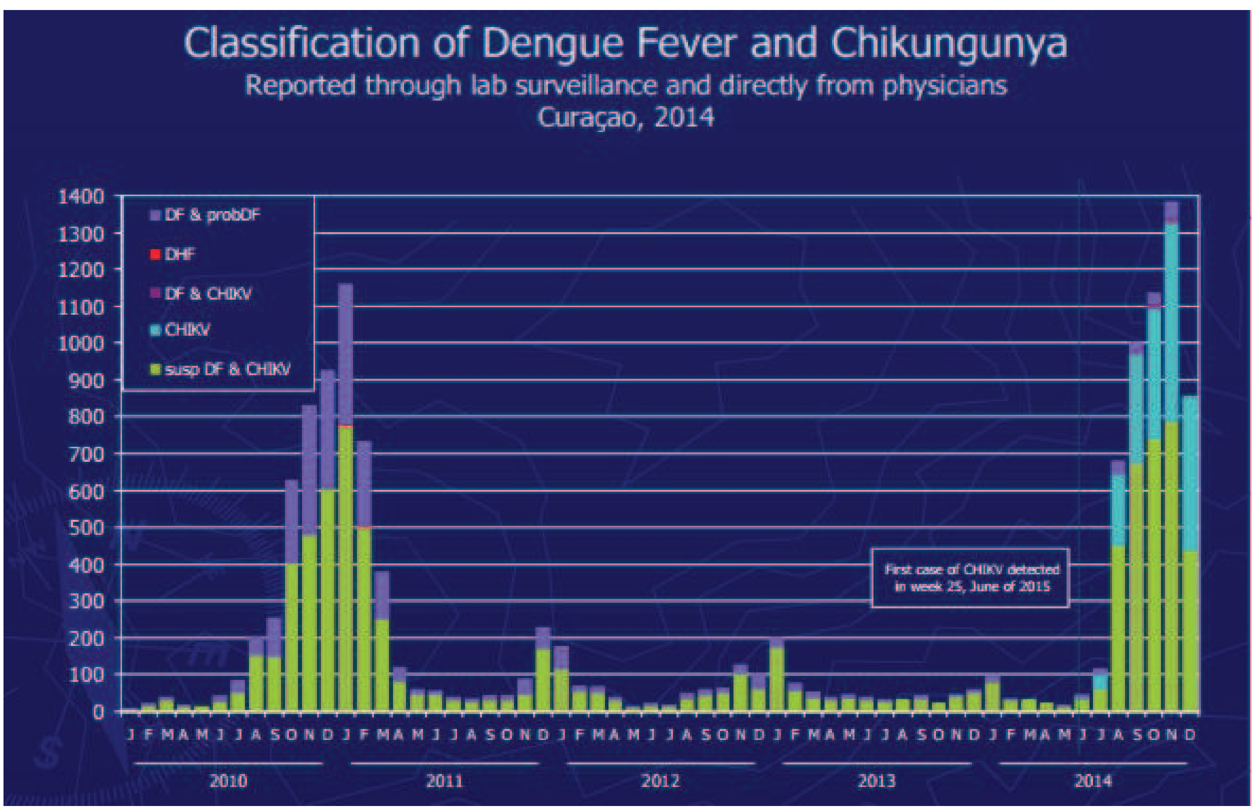
Source: Ministry of Health, Environment and Nature

* Including probable and suspected cases
** Including suspected cases



Y. Halabi & I. Gerstenbluth, Ministry of Health, Environment and Nature, Nov. 2015

Figure 9: Confirmed cases of dengue (including probable and suspected cases)



Y. Halabi & I. Gerstenbluth, Ministry of Health, Environment and Nature, Nov. 2015. DF = lab confirmed dengue fever, DHF = lab-confirmed dengue and hemorrhagic fever[21], CHIKV = chikungunya

Figure 10: Confirmed cases of dengue and chikungunya (including suspected cases)

[21] Dengue fever is a mosquito-borne disease caused by the dengue virus. Recovery generally takes less than two to seven days. In a small proportion of cases, the disease develops into the life-threatening dengue hemorrhagic fever.

6. Environment Protection and Management

A country's engagement in the protection and management of the environment, and therefore the amount of resources it dedicates to the task, is especially important because it is related to information, awareness and the ability to finance environment protection activities and participate in efforts (sometimes international) directed at these activities.

The component of environment protection and management organizes information on environment protection and resource management expenditure with the aim of improving the environment and maintaining the health of ecosystems. Statistics about environmental governance, institutional strength, enforcement of regulations and extreme-event preparedness are also considered. This component also contains information on a wide variety of programs and actions to increase awareness, including environmental information and education, as well as activities aimed at diminishing environmental impacts and improving the quality of local environments.

photo: C. Jager

Topic 6.1.1. Government protection expenditures

This topic includes government expenditure primarily aimed to protect the environment and manage resources. Government expenditure to protect the environment is usually calculated by identifying and aggregating the expenditures considered to be primarily for environment protection and resource management purposes. These expenditures can be found by examining official government finance statistics found in government budgets and/or administrative reports on actual government expenditure incurred. The main institutional partners are the official institutions in charge of reporting government expenditure. National accounts and government finance statistics are typically the divisions in statistical offices which need to be involved when developing these figures.

Due to the new constitutional status of the Netherlands Antilles/Curaçao as per October 2010, no information is available for that year.

Table 26: Government protection expenditures **In ANG 1000**

	2010	2011	2012	2013	2014	2015
Selikor subsidy		29380	29267	29493	32949	32030
sewerage and water purification		40	pm	pm	pm	pm
Carmabi subsidy		359	306	315	291	291
Schoon Curaçao subsidy						75
Punda Limpi i Bunita subsidy						26
Parke Tropikal subsidy		250	250	453	438	513
Protection expenditures (total):	n.a.	30029	29823	30261	33678	32935

Source: Ministry of Finance and CBS

7. Tourism

Tourism is one of the most important activities in many of the Caribbean countries, contributing significantly to the economies. Tourism industries also contribute through the creation of jobs in tourist-related sectors such as security, construction and transportation. However, this key sector also exerts significant pressure on scarce resources such as land, reefs, water and energy. In addition, it also generates a large amount of waste. The indicators under this theme seek to measure and quantify the environmental and social implications such as accommodation, transportation and employment.

Tourism, like all forms of development in the coastal zone, needs to be carefully integrated within the environmental development plans. Curaçao is a partially tourism dependent country, which means that sustainable tourism development should be continuously improved. Environmentally responsible practices by tourism companies are still limited (National Report of Curaçao, June 2104). The key drivers are local environmental NGOs that stimulate voluntary environmental initiatives. Uncontrolled and illegal development of construction and tourism projects and rapid expansion may frustrate and alienate locals due to traffic congestion and restrictive access to private facilities (TAC, May 2013).

photo: C. Jager

Table 27: Visitor and Cruise-ship arrivals

	2010	2011	2012	2013	2014	2015
Ships	220	246	226	293	291	255
Passengers	383589	400596	436068	583994	629145	565.124

Source: Curaçao Tourist Board

A visitor is a traveler taking a trip to a main destination outside his/her usual environment for less than a year, for any main purpose (business, leisure or other personal purpose) other than to be employed by a resident entity in the country or place visited[22]. These trips taken by visitors qualify as tourism trips.

Tourism refers to the activity of visitors. A visitor (domestic, inbound or outbound) is classified as a tourist (or overnight visitor) if his/her trip includes an overnight stay, or as a same-day visitor (or excursionist) otherwise. Cruise passengers are regarded as a special type of same-day visitor (even if the ship overnights at the port) who stay less than twenty-four hours in the country visited. Cruise-ship arrivals refer to the number of times cruise ships enter the country. A cruise ship can be counted multiple times if it leaves the country and then returns with new passengers within the same month.

Table 28: Stay-over tourism

	2010	2011	2012	2013	2014	2015
Total numbers:	341.651	390.282	419.810	440.063	452.042	468.442
Nights:	2888.443	3184.932	3674.700	3754.311	3984.212	3848.351

Source: CBS

Table 29: Tourism ratios

	2010	2011	2012	2013	2014	2015
Tourist Penetration Ratio	5.4	5.8	6.7	6.7	7.0	6.7
Tourism Density Ratio	17.8	19.7	22.7	23.2	24.6	23.7
Tourism Intensity Rate	5.2	6.5	7.0	7.2	7.2	6.7

Source: CBS

[22] Definitions of Caricom, *International Recommendations for Tourism Statistics 2008*

Tourist Penetration Ratio: The penetration ratio quantifies the average number of tourists per thousand inhabitants. Tourist Penetration Ratio = average length of stay x number of visitors / 365 x midyear population estimates.

Tourism Density Ratio: This ratio attempts to show the density of tourists in the country at any one time on average. Its value is limited by the fact that tourist flows are seasonal and tourism activity tends to be concentrated in specific geographic areas (tourist zones). Tourism Density Ratio = average length of stay x number of visitors / 365 x area in square kilometers.

Tourism Intensity Rate (TIR) measures the level of tourist arrivals in relation to the country's area and population size. It serves to show countries with particularly high tourism concentration, and consequently potential impact both for the economy as well as the socio-cultural and natural environment. Tourism Intensity Rate = number of visitors/1,000 population/km^2.

Table 30: Hotels: rooms and occupancy

	2010	2011	2012	2013	2014	2015
Number of rooms:	5421	5776	6038	6180	6405	6490
Occupancy %	71.7	76.2	70.4	67.3	70.0	71.1

Sources: Curaçao Tourist Board and CBS

The room occupancy rate is, according to the Caribbean Tourism Organization (CTO), a measure of capacity utilization for hotels and similar establishments. It is calculated by dividing the monthly or yearly sum of occupied rooms by the number of rooms available for use, then multiplying the quotient by 100.

Table 31: Passengers by air

	2010	2011	2012	2013	2014	2015
Arriving:	635,495	705,093	731,070	732,865	733,887	764,293
Departing:	631,410	684,307	708,997	728,461	730,549	763,087
Transit:	147,165	239,706	317,101	260,175	210,042	204,909
Total:	1414,070	1629,106	1757,168	1721,501	1674,478	1732,289

Source: Curaçao Airport Partners N.V.

Appendix

Air quality: Beth Chaim (industrial area)

Table 10: Monthly average concentration in µg/m³

month	SO_2	times x 20 µg	Total SP
2/1/2010	53.8	2.7	
3/1/2010	5.2	0.3	70.2
4/1/2010	1.9	0.1	76.4
5/1/2010	1.4	0.1	47.6
6/1/2010	44.6	2.2	50.6
7/1/2010	68.3	3.4	48.4
8/1/2010	43.7	2.2	35.6
9/1/2010	31.8	1.6	30.4
10/1/2010	24.6	1.2	30.7
11/1/2010	15.2	0.8	26.9
12/1/2010	37.9	1.9	28.6
1/1/2011	90.6	4.5	45.9
2/1/2011	89.0	4.5	47.0
3/1/2011	50.0	2.5	40.5
4/1/2011	73.3	3.7	46.0
5/1/2011	53.1	2.7	49.0
6/1/2011	49.8	2.5	49.2
7/1/2011	57.7	2.9	43.1
8/1/2011	95.6	4.8	52.3
9/1/2011	79.9	4.0	60.6
10/1/2011	58.8	2.9	50.1
11/1/2011	30.9	1.5	41.9
12/1/2011	27.7	1.4	29.2
1/1/2012	44.2	2.2	32.5
2/1/2012	94.4	4.7	39.0
3/1/2012	109.9	5.5	67.0
4/1/2012	144.6	7.2	44.9
5/1/2012	80.9	4.0	62.8
6/1/2012	57.3	2.9	69.4
7/1/2012	56.7	2.8	58.5
8/1/2012	48.4	2.4	47.5

9/1/2012	61.7	3.1	45.7
10/1/2012	37.9	1.9	30.6
11/1/2012	14.0	0.7	33.2
12/1/2012	12.8	0.6	33.8
1/1/2013	124.9	6.2	39.6
2/1/2013	165.9	8.3	50.1
3/1/2013	88.9	4.4	43.8
4/1/2013	185.8	9.3	55.1
5/1/2013	152.9	7.6	56.8
6/1/2013	196.0	9.8	69.7
7/1/2013	151.0	7.5	44.6
8/1/2013	241.1	12.1	51.3
9/1/2013	166.7	8.3	45.0
10/1/2013	170.0	8.5	55.4
11/1/2013	103.1	5.2	36.9
12/1/2013	122.2	6.1	36.8
1/1/2014	178.1	8.9	46.7
2/1/2014	130.2	6.5	52.0
3/1/2014	158.6	7.9	56.9
4/1/2014	258.2	12.9	72.1
5/1/2014	251.7	12.6	73.3
6/1/2014	190.3	9.5	83.0
7/1/2014	206.6	10.3	61.5
8/1/2014	159.5	8.0	54.3
9/1/2014	129.4	6.5	49.1
10/1/2014	98.6	4.9	39.0
11/1/2014	118.7	5.9	37.4
12/1/2014	153.7	7.7	43.2
1/1/2015	163.2	8.2	45.1
2/1/2015	158.2	7.9	50.1
3/1/2015	144.7	7.2	58.7
4/1/2015	261.6	13.1	88.3
5/1/2015	273.4	13.7	104.3
6/1/2015	319.5	16.0	79.6
7/1/2015	258.6	12.9	82.3
8/1/2015	284.5	14.2	72.6
9/1/2015	233.1	11.7	57.1
10/1/2015	113.2	5.7	41.5
11/1/2015	178.7	8.9	46.1
12/1/2015	312.5	15.6	63.4

Source: Monitoring station Public Health Service
A'dam

SO_2 = sulfur dioxide, Air Quality Guideline 24-hour WHO is 20 µg/m³
x 20 = times above 24-hour WHO norm of 20 µg/m³
Total SP = TSP = Total suspended particles

Incl. emissions of DOK utility power plants

Air quality: Kas Chikitu (residential area)

Table 11: Monthly average concentration in µg/m³

month	SO_2	times 20 µg	PM10	times 50 µg
6/1/2010	24.0	1.2	49.2	1.0
7/1/2010	49.0	2.5	44.3	0.9
8/1/2010	39.8	2.0	37.8	0.8
9/1/2010	31.5	1.6	39.9	0.8
10/1/2010	19.5	1.0	34.5	0.7
11/1/2010	16.0	0.8	36.0	0.7
12/1/2010	32.7	1.6	36.5	0.7
1/1/2011	69.3	3.5	33.8	0.7
2/1/2011	83.6	4.2	35.0	0.7
3/1/2011	43.8	2.2	35.0	0.7
4/1/2011	65.5	3.3	34.1	0.7
5/1/2011	40.1	2.0	45.6	0.9
6/1/2011	50.8	2.5	39.9	0.8
7/1/2011	41.0	2.0	39.2	0.8
8/1/2011	52.0	2.6	36.9	0.7
9/1/2011	45.4	2.3	33.6	0.7
10/1/2011	38.2	1.9	35.8	0.7
11/1/2011	22.4	1.1	38.3	0.8
12/1/2011	21.9	1.1	32.4	0.6
1/1/2012	44.8	2.2	30.6	0.6
2/1/2012	70.5	3.5	34.4	0.7
3/1/2012	114.1	5.7	55.5	1.1
4/1/2012	45.2	2.3	32.7	0.7
5/1/2012	81.0	4.0	49.1	1.0
6/1/2012	28.5	1.4	49.6	1.0
7/1/2012	54.7	2.7	48.9	1.0

8/1/2012	32.6	1.6	36.8	0.7
9/1/2012	40.0	2.0	34.3	0.7
10/1/2012	27.3	1.4	35.2	0.7
11/1/2012	64.9	3.2	30.0	0.6
12/1/2012	52.8	2.6	39.1	0.8
1/1/2013	123.7	6.2	32.9	0.7
2/1/2013	95.0	4.8	35.7	0.7
3/1/2013	83.2	4.2	37.8	0.8
4/1/2013	136.9	6.8	40.9	0.8
5/1/2013	75.7	3.8	45.2	0.9
6/1/2013	85.7	4.3	54.6	1.1
7/1/2013	93.0	4.6	51.1	1.0
8/1/2013	89.7	4.5	42.4	0.8
9/1/2013	58.6	2.9	41.2	0.8
10/1/2013	88.3	4.4	39.8	0.8
11/1/2013	99.8	5.0	39.4	0.8
12/1/2013	122.4	6.1	34.5	0.7
1/1/2014	146.3	7.3	35.0	0.7
2/1/2014	153.2	7.7	39.9	0.8
3/1/2014	113.4	5.7	39.2	0.8
4/1/2014	169.1	8.5	46.2	0.9
5/1/2014	141.3	7.1	43.2	0.9
6/1/2014	135.0	6.8	60.0	1.2
7/1/2014	107.3	5.4	39.1	0.8
8/1/2014	85.6	4.3	39.2	0.8
9/1/2014	96.2	4.8	30.9	0.6
10/1/2014	71.1	3.6	26.0	0.5
11/1/2014	105.6	5.3	26.8	0.5
12/1/2014	145.1	7.3	30.3	0.6
1/1/2015	160.5	8.0	34.3	0.7
2/1/2015	123.8	6.2	31.4	0.6
3/1/2015	151.9	7.6	38.3	0.8
4/1/2015	172.1	8.6	55.8	1.1
5/1/2015	154.04	7.7	64.5	1.3
6/1/2015	170.76	8.5	48.1	1.0
7/1/2015	142.18	7.1	54.1	1.1
8/1/2015	106.51	5.3	40.9	0.8
9/1/2015	82.61	4.1	43.8	0.9
10/1/2015	33.1	1.7	35.2	0.7
11/1/2015	61.03	3.1	34.9	0.7
12/1/2015	113.71	5.7	37.2	0.7

Source: Monitoring station Public Health Service A'dam

SO_2 = sulfur dioxide, Air Quality Guideline 24-hour WHO is 20 μg/m^3
x 20 = times above 24 hours WHO norm of 20 μg/m^3
PM_{10} = particles ("fijnstof"), with a diameter till 10
micrometer (μm)
x 50μg = times above 24-hour WHO day norm of 50 μg/m^3

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List of Acronyms

Caricom	Caribbean Community
$CaCO_3$	Calcium Carbonate, limestone or 'kalksteen' (Dutch)
Carmabi	Caribbean Research and Management of Biodiversity
CBS	Central Bureau of Statistics
CH_4	Methane
CIC	Caribbean Incineration Company
CO_2	Carbon dioxide
CRC	Curaçao Recycling Company
CRED	Center for Research on the Epidemiology of Disaster
CRU	Curacao Refinery Utilities
CTO	Caribbean Tourism Organization
DNA	Deoxyribonucleic Acid
FDES	Framework for the Development for Environment Statistics
GGD	Geneeskundige- en Gezondheidsdienst
GHGs	Greenhouse Gasses
IFO	Industrial Fuel Oil
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
Kton	1000 tons
kWh	kilowatt hour
MW	Megawatt
MDG	Millennium Development Goal

NGO	Non-Governmental Organization
NOx	Nitrogen Oxide
PM10	Particulate matter; 10 micrometers or less
PO4	Phosphate
SIDS	Small Island Developing States
SEEA	System of Environmental-Economic Accounting
SNA	System of National Accounts
SO2	Sulphur Dioxide
TAC	Thierry Apoteker Consulting
TIR	Tourism Intensity Rate
TSP	Total Suspended Particulates
UNEP	United Nations Environment Programme
UNSD	United Nations Statistical Department
WHO	World Health Organization
WMO	World Meteorological Organization

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Caricom

Carmabi

CBS

Collector's office / Ontvanger

CRU / BOO

Curaçao Airport Partners

Curaçao Tourism Board

Curaçao Mining Company

Curoil / Curgas

GGD Curaçao

GGD Amsterdam

Kool Caribe Consult

Meteorological Department

NuCapital

Refineria ISLA

Selikor

UNSD

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