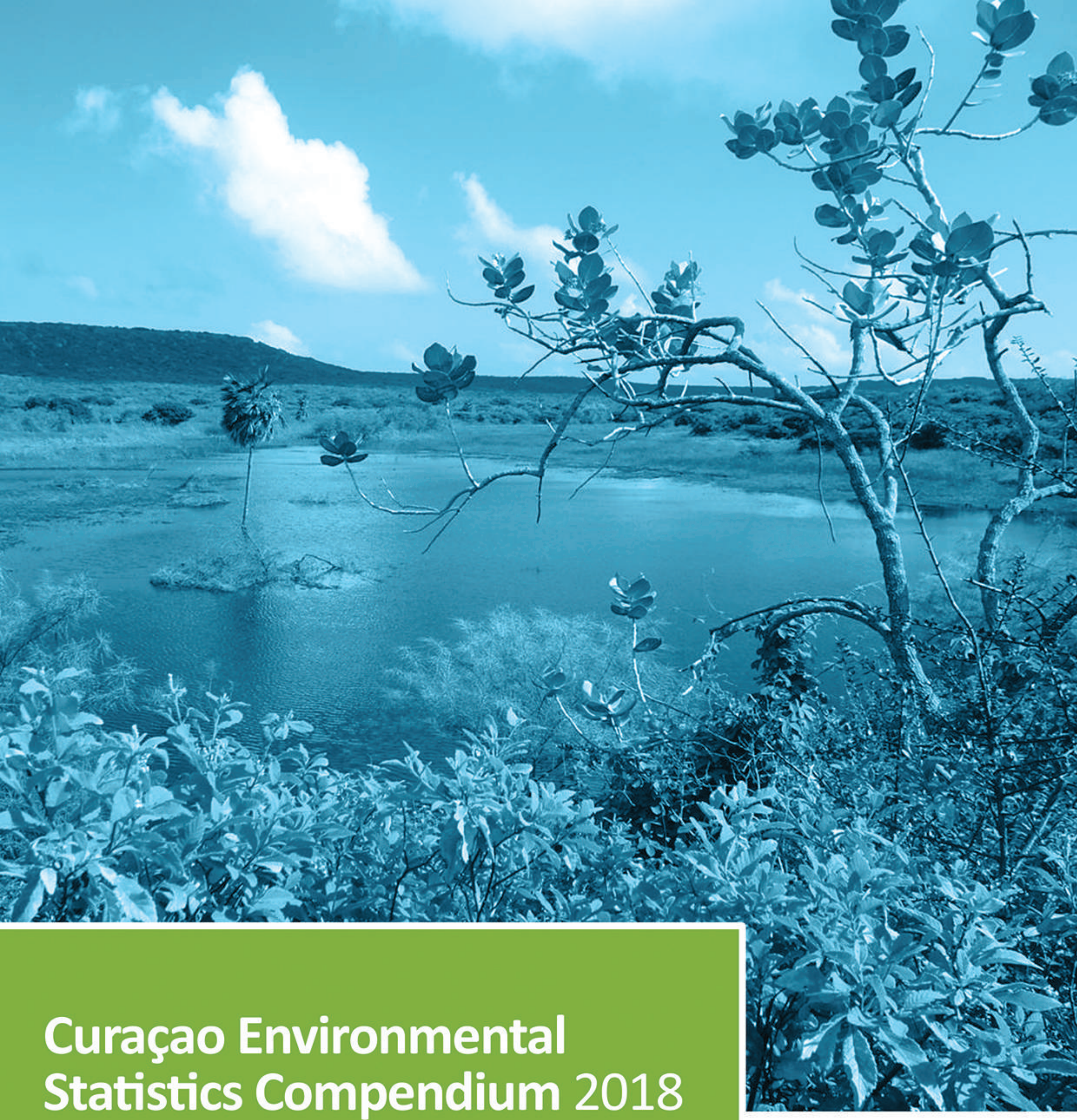

Curaçao Environmental Statistics Compendium 2018

Central Bureau of Statistics Curaçao

CURAÇAO

ENVIRONMENTAL STATISTICS

COMPENDIUM 2018

Central Bureau of Statistics Curaçao

Willemstad, September 2020

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Preface

The Central Bureau of Statistics (CBS) of Curaçao is very pleased to release its fourth issue of the Environment Statistics Compendium. As has been said in the former publications, it is the intention to update the Compendium annually.

A compendium is a collection of information in which a brief summary is presented on environmental Statistics. The data collected is based on the principles of, the for Curaçao adjusted version, of the Core Set of the FDES, the Framework for the Development of Environmental Statistics of the U.N. 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 that 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 2018.

Mr. Chris Jager, senior statistician Business Statistics and Environmental Statistics, writes this publication.

Drs. Sean de Boer,

Director

Cover photo: Savonet as seen from Christoffelberg, C. Jager

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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
MDG	Millennium 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. Also 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 and a refinery which is struggling with modern environmental requirements.

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 other developing countries and SIDS, 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 third Compendium 2018 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 has to 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 in order 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 actually 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**, 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.

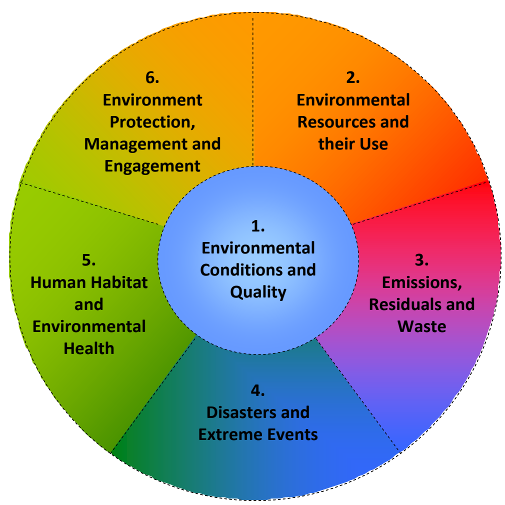

Figure 1. The FDES components

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 developing and thus the availability of environmental information will increase in the near future. 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 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.

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 conditi0ons 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.

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**
2016	26.6	27.1	27.7	28.3	28.9	29.2	29.2	29.5	29.3	29.4	28.2	27.3	**28.4**
2017	26.2	26.7	27.2	28.1	28.5	28.6	28.8	29.2	29.8	29	28.4	27.5	**28.2**
2018	27.2	26.2	27	27.6	27.9	28.1	28.2	28.8	29.2	28.1	27.9	26.8	**27.8**
5 year mean	26.4	27.0	27.4	27.9	28.3	28.7	28.7	29.2	29.5	29.2	28.2	27.4	**28.1**

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**
2016	30.1	30.7	31.2	31.7	32.5	33.0	32.8	33.4	33.1	33.0	31.2	30.0	**31.9**
2017	29.0	30.0	30.5	31.5	32.1	32.1	32.3	32.9	34.0	32.7	31.5	30.5	**31.6**
2018	30.3	29.4	30.5	31.4	31.0	31.4	31.5	32.3	33.2	31.0	31.1	30.1	**31.1**
5 year mean	29.8	30.6	30.8	31.3	31.7	32.0	32.2	32.8	33.3	32.7	31.2	30.3	**31.5**

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**
2016	24.5	25.3	25.7	26.5	27.1	27.2	27.1	27.5	27.1	26.9	25.7	24.9	**26.3**
2017	23.9	24.1	25.2	26.2	26.4	26.4	26.4	26.9	27.2	26.5	26.6	25.2	**25.9**
2018	24.9	23.4	24.9	25.5	26.2	26.2	26.2	26.5	26.8	25.6	25.4	24.7	**25.5**
5 year mean	24.1	24.9	25.3	26.1	26.4	26.7	26.6	27.0	27.2	26.9	25.7	25.2	**25.9**

1) Average of daily 24 hourly observations

Rainfall

Curaçao Int. Airport

Table 4: 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	1	12	13	15	13	41	125	19	181	86	**529**
2014	29	11	0	1	6	7	15	36	17	55	146	60	**384**
2015	38	15	62	16	3	2	16	6	10	28	131	12	**340**
2016	8	4	5	2	2	10	28	3	53	37	282	106	**541**
2017	97	11	25	7	29	33	34	32	24	69	79	80	**519**
2018	36	97	1	6	2	24	41	22	32	262	42	32	**597**
5 year mean	38.2	9.2	18.7	7.4	10.7	13.4	21.2	23.7	45.7	41.6	163.9	68.7	**476**

Table 5: 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**
2016	2	1	1	1	1	2	5	1	7	5	16	14	**56**
2017	13	2	7	1	3	8	6	6	3	7	4	17	**77**
2018	8	15	1	1	1	3	7	4	6	13	11	8	**78**
5 year mean	8	2	3	1	2	3	5	4	5	5	11	11	**64**

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 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 al[1] (figure 3).

Concerning geographical information it can be said that the countries 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 (http://www.unesco.org/csi/pub/papers/pors.htm)

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

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

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 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".

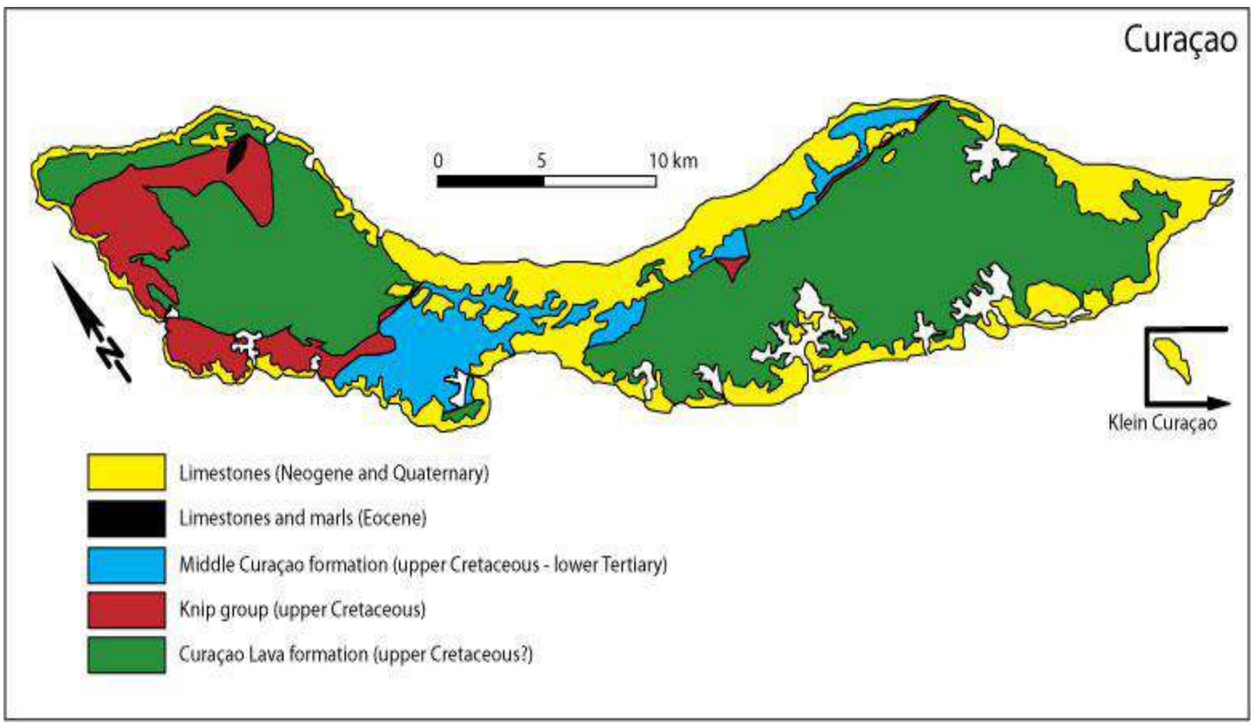

Figure 2: Geological map Curaçao. Source: CARMABI 2014

The <u>vegetation of the island</u> 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 comprises 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 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 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 Kanoa to Oostpunt including the St. Joris Bay.

Christoffel National Park   photo: C. Jager

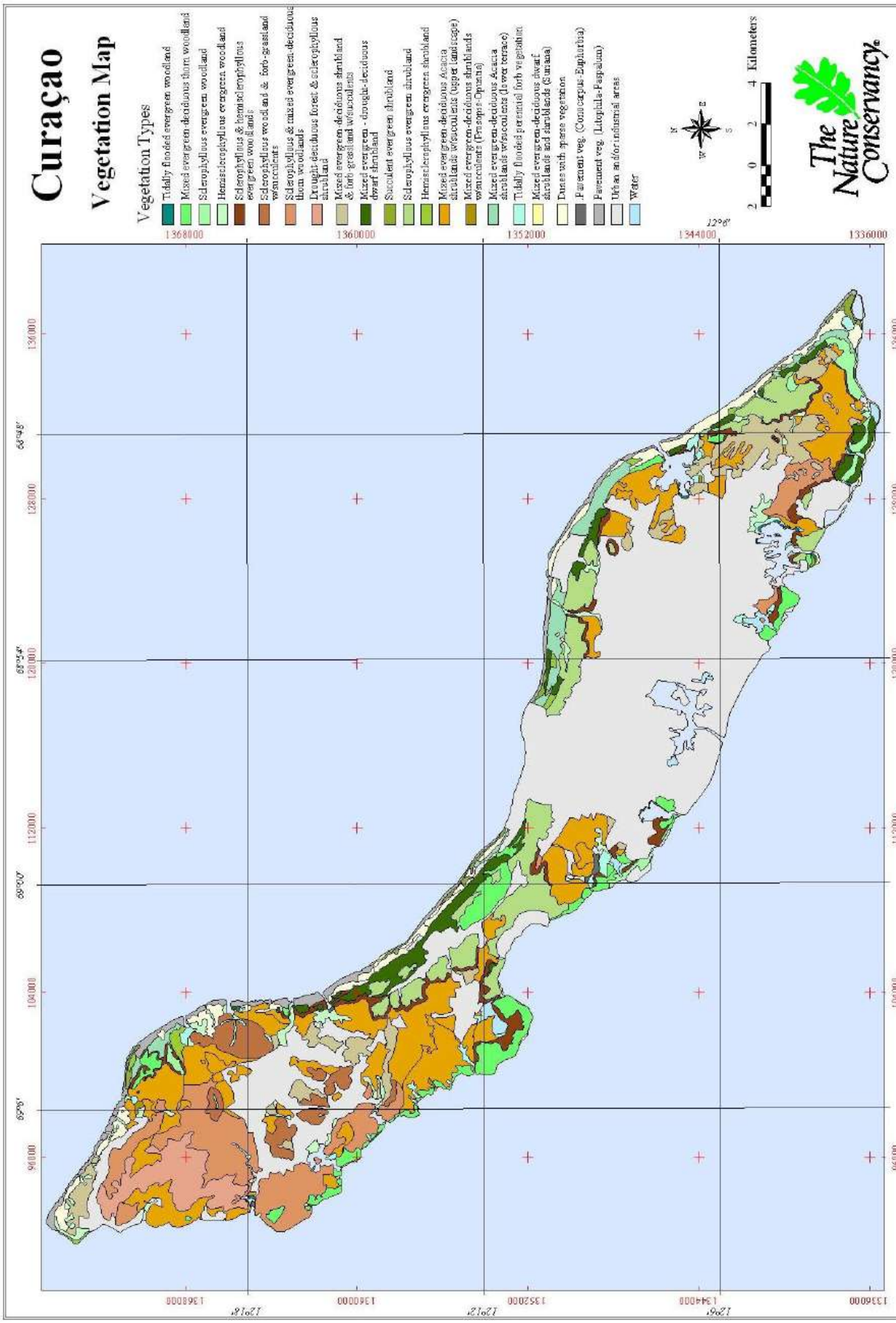

Figure 3: Curaçao Vegetation map 1997

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.

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 times[2]. 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 (0,27%). Both Green Turtles and Hawksbills nest on Curaçao and can be seen along

[2] Waitt Institute, May 2018.

the entire coast and Klein Curaçao. Fishing gear entanglement, illegal harvesting, coastal development and marine pollution are still putting serious pressure on turtle populations.

Ecosystems

Table 6: Threatened species

	Critically endangered, IUCN red list[3]
Fish	Goliath grouper
	Black grouper
Sharks and rays	smalltooth, wide sawfish
	largetooth sawfish
Reptiles	Hawksbill turtle
	Leatherback turtle
Corals	Staghorn coral
	Elkhorn coral
	Endangered, IUCN red list
Fish	Nassau grouper
	Red porgy
Sharks and rays	Barndoor skate
	Winter skate
	Great hammerhead
	Scalloped hammerhead
Mammals	Coalfish whale
	Blue whale
	Fin whale
	North Atlantic right whale
Reptiles	Loggerhead turtle
	Green turtle
Corals	Box fire coral
	Mountainous star coral

[3] The International Union for Conservation of Nature (IUCN) is the global authority on the status of the natural world and the measures to safeguard it and by doing so; enable human progress, economic development and nature conservation.

Threatened species,	CARMABI
Birds	Caribbean Coot
	Scarlet ibis
	West Indian whistling duck
	Fulvous whistling duck
	American flamingo
Mammals	Curaçao White-tail Deer
(bats)	Glossophaga longirostris elongata
	L. curasoe
	Mormoops megalophylla intermedia
	Natalis tumidirostris
	Myotis nesopolus
	Pteronotus davy
	Noctilio leporinus
Fish	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
Sharks & rays	Bigeye thresher
	Whale shark
Reptiles	Lesser Antillian iguana
	Green iguana
Invertebrates	Lace corals
	Black corals
	Stony corals
	Queen conch
	Spin
	y lobster

Source: CARMABI and Waitt Institute

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.

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.

	km2	Ramsar[4]; since 2013

[4] 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

Table 8: Protected areas, incl. marine area

Northwest Curaçao	24.4
Muizenberg (wetland)	0.65
Rif Sint Marie (wetland)	6.7
Malpais/Sint Michiel (wetland)	11.0

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 refugee 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.

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.

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 located 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 km^2 of fringing reefs and though threatened, the island still harbors some of the best coral ecosystems in the region[5]. 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 Caribbean[6].
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 decades[7]. The reefs harbor about 69 coral species.

[5] Jackson et al. 2013
[6] Miloslavich et al. 2010
[7] Bak, Meesters en Nieuwland, 2005

Flamingo's Photo: C. Jager

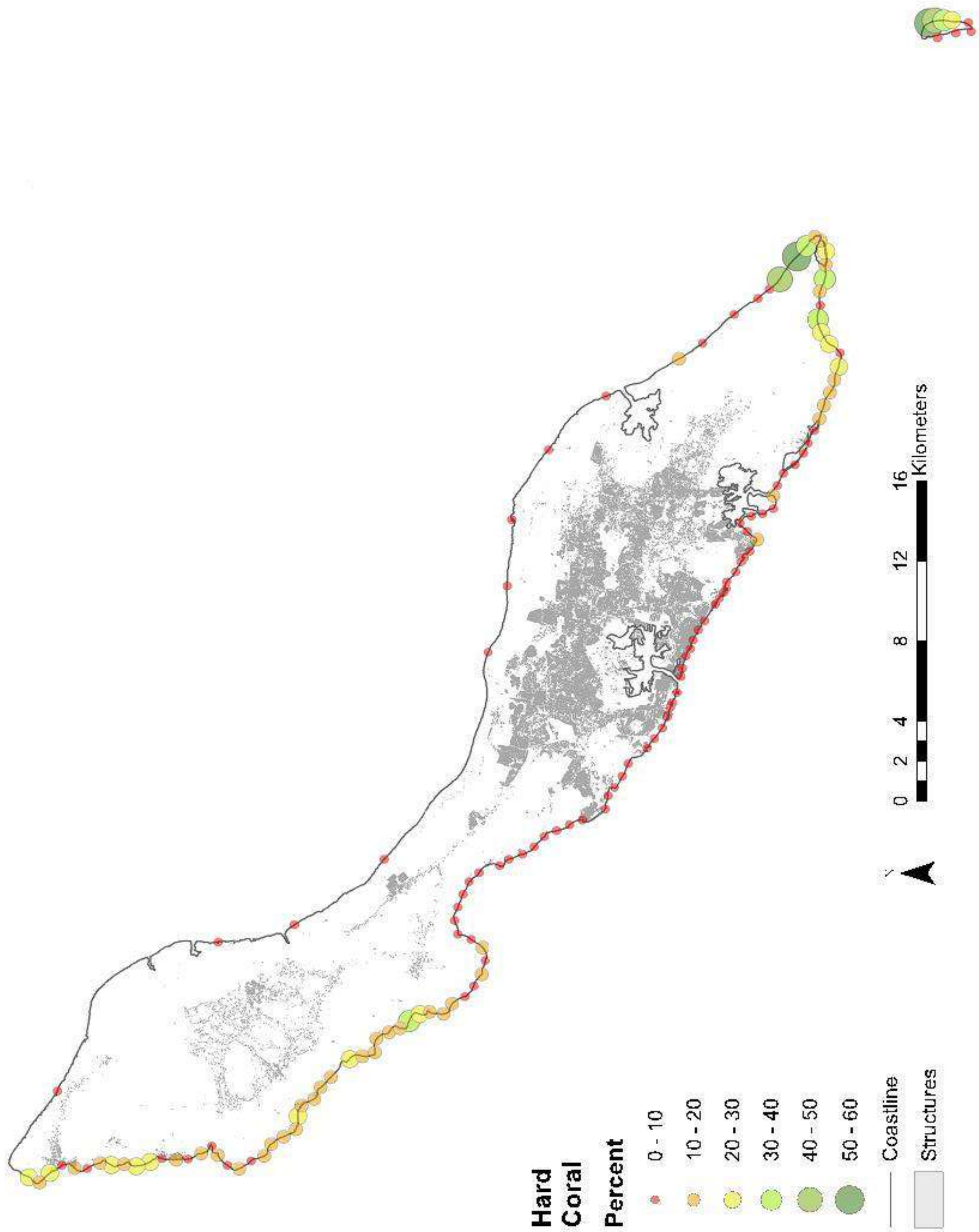

Figure 4: coral cover Curaçao reefs (CARMABI, 2016)

Since 2016 CARMABI started trying to identify and map Key Biodiversity Areas (KBA's). This in order to define conservation outcomes. KBA's are defined at 3 ecological levels: species, sites (or habitats) and ecological corridors (inter-connected landscapes of sites)[8]. 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 a work in progress that will be validated through the consultation of local actors.

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

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

[8] Best III Working document CARMABI 2017

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 accreditation[9].

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)[10].

- For SO_2 the WHO maximum concentration is 20 μg/m3, this on basis of a day, i.c. 24-hour mean
- For PM_{10} this is 50 μg/m3, this on basis of a day, i.c. 24-hour mean

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

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

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

less, also known as PM_{10} 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 actually 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)[11].

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 (SO_2) and natural resources (particulates) cannot be fully excluded.

Unfortunately, the figures 6 and 7 show clearly that the diminishing production of the refinery in 2018 had a limited 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 SOs have exceeded the WHO levels (20 μg/m3) almost every month. The low concentrations for 2010 are not representative because the refinery was not active for 8 months. As can clearly be seen these high levels for SO_2 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-owned operator of the refinery. In 2018 the production further diminished till a minimum level whereby SO_2 levels became as low as 10 μg/m3.

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

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[11] The smaller PM2.5 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*).*

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 the diminishing production in 2018, this problem, at least for the time being, has become less threatening.

As soon as the refinery will 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 plant[12]. This can help reduce the SO_2 air pollution considerably.

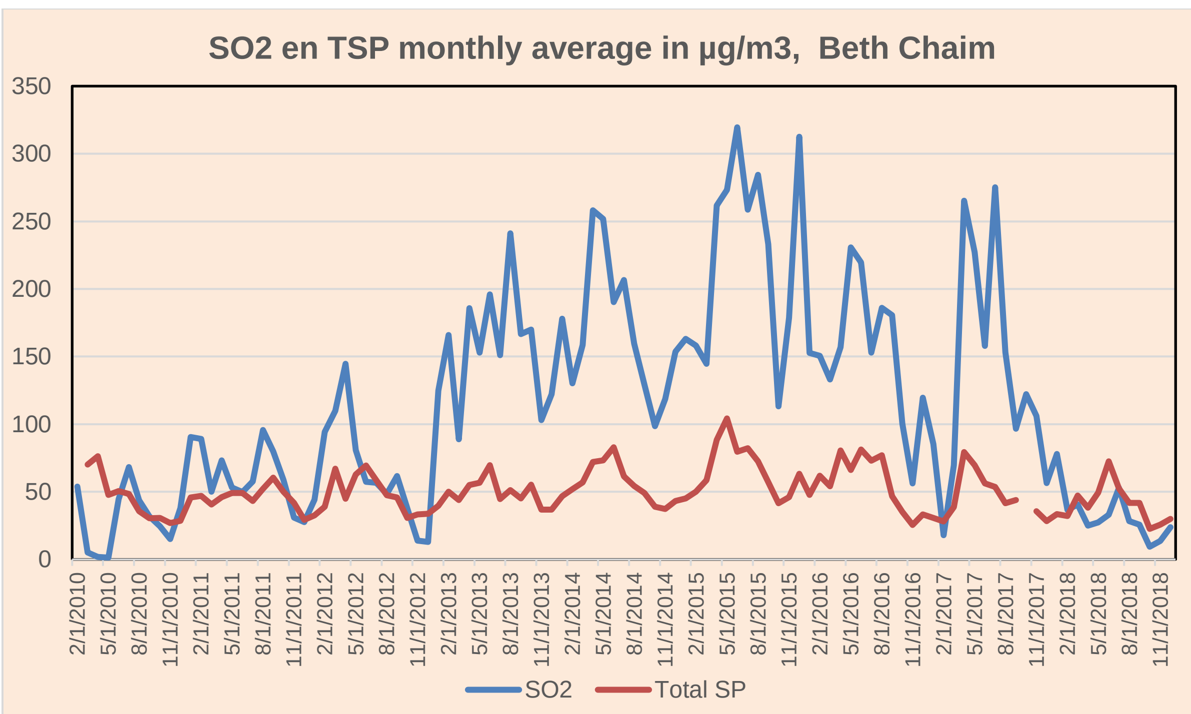

Figure 6: SO_2 and TSP, Beth Chaim

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

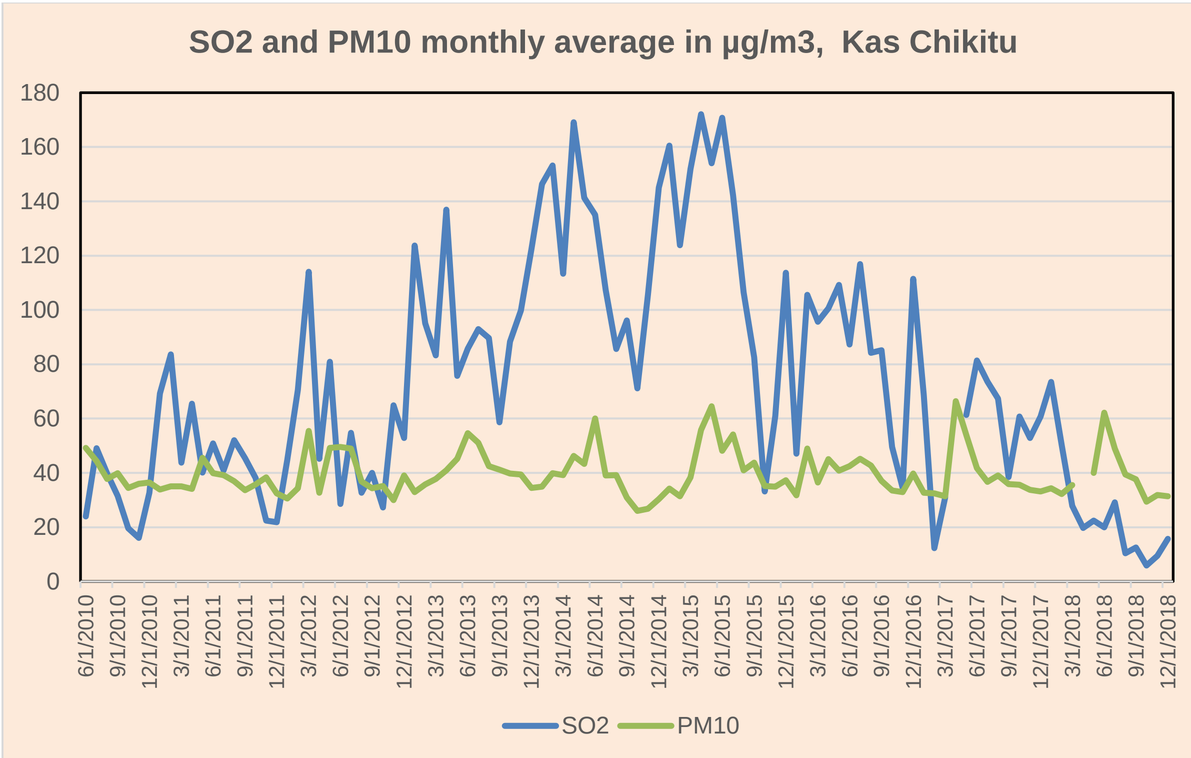

Figure 7: SO^2 and PM10, Kas chikitu

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	NO2 & NO3 (nitrates)	0.65 µM/ l
	2007	NH4 (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 O2 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 island[13]. 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.

Playa Lagoon photo: C. Jager

[13] The State of Curaçao's Coral Reefs, Waitt Institute, May 2017.

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 SEEA[14], 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

[14] 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.

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 a number of 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
Production index blocks	275	252	242	242	189	194	202	187	176
Production index sand	146	145	144	140	117	125	130	133	108
Mining index CBS	211	199	193	191	153	160	166	160	142
Turnover index	100	83	75	105	90	90	112	97	102

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 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 (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 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 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% what is close to the target of 25% (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. 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 general 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 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 these steps still need to be taken, 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.[15] 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
Water production (1000 m3)									
	13,846	14,398	14,560	14,495	14,232	13,759	14,141	14,648	15,193
Connections*:									
		73,764	75,030	76,522	77,804	79,304	80,619	82,324	83,654
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
From windparks:			62,700	116,600	133,200	144,200	121,919	169,100	233,760
% from wind:			6.9	13.0	15.3	16.4	13.8	19.1	27.0
Connections*:		73,079	74,411	76,075	77,259	78,746	80,079	81,588	82,068
Wind: installed capacity in MW per Dec.									
	8	8	30	30	30	30	30	45	45
Solar: official installed capacity in MW per Dec.									
	nihil	nihil	0.1	3.1	7.7	10.1**	11.1	11.1	11.9
Sources: Aqualectra (water and electricity, all info for 2017), Nucapital (wind), BTP (solar), CBCS (Refinery)									
* each January									
** adapted projection (due to the introduction of the 2015 service fee) from 28.6 to 20 MW , later to 10.1									

[15] Evidence-based infrastructure in Curaçao, UNOPS, May 2018.

Table 15: product mix electricity, installed capacity

per end of 2018	MW	%
Dokweg I, II and III:	117.6	45.9
Diesel, refinery:	33.6	13.1
Gasturbine 2	21.0	8.2
Wind turbines:	45.0	17.6
Solar panels:	17.0	6.6
CRU:	22.0	8.6
Total:	256.2	100.0

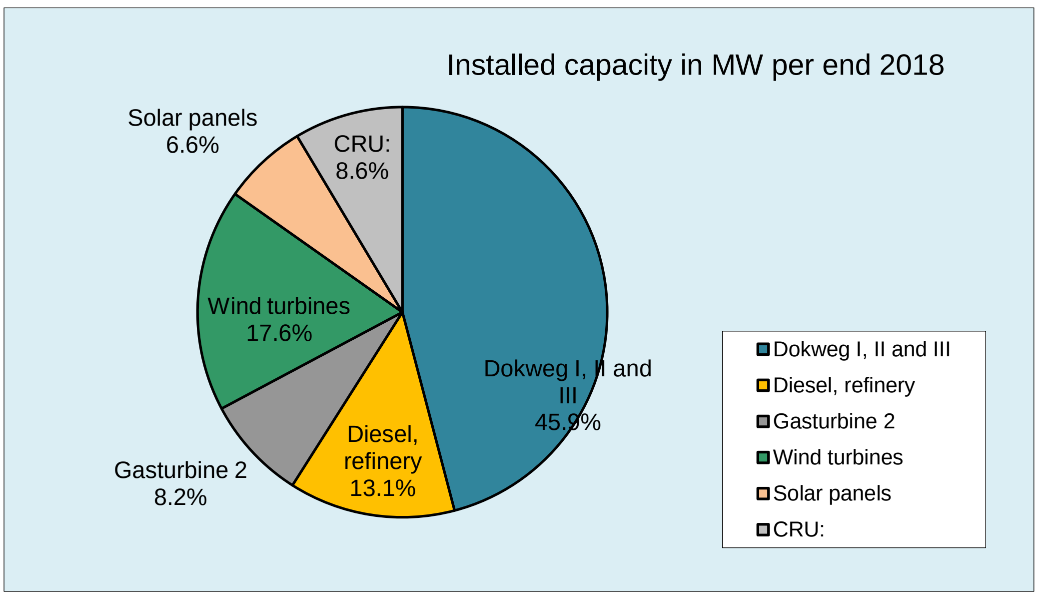

Figure 8: Installed capacity in MW

Source: Aqualectra

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. Karskens[16]. 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 2006[17]) 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. m^3 which is 3.4 mln. m^3. 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 correspondents with a loss of 3,4 mln. m^3.

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

[17] 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 IPCC[18], 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 (SO_2) and nitrogen oxides (NO_x). The most important GHG's are both direct and are carbon dioxide CO_2 and methane CH_4. Though methane is not very common on Curaçao its relative impact is high because of the high global warming potential (GWP) relative to CO_2. According to the IPCC Fifth Assessment Report of 2014 the GWP is 28 times CO_2.

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.

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 the diminishing low and probably temporary 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.

[18] 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: CO_2 and CH_4	2010		2015		2018	
	kton	relative	kton	relative	kton	relative
Transport	420.4	9.3%	407.8	9.8%	399.7	17.3%
Cooking, natural gas	23.8	0.5%	23.4	0.6%	27.8	1.2%
Production of electricity and water	795.4	17.7%	409.6	9.8%	381.4	16.5%
Industry: refinery	1446.1	32.1%	1609.9	38.5%	202.3	8.8%
Industry: production of energy for refinery	1418.9	31.5%	1325.9	31.7%	880.5	38.2%
Industry: production of concrete	10.1	0.2%	7.1	0.2%	6.5	0.3%
landfill	387.6	8.6%	394.0	9.4%	409.7	17.8%
Total:	4502.3	100.0%	4177.9	100.0%	2307.8	100.0%

Source: Carbon Footprint Study CBS

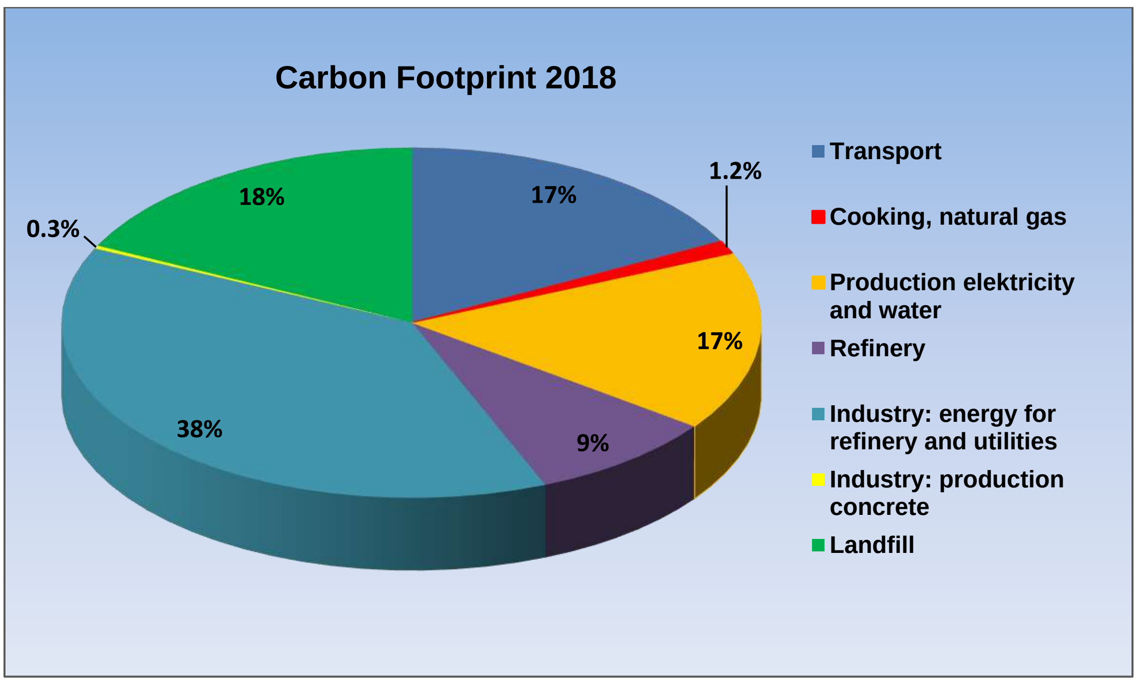

Figure 9: relative share of emissions

Tabel 18: Emissions and benchmarks GHG's 2018

capita:	160012		per capita in ton CO_2
Total Curaçao 2018	kton CO2	2308	14.4
Total excl. refinery / CRU	kton CO2	1225	7.7
	Eur. Union	3548000	7.0
	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 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. Indications are that sewage waters are probably a major problem.

Nowadays 33 percent of the households and businesses are connected to the sewage system[19]. Transported by approximately 390 km. of sewage pipelines it is brought to

[19] U. Cordilia, UNOPS Kick-off workshop 2018.

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 2017, around 16 percent of the wastewater was treated, the remaining 84 percent untreated and was discharged into the terrestrial and marine environment[20].

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
Abbatoir	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

[20] Evidence-based infrastructure in Curaçao, UNOPS, May 2018.

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[21]. An adequate management of waste is essential for the protection of public health and the environment. The problems that threat 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 3.4 kg. For 2018 this is 1230 kg/capita, which is very high and three times compared to the amount in Latin America and the Caribbean.[22]

[21] National Report of Curaçao for the 3d Conference on SIDS, September 2014
[22] Waste Management Outlook, UNEP, October 2018.

Table 20: Municipal waste collected									
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Deposited on Landfill	173907	176786	180874	143930	168743	176806	156540	158852	183824
Recycled	18468	14728	29797	11729	53110	80357	21137	14193	13441
Burned	63	155	70	147	94	81	81	78	98
Total waste:	192438	191669	210741	155806	221947	257244	177758	173123	197363
Population:	147122	150284	151378	152798	154843	156971	158989	160337	160012
Waste/capita/day: (kg)	3.6	3.5	3.8	2.8	3.9	4.5	3.1	3.0	3.4
In 1000 kg. Recycling at CRC: Curaçao Recycling Company									
Burning at CIC; Caribbean Incineration Company									
Source: Selikor									

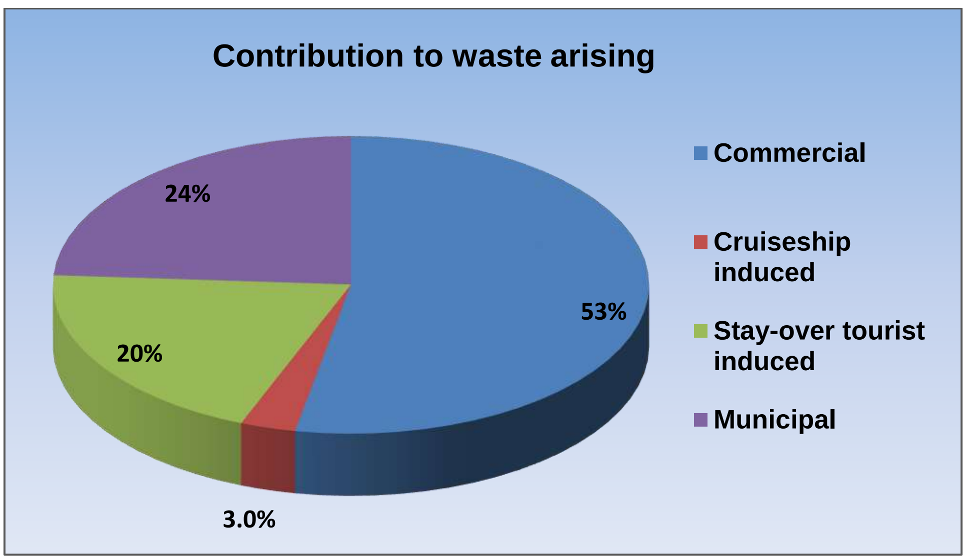

Figure 10: contributions to waste. Source: UNOPS report May 2018.

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 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 into this sub component 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. 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 $10 million[23]. 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 NAƒ110 million ($63mln), though total damage costs from Tomas were estimated at NAƒ200 million ($115 million).[24]

[23] Sharlon Monart (November 3, 2010). 'Miljoenenschade Tomas aan woningen, winkels en bedrijven'
[24] 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, 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.

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 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 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.

photo: C. Jager

Topic 5.1.1. Urban and rural population

Humans live primarily in rural or urban communities[25], 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/km^2. 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; 511[27]. The number of households in 2018 was 58384.

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[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 2000-2018

	Total	Male	Female	Sex ratio [1)]	Pop./km2	Pop. growth	%	HH
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

1) Males per 100 females

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

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

Pop. = population, HH = households

Household estimates compiled from censuses 1992, 2001 and 2011

Date populations is January 1st.

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 MDG indicator 7.9[28] 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 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	0.0	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 ('beerput')	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

[28] The Millennium Development Goal (MDG) indicator 7.9 is the proportion of 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 totality of the population.

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.

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 25: Number of motor vehicles

	2011	2012	2013	2014	2015	2016	2017	2018
Passenger cars	61578	69035	67998	69062	69574	72848	75709	77332
Motor lorries and pick-ups	12021	12908	12377	12079	12768	11814	11869	11739
Motor buses	379	369	346	297	331	318	319	317
Taxis	179	159	138	141	138	132	128	152
Other cars	163	404	472	459	500	604	434	507
Total cars and buses:	74320	82875	81331	82038	83311	85716	88459	90047
Motorcycles, incl. mopeds	1117	1300	1689	1757	1758	1439	1310	1172
Passenger cars/km²	139	155	153	156	157	164	171	174

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

Numbers for 2010 are not considered to be reliable

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, 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 SO2 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 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
Dengue *	2800	2654	720	680	167	39	309
Chikungunya					1657	1847	1847
Dengue and Chikungunya **					3587	686	3405
Zika						1***	1725
Zika and Dengue							185
Zika and Chikungunya							14
Zika, Dengue and Chikungunya							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 Ziika 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 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.

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
subsidy Selikor		29380	29267	29493	32949	32030	30624	34214	32319
sewerage and water purification		40	pm	pm	pm	pm	pm	pm	pm
subsidy Carmabi		359	306	315	291	291	291	291	281
subsidy Schoon Curaçao						75			
subsidy Punda Limpi I Bonita						26	2		
subsidy Parke Tropikal		250	250	453	438	513	475	474	459
Protection expenditures (total):	n.a.	30029	29823	30261	33678	32935	31392	34979	33059

source: Ministry of Finance, Carmabi 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, 2014[29]). 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).

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

Airport 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 visited[30]. 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
Ships	220	246	226	293	290	254	232	282	296
Passengers	383589	400596	436068	583994	596709	511085	469498	634370	757278
Source: Curaçao Port Authority CPA									

Table 29: Stay-over tourism									
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Total numbers:	341,651	390,282	419,810	440,063	452,042	468,442	441,332	399,013	431,701
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
Source: CTB									

Table 30: Tourism ratio's									
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Tourist Penetration ratio	5.4	5.8	6.7	6.7	7.0	6.7	6.2	6.1	6.7
Tourism Density Ratio	17.8	19.7	22.7	23.2	24.6	23.7	22.2	22.1	24.1
Tourism Intensity rate	5.2	6.5	7.0	7.2	7.2	6.7	6.3	5.6	6.1
Source: CBS									

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/km2

Table 31: Hotels: rooms and occupancy									
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Number of rooms:	5421	5776	6038	6180	6405	6490	6332	6693	7970
Occupancy %	71.7	76.2	70.4	67.3	70.0	71.1	68.0	73.3	74.9
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.

Table 32: Passengers by Air									
	2010	2011	2012	2013	2014	2015	2016	2017	2018
Arriving:	635,495	705,093	731,070	732,865	733,887	764,293	733,674	659,161	673,167
Departing:	631,410	684,307	708,997	728,461	730,549	763,087	741,039	662,279	669,932
Transit:	147,165	239,706	317,101	260,175	210,042	204,909	211,515	90,537	59,000
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	1,402,099
Source: Curaçao Airport Partners N.V.									

Appendix

Air quality: Beth Chaim (industrial area)

Tabel 10: monthly <u>average</u> concentration in µg/m3

month	SO2	Total SP	SO2 times x 20 µg
2/1/2010	53.8		2.7
3/1/2010	5.2	70.2	0.3
4/1/2010	1.9	76.4	0.1
5/1/2010	1.4	47.6	0.1
6/1/2010	44.6	50.6	2.2
7/1/2010	68.3	48.4	3.4
8/1/2010	43.7	35.6	2.2
9/1/2010	31.8	30.4	1.6
10/1/2010	24.6	30.7	1.2
11/1/2010	15.2	26.9	0.8
12/1/2010	37.9	28.6	1.9
1/1/2011	90.6	45.9	4.5
2/1/2011	89.0	47.0	4.5
3/1/2011	50.0	40.5	2.5
4/1/2011	73.3	46.0	3.7
5/1/2011	53.1	49.0	2.7
6/1/2011	49.8	49.2	2.5
7/1/2011	57.7	43.1	2.9
8/1/2011	95.6	52.3	4.8
9/1/2011	79.9	60.6	4.0
10/1/2011	58.8	50.1	2.9
11/1/2011	30.9	41.9	1.5
12/1/2011	27.7	29.2	1.4
1/1/2012	44.2	32.5	2.2
2/1/2012	94.4	39.0	4.7
3/1/2012	109.9	67.0	5.5
4/1/2012	144.6	44.9	7.2
5/1/2012	80.9	62.8	4.0
6/1/2012	57.3	69.4	2.9
7/1/2012	56.7	58.5	2.8
8/1/2012	48.4	47.5	2.4
9/1/2012	61.7	45.7	3.1
10/1/2012	37.9	30.6	1.9
11/1/2012	14.0	33.2	0.7
12/1/2012	12.8	33.8	0.6
1/1/2013	124.9	39.6	6.2

2/1/2013	165.9	50.1	8.3
3/1/2013	88.9	43.8	4.4
4/1/2013	185.8	55.1	9.3
5/1/2013	152.9	56.8	7.6
6/1/2013	196.0	69.7	9.8
7/1/2013	151.0	44.6	7.5
8/1/2013	241.1	51.3	12.1
9/1/2013	166.7	45.0	8.3
10/1/2013	170.0	55.4	8.5
11/1/2013	103.1	36.9	5.2
12/1/2013	122.2	36.8	6.1
1/1/2014	178.1	46.7	8.9
2/1/2014	130.2	52.0	6.5
3/1/2014	158.6	56.9	7.9
4/1/2014	258.2	72.1	12.9
5/1/2014	251.7	73.3	12.6
6/1/2014	190.3	83.0	9.5
7/1/2014	206.6	61.5	10.3
8/1/2014	159.5	54.3	8.0
9/1/2014	129.4	49.1	6.5
10/1/2014	98.6	39.0	4.9
11/1/2014	118.7	37.4	5.9
12/1/2014	153.7	43.2	7.7
1/1/2015	163.2	45.1	8.2
2/1/2015	158.2	50.1	7.9
3/1/2015	144.7	58.7	7.2
4/1/2015	261.6	88.3	13.1
5/1/2015	273.4	104.3	13.7
6/1/2015	319.5	79.6	16.0
7/1/2015	258.6	82.3	12.9
8/1/2015	284.5	72.6	14.2
9/1/2015	233.1	57.1	11.7
10/1/2015	113.2	41.5	5.7
11/1/2015	178.7	46.1	8.9
12/1/2015	312.5	63.4	15.6
1/1/2016	152.7	47.8	7.6
2/1/2016	150.6	62.0	7.5
3/1/2016	133.0	54.2	6.6
4/1/2016	157.0	80.6	7.9
5/1/2016	230.7	66.2	11.5
6/1/2016	219.5	81.3	11.0
7/1/2016	153.0	73.0	7.7
8/1/2016	186.1	77.1	9.3
9/1/2016	180.6	46.8	9.0
10/1/2016	100.3	35.3	5.0
11/1/2016	56.2	25.5	2.8

12/1/2016	119.7	33.2	6.0
1/1/2017	85.2	30.6	4.3
2/1/2017	17.8	28.1	0.9
3/1/2017	69.6	38.8	3.5
4/1/2017	265.2	79.4	13.3
5/1/2017	227.1	69.6	11.4
6/1/2017	157.8	56.2	7.9
7/1/2017	275.3	53.7	13.8
8/1/2017	153.1	41.5	7.7
9/1/2017	96.7	43.9	4.8
10/1/2017	122.1		6.1
11/1/2017	106.2	35.7	5.3
12/1/2017	56.4	28.2	2.8
1/1/2018	77.9	33.6	3.9
2/1/2018	36.5	32.0	1.8
3/1/2018	40.7	47.3	2.0
4/1/2018	24.9	38.2	1.2
5/1/2018	27.4	49.3	1.4
6/1/2018	33.0	72.5	1.6
7/1/2018	52.9	52.4	2.6
8/1/2018	28.4	41.8	1.4
9/1/2018	25.7	41.8	1.3
10/1/2018	9.5	22.6	0.5
11/1/2018	13.7	25.7	0.7
12/1/2018	23.8	30.1	1.2

Source: monitoringstation Public Health Service Amsterdam

SO2 = sulfurdioxyde, Air Quality Guidelinde 24 hours WHO is 20 µg/m3
times x 20 = times above 24 hours WHO norm of 20 µg/m3
TSP = Total suspended particles
Incl. motor vehicle emissions

Air quality: Kas Chikitu (residential area)

Table 11: monthly average concentration in µg/m3

month	SO2	PM10	times 20 µg	times 50 µg
6/1/2010	24.0	49.2	1.2	1.0
7/1/2010	49.0	44.3	2.5	0.9
8/1/2010	39.8	37.8	2.0	0.8
9/1/2010	31.5	39.9	1.6	0.8
10/1/2010	19.5	34.5	1.0	0.7
11/1/2010	16.0	36.0	0.8	0.7
12/1/2010	32.7	36.5	1.6	0.7
1/1/2011	69.3	33.8	3.5	0.7
2/1/2011	83.6	35.0	4.2	0.7
3/1/2011	43.8	35.0	2.2	0.7
4/1/2011	65.5	34.1	3.3	0.7
5/1/2011	40.1	45.6	2.0	0.9
6/1/2011	50.8	39.9	2.5	0.8
7/1/2011	41.0	39.2	2.0	0.8
8/1/2011	52.0	36.9	2.6	0.7
9/1/2011	45.4	33.6	2.3	0.7
10/1/2011	38.2	35.8	1.9	0.7
11/1/2011	22.4	38.3	1.1	0.8
12/1/2011	21.9	32.4	1.1	0.6
1/1/2012	44.8	30.6	2.2	0.6
2/1/2012	70.5	34.4	3.5	0.7
3/1/2012	114.1	55.5	5.7	1.1
4/1/2012	45.2	32.7	2.3	0.7
5/1/2012	81.0	49.1	4.0	1.0
6/1/2012	28.5	49.6	1.4	1.0
7/1/2012	54.7	48.9	2.7	1.0
8/1/2012	32.6	36.8	1.6	0.7
9/1/2012	40.0	34.3	2.0	0.7
10/1/2012	27.3	35.2	1.4	0.7
11/1/2012	64.9	30.0	3.2	0.6
12/1/2012	52.8	39.1	2.6	0.8
1/1/2013	123.7	32.9	6.2	0.7
2/1/2013	95.0	35.7	4.8	0.7
3/1/2013	83.2	37.8	4.2	0.8
4/1/2013	136.9	40.9	6.8	0.8
5/1/2013	75.7	45.2	3.8	0.9
6/1/2013	85.7	54.6	4.3	1.1
7/1/2013	93.0	51.1	4.6	1.0
8/1/2013	89.7	42.4	4.5	0.8
9/1/2013	58.6	41.2	2.9	0.8
10/1/2013	88.3	39.8	4.4	0.8

11/1/2013	99.8	39.4	5.0	0.8
12/1/2013	122.4	34.5	6.1	0.7
1/1/2014	146.3	35.0	7.3	0.7
2/1/2014	153.2	39.9	7.7	0.8
3/1/2014	113.4	39.2	5.7	0.8
4/1/2014	169.1	46.2	8.5	0.9
5/1/2014	141.3	43.2	7.1	0.9
6/1/2014	135.0	60.0	6.8	1.2
7/1/2014	107.3	39.1	5.4	0.8
8/1/2014	85.6	39.2	4.3	0.8
9/1/2014	96.2	30.9	4.8	0.6
10/1/2014	71.1	26.0	3.6	0.5
11/1/2014	105.6	26.8	5.3	0.5
12/1/2014	145.1	30.3	7.3	0.6
1/1/2015	160.5	34.3	8.0	0.7
2/1/2015	123.8	31.4	6.2	0.6
3/1/2015	151.9	38.3	7.6	0.8
4/1/2015	172.1	55.8	8.6	1.1
5/1/2015	154.04	64.5	7.7	1.3
6/1/2015	170.76	48.1	8.5	1.0
7/1/2015	142.18	54.1	7.1	1.1
8/1/2015	106.51	40.9	5.3	0.8
9/1/2015	82.61	43.8	4.1	0.9
10/1/2015	33.1	35.2	1.7	0.7
11/1/2015	61.03	34.9	3.1	0.7
12/1/2015	113.7	37.2	5.7	0.7
1/1/2016	47.0	31.7	2.4	0.6
2/1/2016	105.5	48.9	5.3	1.0
3/1/2016	95.6	36.4	4.8	0.7
4/1/2016	100.7	45.1	5.0	0.9
5/1/2016	109.2	40.8	5.5	0.8
6/1/2016	87.3	42.4	4.4	0.8
7/1/2016	116.9	45.1	5.8	0.9
8/1/2016	84.2	42.7	4.2	0.9
9/1/2016	85.1	37.1	4.3	0.7
10/1/2016	49.5	33.5	2.5	0.7
11/1/2016	34.4	33.0	1.7	0.7
12/1/2016	111.4	39.7	5.6	0.8
1/1/2017	68.7	32.7	3.4	0.7
2/1/2017	12.3	32.4	0.6	0.6
3/1/2017	31.0	31.4	1.6	0.6
4/1/2017		66.4	0.0	1.3
5/1/2017	61.3	53.9	3.1	1.1
6/1/2017	81.4	41.7	4.1	0.8
7/1/2017	73.6	36.7	3.7	0.7
8/1/2017	67.4	39.0	3.4	0.8

9/1/2017	38.5	35.9	1.9	0.7
10/1/2017	60.8	35.6	3.0	0.7
11/1/2017	52.9	33.7	2.6	0.7
12/1/2017	60.7	33.1	3.0	0.7
1/1/2018	73.4	34.4	3.7	0.7
2/1/2018	50.2	32.2	2.5	0.6
3/1/2018	27.8	35.5	1.4	0.7
4/1/2018	19.7		1.0	0.0
5/1/2018	22.4	40.0	1.1	0.8
6/1/2018	19.9	62.2	1.0	1.2
7/1/2018	29.1	49.0	1.5	1.0
8/1/2018	10.3	39.4	0.5	0.8
9/1/2018	12.5	37.7	0.6	0.8
10/1/2018	5.9	29.4	0.3	0.6
11/1/2018	9.5	31.9	0.5	0.6
12/1/2018	15.7	31.3	0.8	0.6

Source: monitoringstation Public Health Service Amsterdam

SO2 = sulfur dioxide, Air Quality Guidelinde 24 hours WHO is 20 µg/m3
times x 20 = times above 24 hours WHO norm of 20 µg/m3
H2S = hydrogen sulfide
PM10 = particulates ('fijnstof'), till 10 µm ug/m3
times 50µg = times above 24 hours WHO day norm of 50 µg/m3
Incl. motor vehicle
emissions

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