



**Curaçao Environmental
Statistics Compendium 2020**



Central Bureau of Statistics Curaçao

CURAÇAO
ENVIRONMENTAL STATISTICS
COMPENDIUM 2020

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Preface

The Central Bureau of Statistics (CBS) of Curaçao is very pleased to release its fifth issue of the Environment Statistics Compendium.

A compendium is a collection of information in which a summary is presented on environmental Statistics. The data collected is based on the principles of a for Curaçao adjusted version of the Core Set of the FDES, the U.N. Framework for the Development of Environmental Statistics. The Core Set contains the most important environment statistics to describe statistical topics thus providing guidance to environmental programs and policies.

The publication reflects the collation of existing CBS data sources and administrative sources of government- and non-government entities. Although it was not possible to receive all the data needed and the CBS still has some 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 continue to issue this publication bi-annually. In principle, the data presented here cover the years 2010 to 2020.

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

Drs. Sean de Boer,

Director

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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	Curaçao Refinery Utilities
CTO	Caribbean Tourism Organization
DNA	DeoxyriboNucleic Acid
FDES	Framework for the Development for Environment Statistics
GGD	Geneeskundige- en Gezondheidsdienst
GHG's	Green House Gasses
IFO	Industrial Fuel Oil
IPCC	Intergovernmental Panel on Climate Change
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
Kton	1000 ton
kWh	kilo Watt hour
MW	Mega Watt
SDG	Sustainable Development Goal

NGO	Non-Governmental Organization
NO _x	Nitrogen Oxide
PM10	Particulate matter; 10 micrometers or less
PO ₄	Phosphate
SIDS	Small Island Developing States
SEEA	System of Environmental-Economic Accounting
SNA	System of National Accounts
SO ₂	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

Introduction

The demand for environment statistics is increasing in accordance with continuing 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. This is also the case in the Caribbean with its many islands and Small Island Developing States (SIDS) and so, also in Curaçao, with its high population density, unsustainable demands on solid waste infrastructure, energy-intensive and costly water, a high dependency on imported fossil fuels.

The recognition that human well-being and development depends on the environment, has led to an increasing emphasis on environment and sustainability concerns (e.g., the National Development Plan Curaçao 2015) on which decisions and actions need to be taken. Paramount 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 our society and can be used as input and support for fact-based policymaking. Like in many other countries, environment statistics is a new and emerging domain, which is typically endowed with limited resources (technical, financial, and human) and is challenged by a developing institutional set-up and inter-institutional coordination.

This fifth Compendium 2020 is structured in 7 sections which include:

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.

Methodology

Environment statistics give us information about the state and changes of 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 social actions and economic measures taken by societies. This to avoid or mitigate these impacts and to restore and maintain the capacity of the environment to provide the services that are essential for life and human wellbeing. Environment statistics thus cover a wide range of information. Their sources are dispersed 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. Like many countries, Curaçao is limited in its organizational, technical, and financial capacity and must deal with the challenge of cooperation and data-gaps. Therefore, environment statistics require a proper framework to guide this development. For this reason, the FDES and especially the Core Set were chosen to serve as a good tool for the CBS to set up and enhance these statistics.

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

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 the first level ('tier 1') of a greater Basic Set of environment statistics composed of three levels, according to the level of relevance, availability, and methodological development of these statistics.

The Core Set consists of six fundamental components, divided into 'topics' (here used as paragraphs), that follow the FDES 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 **Disasters and extreme events**, both natural and technological, 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**, refers 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.

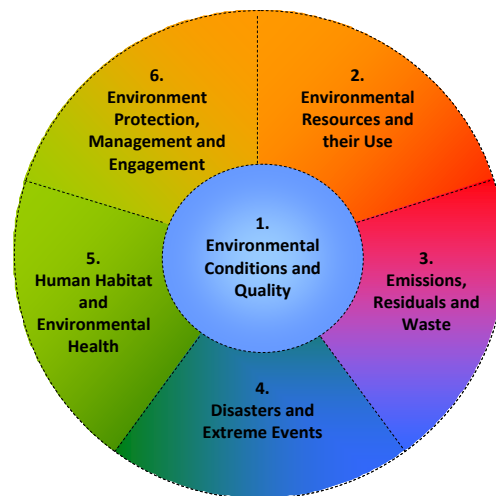


Figure 1. The FDES components

During a CARICOM workshop in April 2014 it became clear that it is necessary for Curaçao, like for other Caribbean countries, to make **Tourism** a 7th additional component to the Core Set of the FDES framework. This in accordance with the CARICOM indicators and the high social- and economical importance of tourism in Caribbean countries.

Information about our environment is in development and therefore the availability of environmental information will increase soon. The dissemination of information and regular publication of this compendium will 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 because 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.



Piscaderabay

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 way that the atmosphere is behaving on the island in the short term 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 a distinguishable dry and rainy season. 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 the 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, which can be more than 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. The skies are in general mostly clear to partly cloudy

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 territory and 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 al¹ (figure 3).

¹ C.E. Beers, J. de Freitas, P. Ketner, "Landscape ecological vegetation map of the island of Curaçao, Netherlands Antilles", 1997.

Concerning geographical information, it can be said that the country's territory is 444 km². The total surface of coral reefs is 16 km² (van Duyl, 1985) and the mangroves have a surface of less than 0.6 km².²

The geological history of Curaçao began about 90 million years ago. 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. The basalt is locally at least 5km thick suggesting the island's origin started that deep below the ocean surface and is geologically "younger" towards the West of the island.

The Knip Group overlies the volcanic sequence, hence is a little younger. The significant difference in appearance with the older volcanic rocks is the distinct layering.

The Mid Curaçao Formation originated through a reorganization of the geological features that were 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 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 that were formed 5 million years ago. No significant rock formation occurred on Curaçao between the formation of 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

² <http://www.unesco.org/csi/pub/papers/pors.htm>

years ago.

The subsequent glacial period caused sea levels to drop resulting in a “lower” reef terrace (1 million years ago) on which Tera Kora 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”.

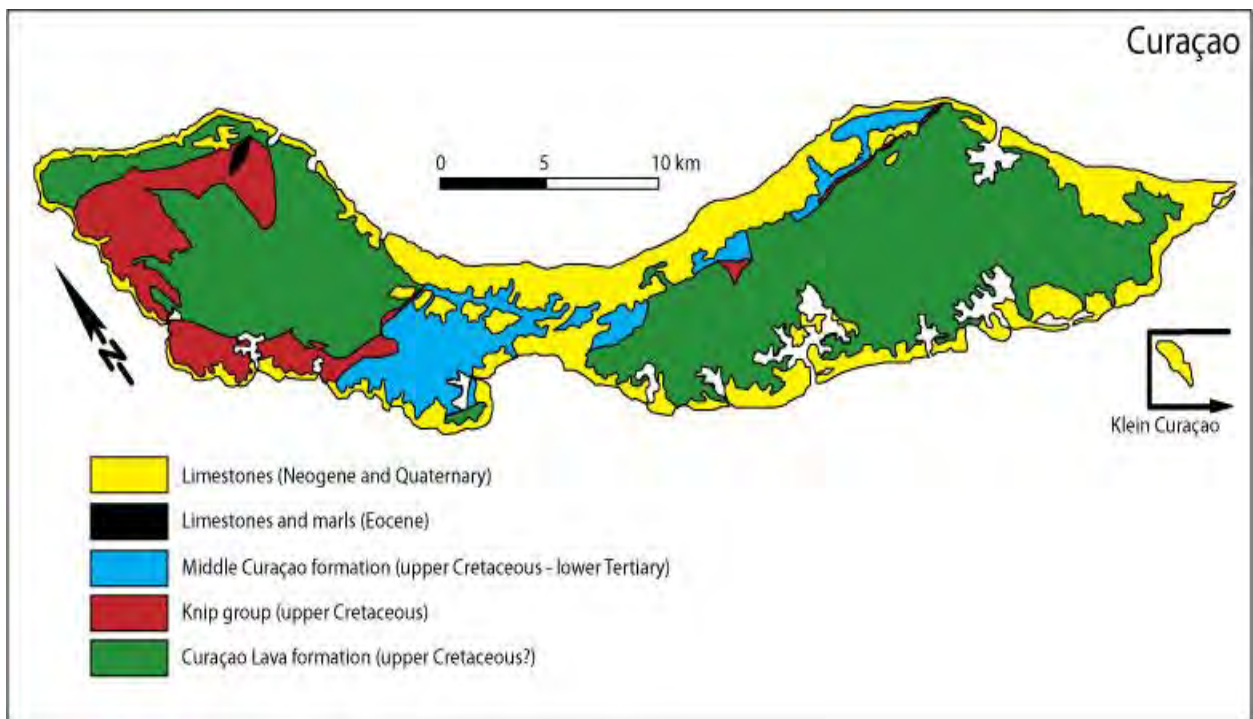


Figure 2: Geological map Curaçao. Source: CARMABI 2014

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 7 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 salinas.

Almost everywhere in 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 development of tourism. On many parts of the island these trends were and are 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 are:

- the plantations of Knip, Jeremi and St. Hieronymus,
- the coastal terraces between Hato and Boca Ascension,
- the plantation of Malpais and surrounding properties,
- the freshwater basin of Muizenberg,
- the limestone terrace landscape and coastal zone stretching from Caracas Bay to Oostpunt,
- the salinas of Jan Thiel and St. Marie,
- the main mangrove areas and
- the north coast reefs from Playa Kanoa to Oostpunt including the St. Joris Bay.



Christoffel National Park photo: C. Jager

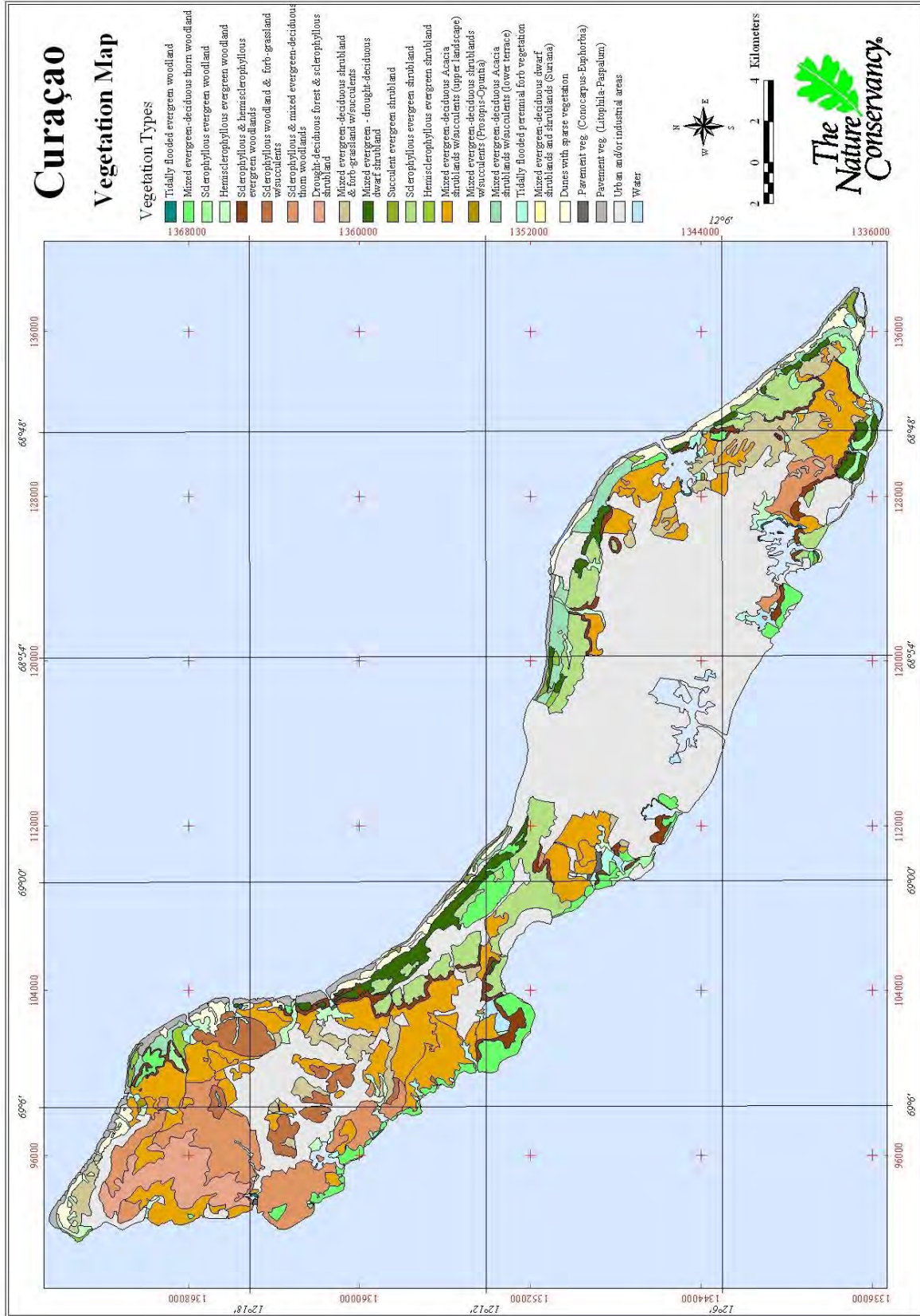


Figure 3: Curaçao Vegetation map 1997

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. Ecosystems and biodiversity can be considered as the life support system for our environment and our planet.

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, artificial beach construction and a lack of enforcement of (outdated) legislation.

Statistics on biological components of ecosystems provide information on the conditions of plants, animals and living habitats, e.g. species at risk of extinction. Although information about ecosystems in Curaçao is developing and therefore will be increasingly available, using it for statistics describing ecosystems is still rather infrequent and non-systematic. There are many threatened and endangered species on Curaçao (table 6), but information on their abundance, critical habitats and population trends is scarce or absent for most species.

To give an impression of the degree of extinction, in the Dutch Caribbean more than 25 shark and ray species have been documented. Populations of most species has unquestionably declined dramatically from former times³. In the 1940s different writers recount the high abundance of large fishes in the near shore waters surrounding Curaçao. Sharks were observed practically every snorkeling trip, whereas today they are only sporadically encountered during dives (A. Debrot, M. Vermey et.al).

Also, turtles have become endangered. Once amazingly abundant, Caribbean Sea turtles have seen a rapid decline. Scientists estimate that in the 17th century over 90 million Green Turtles swam in the Caribbean seas. Today the number is estimated at 300,000 (0,33%). Hawksbill have plunged from an estimated 11 million to 30.000

³ Waitt Institute, May 2018.

(0,27%). Both Green Turtles and Hawksbills nest on Curaçao and can be seen along the entire coast and Klein Curaçao. Fishing gear entanglement, illegal harvesting, coastal development, and marine pollution are still putting serious pressure on turtle populations.

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 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 out compete other species and change the ecosystem.

Ecosystems

Table 6: Threatened species

	Critically endangered, IUCN red list
<i>Fish</i>	Goliath grouper Black grouper
<i>Sharks and rays</i>	smalltooth, wide sawfish largetooth sawfish
<i>Reptiles</i>	Hawksbill turtle Leatherback turtle
<i>Corals</i>	Staghorn coral Elkhorn coral
	Endangered, IUCN red list

<i>Fish</i>	Nassau grouper
	Red porgy
<i>Sharks and rays</i>	Barndoor skate
	Winter skate
	Great hammerhead
	Scalloped hammerhead
<i>Mammals</i>	Coalfish whale
	Blue whale
	Fin whale
	North Atlantic right whale
<i>Reptiles</i>	Loggerhead turtle
	Green turtle
<i>Corals</i>	Box fire coral
	Mountainous star coral

Threatened species, CARMABI

<i>Birds</i>	Caribbean Coot
	Scarlet ibis
	West Indian whistling duck
	Fulvous whistling duck
	American flamingo
<i>Mammals</i>	Curacao White-tail Deer
<i>(bats)</i>	Glossophaga longirostris elongata
	L. curasoe
	Mormoops megalophylla intermedia
	Natalis tumidirostris
	Myotis nesopolus
	Pteronotus davy
	Noctilio leporinus
<i>Fish</i>	Queen triggerfish
	Lancer dragonet
	Lined seahorse
	Yellowedge grouper
	Snowy grouper
	Atlantic white marlin
	Hogfish
	Mutton snapper
	Cubera snapper

	Blue marlin
	Giant manta
	Tarpon
	Yellowmouth grouper
	Cano toadfish
	Bigeye tuna
	Atlantic bluefin tuna
<i>Sharks & rays</i>	Bigeye thresher
	Whale shark
<i>Reptiles</i>	Lesser Antillian iguana
	Green iguana
<i>Invertebrates</i>	Lace corals
	Black corals
	Stony corals
	Queen conch
	Spiny lobster

Source: CARMABI and Waitt Institute

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
Northwest Curaçao	24.4
Muizenberg (wetland)	0.65
Rif Sint Marie (wetland)	6.7
Malpais/Sint Michiel (wetland)	11

Northwest Curaçao is an important bird area and comprises a great variety of ecosystems such as coral reefs, coastal lagoons with sea grass beds and mangroves, freshwater dams and natural springs. This Ramsar site includes parts of Shete Boka and Christoffel Park. Some of the different caves are important as nesting and roosting sites for rare and endemic bat species. Furthermore, Indian drawings can be found estimated to be more than 5,000 years old.

Muizenberg is an important bird area and comprises an intermittent shallow lake created by the damming of a stream that drains the surrounding low hills. The Muizenberg dam has a capacity of 650,000 m³ and is the largest freshwater reservoir on the island.

Rif St. Marie is a relatively undisturbed important bird area, especially flamingoes and several water birds, and comprises a salt marsh. The area is currently used for recreational purposes like hiking, biking and guided eco-tours.

Malpais comprises two freshwater lakes and a lagoon connected to a bay with coral reefs. The area provides refuge for many birds.

Klein Curaçao is declared as Ramsar site per September 2018. The eastern shore of this small island features a near-pristine coral reef system that supports an enormous diversity of marine organisms. This reef system is one of the few remaining healthy examples and is representative of Caribbean reef communities in general. The island is of global importance for its breeding population of the least tern (*Sterna Antillarum*), while a 600-metre stretch of sandy beach is the most important nesting area within Curaçao for turtles. From 2019 on it will have a formal legal protection.

Table 9: Nature parks without formal legal protection km²

Christoffel Park (since 1978)	23
Curaçao Marine Park (since 1983)	10.4
Shete Boka (since 1994)	4.7

The Christoffel Park has the highest diversity of flora and fauna on the ABC islands that are otherwise rare on and endemic to the island. Rare species include a population of about 250 individuals of the White-tailed deer, an endemic sub-species. The Christoffel Park also harbors vegetation types that are only found in the Park.

The Curaçao Marine Park (or Underwater Park) is in the southeastern part of the island and covers 12 km of coastline. It is harboring pristine fringing coral reefs, sea grass beds, mangroves and a high diversity of fish species (some 350 fishes). From 2019 on it will have a formal legal protection.

The Shete Boka Park is located on the island's rocky north coast and has been designated to protect the pocket beaches ('bokas') that constitute important sea turtle nesting sites.

Curaçao is surrounded by 15.7 km² of fringing reefs and though threatened, the island still harbors some of the best coral ecosystems in the region⁴. It's part of one of the five richest hotspots for biodiversity and endemism on earth (i.e. the Caribbean) and represents a hotspot center by itself within its wider eco region together with the Cayman Islands, Aruba and Bonaire. The reefs of Oostpunt are currently increasing in coral cover and are ranked among the best three reef systems left in the Caribbean⁵.

Especially the north shore and eastern and western sides of the south coast harbor healthy coral communities. In developed areas, a significant decline has been observed in coral cover; up to 80% in less than 3 decades⁶. The reefs harbor about 69 coral species.

⁴ Jackson et al. 2013

⁵ Miloslavich et al. 2010

⁶ Bak, Meesters en Nieuwland, 2005



Boka Ascencion

Photo: C. Jager

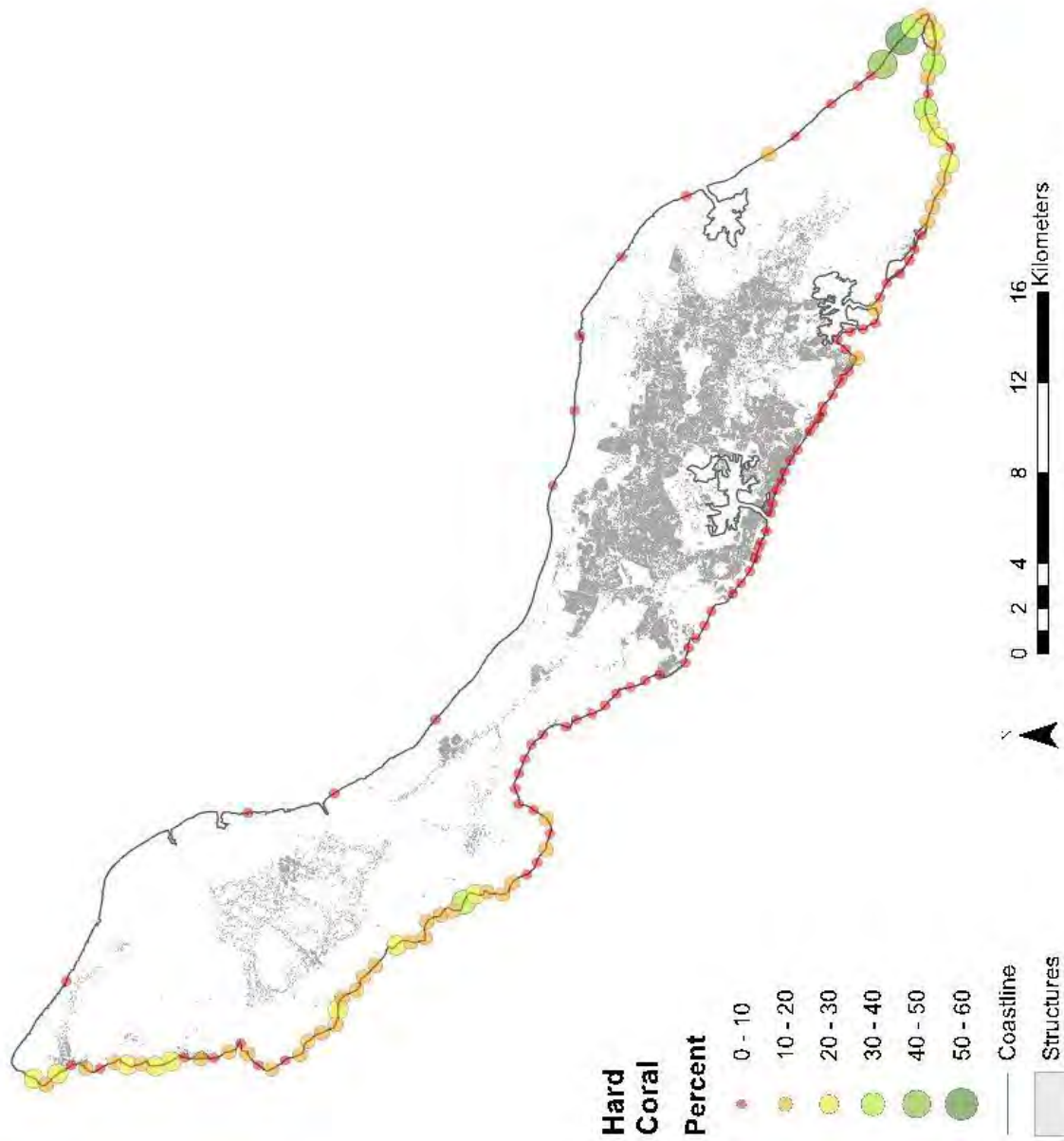


Figure 4: coral cover Curaçao reefs (CARMABI, 2016)

Since 2016 CARMABI started trying to identify and map Key Biodiversity Areas (KBA's). This to define conservation outcomes. KBA's are defined at 3 ecological levels: species, sites (or habitats) and ecological corridors (inter-connected landscapes of sites)⁷. Regarding the information, a list of potential KBA's is proposed (figure 5). The KBA's are the grey areas, the red areas represent no-fishing areas of which some of them are located within the proposed KBA's delineation. This is still a work in progress that will be validated through the consultation of local actors.



Figure 5: proposed KBA's (in red) for Curaçao

⁷ Best III Working document CARMABI 2017

Topic 1.3.1. Air quality

Statistics on air quality includes 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 at 2 monitoring stations, near the oil refinery by the Public Health Service ('GGD'), Amsterdam, Netherlands. The stations are at Beth Chaim (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 accreditation⁸.



Monitoring stations Beth Chaim and Kas Chikitu

Photo's: Government of Curaçao

For guidelines on air quality, CBS uses the Global Update 2005 of the World Health Organization (WHO)⁹.

- For SO₂ the WHO maximum concentration is 20 µg/m³, this on basis of a day, i.c. 24-hour mean
- For PM₁₀ this is 50 µg/m³, this on basis of a day, i.c. 24-hour mean

⁸ For more information, see www.luchtmetingencuracao.org.

⁹ http://www.who.int/phe/health_topics/outdoorair/outdoorair_agq/en/

Particulate matter (PM) or atmospheric particulate matter, is microscopic solid or liquid matter suspended in the atmosphere. They have effect on the climate and affect 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 PM₁₀ and fine particles with a diameter of 2.5 [micrometers](#) or less, PM_{2.5}. Total Suspended Particulates (TSP or Total SP) are tiny particles 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 no safe level of particulates. For every increase of 10 µg/m³ in PM₁₀, the [lung cancer](#) rate rose with 22% (*The Lancet Oncology*, July 2013)¹⁰.

The levels for SO₂ 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 (SO₂) and natural resources (particulates) cannot be fully excluded.

Unfortunately, the figures 6 and 7 clearly show that, though an enormous effect on the emission of SO₂, the diminishing production of the refinery in 2018 had less effect on the emissions of particulates.

These same figures 6 and 7 show (and table 10 and 11 of the appendix) that since 2010 the average concentration levels for SO₂ have exceeded the WHO levels (20 µg/m³) almost every month. The low concentrations for 2010 are not representative because the 335,000 b/d oil refinery was not active for 8 months. As can clearly be seen these high levels for SO₂ have even further increased, this for not fully known reason, until 2016. It is at least partly due to an increased production in the 2010-2015 period 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%). Since 2016 the SO₂ levels have decreased due to the diminishing production of the Venezuelan state-

¹⁰ The smaller PM_{2.5} were particularly deadly, with a 36% increase in lung cancer per 10 µg/m³ as it can penetrate deeper into the lungs (*The Lancet Oncology* 14, July 10, 2013).

owned operator of the refinery. In 2018 the production further diminished till a minimum level whereby SO₂ levels became as low as 10 µg/m³. Despite struggling for more than a year to restart the refinery, the lease ended in December 2019 and production came to a halt.

The contribution of SO₂ concentrations from the utility plant at Dokweg in relation to the total measured concentrations at Beth Chaim is estimated at 33.2 percent. For Kas Chikitu this is 36.6 percent on basis of an analysis of the 24-hour mean levels in 2013 and 2014. Though this could be true, measures taken in the summer of 2018, when there was no production, suggest that this percentage is somewhat lower.

In the past five years the levels at Beth Chaim (appendix, table 10) increased to more than 10 times the WHO maximum concentration. In 2015 this happened for 6 consecutive months with a record of almost 16 times the WHO limit. In 2016, when levels decreased, this still happened two times, in 2017 three times. This obviously did pose a serious threat for the health of thousands of people in the region and vicinity of the refinery. Due to ceasing the production in 2019, this problem, at least for the time being, has become less threatening.

As soon as the refinery get back to its normal level of production, part of the solution to cope with the pollution issue is the use of natural gas as fuel in the refining process at the refinery and the CRU/BOO plant¹¹. This can help reduce the SO₂ air pollution considerably. If production will restart indeed is unknown at this moment.

¹¹ The Curaçao Refinery Utilities (CRU) manages the BOO power plant (Build, Own and Operate), of which the Refineria di Korsou (RdK) is the owner.

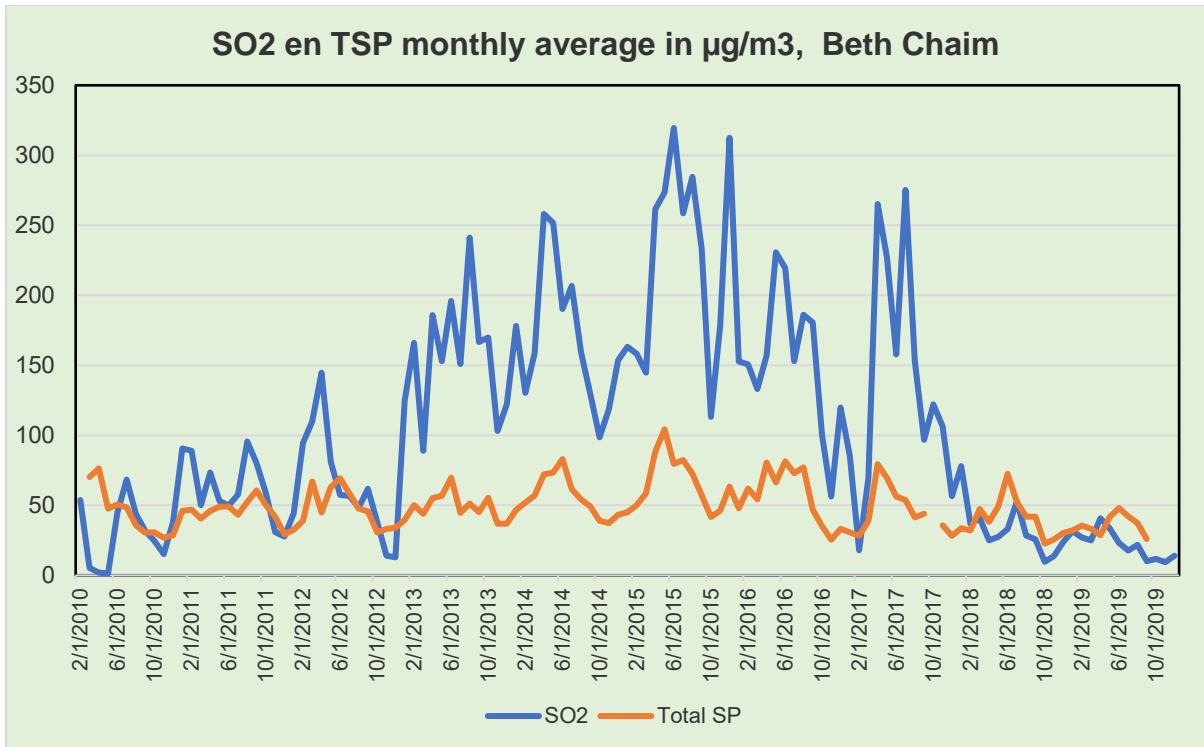


Figure 6: SO₂ and TSP, Beth Chaim

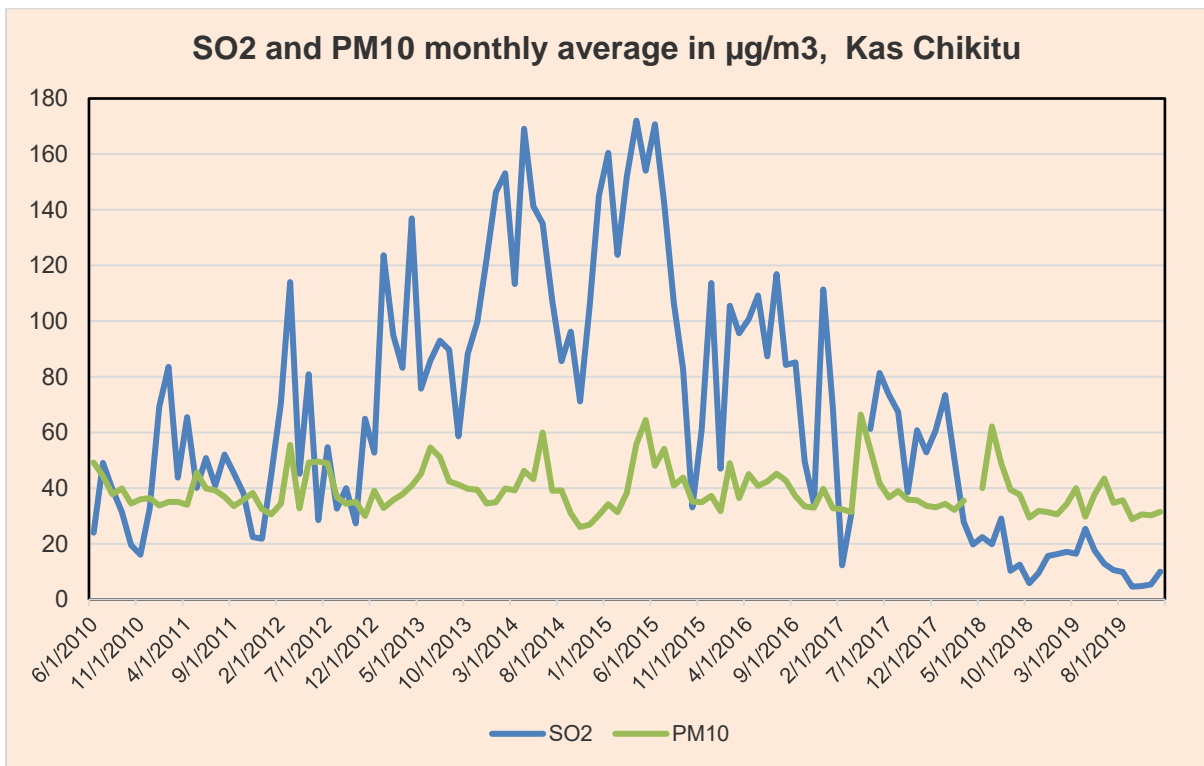


Figure 7: SO₂ and PM₁₀, Kas Chikitu

Topic 1.3.3. Marine water quality

Relevant statistics about 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	PO ₄ (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.

Sewage pollution of nearshore water is highest in the zone near Willemstad, being the most developed region on the island¹². Trash is common on reefs in especially Bullenbaai and Westpunt. Extensive dumping has occurred historically on the north shore and piles of car tires were observed at depths between 25 and 40 meters over an area that is multiple kilometers in length.

¹² The State of Curaçao's Coral Reefs, Waitt Institute, May 2017.



Clean up activity

photo: C. Jager

2. Environmental Resources and their use

Component 2 of the Core Set entails the living and non-living constituents of the earth, together comprising 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 SEEA¹³, the System of Environmental-Economic Accounting of the UN. This is partly because 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.



Pitch lake and refinery

photo: C. Jager

¹³ 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) 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 number 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.

In 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 are sufficient till 2045. As can be seen in table 13 production of blocks and sand as well as the mining index is clearly diminishing.

Limestone from the Tafelberg is used for several applications such as asphalt, concrete, plasterwork, paves, glass production and water purification.

Table 13: Stocks of mineral resources, limestone

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Production index blocks	275	252	242	242	189	194	202	187	176	176	153
Production index sand	146	145	144	140	117	125	130	133	108	105	112
Mining index CBS	211	199	193	191	153	160	166	160	142	140	132
Turnover index	100	83	75	105	90	90	112	97	102	98	96

Source: Curaçao Mining Company and CBS

The mining index is the mean of the blocks- and sand indexes

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 several 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 (Green House Gasses) and waste. It is therefore that 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 as 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 fossil fuel energies. The initial target for renewable production was set at 25% in 2015. In 2012 two wind parks became operational, supplying approximately 16% of total installed capacity. In 2017 the wind park at Terra Kora was expanded with 16.5 MW. As a result, the installed capacity increased to almost 24% which is close to the target of 25% (table 15). Per end of 2020 the total solar/wind capacity is 25.7%, slightly more than the initial target of 25%.

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. This was an overwhelming success. To capitalize on this success measures were taken at the end of 2014 by the utilities and the government by introducing a service fee. This fee, called 'solar tax' by the public, discouraged the use of solar panels. Users who like to install solar panels to generate renewable energy, had to pay 16 guilders per panel per month, businesses 32 guilders per month. The discourage policy for solar energy (and so, encouraging the use of fossil fuels) has proven to be effective. While the projection for 2016 was 28.6 MW, the real installed capacity turned out to be no more than 11.1 MW (38.8% of the projection). For several reasons, action has been taken and since January 2018 the service fee has been reduced to 8 guilders per panel per month for households and 16 guilders for businesses.

The oil import in volumes has already been decreased in the past and will likely decrease more if the intentions to invest more in sustainable energy like wind, solar power and the construction of a 15 MW solar park, will be executed. Although still a lot has to be done the route is set towards a new era with less oil and more renewables.

Potable water is currently provided in adequate numbers for residents and visitors.¹⁴ However, uncertainty around future demands, particularly those linked to tourism, necessitate actions to maintain this water production security in the long-term. The capacity margin (production minus demand) will decline in case that both the residential population increases, and the tourist numbers grow.

Table 14: Production and use of energy

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Water production (1000 m3)											
	13,846	14,398	14,560	14,495	14,232	13,759	14,141	14,648	15,193	14,974	14,345
Connections*:											
		73,764	75,030	76,522	77,804	79,304	80,619	82,324	83,654	84,176	86,758
Electricity production (1000 kWh, incl. production from CRU and windparks)											
	868,910	902,239	910,254	894,064	872,259	878,000	883,700	887,471	865,867	880,160	844,128
From windparks:											
			62,700	116,600	133,200	144,200	121,919	169,100	233,760	217,807	191,387
% from wind:											
			6.9	13.0	15.3	16.4	13.8	19.1	27.0	24.7	22.7
Connections*:											
		73,079	74,411	76,075	77,259	78,746	80,079	81,588	82,068	75,208	
Wind: installed capacity in MW per Dec.											
	8	8	30	30	30	30	30	46.5	46.5	46.5	46.5
Solar: official installed capacity in MW per Dec.											
	nihil	nihil	0.1	3.1	7.7	10.1**	11.1	11.1	11.9	11.9	13.2

Sources: Aquallectra (water and electricity, all info for 2017), Nucapital (wind), BTP (solar), CBCS (Refinery)

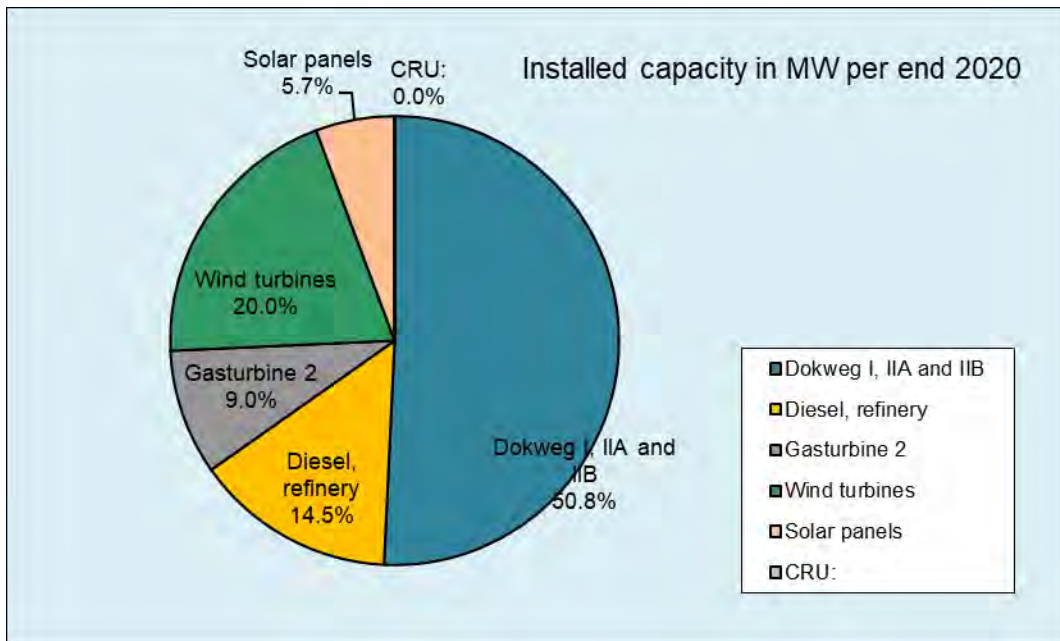
* each December

** adapted projection (due to the introduction of the 2015 service fee) from 28.6 to 20 MW , later to 10.1

¹⁴ Evidence-based infrastructure in Curaçao, UNOPS, May 2018.

Table 15: product mix electricity, installed capacity

per end of 2020	MW	%
Dokweg I, IIA and IIB	117.8	50.8
Diesel, refinery	33.6	14.5
Gasturbine 2	21.0	9.0
Wind turbines	46.5	20.0
Solar panels	13.2	5.7
CRU:	0.0	0.0
Total:	232.1	100.0



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, groundwater abstraction is widely used, 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, in Curaçao this is the case. According to the production company (December 1989) the 'non-revenue water' (also called unaccounted for water) amounted to 30% of the distributed volumes of water. Of this percentage 13.5% was due to physical losses and 17.5% to so-called administrative losses, including water use through illegal connections. In 2006 the same percentage of 30% was mentioned in an advisory report of drs. M. Karskens¹⁵. More recent figures of 2013 from the Bureau for Telecommunication, Post & Utilities (BTP&U) show that the losses of non-revenue water were 24 to 28% of total production. These figures are confirmed by the UNOPS report of May 2018. According to BTP&U (World Bank 2006¹⁶) a level of non-revenue water for developing countries of 17.5% is reasonable.

Bearing in mind that potable water in Curaçao is strongly related to energy (it is produced by desalinating seawater in conjunction with electricity production) the high levels of unaccounted for water represent a serious economic cost. In 2014 this can be estimated at 24% of 14.2 mln. m³ which is 3.4 mln. m³. For that reason, several actions and programs of reducing water losses has been embarked upon by the water producing- and distributing company. The most recent action plan is focused to reduce the water losses in 3 years to 17 percent by 2018. According to the UNOPS report the percentage of non-revenue for 2017 was 23% which corresponds with a loss of 3,4 mln. m³.

¹⁵ Drs. M.W.R. Michiel Karskens, (September 2006). *Energieconsument op Curaçao*

¹⁶ 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 contains flows from the economy to the environment. Its statistics gives 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 materials that are discarded, discharged or emitted directly to the environment or be captured, collected, treated or reused. The main groups of residuals are emissions, wastewater and waste.



Illegal dumping

photo: Uniek Curaçao

Topic 3.1.1. Emission of Green House Gases (GHG's)

A special category of air emissions is the emissions of GHG's. Emission inventories of GHG's are compiled according to the guidelines developed by the IPCC¹⁷, under the auspices of the UN Framework Convention on Climate Change (UNFCCC). GHG's include both direct and indirect GHG's, such as Sulphur dioxide (SO₂) and nitrogen oxides (NO_x). The most important GHG's are both direct and are carbon dioxide CO₂ and methane CH₄. Though methane is not very common on Curaçao its relative impact is high because of the high global warming potential (GWP) relative to CO₂. According to the IPCC Fifth Assessment Report of 2014 the GWP is 28 times CO₂.

At the end of 2011 a first Greenhouse Gas Inventory or 'Carbon Footprint study' has been executed for Curaçao for the year 2010. This is by CBS in cooperation with Kool Caribe Consult. Such a Footprint gives information about the contribution of Curaçao to emissions of GHG's which are the most important and fundamental cause of the greenhouse effect and climate change. By the end of 2016 a second GHG inventory has been made by the CBS for the year 2015 and in 2019 a third one for the year 2018. The next inventory will be made for the year 2021.

As can be seen in table 17 most of the emissions in 2018 are related to production of energy for the refinery and utilities, waste (landfill) and transport. The relative low production of GHG's by the refinery (8.8%) is due to a decrease in production of the refinery in 2018. The contribution of the utility industry is limited to 16.5 percent. Landfill (waste) counts for almost 18 percent and transport more than 17 percent. The 2018 emissions of Curaçao in comparison to 2015 show a reduction of 1870 kton, i.c. almost 45 percent in 3 years.

¹⁷ 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)

Tabel 17: GHG's 2018: CO₂ and CH₄

	2010		2015		2018	
	kton	relative	kton	relative	kton	relative
Transport	420.4	9.30%	407.8	9.80%	399.7	17.30%
Cooking, natural gas	23.8	0.50%	23.4	0.60%	27.8	1.20%
Production of electricity and water	795.4	17.70%	409.6	9.80%	381.4	16.50%
Industry: refinery	1446.1	32.10%	1609.9	38.50%	202.3	8.80%
Industry: production of energy for refinery	1418.9	31.50%	1325.9	31.70%	880.5	38.20%
Industry: production of concrete	10.1	0.20%	7.1	0.20%	6.5	0.30%
landfill	387.6	8.60%	394	9.40%	409.7	17.80%
Total:	4502.3	100.00%	4177.9	100.00%	2307.8	100.00%

Source: Carbon Footprint Study CBS

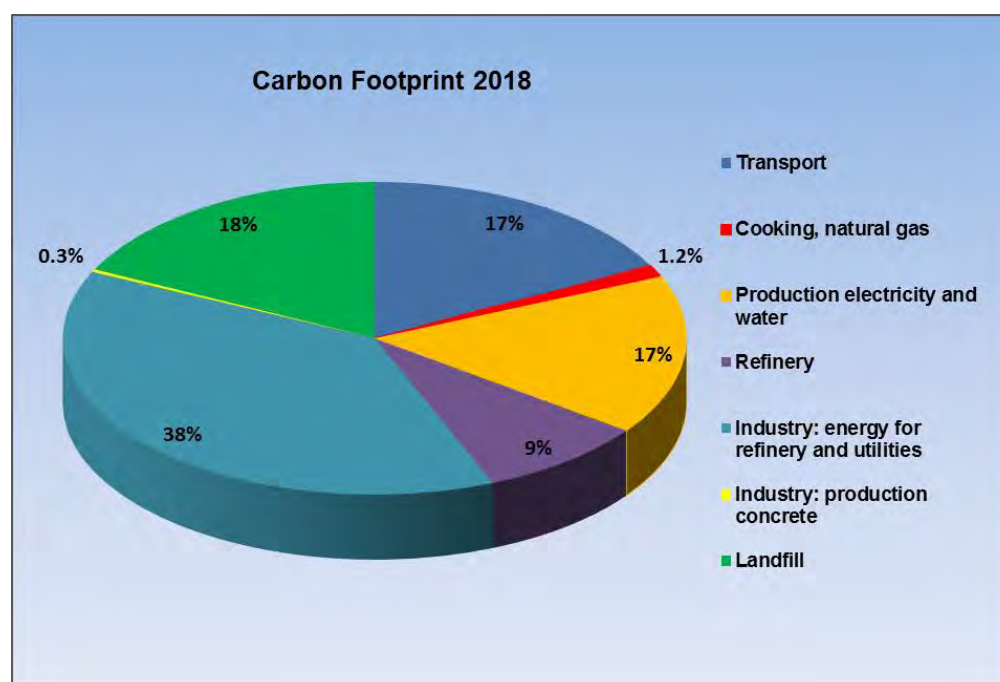


Figure 9: relative share of emissions

Tabel 18: Emissions and benchmarks GHG's 2018

	capita:	160012	per capita in ton CO ₂
Total Curaçao 2018	kton CO ₂	2308	14.4
Total excl. refinery / CRU	kton CO ₂	1225	7.7
	Eur. Union	3548000	7
	World	37077000	4.9
	Aruba	959	9.1
	Kuwait	97200	23.5
	Netherlands	174800	10.3
	Trinidad	37700	27.6
	Colombia	75000	1.5
	China	10877000	7.7
	U.S.A.	5107400	15.7

Topic 3.2.2. Collection and treatment of wastewater

Generated waste water basically can be discharged in two ways. It can be discharged directly to the environment by the generator, or it can be collected in sewerage systems and treated in sewage treatment plants (STP's).

The collection and treatment of wastewater on Curaçao is very important. Especially because 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. Indications are that sewage waters are probably a major problem.

Nowadays 33 percent of the households and businesses are connected to the sewage system¹⁸. Transported by approximately 390 km. of sewage pipelines it is brought to 4 sewage treatment plants at Klein Hofje, Klein Kwartier, Tera Kora and Abattoir (table 19). Their total capacity is more than 5100 m³ per day and the treatment consists of 3 steps: a mechanical, a biological and finally a chemical treatment. In

¹⁸ U. Cordilia, UNOPS Kick-off workshop 2018.

2017, around 16 percent of the wastewater was treated, the remaining 84 percent untreated and was discharged into the terrestrial and marine environment¹⁹.

Table 19: Sewage Treatment Plants, capacity

per end of 2016	m3/day	%
Klein Hofje	3200	62.2
Klein Kwartier	1752	34.1
Tera Kora	166	3.2
Abattoir	25	0.5
Total:	5143	

Source: Dept. of Public Facilities

Wastewater collected at the sewage treatment plant Klein Hofje in Curaçao typically contains about 83 ppm of N products, this value is probably indicative for other local wastewater as well. There is also some seepage of sewage water via inner bays (Spanish water, Schottegat, Piscaderabay) 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 Development²⁰. An adequate management of waste is

¹⁹ Evidence-based infrastructure in Curaçao, UNOPS, May 2018.

²⁰ National Report of Curaçao for the 3d Conference on SIDS, September 2014

essential for the protection of public health and the environment. 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.

A notable challenge beyond that of solid waste management is the management of toxic substances such as pesticides, waste oil and heavy metals. Currently there is a limited capacity to manage or dispose toxic waste substances, which results in significant risks to terrestrial marine environments.

Recycled materials consist mainly of building materials (more than 98%). The high figures for 2014 and especially 2015 are due to the dismantling of the St. Elisabeth hospital. The main infrastructure for solid waste is the 45-hectare sanitary landfill at Malpais. It has a remaining estimated lifetime until 2026.

The amount of total waste collected per capita per day is 3.3 kg. For the year 2020 this is almost 1200 kg/capita, which is very high and three times compared to the amount in Latin America and the Caribbean.²¹

Table 20: Municipal waste collected

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Deposited on Landfill	173,907	176,786	180,874	143,930	168,743	176,806	156,540	158,852	183,824	147,460	125,310
Recycled	18,468	14,728	29,797	11,729	53,110	80,357	21,137	14,193	13,441	20,556	61,854
Burned	63	155	70	147	94	81	81	78	98	86	80
Total waste:	192,438	191,669	210,741	155,806	221,947	257,244	177,758	173,123	197,363	168,102	187,244
Population:	147,122	150,284	151,378	152,798	154,843	156,971	158,989	160,337	160,012	158,659	156,223
Waste/capita/day: (kg)	3.6	3.5	3.8	2.8	3.9	4.5	3.1	3.0	3.4	2.9	3.3

In 1000 kg. Recycling at CRC: Curaçao Recycling Company
Burning at CIC; Caribbean Incineration Company

Source: Selikor

²¹ Waste Management Outlook, UNEP, October 2018.

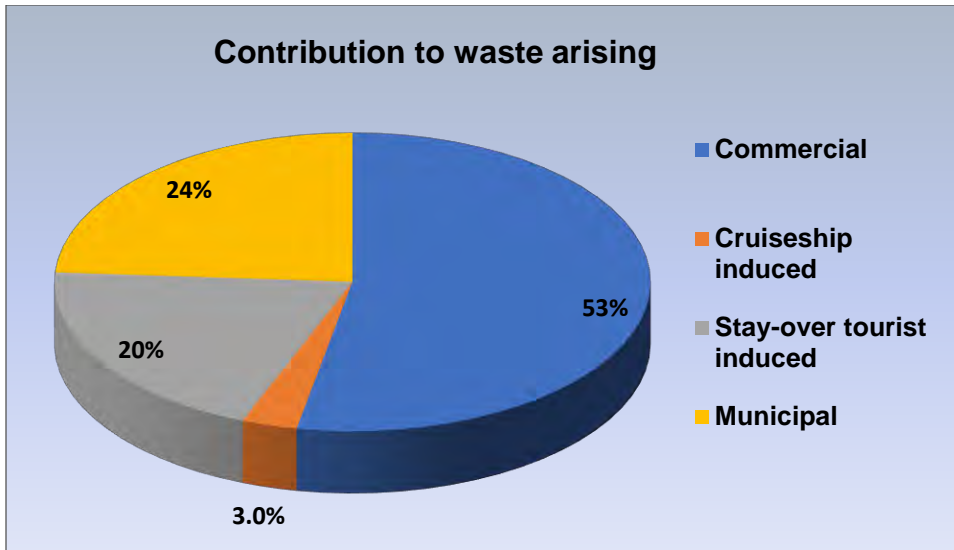


Figure 10: contributions to waste. Source: UNOPS report May 2018.

4. Extreme Events and Disasters

This component contains statistics regarding the occurrence and impacts of extreme events and disasters on human well-being and on the infrastructure. It consists of two sub-components:

- Natural Extreme Events and Disasters; frequency and intensity, 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 arising as a result of human intent, negligence or error, or from faulty or failed technological applications.



Hurricane Tomas

photo: 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 because 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 into this subcomponent a disaster should be categorized using the CRED criteria. This means that at least one of the following criteria must be fulfilled:

- Ten or more people reported killed.
- One hundred or more people reported affected.
- Declaration of a state of emergency, or
- 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 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 and will face increasing social and economic impacts.

November 1, 2010: Hurricane Tomas. The damage caused by this hurricane is estimated at Ang 200 mln. and caused at least two deaths. 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, it moved through the [Windward Islands](#) and passed [Saint 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 many as 265 mm were recorded over a 24-hour period in the eastern part of the island. Most 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 \$10 million²². 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 [NAf110 million](#) (\$63mln), though total damage costs from Tomas were estimated at [NAf200 million](#) (\$115 million).²³

²² Sharlon Monart (November 3, 2010). '[Miljoenenschade Tomas aan woningen, winkels en bedrijven](#)'

²³ Sharlon Monart (November 25, 2010). '[Helft schade Tomas niet te verhalen](#)'. [Radio Netherlands Worldwide](#)



photos: Curaçao Chronicle

March 2020: Covid 19 pandemic. On March 2020 the World Health Organization (WHO) declared the coronavirus, Covid-19 outbreak a global pandemic. During those days the virus spread rapidly from China to other countries, including the Caribbean and Curaçao. During the year it has sickened more than 1321 people and 126 had to be hospitalized. Unfortunately, 14 people died that year from the virus, most of them with underlying complaints. Besides health, the pandemic had a devastating effect on employment and the economy. Hundreds of businesses had to close and many of them went bankrupt, causing many to lose their work and income and thus increasing poverty. The economic contraction for 2020 was estimated at an incredibly high percentage of 18, which is also high in comparison with the Caribbean (12.6%)²⁴.

Topic 4.2. Technological Disasters

Disasters may arise because of human intent, negligence, or error, or from failed technological applications. Policy makers, analysts and civil society require statistics on technological disasters to understand who is ultimately responsible, what the immediate and potential impact may be, and 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.

²⁴ World Bank, 'The World Bank in the Caribbean', April 2021

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

- Industrial accidents which cover accidents associated with chemical spill, 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 Sint 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 Naf 10.000.

Just 8 days later there was a disaster at the Amuay refinery at nearby Punto Fijo (Venezuela) when a gas leak set of an explosion August 25, killing 42 people and sending toxic black clouds of smoke into the air (source Curaçao Chronicle).

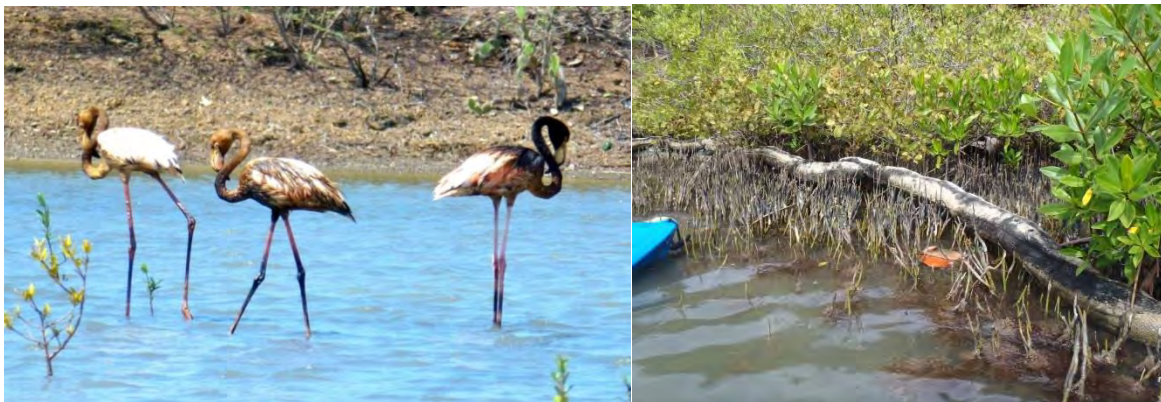


photo: Curaçao Chronicle

photo: Uniek Curaçao

December 15, 2012: Fire Work Explosion. An explosion in a firework warehouse on an industrial estate claimed the lives of four persons, one died at the scene, the others later. Furthermore, it wounded another 4 of which 1 seriously. The building and 3 cars were destroyed. The cause of the incident is still unknown for (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 about 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 those posed by extreme events and disasters) can be substantially mitigated or increased by several factors. These factors 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.



Neighbourhood of Penstraat

photo: C. Jager

Topic 5.1.1. Urban and rural population

Humans live primarily in rural or urban communities²⁵, 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. Population data 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 (population/km²). These statistics are a very important and a 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](#)²⁶ 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 Encyclopedia).

In January 2018, total official population of Curaçao decreased very slightly to 160,012 inhabitants with a population density of 361 people/km². This is high and comparable with Japan (347), the Philippines (358) and Puerto Rico (360). Other benchmarks for population density are Caribbean small states; 18, Colombia; 45, Dominican Republic; 220 and the Netherlands; 511²⁷. The number of households in 2018 was 58384.

²⁵ At present there are no (separate) urban and rural population figures. However, in the future the CBS is planning to do so.

²⁶ 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.

²⁷ World Bank figures 2018.

Table 21: Population Curaçao 2000-2020

	Total	Male	Female	Sex ratio ¹⁾	Pop./km2	Pop. growth	%	H.H.
2000	136969				308			44442
2001	130822	60643	70179	86.4	295	-6147	-4.5	43173
2002	127296	58860	68436	86.0	287	3847	3.0	42415
2003	131143	60542	70601	85.8	295	1512	1.2	44123
2004	132655	60843	71812	84.7	299	3092	2.3	45071
2005	135747	62222	73525	84.6	306	3849	2.8	46580
2006	139596	63901	75695	84.4	314	3306	2.4	48381
2007	142902	65457	77445	84.5	322	2318	1.6	50029
2008	145220	66447	78773	84.4	327	1323	0.9	51361
2009	146543	67044	79499	84.3	330	579	0.4	52364
2010	147122	67429	79693	84.6	331	3162	2.1	53120
2011	150284	68700	81584	84.2	338	1094	0.7	54834
2012	151378	69120	82258	84.0	341	1420	0.9	55233
2013	152798	69860	82938	84.2	344	2048	1.3	55751
2014	154846	70824	84022	84.3	349	2125	1.4	56499
2015	156971	71713	85258	84.1	354	2018	1.3	57274
2016	158989	72660	86329	84.2	358	1349	0.8	58010
2017	160338	73320	87018	84.3	361	-326	-0.2	58502
2018	160012	73172	86840	84.3	360	-1347	-0.8	58384
2019	158659	72538	86121	84.2	357	-1353	-0.9	61471
2020	156223	71277	84946	83.9	352	-2436	-1.6	

Source: Population and Housing Census 2001 and 2011; Population Registry

CBS estimates are compiled from various data sources and publications of the CBS.

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 of SDG indicator 6.2.1²⁸ defines an improved sanitation facility as one that hygienically separates human excreta from human contact, and includes flush

²⁸ The Sustainable Development Goal (SDG) indicator 6.2.1 is the proportion of population using (a) safely managed sanitation services and (b) a hand-washing facility with soap and water.

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 22: 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	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: census CBS

Table 23: Occupied living accommodations by type of sanitation

Drainage of the toilets via:	2001	%	2011	%
The cesspool ('beer put')	31123	72.1	42375	77.1
The septic tank	n.r.		1703	3.1
The sewage	9801	22.7	10209	18.6
Other	379	0.9	240	0.4
Not applicable	50		208	
Not reported	133		201	

Source: census CBS

Table 24: 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

** Inclusive solar power

Source: census CBS

Topic 5.1.5. Environmental concerns specific to urban settlements

The topic of environmental concerns is meant 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.

About 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 25: Number of motor vehicles

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Passenger cars	80973	61,578	69,035	67,998	69,062	69,574	72,848	75,709	77,332	74,753	51,147
Pick-ups	15878	12,021	12,908	12,377	12,079	12,768	11,814	11,869	11,739	10,564	9,272
Motor buses	434	379	369	346	297	331	318	319	317	282	267
Taxis	193	179	159	138	141	138	132	128	152	140	117
Other cars	319	163	404	472	459	500	604	434	507	867	931
Total cars and buses:		74,320	82,875	81,331	82,038	83,311	85,716	88,459	90,047	86,606	61,734
Motorcycles, incl. mopeds	1944	1,117	1,300	1,689	1,757	1,758	1,439	1,310	1,172	1,447	1,174
Passenger cars/km ²	888	139	155	153	156	157	164	171	174	168	115

Note: excluding motor vehicles owned by the government

Number of motor vehicles registered, per Dec. 31

The relative low number of cars in 2011 is due to an administrative clean up of the data

Numbers for 2010 are not considered to be reliable

The number of passenger cars 2020 is due to the fact that during COVID-19 many did not pay their motor vehicle tax

Source: Collector's office, '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, SO₂ or O₃). 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 SO₂ emissions from the refinery, there is no statistical information available on this topic.

The Coronavirus 2019 (COVID-19) is airborne through droplets to being airborne, typically in indoor settings. It is a contagious disease caused by the severe acute respiratory syndrome coronavirus 2 (SARS-CoV-2). The first case was identified in Wuhan, China, in December 2019. The disease has since spread worldwide, leading to a pandemic.

Symptoms of COVID-19 are variable, but often include fever, cough, fatigue, breathing difficulties, and loss of smell and taste. Of those people who develop symptoms, most (81%) develop mild to moderate symptoms, while 14% develop severe symptoms and 5% suffer critical symptoms (respiratory failure, shock, or multi-organ dysfunction). Older people are more likely to have severe symptoms. At least a third of the people who are infected with the virus remain asymptomatic and do not develop noticeable symptoms at any point in time, but still can spread the disease.

As has been said in Topic 4.1 it has sickened more than 1321 people in the year 2020. Of those cases 126 had to be hospitalized of which 14 people died, most of them with underlying complaints.

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 labour force and on the economic costs. In Curaçao there are no recent known cases of legionella. 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 labour force and on the economic costs.

Official figures from 2017 till now do not give a good impression of the actual situation. This because many patients who visit a medical are not referred to a laboratory. The *estimated* number of persons with Dengue, Chikungunya or Zika for 2017 is 29.260. This is 24 percent of the adult population. From 2018 on there were no sincere outbursts anymore of Dengue, Chikungunya or Zika.

Table 26: Vector borne diseases

	2010	2011	2012	2013	2014	2015	2016	2017	2018
Dengue *									
Chikungunya	2800	2654	720	680	167	39	309		
Dengue and Chikungunya **					1657	1847	1847		
Zika					3587	686	3405		
Zika and Dengue						1***	1725		
Zika and Chikungunya							185		
Zika, Dengue and Chikungunya							14		
							7		

Source: Ministry of Health, Environment and Nature

* DF, DHF and probable and suspected cases

** Including suspected cases

*** 14 cases were tested, only 1 was confirmed

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 fever.

Chikungunya is an [infection](#) caused by the Chikungunya [virus](#). Symptoms include [fever](#) and [joint pain](#). These typically occur two to twelve days after exposure. Most people are cured within a week.

Zika is [spread](#) by daytime-active [Aedes](#) mosquitoes. Its name comes from the [Zika Forest](#) of Uganda. Zika virus is related to the [dengue](#), [yellow fever](#), [Japanese encephalitis](#), and [West Nile](#) viruses. Since the 1950s, it has been known to occur within a narrow equatorial belt from Africa to Asia. [From 2007](#) to 2016, the virus spread eastward, [across the Pacific Ocean](#) to the Americas, leading to the [2015–16 Zika virus epidemic](#).

6. Environment Protection and Management

A country's engagement in the protection and management of the environment, and therefore the number 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.



Coastal development

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 of that year.

Government expenses on protection the environment consist mainly (98%) on subsidizing the national waste company Selikor. In 2018 total government expenses diminished from almost Ang. 35 million (2017) with 5.5 percent to Ang. 33.1 million.

Table 27: Government protection expenditures		In Ang. 1000									
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
subsidy Selikor		29,380	29,267	29,493	32,949	32,030	30,624	32,715	31,069	35,076	23,828
sewerage and water purification		40	pm	pm	pm	pm	pm	pm	pm	pm	pm
subsidy Carmabi		359	306	315	291	291	291	291	281	279	260
subsidy Schoon Curaçao						75					
subsidy Punda Limpi I Bonita						26	2				
subsidy Parke Tropikal		250	250	453	438	513	475	397	381	374	425
Protection expenditures (tot:	n.a.	30,029	29,823	30,261	33,678	32,935	31,392	33,403	31,731	35,729	24,513

source: Ministry of Finance, Carmabi, CBS and Selikor.

7. Tourism

Tourism is one of the most important activities in many of the Caribbean countries contributing significantly to the economies. Tourism industries benefits 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, 2014²⁹). The key drivers are local environmental NGO's 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).

Due to severe Covid restrictions, a lockdown and even a temporary closing of the airport, tourism suffered strongly in 2020 and in some sectors even came to a complete hold. Also, for visitors from low-risk countries. The number of cruise ship passengers declined with 68 percent, stay-over tourism with 58 percent, passenger arrivals with 63 percent and the average hotel occupancy declined to a historically low rate of 34 percent.

²⁹ National Report of Curaçao for the third Conference on SIDS, September 2014.



Playa Lagoon

photo: C. Jager

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 visited³⁰. 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 visitors (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, then returns with new passengers within the same month.

³⁰ Definitions of CARICOM, *International Recommendations for Tourism Statistics 2008*

Table 28: Cruise ship arrivals

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Ships	220	246	226	293	290	254	232	282	297	309	100
Passengers	383,589	400,596	436,068	583,994	596,709	511,085	469,498	634,370	760,566	809,874	256,033

Table 29: Stay-over tourism

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Total numbers:	341,651	436,255	472,095	487,258	500,044	505,749	474,349	423,217	452,387	483,137	180,209
Nights:	2,888,443	3,184,932	3,674,700	3,754,311	3,984,212	3,848,351	3,612,155	3,578,649	3,912,704	4,131,922	1,750,181

Source: CTB

Table 30: Tourism ratio's

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Tourist Penetration ratio	5.4	5.8	6.7	6.7	7.0	6.7	6.2	6.1	6.7	7.1	3.1
Tourism Density Ratio	17.8	19.7	22.7	23.2	24.6	23.7	22.2	22.1	24.1	25.5	10.8
Tourism Intensity rate	5.2	6.5	7.0	7.2	7.2	6.7	6.3	5.6	6.4	6.9	2.6

Source: CBS

* = average length x number of visitors

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 shows 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/km²

Table 31: Hotels: rooms and occupancy

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Number of rooms:	5,421	5,776	6,038	6,180	6,405	6,490	6,332	6,693	7,970	8,209	8,565
Occupancy %	72	76	70	67	70	71	68	73	75	72	34

Source: Curaçao Tourist Board and CBS

The number of rooms only includes officially registered ones and does not count alternative accommodations offered by Webpages like AirBnB and Home away.

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.

The low occupancy rate for 2020 is due to the Covid 19 pandemic.

Table 32: Passengers by Air

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Arriving:	635,495	705,093	731,070	732,865	733,887	764,293	733,674	659,161	673,167	671,587	251,306
Departing:	631,410	684,307	708,997	728,461	730,549	763,087	741,039	662,279	669,892	696,512	263,008
Transit:	147,165	239,706	317,101	260,175	210,042	204,909	211,515	90,537	59,000	86,160	23,686
Total:	1,414,070	1,629,106	1,757,168	1,721,501	1,674,478	1,732,289	1,686,228	1,411,977	1,402,059	1,454,259	538,000

Source: Curaçao Airport Partners N.V.

Appendix Air traffic

Please click <https://www.cbs.cw/environment-publications> for the tables:

- Air quality: Beth Chaim (industrial area)
- Air quality: KAS CHIKITI

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