

**STATE OF THE
ENVIRONMENT
2001 AND 2002**

Mission Statement

The Environmental Management Authority is committed to protecting and conserving the natural environment to enhance the quality of life by promoting:

- Environmentally responsible behaviour
- Development and enforcement of environmental legislation
- Encouragement of voluntary compliance
- The use of economic and other incentives

This is to be achieved in an atmosphere of mutual respect, professionalism, accountability, transparency, collaboration and social responsibility.

Chairman's Message

The Board of Directors of the EMA has asked me to explain the exceptional circumstances that have led to the simultaneous presentation of the 2001 and 2002 Annual Reports of the EMA. This unusual situation occurred because Parliament, having been dissolved for a general election, was unable to meet for most of the year 2002 during which the 2001 EMA Annual Report should have been laid in Parliament. In the interim, a new board of directors was appointed in the latter part of 2002. In order to save costs, the new Board decided to consolidate the EMA annual report for 2002 with the unpublished report prepared for 2001 by the previous Board chaired by Professor Dyer Narinesingh.

This year's state of the environment report presents in one consolidated text, a review of the environmental vulnerability of Trinidad and Tobago, using an Environmental Vulnerability Index composed of 48 environmental vulnerability indicators. The index focuses on the vulnerability of the environment to natural risks and to humans. It is based on the premise that the vulnerability of the environment to events in the near future can be determined from the calculated probability of their actual occurrence in the recent past. The main strength of the EVI is that it is an impartial measure and provides simplified summary information and, also the detailed data required to highlight specific areas of concern for environmental managers, scientists and the general public. It thus helps identify mechanisms that tend to degrade the state of the environment which provide goods (e.g. food, fibre, oxygen) and services (e.g. water purification, waste treatment, pollination, recreation) that support human well-being.

The indicators are divided into 5 categories of environmental vulnerability such as meteorological events (6 indicators), geological events (3 indicators), country characteristics (7 indicators), biological factors (8 indicators) and anthropogenic factors (24 indicators). The indicators are scored on a global vulnerability scale of 1-7, where 4 are average and scores 1-3 indicate below average vulnerability while scores of 5-7 indicate above average vulnerability.

The results show that for Trinidad, indicators scoring 7 on the EVI are, intensive farming (especially poultry farming), human population density (especially in urban areas), rate of removal of natural vegetation (especially in the northern range), oil spills (especially on land), vehicle density (most air pollution is from vehicles), fertiliser usage (especially on Caroni lands), degraded land (especially from fires), water usage per capita (more of half of the water produced is unaccounted for) and mining activity (development activity in the petrochemical sector is exceptionally aggressive). In other words nearly all of Trinidad's major environmental vulnerabilities are anthropogenic in nature and due to poor management of the environment by human beings.

The good news is that since humans are the sole source of all the environmental problems (as compared to hurricanes, volcanoes etc. on other islands) then they can be managed by modifying human behaviour using moral persuasion and vigorous enforcement of environmental laws.

Tobago on the other hand is a far better place to live from an environmental vulnerability standpoint. The major environmental vulnerabilities in Tobago are due to the elevated density of endemic species per square kilometre that is fairly typical for an island, high density of people living in coastal settlements, high percentage of degraded land in the coastal zone and high water usage per capita. For its size Tobago has more unique biodiversity than Trinidad and so protection of its remaining natural vegetation is an urgent priority.

EMA made significant strides in addressing the environmental vulnerabilities highlighted by implementing for 4 pieces of subsidiary environmental legislation, which were enacted by Parliament. These are the Environmentally Sensitive Areas Rules 2001, the Environmentally Sensitive Species Rules 2001, the Certificate of Environmental Clearance Rules 2002 and the Noise Pollution Rules 2002. Also prepared and waiting to be laid in Parliament in 2003 are the Water Pollution Rules, the Air Pollution (Stationary Sources) Rules and the Deposit/refund Bill for beverage containers.

The EMA is also giving urgent attention to enforcement, and to-date the Environmental Police Unit has issued more than 7000 tickets for environmental transgressions with more than \$1,000,000 in fines for vehicle emissions, litter and noise violations being paid into the consolidated fund as a result. Control of the environmental impact of development activities is also being enforced through the issuance of more than 400 Certificates of Environmental Clearance all with conditions and requirements for mitigation measures. Notices of Violation and Administrative orders are being enforced against developers who fail to comply. As Trinidad and Tobago strives towards developed country status by 2020, EMA reaffirms that these command and control laws are part of a larger effort to establish a baseline of environmental quality, which protects human health, and the environment while our country pursues a path of accelerated economic development. Against this backdrop, our primary strategy is to elicit voluntary co-operation in the conservation of the environment through dialogue and partnership with stakeholders encouraged via public education and awareness campaigns, economic incentives and alternative dispute resolution.

Dr. John Agard
Chairman
Environmental Management Authority

**STATE OF THE ENVIRONMENT REPORT
2001 & 2002**

**Environmental Vulnerability Index
(EVI):
Provisional indices and profiles for
Trinidad and Tobago**

John Agard
And
Marissa Gowrie

**University of the West Indies
and
Environmental Management Authority**

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Dedication

This report is dedicated to the memory of the late Professor Peter Bacon of UWI who passed away during 2002. Professor Bacon was the former Head of the Department of Life Sciences at UWI and simultaneously an Environmental Officer of the EMA. He was for many years a member of the national wetlands committee and was one of the lead authors of the National Wetlands Policy. He is also remembered as the architect of the turtle conservation laws. It was Professor Bacon's idea to allow M.Sc. students at UWI to do research projects that contributed to this environmental vulnerability study of Trinidad and Tobago.

Acknowledgments

Data collection for some of the EVI indicators which form the basis of this combined 2001 and 2002 State of the Environment Report was done by postgraduate students of the M.Sc. Programme in Science and Management of Tropical Environments at the UWI, St. Augustine Campus. In this regard we wish to acknowledge with gratitude, Ms. Christina Atwell, Ms. Joy Austin, Mr. Arnold Balgaroo, Ms. Cindy Buchoon, Ms. Janice Chitaman, Ms. Marissa Gowrie, Ms. June Ragbirsingh-Chang, Ms. Vaani Ramkhelawan, Ms. Karen Ragoonanan, Mr. Anthony Ramdath and Ms. Debbie Ramnarine.

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1.0 Introduction

Concern regarding the issue of vulnerability of Small Island Developing States (SIDS) was first brought to international attention during the Global Summit on Small Island States held in Barbados in 1994. At this conference, SIDS, with the support of the United Nations, expressed the desire for the development of a vulnerability index that reflected the status of SIDS and integrated ecological fragility and economic vulnerability. This desire was included in the Barbados Programme of Action with additional support from the Alliance of Small Island States (AOSIS). As a result of these events, the South Pacific Applied Geoscience Commission (SOPAC) was approached to develop an Environmental Vulnerability Index (EVI) for the natural environment. Its purpose was primarily to highlight an increasing awareness that SIDS face disadvantages to their sustainable development as a result of their remoteness, small size, dispersion, economic conditions, natural disasters and limited natural resources (Kaly & Pratt, 2000).

The impacts of natural hazards and human activities on the environment can potentially affect all countries and their ecosystems. Their impacts can influence countries large and small, developed and developing, or land-locked and fragmented. Further, hazards may be operating under a number of guises, each with different operational definitions. An example of this is storm force winds which occur throughout the world and are known by several different names including cyclones, hurricanes or typhoons depending on the part of the world in which they occur. This means that any methodology developed for

determining environmental vulnerability should be applicable to all countries on a common basis if any meaningful comparisons are to be made and if we are to determine which countries are more vulnerable than others in the world context.

Vulnerability indices have been developed in the past which describe the risks associated with economic and social conditions, climate change, sea-level rise, natural disasters, anthropogenic impacts and more recently, sustainability. Most of these indices describe the vulnerability of human systems with only limited attempts having been made to describe effects on the environment. Human systems and the environment are dependent on one another so that risks to the environment of a state will eventually translate into risks to humans and their welfare. The index described here has been the first attempt to construct an index that focuses on the vulnerability of the environment.

The environmental vulnerability index (EVI) is being developed as a robust, flexible tool aimed at providing a simple, short cut measure of the vulnerability of the environment of countries. The index will be intuitively and easily comprehensible to allow for wide usage in international processes (such as determination of LDC status) in addition to being a powerful tool for identifying vulnerability issues. That is, the main strength of the EVI will be that it can provide not only simplified summary information, but also the detailed data required to highlight specific areas of concern for environmental managers and scientists.

The EVI is an impartial measure that will differentiate among countries and allow comparisons and determination of which countries are more vulnerable than others on the world scale.

The Calculation of the EVI is based on 50 indicators of environmental vulnerability, which have been selected by global scientific and expert review. This list includes 35 indicators of risk (REI), 7 indicators of intrinsic resilience (IRI) and 8 indicators of environmental integrity or degradation (EDI).

The indicators are also divided into 5 sub categories, independently of the sub-index to which they belong: Weather and Climate (6 indicators), Geological events (3 indicators), Country Characteristics (7 indicators, and is the same as the IRI), Resource and Service Indicators (20 indicators) and Anthropogenic factors (14 indicators).

The theoretical framework for the EVI is based on the fact that the maintenance of ecosystem integrity is critical to the development of an environmental vulnerability index.

Ecosystem integrity depends on biodiversity, ecosystem function and resilience, and is influenced by a variety of factors at the spatial, temporal and hierarchical levels relating to the ecosystem. Given the complexity of an ecosystem, a single indicator would not adequately represent the interrelated variables of the system. A true representation of ecosystem integrity is therefore determined by the use of a set of indicators, such as these, incorporating all the interconnected variables.

The environmental vulnerability indices are presented separately for Trinidad and Tobago given that Trinidad is highly industrialized, populated and developed whereas Tobago lacks the presence of heavy industries, depends heavily on tourism and is in a transitional stage with respect to development. Consequently the vulnerability indices are different for these two islands.

1.1 Approaches and Methods Used in Data Collection

The Environmental Vulnerability Index was designed to summarize a wide range of environmental vulnerability information for a country. A significant amount of the data collection required extracting data and information from Government Ministries, State Agencies, private companies and international environmental organizations. Information was also gathered through interviews and written requests for data from various other agencies and companies in Trinidad and Tobago.

It should be noted that the EVI Scoring Table is currently being revised by SOPAC using a global data set. The scoring tables for a few indicators (Indicators # 1,4,5,6,17,39) are therefore based on the old scoring scale. The overall EVI scores for Trinidad and Tobago only took into consideration the revised EVI scales.

2.0 Results

2.1 Weather & Climate Vulnerability Indicators

The indices in this Section focus on the vulnerability of the islands of Trinidad and Tobago to meteorological events. These events include deviations in sea surface temperature, high winds, dry periods, wet periods, heat and cold spells. The data used in the calculation of these indicators were collected from the meteorological stations at the Piarco and Crown Point Airports. It should be noted that the average mean period used for Tobago was approximated to 1969-1990 rather than the standard period 1961-1990, since the meteorological station in Tobago was only opened in 1968. The average deviation in sea surface temperature was determined using temperature data from the Climate Research Unit of the University of East Anglia and the Hadley Center of the United Kingdom Meteorological Office (Jones et al 1999). Calculations were done on annual temperature time series data at a grid-box resolution of 5° latitude by 5° longitude over the period 1880-2002. For Trinidad and Tobago, the grid box used was 10-15° N Latitude and 60-65° W Longitude.

EVI Indicator # 1 - High Winds

Number of days over the last five years (1998-2002) during which the maximum recorded wind speed (3 second wind gusts) is greater than 20 % higher than the (30-year) average maximum wind speed for that month.

This indicator illustrates strong hurricane, tornado, storm and other explosive wind activities, which can adversely affect natural and human ecosystems. For Trinidad during the

period 1998-2002, there were 0 days with maximum wind speeds >20% higher than the average maximum for that month Table 2.1.1. Similarly in Tobago there were 0 days recorded with maximum wind speeds >20% higher than the average maximum for that month. It should be noted that the data set for Tobago was incomplete for some months. Trinidad and Tobago both scored a 1 on the EVI scale Table 2.1.2. Confidence, in the estimate is high.

Table 2.1.1. Maximum recorded wind speed >20% higher than the 30-year average maximum wind speed for that month.

Trinidad 30-year Average Maximum Monthly Wind speeds 1961-1990 (knots)		No of days 1998-2002 max. wind speed >20% higher than 30-year average
January	31	0
February	30	0
March	30	0
April	29	0
May	30	0
June	33	0
July	32	0
August	31	0
September	30	0
October	31	0
November	30	2
December	30	0
Total		0

Tobago 30-year Average Maximum Monthly Wind speeds 1969-1990 (knots)		No of days 1998-2002 max. wind speed >20% higher than 30-year average
January	29.8	0
February	30.5	0
March	30.1	0
April	30.7	0
May	31.2	0
June	37.9	0
July	34.7	0
August	34.3	0
September	32.9	0
October	33.1	0
November	35.5	2
December	31.9	0
Total		0

Data Source: Meteorological Services Division, Ministry of Public Utilities and the Environment

Table 2.1.2. Scoring Table for Indicator #1 High Winds

Score	No. of days from 1998-2002 wind speeds >20% higher than 30 yr. average maximum
1	0 (Tr) (To)
2	1-10
3	11-20
4	21-30
5	31-40
6	41-50
7	> 50

(Tr) = Trinidad; (To) = Tobago

This suggests that the vulnerability of both Trinidad and Tobago to strong storm and explosive wind activities such as hurricanes is low and therefore the likelihood of damage to the environment as a result of these activities is also low.

EVI Indicator #2 - Drought

Number of months over the last five years (1998-2002) during which rainfall was greater than 20% lower than the 30 year average for that month.

The indicator for dry periods captures the risk from drought and dry spells associated with low rainfall, as well as the vulnerability of water resources to these dry periods. In Trinidad during the period 1998-2002, 23 days were recorded as having >20% lower rainfall than the 30-year average (Table 2.1.3). For Tobago the comparative figure was 24 days. According to the EVI scale this scores both Trinidad and Tobago as a 1 (Table 2.1.4). Confidence in the estimate is high. The data suggests that both Trinidad and Tobago have a low vulnerability to an increasing frequency of dry periods.

Table 2.1.3. Rainfall >20% lower than the 30-year average rainfall for that month.

Trinidad 30-year mean rainfall 1961-1990 (mm)		No of months 1998-2002 rainfall >20% lower than 30-year average for that month
January	71.3	2
February	43	3
March	34.3	2
April	51.1	2
May	116.5	2
June	252.1	1
July	266.3	3
August	250.1	1
September	202.5	2
October	199.3	1
November	227.8	2
December	155.6	2
Total		23

Tobago 30-year mean rainfall 1969-1990 (mm)		No of months 1998-2002 rainfall >20% lower than 30-year average for that month
January	48.9	1
February	46.2	1
March	41.6	1
April	37.9	3
May	57.0	2
June	149.1	2
July	175.6	3
August	159.5	1
September	169.3	4
October	210.1	3
November	201.3	1
December	139.3	2
Total		24

Data Source: Meteorological Services Division, Ministry of Public Utilities and the Environment

Table 2.1.4. Scoring Table for Indicator #2 Drought

Score	No. of months from 1998-2002 rainfall >20% lower than 30 yr. average for that month
1	$x \leq 4$ (Tr) (To)
2	$4 < x \leq 4.5$
3	$4.5 < x \leq 5$
4	$5 < x \leq 5.5$
5	$5 < x \leq 5.5$
6	$5.5 < x \leq 6$
7	$6.5 < x$

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #3 Wet Periods

Number of months over the last five years (1998-2002) during which rainfall was greater than 20% higher than the 30 year average for that month.

The indicator for wet periods highlights flood and high rainfall events, which can cause soil erosion and the pollution of coral reefs and other coastal ecosystems. In Trinidad a total of 17 days had rainfall which was >20% higher than the 30 year average, thus scoring a 1 on the EVI scale. In Tobago, the comparative figure was 18 days also scoring a 1 on the EVI scale. Confidence in the estimate is high. We conclude that both Trinidad and Tobago have low vulnerability to high rainfall events.

Table 2.1.5. Rainfall >20% higher than the 30-year average rainfall for that month.

Trinidad 30-year mean rainfall 1961-1990 (mm)		No of months 1998-2002 rainfall >20% higher than 30-year average
January	71.3	2
February	43	1
March	34.3	3
April	51.1	3
May	116.5	2
June	252.1	1
July	266.3	0
August	250.1	0
September	202.5	0
October	199.3	1
November	227.8	2
December	155.6	2
Total		17

Tobago 30-year mean rainfall 1969-1990 (mm)		No of months 1998-2002 rainfall >20% higher than 30-year average
January	48.9	3
February	46.2	2
March	41.6	3
April	37.9	2
May	57.0	2
June	149.1	0
July	175.6	0
August	159.5	2
September	169.3	1
October	210.1	0
November	201.3	2
December	139.3	1
Total		18

Data Source: Meteorological Services Division, Ministry of Public Utilities and the Environment

Table 2.1.6. Scoring Table for Indicator #3 Wet Periods

Score	No. of months from 1998-2002 rainfall >20% higher than 30 yr. average for that month
1	$x \leq 5$ (Tr) (To)
2	$5 < x \leq 7$
3	$7 < x \leq 9$
4	$9 < x \leq 11$
5	$11 < x \leq 13$
6	$13 < x \leq 15$
7	$15 < x$

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #4 Heat Spells

Number of days over the last five years in which the maximum temperature was greater than 5°C higher than the mean monthly maximum (reference mean is from the 30 year average).

EVI Indicator #5 Cold Spells

Number of days over the last five years in which the minimum temperature was greater than 5°C lower than the mean monthly minimum (reference mean is from the 30 year average).

These indicators reflect extreme high and low temperature events, respectively. These extreme episodes can cause damaging effects to ecosystems and living organisms. Extreme high temperatures can cause desertification, and place a strain on water resources, whereas extreme low temperature can cause temperature stress affecting the functioning of ecosystems and the organisms within it.

In Trinidad during the period 1998-2002, there was only one day during which the maximum temperature was $>5^{\circ}\text{C}$ higher than the mean monthly maximum for that month and there were no days during which the minimum temperature was $>5^{\circ}\text{C}$ lower than the mean monthly minimum for that month.

In Tobago there were no days during which the maximum temperature was $>5^{\circ}\text{C}$ higher than the mean monthly maximum for that month nor were there any days during which the minimum temperature was $>5^{\circ}\text{C}$ lower than the mean monthly minimum for that month. Consequently, the score derived for both Trinidad and Tobago for the two indicators is 1 (Table 2.1.7). Confidence in the estimate is high.

These results suggest that the vulnerability of both Trinidad and Tobago to extreme high and low temperature events is low and hence the environment of both these islands are not at risk to stresses associated with extreme temperature events.

Table 2.1.7 Scoring Table for Indicator #4 Heat Spells and #5 Cold Spells

Score	No. of days with Heat Spells (1998-2002)	No. of days with Cold Spells (1998 -2002)
1	0-10 (Tr) (To)	0-10 (Tr) (To)
2	11-20	11-20
3	21-30	21-30
4	31-50	31-50
5	51-70	51-70
6	71-80	71-80
7	81-100	81-100

Data Source: Meterological Services Division, Ministry of Public Utilities and the Environment
(Tr) = Trinidad; (To) = Tobago

EVI Indicator # 6 - Sea Surface Temperature

Greatest average annual deviation in Sea Surface Temperatures (SST) in the last 5 years (1998-2002) compared with the long term mean (30 years).

Significant deviations in sea surface temperature can cause severe environmental stress and are a general indicator of climate change. Changes in sea surface temperatures can impact on fisheries, influence the frequency of hurricanes, cause coral bleaching and alter ocean currents. Annual temperatures are expressed as anomalies relative to the means of a standard 1961-1990 reference period.

The greatest average annual deviation in SST based on actual spatially averaged temperature anomalies, for Trinidad and Tobago during the period 1998-2002 was 0.84°C in 1998. Trinidad and Tobago is therefore scored as a 5 on the EVI scale (Table 2.1.9). Overall, confidence in this estimate is high.

Table 2.1.8. Greatest Average Annual Deviation in SST for Trinidad and Tobago

Year	Greatest Average Annual Deviation in SST (⁰ C)
1998	0.84
1999	0.59
2000	0.14
2001	0.23
2002	0.33

Data Source: <http://www.co2science.org> (Jones et al)

Table 2.1.9. Scoring Table for Indicator #6 SST

Score	Greatest Average Annual Deviation in SST (⁰ C)
1	0
2	-
3	-
4	-
5	>0-1 (T & T)
6	>1-2
7	>2

(T&T) = Trinidad and Tobago

The results suggest that Trinidad and Tobago has slightly more than average vulnerability to environmental stress resulting from rising sea surface temperatures.

2.2 Geological Vulnerability Indicators

The indices in this section focus on the vulnerability of the islands to geological phenomena, in particular volcanic eruptions, earthquakes and tsunamis. Data for these indicators was sourced from the Seismic Research Unit of the University of the West Indies, St. Augustine.

EVI Indicator #7 - Volcanic Eruptions
Number of volcanoes with potential for eruption greater than or equal to Volcanic Explosive Index of 4 (VEI 4) within 100 km of country land boundary per area of land.

This indicator reflects cataclysmic volcanic activity, which has the potential to cause significant changes in the environment such as loss of ecosystems and biodiversity as a result of fires, landslides, dust ash and marine kills.

The islands of Trinidad and Tobago do not possess any volcanoes and are therefore not vulnerable to the impacts of volcanic activity. Given that there are no volcanoes on the islands, the EVI score obtained for both Trinidad and Tobago for this indicator was 1 (Table 2.2.1). Confidence in the estimate is high.

Table 2.2.1 Scoring Table for Indicator #7 Volcanic Eruptions

Score	No. of volcanoes per km ²
1	0 (Tr) (To)
2	1≤x<5
3	5≤x<10
4	10≤x<15
5	15≤x<20
6	20≤x<35
7	35≤x

Data Source: Seismic Research Unit, UWI.

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #8 - Earthquakes

Cumulative earthquake energy within 100 km of country land boundaries per land area with Local Magnitude (ML) greater than or equal to six (≥ 6.0) and less than or equal to depth of fifteen kilometers (≤ 15 km) over 5 years.

This indicator reflects vulnerability to earthquakes and landslides. Earthquakes deep within the earth's crust present significantly less risk to the environment than shallow earthquakes (less than 15 km depth). These shallow earthquakes are likely to cause the most significant environmental changes and have the most impact on the overlying environments.

In spite of the potential for earthquakes on both the islands, there has only been one earthquake recorded within 100 km of the country land boundaries with Local Magnitude (ML) ≥ 6.0 and ≤ 15 km depth, over the last five years. This earthquake measured 6.1 and was recorded in 1997.

The land area of Trinidad is 4828 km² and the land area for Tobago is 300.8 km², so that the cumulative earthquake energy within 100 km of country land boundaries per land area with Local Magnitude (ML) ≥ 6 and ≤ 15 km depth, over a 5 year period for Trinidad is 0.0002 and for Tobago is 0.003. For this indicator therefore, both Trinidad and Tobago scores a 1. Confidence in the estimate is high. This indicates that Trinidad and Tobago have a low vulnerability to major earthquakes (Table 2.2.2)

Table 2.2.2 Scoring Table for Indicator #8 Earthquakes

Score	Earthquakes/km ²
1	0 \leq x<1 (Tr) (To)
2	1 \leq x<2
3	2 \leq x<3
4	3 \leq x<4
5	4 \leq x<5
6	5 \leq x<6
7	6 \leq x

Data Source: Seismic Research Unit, UWI.

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #9 - Tsunamis

Number of Tsunamis or storm surges with run up greater than 2 meters above Mean High Water Spring tide (MHWS) per 100km coastline since 1900.

This indicator captures the potential loss of shoreline, ecosystems and loss of species due to run up of seawater into coastal lands. It serves as a proxy for

tidal waves, erosion, disturbance and organism kills.

There have been no incidences of tsunamis or storm surges with run up greater than 2 meters above Mean High Water Spring tide (MHWS) per 100 km coastline on both islands since 1900. Trinidad and Tobago therefore scores a 1 for this indicator (Table 2.2.3). Confidence in the estimate is high.

This suggests that the vulnerability of these islands to tsunamis and storm surges with run up greater than 2 meters above Mean High Water Spring tide (MHWS) is very low.

Table 2.2.3 Scoring Table for Indicator #9 Tsunamis

Score	Tsunamis/100 km coastline
1	0 (Tr) (To)
2	0<x<1
3	1<x<2
4	2<x<5
5	5<x<10
6	10<x<15
7	x >15

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #10– Slides

Number of slides (include landslides, mudslides, avalanches) lasting more than 30 seconds recorded over the past 5 years, divided by area of mountainous lands (above 1000m).

Landslides can be brought about by rainfall, wind and gravity and can result in the removal of topsoil from upland areas. This causes loss of organic matter and nutrients for vegetation, loss of subsoil, reduced anchorage for roots and less material for soil formation. Soil loss creates conditions that generally reduce productivity of trees and other plants,

especially when human induced disturbances accelerate erosion processes to levels beyond those of natural systems.

The calculation of this indicator requires information on land 1000m above sea level. According to the GIS Section, WASA there is no land above the elevation of 1000m found in Trinidad and Tobago. The highest point in Trinidad is the El Cerro Del Aripo which is 940m, and the highest point in Tobago on the Main Ridge is 576m.

Trinidad and Tobago falls outside of the scope of this indicator, regardless of the number of landslides which occur on the islands. The score derived is therefore a 1. Confidence in this estimate is high.

This suggests that the vulnerability of these islands to landslides and mudslides is low.

Table 2.2.4. Scoring Table for Indicator #10 Slides

Score	Number of slides (include landslides, mudslides, avalanches) lasting more than 30 seconds recorded over the past 5 years, divided by area of mountainous lands (above 1000m).
1	$x=0(\text{Tr}) (\text{To})$
2	$0 < x \leq 0.5$
3	$0.5 < x \leq 1$
4	$1 < x \leq 1.5$
5	$1.5 < x \leq 2$
6	$2 < x \leq 2.5$
7	$x > 2.5$

(Tr) = Trinidad; (To) = Tobago

2.3 Geography Characteristics

The characteristics of the islands were examined in order to provide a more holistic view of their susceptibility to

natural vulnerabilities. The indices studied in this section included land area, fragmentation, isolation, vertical relief, and lowlands.

EVI Indicators #11 - 15

Data for indicators 11-15 were collected from the Forestry Division of the Ministry of Public Utilities and the Environment, Maritime Services Division of the Ministry of Works and Transport, Water and Sewerage Authority, and the Fisheries Division of the Ministry of Agriculture (Table 2.3.1).

Table 2.3.1 Trinidad and Tobago Country Characteristics

Country Characteristic	Trinidad	Tobago
Land area (km ²)	4828	300.8
Length of shoreline (km)	553	158.1
Distance to nearest Continent (km)	12.87	112.05
Vertical relief (m)	940	576
% of land area < 10m above sea level (%)	15.12	9.84

EVI Indicator #11 - Land Area

Total land area (km²).

This indicator is specifically aimed at capturing ecosystem diversity within a country. It is assumed that the size of a country is directly related to ecosystem diversity, extent and persistence. The main proxy factors for this indicator include richness of habitat types, refuges, and species redundancy and richness.

The land area of Trinidad is 4828 km² giving an EVI score of 4, whereas the land area of Tobago is 300.8 km² giving an EVI score of 6 (Table 2.3.2). Confidence in the estimate is high. This indicator highlights that as a result of the

relatively small size of both islands, there is a slightly greater than average chance that environmental impacts are likely to occur throughout the entire area of the island, rather than only small parts.

Table 2.3.2 Scoring Table for Indicator #11 Land Area

Score	Land Area (km ²)
1	X>14
2	12<X≤14
3	10<X≤12
4	8<X≤10 (Tr)
5	6<X≤8
6	4<X≤6 (To)
7	<4

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #12 – Country Fragmentation

Length of shoreline divided by total land area.

This indicator shows the “islandness” or fragmentation of a country. The more fragmented a country, the more vulnerable it is to disturbances that can enter across its coastline. The ratio of length of shoreline to land area is 0.11 for Trinidad and 0.53 for Tobago as ascertained from the GIS Section, WASA, which scores both Trinidad and Tobago as a 1. Confidence in the estimate is high.

The low ratios can be attributed to the shape of the islands and suggests that the degree of fragmentation is low for both islands. As a result of the small amount of fragmentation, there is little land vulnerable to sea related threats for either Trinidad or Tobago.

Table 2.3.3 Scoring Table for Indicator #12 Country Fragmentation

Score	Length of shoreline divided by total land area (km/km ²)
1	x≤2 (Tr) (To)
2	2<x≤3
3	3<x≤4
4	4<x≤5
5	5<x≤6
6	6<x≤7
7	x>7

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #13 – Geographical Isolation

Distance to nearest continent within 10 degrees latitude (km).

This indicator is a proxy for isolation between islands and continents. Isolated countries have a greater risk of species loss than countries in close proximity to a source of re-colonizers of a species that has totally become extinct.

Trinidad and Tobago are both relatively close to the South American mainland, although Tobago is a little further away than Trinidad given the positioning of this island. Trinidad scored a 2 on the EVI scale and Tobago scored a 4 (Table 2.3.4).

Therefore in the event of a natural disaster, re-colonization by plant and animal species should occur fairly rapidly for Trinidad and a little slower for Tobago. The re-colonization process is even more likely given that the islands lie in the mouth of the Orinoco river system. This suggests a high degree of resilience for Trinidad and a lower degree of resilience for Tobago to permanent loss of species from natural disasters.

Table 2.3.4 Scoring Table for Indicator #13 Geographical Isolation

Score	Distance to nearest continent within 10 degrees latitude (km).
1	$x < 0$
2	$0 < x \leq 50$ (Tr)
3	$50 < x \leq 100$
4	$100 < x \leq 400$ (To)
5	$400 < x \leq 800$
6	$800 < x \leq 1600$
7	$x > 1600$

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #14 – Vertical Relief

Altitude range (highest point minus the lowest point in the country).

This indicator is a proxy for ecosystem diversity, that is, biodiversity of habitat and species. A country with a high altitude range is likely to have a greater variety of ecosystems as a result of the range of conditions, which may support different habitats.

In Trinidad, the highest point on the island is 940 m (El Cerro del Aripo) and the lowest point is 0 m (Caribbean Sea). In Tobago, the highest point on the island (highest point on the Main Ridge) is 576 m and the lowest point is also 0 m. Both these islands scored a 1 on the EVI scale.

Confidence in the estimate is high. The altitude range on both islands is able to accommodate a fair range of habitats and species, as well as refugees for re-colonization after a destructive event.

This suggests a low vulnerability for both Trinidad and Tobago based on their diversity of ecosystems.

Table 2.3.5 Scoring Table for Indicator #14 Vertical Relief

Score	Altitude Range (m)
1	$50 < x < 1500$ (Tr) (To)
2	$1500 \leq x < 3000$
3	$3000 \leq x < 4500$
4	$4500 \leq x < 6000$
5	$6000 \leq x < 7000$
6	$7000 \leq x < 8000$
7	$x \leq 10, 8000 \leq x$

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #15 – Lowlands

Percent of land area less than 10 meters above sea level

This indicator describes resilience to tsunamis, sea level rise, and flooding, and can be used to estimate ecosystem diversity. This indicator is also a proxy for areas of accumulation of pollution and for sensitive habitats such as wetlands.

This indicator was determined from GIS derived maps produced by WASA. The proportion of land area less than 10m above sea level is 15.1% for Trinidad and 9.8% for Tobago. This scores Trinidad as a 3 and Tobago as a 2 (Table 2.3.6). Confidence in the estimate is high.

This suggests that both Trinidad and Tobago are slightly vulnerable to such events as sea level rise and flooding. These events would cause inundation of those areas less the 10m above sea level, which could result in the loss of habitats and species within these areas.

Table 2.3.6 Scoring Table for Indicator #15 Lowlands

Score	% land area < 10m above sea level
1	$x=0$
2	$x < 15$ (To)
3	$15 < x < 30$ (Tr)
4	$30 < x < 45$
5	$45 < x < 60$
6	$60 < x < 75$
7	$75 < x$

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #16 – Shared Borders

Number of land and sea borders shared with other countries.

This indicator is a proxy measure for the exposure to introductions, lack of control of effects from neighbouring countries, lack of control of straddling stocks of resources and uncontrolled migrations of humans. Trinidad and Tobago is an archipelagic State and as such there are no borders which are shared with another country. Trinidad and Tobago therefore scores a 1 for this indicator.

Confidence in this estimate is high. This suggests that Trinidad and Tobago has full responsibility for overseeing its resources, has control over the entry of migrants in the country and the risk of introductions by a shared border is low.

Table 2.3.7. Scoring Table for Indicator #16 Shared Borders

Score	Number of land and sea borders shared with other countries.
1	$x=0$ (Tr) (To)
2	$0 < x < 2$
3	$2 < x < 4$
4	$4 < x < 6$
5	$6 < x < 8$
6	$8 < x < 10$
7	$x > 10$

(Tr) = Trinidad; (To) = Tobago

2.4 Resources & Services Indicators

Factors examining the status and usage of biological resources, were also included in the determination of the environmental vulnerability of Trinidad and Tobago. These indicators attempt to measure vulnerability in relation to biological phenomena such as species and disease introductions, organism outbreaks, resource utilization and extinctions.

EVI Indicator #17 - Pathogens

Number of reported and verified organism outbreaks over the last five years / land area

This indicator investigates catastrophic organism outbreaks including plant diseases, viruses, pathogens, blooms, and plagues. This includes, but is not restricted to rats, mice, locusts, mealybugs, fruit-flies, toads, red tides, paralytic shellfish poisoning, chicken flu, ciguatera poisoning and many others. The main proxy factors for this indicator include ecosystem stress, eutrophication, pollution, introductions and disturbances.

Table 2.4.1 shows the total number of outbreaks for the period 1995-1999 for Trinidad as provided by the Government Veterinary Laboratory, Central Experimental Station, and CAREC. The diseases include, dengue fever, acute haemorrhagic conjunctivitis, citrus blackfly, hibiscus mealybug, bacteria and fungi, parasites, anaplasmosis, babesiosis, brucellosis, dermatophilosis, equine influenza, fowl cholera, johns disease, leptospirosis, rabies, salmonellosis, and tuberculosis.

Table 2.4.1. Number of outbreaks for the period 1995-1999 for Trinidad

Year	# of outbreaks
1995	88
1996	82
1997	65
1998	68
1999	78
Total	381

Source: Government Veterinary Laboratory, Central Experimental Station, and CAREC

There were only three organism outbreaks reported and verified in Tobago, all of which were plant related and included one major and two minor incidents. The three outbreaks occurred in 1997, the major outbreak was the Hibiscus Mealy Bug which affected mainly hibiscus plants or related families, whereas there were minor outbreaks of the citrus blackfly and citrus leaf minor disease, both affecting citrus crops.

Additional information was obtained from the Ministry of Health, which indicated that there were two outbreaks within the health sector over the last five years. These include the mosquito borne diseases of dengue and malaria. There have therefore been a total of five outbreaks in Tobago over the last five years.

The number of reported and verified organism outbreaks over the last five years per land area for Trinidad was calculated to be 0.08 outbreaks/km², scoring a 2 on the EVI scale. The number of reported and verified organism outbreaks over the last five years per land area for Tobago was calculated to be 0.02 outbreaks/ km², also scoring a 2 on the EVI scale. Confidence in the estimate is medium. This suggests that Trinidad and Tobago are not very vulnerable to organism outbreaks.

Table 2.4.2. Scoring Table for Indicator #17 Pathogens

Score	Outbreaks/km ²
1	0
2	>0-10 (Tr) (To)
3	11-30
4	31-50
5	51-70
6	71-100
7	>100

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #18 – Freight Imports

Total tonnage of freight imported / year/ land area.

This indicator is a proxy for the risk of species invasion. The risk of species invasion is seen as proportional to the freight imported. The total tonnage of freight imported into Trinidad and Tobago between 1998-2002 is shown below (these figures do not include freight imported at Point Lisas):

Table 2.4.3. Tonnage of freight imported into Trinidad and Tobago between 1998-2002

Year	Tonnage of Freight Imported		
	Sea	Air	Total
1998	2,955,968	16,649.76	2,972,617.76
1999	4,142,173	14,435.87	4,156,608.87
2000	3,578,094	15,064.20	3,593,158.20
2001	2,671,201	14,587.96	2,685,788.96
2002	3,291,237	17,123.86	3,308,360.86
Avg			3,343,306.93

Source: Port Authority of Trinidad and Tobago Airports Authority of Trinidad and Tobago

Statistics were also obtained from the Port Authority and Airports Authority to determine the tonnage of cargo moved by air and sea to Tobago. This information is shown in Table 2.4.4.

Table 2.4.4. Tonnage of cargo moved by air and sea to Tobago

Year	Tonnage of Freight Imported		
	Sea	Air	Total
1998	7,045	959.97	8004.97
1999	5,950	1084.30	7034.30
2000	5,654	1140.19	6794.19
2001	6,469	1026.67	7495.67
2002	7,830	762.76	8592.76
Average			7584.38

Source: Port Authority of Trinidad and Tobago
Airports Authority of Trinidad and Tobago

Table 2.4.5. Value of cargo moved by sea to Trinidad and between Trinidad and Tobago

Year	Revenue earned from Cargo imported to Trinidad (\$)	Revenue earned from Cargo moved between Trinidad and Tobago (\$)
1998	100,347,602.00	4,477,237.00
1999	110,595,133.00	5,856,780.00
2000	112,975,656.00	5,833,878.00
2001	112,235,356.00	7,131,818.00
2001	117,713,664.00	7,421,553.00

Source: Port Authority of Trinidad and Tobago
Airports Authority of Trinidad and Tobago

It should be noted that the statistics for the cargo moved through the Port Authority to Tobago, did not include flat beds since these vessels were counted and not weighed. Also the figures obtained for air cargo into Tobago include freight from both domestic and international origin. The value of freight could only be accurately obtained for freight moved by sea from the Port Authority. There are various private air carriers which gather revenue from air cargo handling; however this information is more difficult to compile.

Given the statistics available, the total tonnage of freight imported / year/ land area for Trinidad was 692.48 t /sq km / yr, giving a score of 7. The total tonnage of freight imported / year/ land area for Tobago was 25.21 t/km²/yr, giving a

score of 6. Confidence in these estimates is moderate.

These figures indicate that the islands of Trinidad and Tobago are particularly at risk of species invasion by way of imported freight.

Table 2.4.6. Scoring Table for Indicator #18 Freight Imports

Score	Freight Imported (t/km ² /yr)
1	$x \leq 1$
2	$1 < x \leq 1.5$
3	$1.5 < x \leq 2$
4	$2 < x \leq 2.5$
5	$2.5 < x \leq 3$
6	$3 < x \leq 3.5$ (To)
7	$x > 3.5$ (Tr)

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #19 – Migratory Species

Number of known species which migrate outside the territorial area at any time during their life spans (including marine species)/ land area.

This indicator focuses on species which pass outside of the control of the country and during that time may be harmed in some way from actions beyond the control of the country.

In Trinidad and Tobago, there are two known species, which migrate outside the territorial area during their lifespan. Confidence in this estimate is moderate.

The bird *Eudocimus ruber* commonly known as the Scarlet Ibis is a protected species as it the national bird of Trinidad and Tobago. The Scarlet Ibis lives in large groups and feed in shallow waters along the coast, as well as mudflats and lagoons. This species is highly migratory and breed in young mangroves. If not enough of these trees are found they may

fly from Trinidad to Venezuela, Colombia, French Guiana or Brazil.

The only other migratory species *Hirundicthys affinis* commonly known as the Four Winged Flying fish has a migratory path which extends along the island chain as far up as Dominica. Studies have shown that this species breeds throughout the islands however there is a major spawning site found off Tobago.

Trinidad and Tobago therefore scores a 7 for this indicator. Confidence in this estimate is moderate. This indicates that there is a high vulnerability for species whose migration pattern extends beyond the boundaries of Trinidad and Tobago.

Table 2.4.7. Scoring Table for Indicator #19 Migratory Species

Score	Number of known species which migrate outside the territorial area at any time during their life spans (including marine species).
1	$x \leq 1$
2	$1 < x \leq 1.5$
3	$1.5 < x \leq 2$
4	$2 < x \leq 2.5$
5	$2.5 < x \leq 3$
6	$3 < x \leq 3.5$
7	$x > 3.5$ (Tr) (To)

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #20 - Endemic Species

Number of known endemic species per square kilometer land area.

The greater the number of endemic species a country has the more vulnerable it is because localized extinction cannot be replaced from elsewhere by natural mechanisms or augmented by re-colonization. This

indicator describes the biodiversity and number of unique species of a country.

The islands of Trinidad and Tobago having separated from the mainland comparatively recently about 13,000 and 1,500 years ago respectively (Kenny 2000) are expected to have comparatively low endemism likely reflecting past xeric and mesic cycles. Yasmin Comeau Curator of the National Herbarium and Dennis Adams of Kew Gardens England during 2002 have completed a comprehensive revision of the checklist of the flora of Trinidad and Tobago. The total number of native and naturalised plants of Trinidad and Tobago is reported to be 2361. They have also estimated the number of endemic floral species to be 91 for Trinidad and 21 for Tobago with a further 17 endemic species occurring jointly on both islands (Table 2.4.8). The rate of endemism in the flora of Trinidad and Tobago is therefore about 5.5%.

Table 2.4.8. Endemic flora of Trinidad and Tobago

Taxa	Trinidad only	Tobago only	Trinidad & Tobago
Dicots.	54	17	15
Monocots.	18	4	1
Pteridophyta	19	0	1
Total	91	21	17

Data Source: National Herbarium of Trinidad and Tobago; Kew Gardens, England.

Among the fauna, Trinidad has 1 possible endemic bird or su-species, the Pawi (*Pipile pipile*), 2 possible endemic mammals (the rats *Proechimys trinitatus* and *Rhipidomys couesi*), 1 possible amphibian (the golden tree frog *Phyllodytes auratus*), 1 claimed reptile (the luminous lizard *Proctoporus shrevei*) and 1 possible snake (*Heminthophis* sp.). In Tobago there is 1 possible endemic mammal (the rat

Rhipidomys nitela), 2 endemic amphibians (the frogs *Eleutherodactylus charlottevillensis* and *Eleutherodactylus cf. rozei*), 2 species of endemic reptiles (the lizards *Gonatodes ocellatus* and *Bachia heteropa alleni*), 2 or 3 species of endemic snakes (*Erythrolamprus ocellatus*, *Mastigodryas boddaerti dunnii* and possibly *Liophis reginae* ssp. (Murphy, 1997; Boos, 2001). The frog *Mannophryne trinitatis* is also listed as endemic to both Trinidad and Tobago (Murphy, 1997). In addition, several species of invertebrates are also known only from Trinidad and/or Tobago. These include 2 species of onychoporans, 7 species of scorpions, 17 species of caddis flies and 1 scale insect. It is more than likely that these species will eventually turn up in surrounding countries with more vigorous collecting of these groups. For the purpose of the present quantitative assessment only data in which there is high confidence such as the plants, amphibians and reptiles are included in the total count. As a result 93 true endemics are the likely order of magnitude for Trinidad and 27 for Tobago. This gives an average of about 0.019 endemic species/km² for Trinidad and 0.090 for Tobago. This scores Trinidad as a 3 on the EVI scale and Tobago as a 6. If the 17 plants and 1 amphibian which are recorded as being possibly endemic to both Trinidad and Tobago jointly are added to the numbers then the average for Trinidad is 0.023 endemic species/km² and 0.146 endemic species/km² for Tobago. This scores both Trinidad and Tobago as a 2 on the EVI scale. Confidence in the estimate is medium.

Although the total number of endemics is not exceptional for small islands, the EVI scores show that Tobago but not

Trinidad has a high number of endemics on a per land area basis. This is not surprising considering the difference in the times that they have been separated from the mainland.

The EVI suggests that vulnerability to environmental impacts with respect to loss of endemic species is low for both islands. Notwithstanding the conservation of the remaining natural environment of Trinidad and Tobago must be given high priority.

Table 2.4.9 Scoring Table for Indicator #20 Endemic Species

Score	Endemic species/km ² (x1000)
1	0 ≤ x
2	0 < x ≤ 2.5 (Tr) (To)
3	2.5 < x ≤ 5
4	5 < x ≤ 7.5
5	7.5 < x ≤ 10
6	10 < x ≤ 12.5
7	12.5 ≤ x

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #21 – Past Species Introductions

Number of introduced species / square kilometer land area.

This indicator is proxy for the biological impacts caused by the introductions of species into countries. However, given the paucity of baseline data and biological surveys and inventories in both Trinidad and Tobago, the number of introduced species has not yet been accurately determined for either of these islands except for the plants.

The National Herbarium in its 2002 unpublished revision of the checklist of the flora gives a figure of 845 introduced and naturalised plants for Trinidad and Tobago or about 24.1% of the total

recorded flora of vascular plants of Trinidad and Tobago (Yasmin Comeau, personal communication). Except for domestic and farmed animals there are few scientific records of animals (e.g. mongoose) which have been introduced and become naturalised. Based on the plants only, the number of introduced species for Trinidad and Tobago is about 6 per square kilometer. This translates to a score of 4 on the EVI scale (Table 2.4.10). Given the lack of data for animals, confidence in the overall estimate of this indicator is low. The score of 4 on the EVI therefore suggests that vulnerability to biological impacts caused by the introductions of species into both countries is moderate.

Table 2.4.10. Scoring Table for Indicator #21 Past Species Introductions

Score	Introduced species/km ²
1	$x \leq 0$
2	$0 < x \leq 1$
3	$1 < x \leq 1.5$
4	$1.5 < x \leq 2$ (Tr) (To)
5	$2.5 < x \leq 3$
6	$3 < x \leq 3.5$
7	$x > 3$

(T & T) = Trinidad and Tobago

EVI Indicator #22 – Endangered species

Number of endangered and threatened species / square kilometer land area.

This indicator describes the number of endangered and threatened species. A high number of endangered and threatened species reflects the vulnerability of a country's biodiversity. At present, there are few studies of endangered or threatened species in Trinidad and Tobago. The Forestry Division, National Herbarium and World Resources Institute have all however proposed lists of candidates for this designation. Due to the paucity of

supporting scientific studies, confidence in the estimate is low.

Total number of threatened species = 147. Total number of endangered species = 16. Number of endangered and threatened species per square kilometer land area (value * 1000) = 32. The EVI Score for this indicator was found to be 7. This indicates a high overall vulnerability of endangered and threatened species.

Table 2.4.11. Scoring Table for Indicator #22 Endangered Species

Score	Endangered and Threatened Species/km ²
1	$x = 0$
2	$0 < x \leq 1$
3	$1 < x \leq 2$
4	$2 < x \leq 3$
5	$3 < x \leq 4$
6	$4 < x \leq 5$
7	$x > 5$ (Tr) (To)

(T & T) = Trinidad and Tobago

EVI Indicator #23 – Extinctions

Number of species known to have become extinct since 1900 / square kilometre land area.

This indicator reflects the rate at which a country is losing its biodiversity, and is a proxy for ecosystem structure and function. Given the paucity of baseline data and biological surveys in both Trinidad and Tobago, the number of extinct species has not yet been accurately determined for both these islands. However, there is a possibility that 2 species of endemic plants from Trinidad known from specimens in the National Herbarium may no longer be found in the wild and seem to be extinct. This scores Trinidad as a 2 and Tobago as a 1 for this indicator (Table 2.4.12). Confidence in this estimate is low.

This suggests that at present Trinidad and Tobago are not very vulnerable to species extinctions.

Table 2.4.12. Scoring Table for Indicator #23 Extinctions

Score	Species Extinctions/ km ²
1	x=0 (To)
2	0<x<0.25(Tr)
3	0.25<x<0.5
4	0.5<x<0.75
5	0.75<x<1
6	1<x<1.25
7	x>1.25

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #24 – Natural Vegetation

Percentage of natural and re-growth vegetation remaining.

This indicator is a proxy for ecological redundancy and biodiversity. The integrity of the terrestrial and coastal ecosystems in a country increases with a high percentage of natural and re-growth vegetation. This also increases the resilience of the natural environments of the country.

There have been several highly divergent estimates of forest cover for Trinidad and Tobago, varying from 31% as stated in the 1999 World Statistics Pocket Book, Department for Economic and Social Information and Policy Analysis (UN) to 50.5 % in the 2003 publication entitled ‘State of the World’s Forests’ by the Food and Agriculture Organization (UN). However, only 2 known attempts have been made to objectively measure forest cover. A GIS map of the forest cover of Trinidad based on aerial photographs of the island taken in 1996 with limited ground truthing, estimates the forested area of Trinidad to be about 48%. This includes productive or plantation forest but not

mangrove forest. Another estimate was based on a year 2000 study by the University of Maryland Global Land Cover Facility using MODIS satellite coverage to determine forest cover. Using this method the area of forest with crown cover greater than 75% for Trinidad and Tobago was estimated at 229,000 ha or approximately 44.6% of the total land area. Based on this objective data, the EVI Score for Trinidad and Tobago is therefore estimated to be about 3. Confidence in this estimate is moderate.

Table 2.4.13. Scoring Table for Indicator #24 Natural Vegetation Remaining

Score	% Natural and re-growth vegetation remaining
1	x>80
2	60<x<=80
3	40<x<=60(T&T)
4	20<x<=40
5	10<x<=20
6	0<x<=10
7	x=0

(T&T) = Trinidad and Tobago

This suggests that in general the Trinidad and Tobago environment is not particularly vulnerable from existing loss of integrity of its terrestrial and coastal ecosystems. Caution should be exercised in interpreting this indicator because there has been significant loss of natural cover in localised areas such as the slopes of the western to central northern range in Trinidad and also in south-west Tobago.

EVI Indicator #25 – Rate of Loss of Natural Cover

Net percentage of land area changed by removal of natural vegetation over the last five years.

This indicator measures the risk of further losses of natural vegetation from deforestation, as well as loss of wetlands and other natural vegetation ecosystems.

The most reliable source of information to estimate this indicator is satellite imagery of forest cover. Appropriate data for calculating this indicator was obtained from the World Resources Institute, Earthtrends Country Profile at <http://earthtrends.wri.org>. The sources of this information include the Food and Agriculture Organization of the United Nations (FAO), Forest Stewardship Council (FSC), United Nations Environment Program-Global Resource Information Database, and the Global Land Cover Characteristics Database (GLCCD).

From the statistics, the change in forest area during the period 1990-2000 was estimated to be a reduction of about 8%.

If it is assumed that the rate of forest loss was relatively constant, then the percentage change in forest for the five year period 1995-2000 was approximately a reduction of 4% suggesting a loss of roughly 0.8% of forest per year. Trinidad and Tobago therefore scores a 7 on the EVI scale for this indicator. Confidence in this estimate is low.

The scores obtained indicate that both Trinidad and Tobago are highly vulnerable to loss of naturally vegetated areas.

A reduction in natural vegetation reduces available habitat, foraging area and other necessities for the flora and fauna on the island threatening their existence. It also has effects on human

existence contributing to events such as flooding and landslides.

**Table 2.4.14 Scoring Table for Indicator #25
Rate of Loss of Natural Cover**

Score	Loss of Natural Cover (%)
1	$x > 0$
2	No score
3	No score
4	$x = 0$
5	$-1 \leq x < 0$
6	$-2 \leq x < -1$
7	$x \leq -2$ (T&T)

(T&T) = Trinidad and Tobago

EVI Indicator #26 – Fragmentation of Land & Habitats

Percent of natural vegetation cover in fragments of less than or equal to 1000 ha, excluding those that occupy entire islands.

The construction of roadways in forested areas results in the dissection of forest habitat which can increase the environmental stress on fragmented and reduced species populations.

According to the GIS Section, WASA, the aggregate length of roads (Class 1,2,3 & 4) in Trinidad is 13,832.17 km and 667.92 km in Tobago.

Trinidad and Tobago both score a 7 for this indicator. Confidence in this estimate is high.

This indicates a high incidence of habitat fragmentation placing high stress on species inhabiting that area.

**Table 2.4.15. Scoring Table for Indicator #26
Fragmentation of Land & Habitats**

Score	Percent of natural vegetation cover in fragments of less than or equal to 1000 ha, excluding those that occupy entire islands.
1	$x < 0.2$
2	$0.2 < x \leq 0.4$
3	$0.4 < x \leq 0.6$
4	$0.6 < x \leq 0.8$
5	$0.8 < x \leq 1.0$
6	$1.0 < x \leq 1.2$
7	$x > 1.2$ (Tr) (To)

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #27 – Degradation

Percent of land area degraded.

Degraded land can be defined as land that can no longer revert to its natural ecosystem, without active and costly rehabilitation by humans to reverse permanent damage. This includes erosion, salinisation, desertification, conversion of forests to grasslands, and losses of mangroves. This indicator highlights the physical breakdown of the land and soils, which represents the decreasing levels of biodiversity, soil quality, resilience against floods, and assimilative capacity of the environment to pollution.

Information for Trinidad and Tobago on degraded areas was based on remotely sensed satellite data used in the World Resources Institute, Earthtrends Country Profile at <http://earthtrends.wri.org>.

Urban and built up areas can be considered as land that can no longer revert to its natural ecosystem, without active and costly rehabilitation. According to the World Resources

Institute, this is approximately 1.6% of the land area. Trinidad and Tobago therefore scored a 1 for this indicator. Confidence in this estimate is low.

The score obtained for Trinidad and Tobago suggest that both islands have a very low vulnerability to extreme land degradation and the associated decrease in the levels of biodiversity, soil quality, resilience against floods, and assimilative capacity of the environment to pollution.

**Table 2.4.16. Scoring Table for Indicator #27
Degradation**

Score	% land area degraded
1	$x \leq 5$ (Tr) (To)
2	$5 < x \leq 10$
3	$10 < x \leq 15$
4	$15 < x \leq 20$
5	$20 < x \leq 25$
6	$25 < x \leq 50$
7	$x > 50$

(T&T) = Trinidad and Tobago

EVI Indicator #28 – Terrestrial Reserves

Percent of terrestrial land area set aside as no take reserves.

This indicator captures the intactness of the terrestrial environment, the presence of refugia and the level of environmental management.

Information on the terrestrial reserves in Trinidad were obtained from the Forestry Division and shown in Table 2.4.17.

Table 2.4.17 Terrestrial reserves in Trinidad

Category	Trinidad	Tobago
Proclaimed Forest Reserves (ha)	130,187	3,956
Un-Proclaimed Forest Reserves (ha)	12,593	-
Total	142,780	3,956

Source: Forestry Division 2003

The percentage of terrestrial areas set aside as reserves (most since Colonial times) in Trinidad was determined to be 29.6%, giving an EVI score of 1. The area of forest set aside as reserves in Tobago is 39.6 km² which is approximately 13.2% of the terrestrial zone, giving Tobago an EVI score of 3. Confidence in this estimate is moderate. Caution should be exercised in interpreting this indicator since most of the forest land set aside is not actively managed or protected. Some designated forest land also no longer has forest since fires, illegal logging, squatting and slash and burn agriculture have taken their toll.

This indicator suggests that the environment of Trinidad and Tobago probably has a relatively low vulnerability and a high intactness of the terrestrial environment as a result of the terrestrial reserves. Caution should be exercised in interpreting this indicator as a result of the considerable loss of natural cover in localised areas some of which may be within reserves.

Table 2.4.18. Scoring Table for Indicator #28 Terrestrial Reserves

Score	% terrestrial zone set aside as reserves
1	20 < x (Tr)
2	15 < x ≤ 20
3	10 < x ≤ 15 (To)
4	5 < x ≤ 10
5	0 < x ≤ 5
6	No score
7	x=0

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #29 – Marine Reserves
Percent of continental shelf designated as marine protected areas (MPAs).

This indicator indicates the level of protection of the marine environment, the presence of refugia and the level of environmental management. According to the Buccoo Reef Management Plan which was developed by the Institute of Marine Affairs (IMA) and Tobago House of Assembly in 1995, the only marine area set aside as a reserve in Trinidad and Tobago is The Buccoo Reef Reserve which has an area of 7 km².

According to the Institute of Marine Affairs (IMA) the total Exclusive Economic Zone (EEZ) for Trinidad and Tobago is 56,722 km². The percentage marine zone set aside as reserve was therefore determined to be about 0.012 %, scoring approximately a 5 on the EVI scale. Confidence in this estimate is high. This suggests that value ecological components of the marine environment of Trinidad and Tobago are not sufficiently protected and are highly vulnerable to environmental impacts from development activities.

**Table 2.4.19. Scoring Table for Indicator #29
Marine Reserves**

Score	Marine Reserves
1	$20 \leq x$
2	$15 < x \leq 20$
3	$10 < x \leq 16$
4	$5 < x \leq 11$
5	$0 < x \leq 6$ (Tr) (To)
6	No score
7	$x = 0$
Units	%

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #30 – Intensive Farming

Tonnage of intensively farmed animal products (includes aquaculture, pigs, chickens, cattle, etc.) produced / year / square kilometre land area.

This indicator refers to farming, mainly non-point source effluents of which usually cannot be attenuated within the area the farms occupy. This excess effluent is flushed into nearby waterways and coastal waters causing eutrophication and subsequent negative impacts on marine and freshwater ecosystems.

Data was collected on the tonnage of intensively farmed animal products for Trinidad and Tobago for the years 1997-2001 from the Central Statistical Office, Quarterly Agricultural Reports. This included production of beef pork, mutton, pig, poultry and aquaculture. Intensive farming and the associated pollution from animal wastes are mainly a problem in Trinidad where a large percentage of the 36,807,600 tonnes of intensively farmed products produced during the period came from poultry production.

Data coverage for Tobago was incomplete for some years. Even so this

is not expected to have skewed the overall picture because of the comparatively low level of livestock production. During the period 1997-2001 an average of 30,283,400 heads of pig and 35,468,800 heads of chicken were produced in Trinidad. In Tobago, an average of 384,000 heads of pig was produced for this same period.

The data indicates that the average tonnage of intensively farmed animal products in Tobago was 2.5 tonnes/km² giving an EVI value of 1. In contrast the average tonnage of intensively farmed animal products for Trinidad was 7.6 tonnes/km² giving an EVI value of 2. Confidence in the estimate is moderate.

This suggests that water courses in Trinidad are slightly vulnerable to nutrient eutrophication from animal wastes associated with livestock farming. Tobago is much less vulnerable to these effects as indicated by the lower EVI score for that island.

**Table 2.4.20 Scoring Table for Indicator #30
Intensive Farming**

Score	Tonnage of intensively farmed animal products
1	$x \leq 2$ (To)
2	$2 < x \leq 3$ (To)
3	$3 < x \leq 4$
4	$4 < x \leq 5$
5	$5 < x \leq 6$
6	$6 < x \leq 7$ (Tr) (T&T)
7	$x > 7$
Units	t/ km ² /year

(Tr) = Trinidad; (To) = Tobago

(T&T) = Trinidad and Tobago

EVI Indicator #31 –Fertilizers

Tonnes of nitrogen (N), phosphorus (P) and potassium (K) fertilisers used / year / km² of agricultural land (average last five years).

This indicator is a proxy measure of the damage to ecosystems from natural enrichment caused by the use of fertilizers. This enrichment can negatively affect water quality, coral reefs and soil quality.

Data for this indicator is not comprehensively collected in Trinidad and Tobago. It is therefore difficult to determine the total tonnage of NPK fertilizer that is actually used by farmers on agricultural land.

It is also difficult to ascertain the amount of fertilizer used for Tobago alone. The closest approximation for use in Trinidad would be to determine the total tonnage of NPK fertilizer imported into the country, as well as the amount of fertilizers produced and used in the country. This is shown in Tables 2.4.21. and 2.4.22.

Table 2.4.21. Domestic Production of Fertilizers

Year	Anhydrous ammonia (t)	Urea (t)
1996	2110636	563563
1997	2096174	594480
1998	2734213	512511
1999	3357777	588973
2000	3262432	512511
Total	13,561,232	2,772,038

Source: Annual Statistical Digest
Central Statistical Office

Table 2.4.22. Fertilizer Imported into Trinidad and Tobago

Year	1996	1997	1998	1999	2000
Nitrogenous Fertilizers (t)	398	307	300	788	873
Phosphatic Fertilizers (t)	2890	428	1023	536	799
Potassic Fertilizers (t)	2061	1230	831	1041	1837
Other Compounds Fertilizers (t)	1869	5295	8296	2559	3466
Natural Fertilizers (t)	192	525	660	635	619
Total	7410	7785	11110	5559	7594

Source: Annual Statistical Digest
Central Statistical Office

According to the Land & Surveys Division, the area of agricultural land in Trinidad is 690 km². Given this information, the tonnes of NPK fertilizers used/sq km agricultural land/yr for Trinidad was determined to be 4,746 t/ km²/ yr. Trinidad therefore scored a 6 for this indicator. Confidence in this estimate is low. No score is given for Tobago.

A major assumption made in the calculation of this indicator was that the amount of fertilizers, found in Trinidad, equated to the amount of fertilizers used per year.

This suggests that the vulnerability of the environment of Trinidad to damage caused by the excessive use of fertilizers is high. Confidence in the estimate is moderate.

Table 2.4.23. Scoring Table for Indicator #31 Fertilizers

Score	Fertilizers (T/sq km/ yr)
1	$x \leq 2$
2	$2 < x \leq 4$
3	$4 < x \leq 6$
4	$6 < x \leq 7$
5	$7 < x \leq 8$
6	$8 < x < 9$ (Tr)
7	$x > 9$

(T&T) = Trinidad & Tobago

EVI Indicator #32 – Pesticides

Tonnes of pesticides used / square kilometre of agricultural land (average last five years).

This indicator represents the damage resulting from the use of pesticides on ecosystems, water quality, coral reefs and soil quality.

Table 2.4.24. summarises the tonnes of pesticides imported into Trinidad for the period 1998-2002 from information provided by the Chemical Pesticides and Toxic Chemicals Control Board, Food and Drug Division, Ministry of Health.

Table 2.4.24. Tonnes of pesticides imported to Trinidad for the period 1998-2002

Year	Tonnes
1998	4,845.5
1999	122,525.7
2000	6,509.3
2001	3,080.7
2002	1,800.0
Total	138,761.1
Average	27,752.2

Source: Chemical Pesticides and Toxic Chemicals Control Board, Food and Drug Division, Ministry of Health

The amount of pesticides used in Tobago is not comprehensively collected and therefore was estimated by interviewing agricultural shops on the island.

Table 2.4.25 Amount of Pesticides Used in Tobago

Agricultural Store	Pesticides used / yr (kg)
Applecade Limited	100
Crop Stock & Agro Supplies	100
Farmers Friend Agro shop	147.6
Tobago Farm & Garden Center	2880
Total	3227.60
	=3.2 (tonnes)

The area of agricultural land is about 690 km² in Trinidad and 65.83 km² in Tobago.

A major assumption made in the calculation of this indicator was that the amount of pesticides, found within both Trinidad and Tobago, equated to the amount of pesticides used per year. Also it was assumed that roughly 1 liter of pesticide = 1 kg of pesticide, since the units for this indicator is in kg.

Given the available data, the tonnes of pesticides used per square kilometre of agricultural land in Trinidad was calculated to be 40.2 t/yr/ km² (*1000 = 40220) scoring a 7 on the EVI scale. Confidence in this estimate is moderate. The tonnes of pesticides used per square kilometre of agricultural land in Tobago was found to be 0.049 t/ km²/yr (*1000 = 49) scoring a 7 on the EVI scale. Confidence in this estimate is low.

This suggests that the environment of Trinidad and Tobago is very vulnerable to damage from pesticides. In particular, the water and soil quality can be severely affected by pesticides, in addition to adverse effects on the biota of aquatic and soil ecosystems..

Table 2.4.26. Scoring Table for Indicator #32 Pesticides

Score	Pesticides
1	x=0
2	0<x≤0.5
3	0.5<x≤1
4	1<x≤2
5	2<x≤3
6	3<x≤4
7	x>4 (Tr) (To)
Units	T/sq km/ yr

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #33 – Biotechnology

Area of land engaged in the agriculture or field testing of any genetically modified organisms.

This indicator is a proxy measure for vulnerability to the introduction of genetically altered species, which can cause an imbalance in the natural ecosystem.

Trinidad and Tobago does not engage in the agriculture or field testing of any genetically modified organisms. There is therefore no land area used for testing of genetically modified organisms. Trinidad and Tobago therefore scores a 1 for this indicator. Confidence in this estimate is high. This suggests that the risk of species alteration, genetic escape and ecosystem interference is low.

Table 2.4.27. Scoring Table for Indicator #33 Biotechnology

Score	Area of land engaged in the agriculture or field testing of any genetically modified organisms (Km ²)
1	x=0 (Tr) (To)
2	No score
3	No score
4	No score
5	0<x<20
6	20<x<50
7	x>50

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #34 – Ecological Over fishing

Percent of fisheries stocks over-fished.

This indicator is proxy for marine degradation. The over-fishing of fisheries stocks clearly indicates the loss of marine species and an imbalance in

marine ecosystems causing degradation of the marine environment.

Stock assessments have not been conducted for all commercial species in Trinidad and Tobago. However, preliminary studies show that species such as brown shrimp, cork shrimp, carite, salmon and croaker are fully exploited. Table 2.4.28 summarises the status of the fishery stocks that have been studied, as provided by the Fisheries Division and the International Commission for the Convention of Atlantic Tunas 1998.

Table 2.4.28 Exploitation status of fishery stocks around Trinidad.

Species	Status of Fisheries Stocks
1. Coastal Pelagics	
Carite	Fully exploited
Kingfish	Optimally exploited
Flying fish	Near full exploitation
Anchovies and sardines	underutilized
2. Coastal demersals (soft bottom)	
White, cork shrimp	Fully to over fished
Brown shrimp	Fully to over fished
Groundfish	
Salmon	Fully to over fished
Croaker	Fully to over fished
3. Coastal demersals (hard bottom)	
	Data available currently is inadequate
4. Oceanic Pelagics	
Blue marlin	Over exploited
White marlin	Severely over exploited
Swordfish	Over exploited
Albacore	At or above full exploitation
Bigeye tuna	Over exploited
Yellowfin tuna	At or over exploited
Skipjack tuna	Status unknown
Bluefin tuna	Considerably over fished
5. Deep water demersals	
	Data available currently is inadequate

Source: Fisheries Division, Ministry of Food Production 1995, 2000; International Commission for the Convention of Atlantic Tunas 1998

From this preliminary information the percent of fisheries stocks over-fished for Trinidad can be estimated at approximately 48%, giving an EVI score of 4 for Trinidad. Confidence in the data

is moderate. An EVI value for Tobago was calculated using information sourced from the Fisheries Division Tobago.

Table 2.4.29 Exploitation status of fishery stocks around Tobago.

Family Name	Local Name
Scombridae	Mackerels: Tunas 2 spp., Kingfish (*), Carite (*), Bonito, Wahoo
Lutjanidae	Snappers: Dog teeth Snapper
Pomadasyidae	Grunts
Istiophoridae	Sailfish : marlin (blue & white)
Coryphaenidae	Dolphin Fish
Excoetidae	Flying Fish
Carangidae	Cavalli, Jacks
Carcharinidae	Sharks (5 spp.)
Sphrynidae	
Sphyraenidae	Barracuda
Serranidae	Grouper (*)
Sciaenidae	Croaker Salmon (*)

Source: Fisheries Division Tobago House of Assembly and EMA State of the Environment Report 1997. (*) species identified as fully or over exploited by Fisheries Division Tobago.

The percentage of fish stocks over-fished for Tobago was determined to be about 17% giving an EVI score of 3 for Tobago. Confidence in the estimate is low. A proxy which can also be used for this indicator is the annual fisheries catches for the country. Annual landings from semi-industrial vessels are not available. However, it is estimated that this fleet contributes about 970 tonnes annually, which has been included in the yearly estimate. Table 2.4.30. details the landings and value of catch for Trinidad and for the period 1997-2001.

Table 2.4.30 Landings and Value of Catch for Trinidad (1997-2001)

Year	Landing (Tonnes)	Value (TT\$ 000,000)
1997	8,054	73.85
1998	10,576	93.91
1999	9,729	85.55
2000	9,577	83.59

2001	11,742	108.54
2002	13,568	NA

Source: Fisheries Division

The data suggests that Trinidad and Tobago are moderately vulnerable to over-fishing.

Table 2.4.31 Scoring Table for Indicator #34 Ecological Overfishing

Score	% fisheries stocks over-fished
1	$x < 1$
2	$1 < x < 2$
3	$2 < x < 3$ (To)
4	$3 < x < 4$ (Tr)
5	$4 < x < 5$
6	$5 < x < 6$
7	$x > 6$

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #35 – Fishing effort

Number of new fisheries stocks or expanded fisheries efforts (greater than 20% increase in catches) added to the country over the last five years (within territory).

This question attempts to capture the pressure on fishing stocks. The assumption made in the calculation of this indicator, is that new species and ecosystems are under increased risk. Therefore, the addition of new stocks may be occurring in response to losses of previously and currently fished stocks.

According to the Environmental Management Authority 1997 Annual Report, the number of fish catches in Trinidad and Tobago rose steadily during the period 1986-1991, peaking in 1992. However, since 1992 there has been a decrease in the number of fish landed.

This suggests that there have been no new fish stocks added to existing fish stocks since 1992.

Given that zero fish stocks have been added to existing stocks, the EVI score obtained for this indicator is 1. Although the score obtained for this indicator is low, the score obtained for Indicator 34 for Trinidad and Tobago, 4 and 3 respectively, shows that Trinidad is moderately vulnerable to over-fishing. Most of the available fish stocks in Trinidad and Tobago are already being fished and some are at risk of over-exploitation.

A proxy measure that can be used for this indicator is the number of fishers. Using the census information from the 1998 Vessel Census (Fisheries Division), it can be approximated that the number of persons actively fishing can be equated to the number of vessels, each with an average of 4 persons per vessel. This therefore amounts to 50, 044 persons actively fishing in 1998.

Table 2.4.32. Scoring Table for Indicator #35 Fishing Effort

Score	Fishing Effort
1	$x \leq 2$ (Tr) (To)
2	$2 < x \leq 2.5$
3	$2.5 < x \leq 3$
4	$3 < x \leq 3.5$
5	$3.5 < x \leq 4$
6	$4 < x \leq 4.5$
7	$x > 4.5$
Units	stocks

(Tr) = Trinidad; (To) = Tobago

EVI Indicator # 36 – Renewable Water

Mean percentage of water usage / year met from renewable and non-declining sources.

Renewable water can be defined as water caught in rain tanks and reservoirs, or collected from streams, rivers, lakes, ice or groundwater that are not being significantly diminished or salinised as a result of the extraction. This indicator attempts to describe the sustainable use of surface free water and groundwater. Table 2.4.33 illustrates the freshwater resources and withdrawals for 2002 and 2003 for Trinidad and Tobago.

Table 2.4.33. Renewable Water Resources for Trinidad and Tobago in year 2003

Location	Surface water Km ³ /yr	Groundwater Km ³ /yr	Total
Trinidad	3.46	0.545	4.005
Tobago	0.14	0.066	0.206

Source: Water Resources Agency

Using the information the volume of water met from non renewable sources for the year for Trinidad is 4,005,000,000,000 L/year and for Tobago is 206,000,000,000 L/yr.

Using the EVI scoring table shown below, the score derived for this indicator for both Trinidad and Tobago was a 7. This indicates that both Trinidad and Tobago have a very high demand on the water resources of the islands. This therefore suggests that watersheds and rivers should be carefully managed, and encroachment should be prevented in watershed areas, in order to preserve the integrity of these systems.

Table 2.4.34. Scoring Table for Indicator #36 Water

Score	Mean percentage of water usage / year met from renewable and non-declining sources
1	$x \leq 10$
2	$10 < x \leq 20$
3	$20 < x \leq 40$
4	$40 < x \leq 60$

5	$60 < x \leq 80$
6	$80 < x \leq 100$
7	$x > 100$ (Tr) (To)
Units	L/capita/day

(Tr) = Trinidad; (To) = Tobago

2.5 Anthropogenic

Factors that are heavily dependent on human activity were also included in the determination of the EVI of Trinidad and Tobago. Some of the indices measured include waste treatment, oil spills, mining, and sanitation.

EVI Indicator #37 –SO₂ Emissions

Maximum 24 hour SO₂ concentration (microgram/m³) (average over last five years).

This indicator can be used as a proxy for air pollution in general, which impacts on many aspects of ecosystem health including such things as water quality and biodiversity.

There is no continuous monitoring data for sulphur dioxide in Trinidad and Tobago. Therefore an estimate for this indicator could not be determined.

EVI Indicator #38 – Waste Production

Total net tonnage of generated and imported toxic, hazardous and municipal wastes per km².

The focus of this indicator is on the amount of wastes being generated or brought into the country. The indicator captures the risk to ground water pollution, pollution of waterways, coastal pollution and solid waste pollution.

The municipal waste generated in Trinidad is land-filled at one of the three

landfill sites located at Beetham, Forres Park and Guanapo. The total municipal waste generated for Trinidad is shown in Table 2.5.1.

Table 2.5.1 Municipal Wastes in Trinidad between 1998-2002

Year	Beetham	Forres Park	Guana-po	Total tonnes
1998	176,949	98,285	47,984	323,218
1999	172,263	113,858	49,863	335,984
2000	195,967	178,957	48,818	423,742
2001	200,527	104,809	73,448	378,784
2002	238,540	103,051	83,393	424,984

Source: Solid Waste Management Company

Waste per square kilometre land area for Trinidad was calculated to be 78.2 tonnes/sq km/year. Thus Trinidad scored a 5 for this indicator.

Data on hazardous waste is not continuously updated in Trinidad, and data on tonnage of municipal wastes generated is not comprehensively collected for Tobago.

The data suggests that Trinidad and Tobago is moderately vulnerable to pollution of waterways, coastal regions and groundwater caused by the large volume of wastes generated on an annual basis. This can result in the reduction of water quality and adversely affect aquatic ecosystems and the biodiversity associated with these ecosystems.

Table 2.5.2 Scoring Table for Indicator #38 Waste Production

Score	Tonnage of generated and imported toxic, hazardous and municipal wastes / km ²
1	$x \leq 1$
2	$1 < x \leq 2$
3	$2 < x \leq 3$
4	$3 < x \leq 4$
5	$4 < x \leq 5$ (Tr)
6	$5 < x \leq 6$
7	$x > 6$

(Tr) = Trinidad

EVI Indicator #39 – Waste treatment

Mean percent of hazardous, toxic and municipal waste “effectively” managed or treated / year.

The focus of this indicator is to measure the effective management of wastes which includes management strategies such as composting, reusing, recycling, controlled incineration, and controlled landfill. This indicator also captures risk to ground water pollution, waterways pollution, coastal pollution and solid waste pollution.

The collection and compilation of data on waste generated and recycled in Trinidad and Tobago is very piecemeal and it is difficult to accurately determine the percent of waste effectively managed or treated per year.

Municipal waste in Trinidad is treated by the process known as land-filling. In this process, the waste is brought to a designated area and is compacted and buried. Approximately 377,342.4 t/yr of waste is land-filled per year. Approximately 12,678,941.5 t/yr of waste is generated, the estimated percentage of waste land-filled is 2.98%.

Most of the other waste generated is re-shipped to manufacturers for recycling. In Trinidad only waste oil is recycled, therefore, given that 897.8 cubic meters of oil is generated per year, with 35.8 cubic meters being recycled, the mean percent of hazardous waste recycled locally is about 4 %.

The percentage of wastewater treated on an annual basis for Trinidad was determined to be about 33 %. Trinidad therefore scored approximately a 4 on

the EVI scale. Confidence in this estimate is low. No data is available to calculate this indicator for Tobago.

This suggests that the waterways, groundwater and coastal regions in Trinidad, are at moderate risk to pollution from the improper disposal of wastes. This pollution can be caused by the introduction of solid waste into the environment, as well as the movement of leachate through the soil into waterways.

Table 2.5.3. Scoring Table for Indicator #39 Waste Treatment

Score	% hazardous, toxic and municipal waste “effectively” managed or treated / year
1	81-100
2	61-80
3	41-60
4	21-40 (Tr)
5	11-20
6	5-10
7	<5

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #40 –Industry

Number of nuclear, chemical and other major industrial facilities (e.g. oil rigs) that could cause significant environmental damage / km².

This indicator captures all major potential chemical and other industrial polluters that could cause significant environmental damage in the event of an accident. It can be used as a proxy for pollution and acid rain.

Trinidad can be considered an industrialized developing country and contains numerous industrial facilities.

According to the Business Surveys Department of the Central Statistical Office, there are 8 industrial facilities

employing more than 1000 persons in Trinidad. There are, however, no industrial facilities employing more than 1000 persons in Tobago. The electricity consumption by all industries, which is measured primarily in kilowatts per hour, can be used as a proxy measurement for this indicator. This information is shown in Table 2.5.4.

Table 2.5.4. Electricity Consumption for all Industries in Trinidad for period 1997-2001

Year	Consumption (KW/hr)
1997	2.88 billion
1998	4.1 billion
1999	3.2 billion
2000	3.3 billion
2001	3.5 billion
Average	3.396 billion

Source: T&TEC Annual Reports 1998-2002

Using this information, Tobago scored a 1 on the EVI scale and Trinidad scored a 2. Confidence in this estimate is high.

This suggests that the environment of Trinidad is in general not especially vulnerable to pollution from chemical and other major industrial facilities. The vulnerability of the environment of Tobago to pollution from chemical and other major industrial facilities is very low.

Table 2.5.5. Scoring Table for Indicator #40
Industry

Score	Toxic Industries (facilities/km ²)
1	$x \leq 5$ (To)
2	$5 < x \leq 10$ (Tr)
3	$10 < x \leq 20$
4	$20 < x \leq 50$
5	$50 < x \leq 100$
6	$100 < x \leq 200$
7	$x > 200$

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #41 – Spills

Number of spills of oil and hazardous substances greater than 1000 litres during the last five years on land, in rivers or within territorial waters / km² .

Oil spills pose a serious threat to ecosystems and loss of marine coastal species. This indicator attempts to illustrate the incidence of oil spillage and the degree of risk of these occurrences to a country.

Trinidad is an oil producing country, so that apart from accidental oil spills, there are a number of oil seeps that occur naturally throughout the island.

According to statistics from the Ministry of Energy and Energy Industries, EMA & Petroleum Industries, the quantity of oil spills occurring during the five-year period 1999-2003 for Trinidad was 927. During 1996-2001 20 hazardous spills greater than 1000 litres were recorded in Trinidad.

From the data obtained it was determined that the number of spills of oil and hazardous substances greater than 1000 litres during the last five years was about 196 spills / 1000 sq km. This scored a 5 on the EVI scale for Trinidad.

According to the Ministry of Energy and Energy Industries, there are no heavy industries located on the island of Tobago. As such, there have been no incidence of spills of oil and hazardous substances >1000 liters on land, in rivers or within territorial waters. Confidence in this estimate is moderate.

This suggests therefore that Trinidad is highly vulnerable to pollution arising

from spills of oil and hazardous substances, whereas the vulnerability of Tobago to these events is low.

Table 2.5.6. Scoring Table for Indicator #41 Spills

Score	Number of spills of oil and hazardous substances within territorial waters / km ²
1	x=0 (To)
2	0<x≤50
3	50<x≤100
4	100<x≤150
5	150<x≤200 (Tr)
6	200<x≤250
7	x>250

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #42 –Mining

Tonnes of mining material (ore + tailings) extracted / km²/ year average last five years.

This indicator represents the risk of large-scale disturbances to the land and seabed, and the effects of pollution on waterways and in the deep-sea.

The material moved by quarrying and mining activities include andesite, blue limestone, yellow limestone, porcellanite, gravel/sand, oil sand, clay and natural asphalt. The data is displayed in Table 2.5.7.

Table 2.5.7. Table showing Tonnage of quarried and Mined Material in Trinidad for period 1995-1999

Year	Quarried Material (tonnes)	Petroleum and Natural gas (tonnes)
1995	2955177.8	55989101
1996	4796087.4	6722151
1997	4917056.1	11716873
1998	5142395.6	12430410
1999	3831451.4	6795990

Source: Ministry of Energy & Energy Industries.

Using the available statistics, the tonnes of mining extracted per square kilometre per land area per year for Trinidad is 4776.17 tonnes/ km²/ year, giving an EVI score of 7 for Trinidad. Confidence in this estimate is moderate.

This indicator has not yet been determined for Tobago.

This suggests that the environment of Trinidad is highly vulnerable to land degradation which is associated with sedimentation of waterways.

Table 2.5.8. Scoring Table for Indicator #42 Mining

Score	Tonnes of mining material / km ² / year average last five years
1	x=0
2	0<x≤1
3	1<x≤2
4	2<x≤3
5	3<x≤4
6	4<x≤5
7	x>5(Tr)

(Tr) = Trinidad

EVI Indicator #43 – Population without Safe Sanitation

Percentage of population with access to safe sanitation.

This indicator is a proxy measure for the quality of water bodies. In instances where sanitation is of a low standard, water bodies have a higher risk of being polluted and/or becoming eutrophic. The percentage of population with access to safe sanitation for Trinidad was determined from the 1990 Population Census and is shown in Table 2.5.9.

Table 2.5.9 Percentage of population with access to safe sanitation for Trinidad

Categories	Counts	%	Cumulative %
Pit	113626	41.34	41.34
With link to sewer	60159	21.89	63.23
No link to sewer	98326	35.77	99.00
Other	189	0.07	99.07
None	1197	0.44	99.51
Not stated	1349	0.49	100.00
Total	274846	100.00	100.00

Source: Ministry of Planning and Development Census Report 1990

It should be noted that information for this indicator from the 2000 Population Census has not yet been made available.

Given these statistics, the percentage of population with access to safe sanitation for Trinidad was determined to be 63%, scoring a 7 on the EVI scale. Confidence in this estimate is low. Accurate data is not available for Tobago. The data suggests that the risk of water bodies being polluted is less than average. Caution should be exercised in interpreting this indicator since most of the country is connected to pit latrines many of which do not function adequately. Even the data concerning persons linked to sewers may be misleading as many private sewerage treatment plants are non-functioning.

Table 2.5.10. Scoring Table for Indicator #43 Population without Safe Sanitation

Score	% population with access to safe sanitation
1	$x < 1.5$
2	$1.5 < x \leq 2$
3	$2 < x \leq 2.5$
4	$2.5 < x \leq 3$
5	$3 < x \leq 3.5$
6	$3.5 < x \leq 4$
7	$x > 4$ (Tr)

(Tr) = Trinidad

EVI Indicator #44 – Vehicles

Number of vehicles per km² of land area.

This indicator is a proxy for human impacts, including loss of biodiversity and fragmentation of forested areas, air pollution, and lead pollution on land and in waterways.

Over the period 1998-2002 there has been a steady increase in the number of vehicles in Trinidad. The number of vehicles in Tobago however, has remained more or less steady during this same period. Table 2.5.11 shows the number of registered vehicles for Trinidad and Tobago.

Table 2.5.11. Number of registered vehicles for Trinidad and Tobago

Year	Total # registered vehicles	
	Trinidad	Tobago
1998	272,809	575
1999	292,460	448
2000	315,587	576
2001	331,182	413
2002	346,930	396
average	311,794	482

Source: Licensing Office, Ministry of Transport

The number of vehicles / land area for Trinidad was determined to be 64.6 vehicles / km² which scored a 7 on the EVI scale. The number of vehicles / land area for Tobago was determined to be 1.6 vehicles / km² which scored a 3 on the EVI scale. Confidence in this estimate is high.

This suggests that the environment of Trinidad is very vulnerable to damage from pollution from vehicles, including lead pollution and air pollution. Tobago is less vulnerable to this particular phenomenon.

**Table 2.5.12. Scoring Table for Indicator #44
Vehicles**

Score	Vehicles (Vehicles / km ²)
1	$x \leq 1$
2	$1 < x \leq 1.5$
3	$1.5 < x \leq 2$ (To)
4	$2 < x \leq 2.5$
5	$2.5 < x \leq 3$
6	$3 < x \leq 3.5$
7	$x > 3.5$ (Tr)

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #45 – Population Density

Total human population density (number / km² land area).

This indicator is a proxy measure for pressure on the environment resulting from the number of humans being supported per unit of land. The greater the number of people living in an area, the greater the pressure on the environment, for resources, and to attenuate the increase amounts of wastes. A high population density also increases the physical disturbance associated with heightened development.

The statistic for the total human population density for the islands of Trinidad and Tobago was obtained from projections using data from the 2000 Population and Housing Census Preliminary Report, Central Statistical Office. The total human population density for Trinidad and Tobago for 2003 was determined to be 250 persons/km². Of this figure, the total human population density for Trinidad (2003) is 254 persons/km² and the total human population density for Tobago is 183 persons/km². Using the EVI scoring Table 2.5.13, the score derived for this EVI indicator for Trinidad and Tobago

was a 6. Confidence in the estimate is high.

This suggests that the environment of Trinidad and Tobago is under high stress to support the growing number of persons living on the island and is highly vulnerable to damage associated with anthropogenic activities. This large number of persons results in an increase in the volume of wastes generated and present in the environment. It also increases the pressure on resources since more resources would be needed to support the large number of residents.

**Table 2.5.13 Scoring Table for Indicator #45
Population Density (People/ km²)**

Score	Population Density
1	$x < 4$
2	$3 < x \leq 3.6$
3	$3.5 < x \leq 5$
4	$4 < x \leq 4.6$
5	$4.5 < x \leq 6$
6	$5 < x \leq 5.6$ (Tr) (To)
7	$x > 5.6$

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #46 – Population Growth

Annual human population growth rate (average over last five years).

This indicator focuses on the potential for damage that can be caused by increasing or decreasing rates of natural resource exploitation. It also attempts to estimate the potential for future damage caused by human activities.

Using data from the Central Statistical Office the annual population growth rate for Trinidad and Tobago was calculated to be about 0.5%. Based on this information, the EVI score is 3 for Trinidad and Tobago. Confidence in the estimate is high. This indicates that both Trinidad and Tobago have no more than

average vulnerability to damage caused by increasing rates of natural resource exploitation.

Table 2.5.14 Scoring Table for Indicator #46 Population Growth

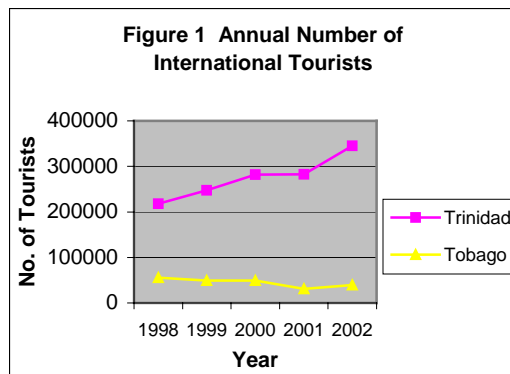
Score	Population Growth (%)
1	$x < -2$
2	$-2 \leq x < -1$
3	$-1 \leq x < 1$ (Tr) (To)
4	$1 \leq x < 3$
5	$3 \leq x < 5$
6	$5 \leq x < 7$
7	$7 \leq x$

(T & T) = Trinidad and Tobago

EVI Indicator #47 – International Tourists

Annual number of international tourists multiplied by the average length of stay in the country over one year / land area (over the last five years).

This is a proxy measure for pressure on the environment resulting from tourists entering a country. Tourists place additional pressure on the environment through increasing demands on local resources and through creation of pollution, including solid waste and effluent.



Source: Licensing Office, Ministry of Transport

Data for this indicator was collected for the period 1998-2002 from the Immigrations Section and Central

Statistical Office (CSO). According to CSO, the average length of stay of tourists to Trinidad and Tobago could only be accurately obtained for 2002. The average of the annual international tourists to Trinidad between 1998-2002 was 275,052 and their average length of stay (in 2002) was 16.8 days, yielding a tourist pressure on the environment of about 2.62 persons/km²/day scoring 1 on the EVI scale.

Similarly, the tourist pressure on the environment of Tobago was 5.60 persons/km²/day scoring 1 on the EVI scale based on an average of 44,875 tourist per annum each staying on average 13.7 days (in 2002). Confidence in this estimate is high.

This suggests that the stress placed on the environment of Trinidad by tourists with respect to its capacity to provide services is low for Trinidad and Tobago.

Table 2.5.15 Scoring Table for Indicator #47 International Tourists

Score	People/ km ² /day
1	$x < 3$ (Tr) (To)
2	$3 < x \leq 3.5$
3	$3.5 < x \leq 4$
4	$4 < x \leq 4.5$
5	$4.5 < x \leq 5$
6	$5 < x \leq 5.5$
7	$x > 5.5$

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #48 – Coastal Populations

Density of people living in coastal settlements (i.e. with a city center within 20 km of the coast).

This indicator is a proxy measure for the degradation of coastal and marine habitats. A high population density and

associated coastal development increases pressure on coastal resources, as well as increases pollution and disturbances, which impact negatively on coastal ecosystems. Table 2.5.16 shows the density of people living in coastal settlements with a city center within 20 km of the coast for Trinidad and Tobago.

Table 2.5.16. Density of people living in coastal settlements with a city center within 20 km of the coast

City Center	Population Size
San Fernando	55419
Port of Spain	49031
Scarborough	1352

Source: Central Statistical Office

The area of Port of Spain (9.58 km²) and San Fernando (6.48 km²) were obtained from the Central Statistical Office whereas the area of Scarborough (1.54 km²) was determined by WASA using GIS. A major assumption made in calculating this indicator for Tobago was that the boundaries used by WASA in determining the area of Scarborough was the same as the boundaries used by CSO in determining the population for this area.

The density of people living in coastal settlements for Trinidad was calculated at about 5118 people/km² for Port of Spain and 8552 persons/ km² for San Fernando giving an EVI value of 7 for Trinidad. The density of people living in coastal settlements for Tobago was calculated at about 878 persons/km² giving an EVI value of 7. Confidence in this estimate is high. This suggests that coastal areas and associated ecosystems in both Trinidad and Tobago are very vulnerable to pollution and other negative impacts of highly developed areas.

Table 2.5.17. Scoring Table for Indicator #48 Coastal Populations

Score	Population density in coastal settlements (People/ km ²)
1	$x < 3$
2	$3 < x \leq 3.5$
3	$3.5 < x \leq 4$
4	$4 < x \leq 4.5$
5	$4.5 < x \leq 5$
6	$5 < x \leq 5.5$
7	$x > 5.5$ (Tr) (To)

(Tr) = Trinidad; (To) = Tobago

EVI Indicator #49 – Environmental Agreements

Environmentally related legislation with regulations.

This indicator investigates the level of environmental management through the operation of the environmental legislation within the country.

According to the Environmental Management Authority State of the Environment Report 1999, there is at present, numerous piecemeal legislation relating to specific environmental issues. Of these pieces of legislation, sixteen relate to waste, sixteen relate to noise pollution, sixty relate to biological resources, and twelve relate to air pollution. Although significant strides have been made in strengthening the legal and regulatory framework for sound environmental management much remains to be done. Major initiatives include the enactment of the Environmental Management Act No.3 of 2000.

Rules and Regulations Tabled in Parliament

The following new environmental management rules and regulations have

been laid in Parliament and obtained negative resolution:

The Noise Pollution Control Rules 2001.

These provide regulations for the control of noise pollution by establishing appropriate standards and acceptable levels of sound pressure.

Certificate of Environmental Clearance Rules 2001

The environmental clearance process is intended to provide a systematic procedure for determining the environmental impact which might arise out of any new or significantly modified construction, process, works or other activity. It also provides a mechanism for undertaking remedial actions where necessary.

The Rules outline the procedures and stipulate indicative timeframes for the granting of Certificates of Environmental Clearance, thus ensuring an efficient, non-discriminatory and transparent system.

Environmentally Sensitive Areas Rules 2001.

The designation of environmentally sensitive areas is intended to preserve biological diversity and ecological integrity of important ecosystems in Trinidad and Tobago. These Rules lay down the procedures and standards for the formal designation of environmentally sensitive areas, and regulate the use and activities undertaken in these areas.

Environmentally Sensitive Species Rules 2001.

The designation of environmentally sensitive species is intended to ensure

the persistence of indigenous species of animals and plants which are currently threatened with extinction and which have beneficial uses. The Rules lay down the procedures and standards for designation of environmentally sensitive species.

Cabinet Approved Rules Regulations awaiting Tabling in Parliament

Draft Water Pollution Rules

These Rules seek to prohibit the discharge of water pollutants from industrial, commercial and agricultural premises or sewage works without a permit from the Environmental Management Authority.

Beverage Containers Bill

By establishing a deposit/refund system for beverage containers, this Bill is intended to promote their voluntary reuse or recycling. It also provides for the regulation by the EMA of beverage distributors who fail to adopt acceptable voluntary management systems.

In addition to these pieces of environmental legislation, Trinidad and Tobago is also signatory to at least 20 Multi-lateral Environmental Agreements which commit the country to local action in the areas of biodiversity, climate change, desertification, plant protection, hazardous waste, and wetland protection to name a few.

In the balance although the recent enactment of environmental legislation and signature to several environmental treaties has provided a framework for environmental management, the importance attached to environmental

management remains unacceptable with several key pieces of legislation remaining in draft for too many years.

Trinidad and Tobago therefore scores approximately a 5 on the EVI scale. Confidence in this estimate is high.

Table 2.5.18. Scoring Table for Indicator #49 Environmental Agreements

Score	Environmentally related legislation with regulations
1	$x > 60$
2	$50 < x \leq 60$
3	$40 < x \leq 50$
4	$30 < x \leq 40$
5	$20 < x \leq 30$ (Tr) (To)
6	$10 < x \leq 20$
7	$x \leq 10$

(Tr) = Trinidad; (To) = Tobago

in this country was not of a large military scale, as is seen in other parts of the world.

Table 2.5.19. Scoring Table for Indicator #50 Human Conflicts

Score	Number of war or civil strife years over the last 50 years within the territory
1	$x = 0$
2	No score
3	No score
4	No score
5	$0 < x \leq 2$ (Tr) (To)
6	$2 < x \leq 5$
7	$x > 5$
Units	years

(Tr) = Trinidad; (To) = Tobago

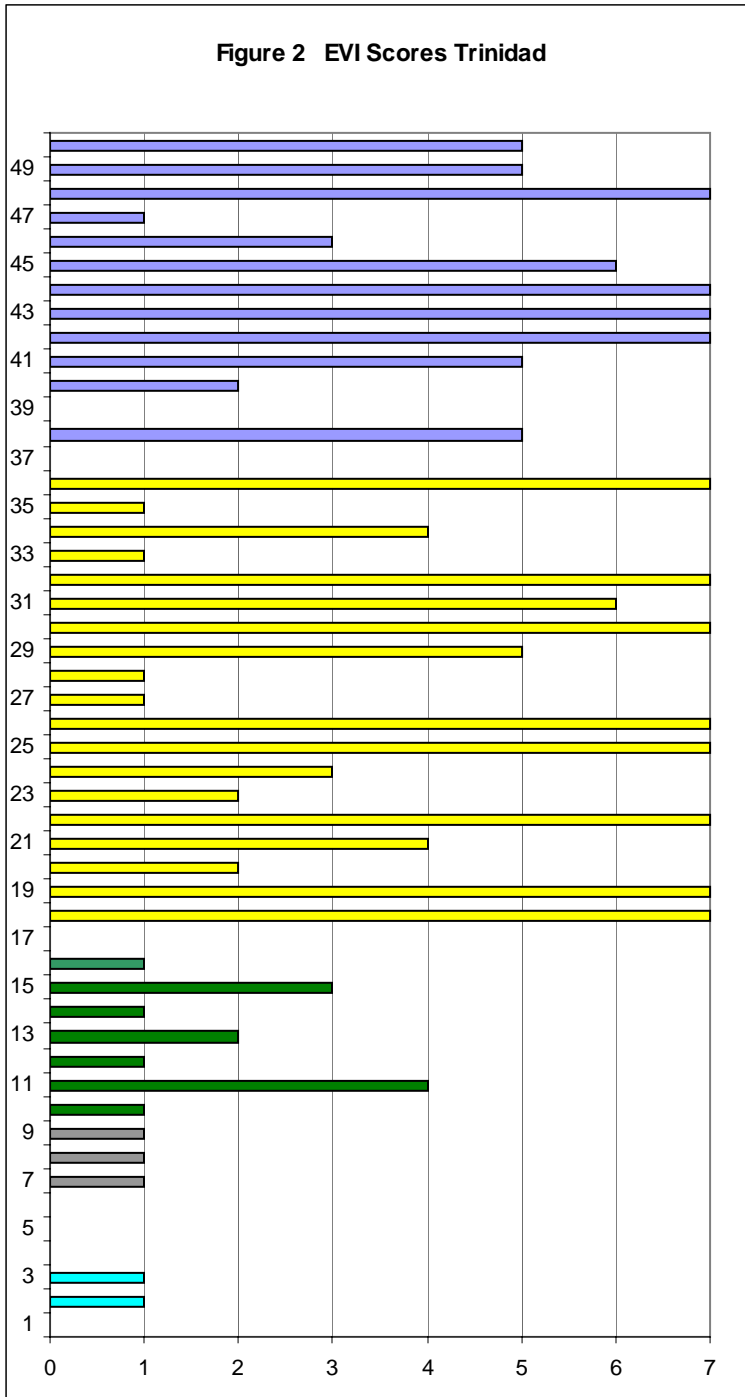
EVI Indicator #50 – Human Conflicts

Number of war or civil strife years over the last 50 years within the territory

This indicator captures environmental degradation caused by bombing, land mines, and chemicals left in the environment. This is a proxy for the lack of environmental management during those years. According to the Ministry of National Security, the attempted coup during 1990, was the only incidence of war or civil strife in Trinidad and Tobago in the last 50 years. Confidence in this estimate is high. Trinidad and Tobago scored a 5 on the EVI Scale for this indicator.

According to the EVI scale, this suggests that the vulnerability of both islands to degradation through bombing, land mines, and chemicals left in the environment is moderate. Caution should be exercised in interpreting this indicator since the unrest which occurred

Figure 2 EVI Scores Trinidad



EVI Trinidad

- Anthropogenic factors
- Resource & Service factors
- Country Characteristics
- Geological factors
- Weather & Climate factors

Areas of greatest environmental vulnerability (EVI Scores 6 & 7):

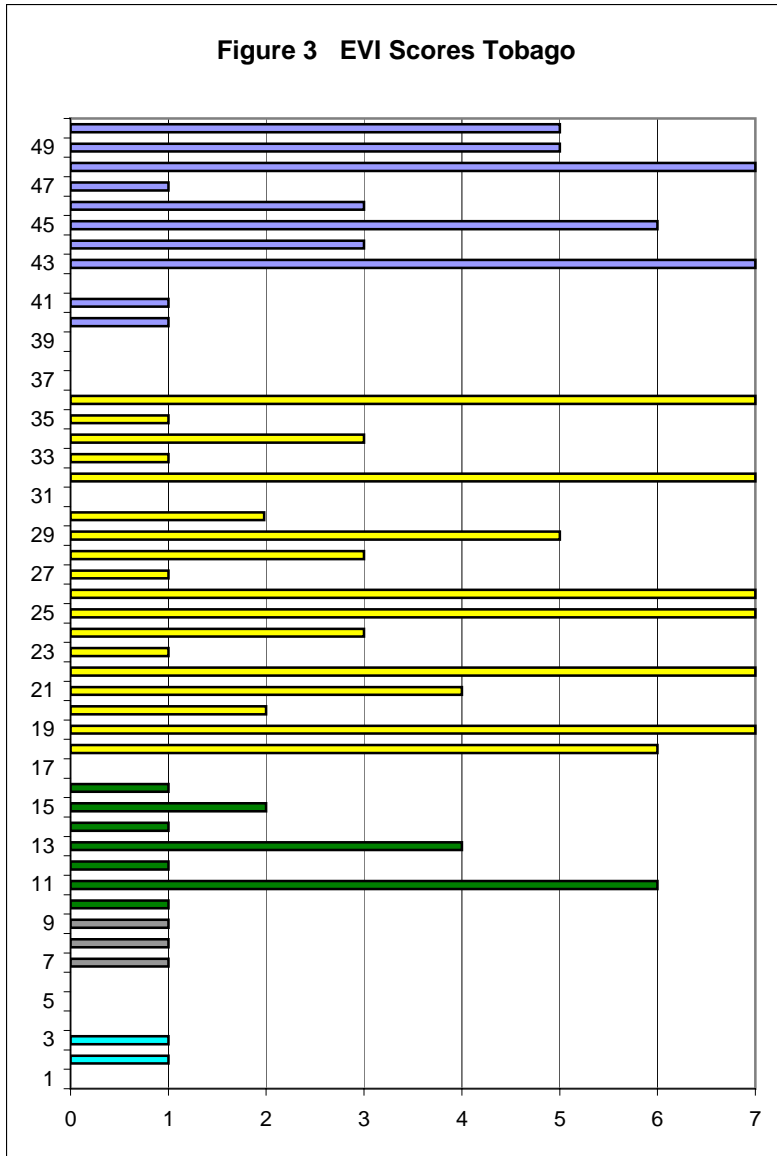
- 17 Freight Imports
- Migratory Species
- 22 Endangered species
- 24 Natural Vegetation Remaining
- 25 Rate of Loss of Natural Cover
- 31 Fertilizers
- 32 Pesticides
- 36 Renewable Water
- 42 Mining
- 43 Population without Safe Sanitation
- 44 Vehicles
- 45 Population Density
- 48 Coastal Populations

No data:

- 37 Sulphur dioxide Emissions

*EVI Scores are 1-7 where 1 = most resilient and 7 = most vulnerable

EVI Tobago



- Anthropogenic factors
- Resource & Service factors
- Country Characteristics
- Geological factors
- Weather & Climate factors

Areas of greatest environmental vulnerability:

- 11 Land Area
- 18 Freight Imports
- Migratory Species
- 22 Endangered species
- 24 Natural Vegetation Remaining
- 25 Rate of Loss of natural cover
- 32 Pesticides
- 36 Renewable Water
- 43 Population without Safe Sanitation
- 45 Population Density
- 48 Coastal Populations

No data:

- 31 Fertilizers
- 37 Sulphur dioxide Emissions
- 38 Waste Production
- 42 Mining

*EVI Scores are 1-7 where 1 = most resilient and 7 = most vulnerable

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