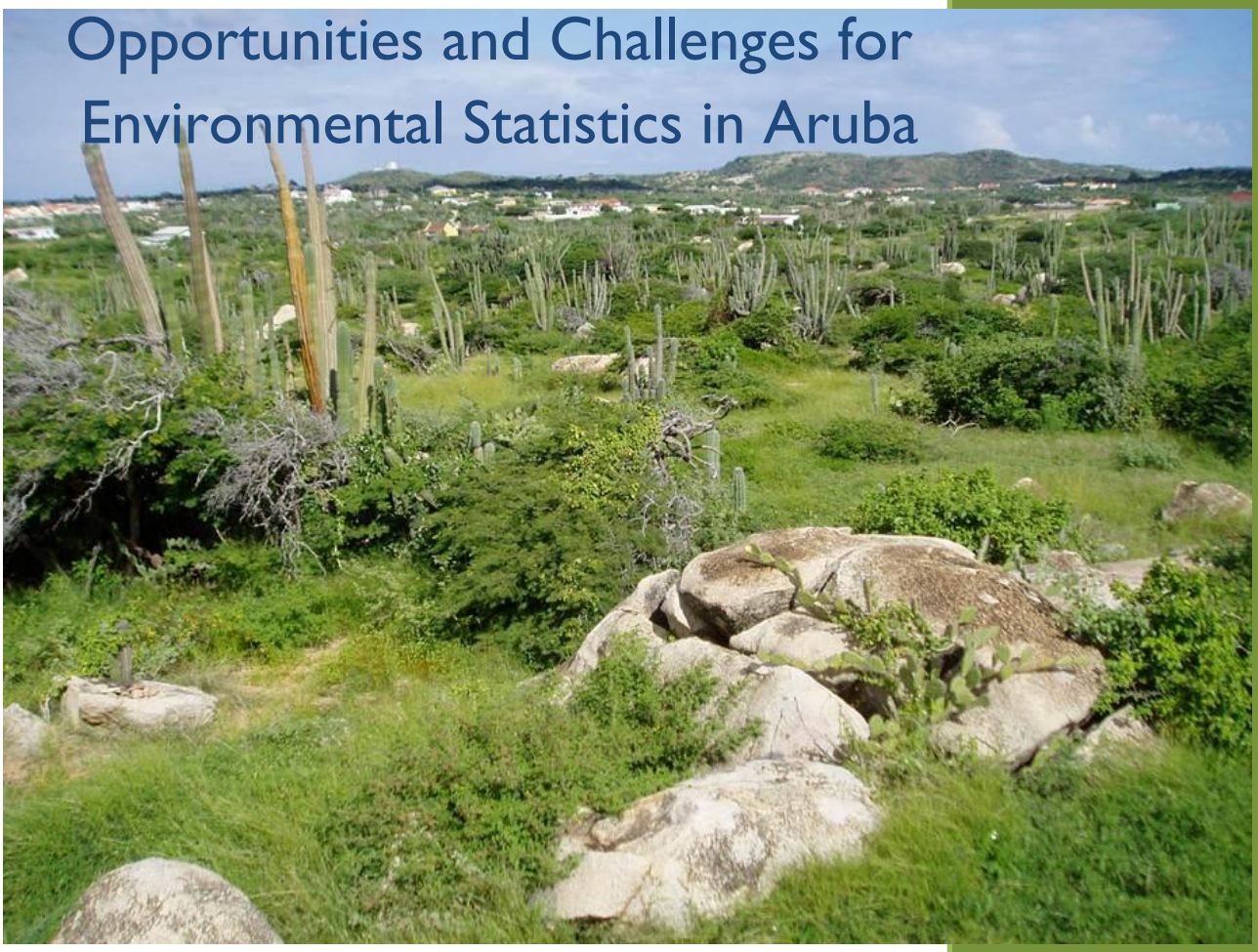
Opportunities and Challenges for Environmental Statistics in Aruba



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Environmental Statistics

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Nature and Environmental Statistics in Aruba

Preface in Dutch

Anno 2014 streeft Aruba met volle overgave om een geheel groene economie te worden. Diverse samenwerkingsprojecten op het gebied van wind en zonne energie zijn momenteel actief. In 2010 heeft de overheid toegezegd dat binnen vijftien jaar de helft van alle benodigde energie verkregen zal worden uit alternatieve energie voorzieningen (wind, zon en zee) waarbij het land geheel onafhankelijk zal zijn van de olie import. Een groen beleid betekend dat de benodigde energie op milieuvriendelijke manier wordt verkregen, recycling en hergebruik zijn geïntegreerd in het afvalbeheer, en dat thema's zoals vervuiling, biodiversiteit en habitatverlies proactief zullen worden benaderd. Om dat te kunnen verwezenlijken is er uitstekende samenwerking noodzakelijk tussen alle betrokken afdelingen en dient een meer centrale toegang tot belangrijke data mogelijk te zijn. De huidige nationale administraties zijn echter nog onvoldoende op elkaar afgestemd om in deze behoefte te kunnen voorzien.

Met de afdeling natuur en milieu statistiek meent het CBS aan een deel van de behoeftes te kunnen voldoen door samenwerking aan te gaan met andere afdelingen. In haar rol als informatiedrager kan het CBS thematische milieu informatie bundelen, analyseren en verspreiden en kan het tevens samen met de andere partners vanuit deze centrale positie de continuïteit en monitoring van specifiek onderzoek stimuleren. Door samenwerking met de verschillende partners kan de integratie van onderzoek vanuit verschillende beleidsterreinen worden vormgegeven en het CBS is bij uitstek geschikt om hierbij als voortrekker een rol te spelen.

De bundeling en integratie van informatie betreffende de natuur en het gezonde leefmilieu speelt een steeds belangrijkere rol ten aanzien van economische vraagstukken. Er is regelmatig behoefte aan recente en betrouwbare informatie over kwesties op het grensvlak waar belangen van het milieu, de economie en de gemeenschap elkaar raken. Een projectmatige samenwerking tussen de afdelingen en het CBS zal bijdragen aan een geïntegreerd milieu- en sociaaleconomisch verantwoord beleid.

Ook op het internationale vlak van politiek overleg wordt de overheid geconfronteerd met milieu gerelateerde vraagstukken. De UN, OECD en de WHO doen regelmatig verzoek tot informatie over de status van het milieu, het verbruik aan water en energie of andere hulpbronnen, en ontwikkelen systemen om dit te vergemakkelijken.

Internationaal wordt gewerkt aan een System of Economic and Environmental Accounts (SEEA) waarbij aansluitend aan het systeem van National Accounts (SNA), de Environmental Accounts (SEA), d.w.z. de monetaire interpretatie van het milieu en de natuurlijke hulpbronnen uitdrukkelijk worden meegenomen. Het doel is te komen tot één groot 'framework' dat de beschrijving van de economie, de populatie en het milieu integraal benaderd en voldoende ondersteuning biedt aan het politieke streven om te komen tot een '*green economy*' waarbij naast economische belangen binnen het kader van '*green growth*' ook aandacht is voor het *duurzame karakter van het milieu*, de *grondstoffenvoorraad* en het *gezonde leefklimaat.* De invoering van een SEEA zou goed aansluiten bij bestaande gegevensstructuren van het CBS.

In 2013 is bij het CBS het onderdeel Milieu Statistiek van start gegaan. In dit stuk wordt uitleg gegeven aan een eerste verkennende periode en wordt een voorstel gedaan om optimale invulling te geven aan natuur- en milieu statistiek bij het CBS.

In het stuk wordt daarom ingegaan op de rol die milieu statistiek speelt binnen het internationale overleg en worden de mogelijkheden van Aruba verkend om hierbij aan te sluiten.

Een van de huidige mijlpalen die in korte tijd is bereikt, is de totstandkoming van een EU projectaanvraag in samenwerking met TNO en in totaal 25 internationale onderzoeksinstituten/ partners (Horizon2020) waarbij in een groot deel van de bovengenoemde behoefte zou kunnen worden voorzien.

Met dit schrijven wordt uitleg gegeven aan de beoogde doelen van de afdeling Natuur en Milieu Statistiek om de onderlinge samenwerking en uitwisseling van informatie te bevorderen.

Dr. Ruud Derix

Summary

In the following we describe a framework for nature and environmental statistics to acknowledge its place within the CBS in Aruba and to acquire the benefit of cooperation with other environmentally-oriented institutions in Aruba. Adequate information on the local environment and surrounding nature plays an important role in economic debates. At current national administrations are inadequately equipped to meet such needs on their own. On the international level of political debate, governments are faced increasingly with environment-related issues. Regularly, directives from organizations like the UN, WHO, OECD and EU aim to encourage governments to provide information about the status of the environment, the abundance of natural resources or the consumption of water and energy resources. Moreover, Aruba's growing economy and suburbanization is often faced with economic as well as social pressure to preserve remaining natural areas, protect its healthy environment and maintain adequate scenery for tourism. There is an intrinsic need for reliable information at the interface between the environment, the economy and the community. However, in Aruba such information when available may be unknown to those who need it as information may be spread between the different departments or be outdated. An adequate, central and easy accessible environmental knowledge-base is lacking.

The CBS, in line with its role as an information carrier, is the ideal instrument to collect, aggregate and analyze information and can play its role well as provider for an integrative socio-economically and environmentally sound policy.

An important landmark is reached already in 2014 with the EU pre-proposal, together with TNO, of a multi-scale international research in which Aruba plays an important factor. When acknowledged, the research will cover many of the areas as discussed in this paper, already.

In the underlying document we address the topics planned to be handled by the section "Environmental Statistics" in Aruba and discuss the opportunities that lie ahead to conform to international and local standards.

Opportunities and Challenges

International Frameworks

Over the last 10 years, Environment Statistics has become an interdisciplinary branch in most Governments.

In 1972, the Club of Rome published "The Limits to growth: a global challenge". The book caused a shockwave through the hemispheres as it propelled the notions that there is a global impact from the combined human actions on the environment that will bounce back on the economy in the years to come and that there will be a limit to economic growth caused by a depletion of natural resources. Thus, the world is to be confronted with increased pollution and shortages in oil, food and water. In the same year, in 1972, at the UN Stockholm 'Conference on Human Environment', countries and international organizations found consensus that they had to standardize their data on the environment in order to be able to adapt a more proactive sustainable approach to economic growth.
In 2001, a thorough worldwide scientific appraisal, with more than a 1000 researchers involved, had been initiated once more, to outline the condition and trends in the world's ecosystems. The idea was to describe the consequences of ecosystem change for human well-being (UN Millennium Ecosystem Assessment, 2001-2005)[1].

The notion that there is to be a global impact by human actions on the environment and that there will be considerable economic costs to it, is increasingly understood today and every new catastrophe propagates the urge to establish a global monitoring system, collect better environmental data and take local as well as global action. Governments experience pressure on the global political stage to join the concept of *green growth* (alternative to the classical concept of economic growth) and to enact the green development goals. The integration of environment and development policies is lifted by these so-called *green development goals* that embrace the new paradigms 'green' and 'sustainable development' into local decision-making policies.
In Statistics, initially, the search was set off to establish something alike the System of National Accounts (*SNA*) that would link environment data to

[1] http://www.unep.org/maweb/en/index.aspx

the economic and social demographic accounts (UNSD, 2000)[2]. But, it was soon realized that a common index, such as the GDP, would be unfeasible to describe the complexity of the environment in so many different areas and thus the focus was not on a single index but more on a ***framework of indexes*** that would offer more flexibility (see figure below). In 1984, the UN Statistical Office published the *Framework for the Development of Environment Statistics* (*FDES)*. Similar frameworks were developed by the OECD (*Pressure State Response Framework PSR*) and by the Commission on Sustainable Development (*Driving Force State Response Framework DSR).* Alternatively, the European Environment Agency (EEA) and the Statistical Office of the European Community (EUROSTAT) had developed *the* European *Driving Force Pressure State Impact Response Framework* (*DPSIR*) (Bartelmus, 2010)[3].

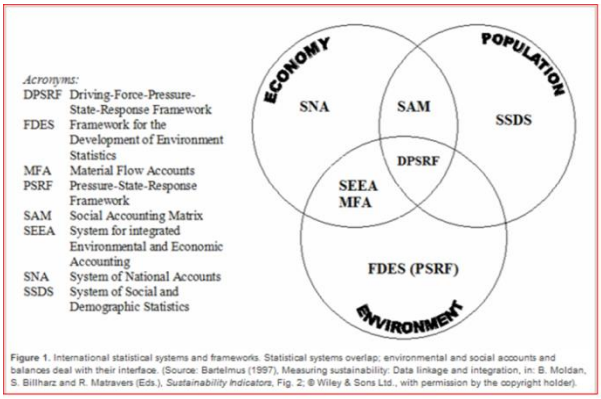

Figure 1. International statistical systems and frameworks. Statistical systems overlap; environmental and social accounts and balances deal with their interface. (Source: Bartelmus (1997), Measuring sustainability: Data linkage and integration, in: B. Moldan, S. Billharz and R. Matravers (Eds.), *Sustainability Indicators*, Fig. 2; © Wiley & Sons Ltd., with permission by the copyright holder).

source: http://www.eoearth.org/article/Environmental_statistics

Different approaches followed different interests and visions to incorporate environmental issues within the view of economic growth. The impetus of economic growth remains dominant, but additional goals were set, such as the quality of life and a sustainable nature.

Today, there is consensus to develop an integrated ***System of Economic and Environmental Accounting*** (SEEA) that supports integrated statistics between the economy, the population and the environment, with emphasis on the economic aspects (UNSD, 2013)[4]. The focus is for instance on the management of natural resources and establishment of a so-called 'green' sustainable economy. In essence it means that the current System of National Accounts (SNA) will be enhanced by a System of Environmental Accounts (SEA).

To be able to include the qualitative 'values' of environmental topics, an additional practice is advocated by environmental economists that is called ***Ecosystem valuation***. It is a way to translate qualitative valuation in terms of monetary units (TEEB)[5]. Approaches like these base on an anthropocentric view of the environment and aim to incorporate the human appraisal of nature's values into the economic model, but at the same time they emphasize the incompetence to deal with the '*complex*' behavior of nature's dynamics. Such valuation approaches may harbor a pitfall that may only reveal in the future. The perception of environmental '*values*' in monetary equivalents, as to include it in the conceptual framework of economic accounting, is susceptible to environmental events and psychological shaping and may induce short-term rational.

Besides these deliberations, it is another step towards the description of interrelationships between the three pillars of a sustainable future[6] (i.e. the economy, the population and the environment) by equations that serve to attain what we like to call a '***sustainable environment***' in addition to a '*sustainable economy*'. Whether there is future room for an even more holistic concept of welfare is to be seen.

Aside from above mentioned initiatives, in 2007 the European Commission with the European Parliament, the OECD, WWF, and the Club of Rome organized a 'Beyond GDP'[7] conference. The initiative

[2] UNSD. (2000). *Activities of the Environmental Statistics. Section of the UNSD*. Retrieved from: http://unstats.un.org/unsd/environment/default.htm

[3] Bartelmus, P. (2010). *The Enceclopedia of Earth*. Source: http://www.eoearth.org/article/Environmental_statistics

[4] *UNSD*. (2013). Retrieved from SEEA: http://unstats.un.org/unsd/envaccounting/SEEA-Brochure-SC-2013.pdf

[5] http://www.teebweb.org/
(The Economics of Ecosystems and Biodiversity)

[6] *Sustainable development* refers to a long term balance between a healthy nature and a healthy socio-economic development and human well-being. Information from the social and economic sphere thus plays an important role in the planning and the implementation of policies in scope of nature and environment and vice versa.

[7] http://www.beyond-gdp.eu/background.html

is a cooperative effort to assimilate similar to the GDP other comprehensive indicators that may account for environmental and social measures as well. Examples of successful candidates that have been in development since are the ***Ecological and Carbon footprints***[8] and the ***Index on Environmental Pressure*** and even an ***Index on environmental quality***.

It is clear that in Aruba at current date, the environmental information is far from up level to meet the international standards and requirements. Environmental Statistics in Aruba, however, follows the vision by the international community (UN, OECD, World Bank and others) to build and eventually incorporate a system of environmental indicators that would fit the different functions.

So, meanwhile we enter the track of developing a *System of Environmental Accounting* we like to focus on ***Key Environmental Indicators*** and follow a more ***Thematic Approach*** that includes all known interrelated information about specific local environmental issues.

Current Global Environmental challenges

There is general consensus within the international community about the fact that the environment seems to behave more erratic and turbulent in recent years. There is still debate about what may be the exact cause, but it is obvious that current information is insufficient and lacking and that more efforts have to be done to establish globally as well as locally the required information database. The prevention of environmental impacts often requires long-term thinking and proactive control that is likely transferred to future generations. But, political understanding and participation for global sustainability is now more important than ever.

Following a recent publication by a group of renowned scientists, nine environmental processes are portrayed to play a major role in the planet's ability to support human life (Sci. Am. 302-4, 2010). These processes are all under severe pressure at present day. For each of the processes, the team of researchers described boundaries and tipping points beyond which global sustainability would become undermined.

Three of the processes behave within clearly marked outer limits beyond which existence is at risk:

- *Climate change* [CO2 concentration],
- *Ocean acidification* [$CaCO_3$ saturation in surface waters]
- *Stratospheric ozone depletion* [O3 concentration],

Four other processes can be defined by outer ranges, beyond which irreversible degradation will exist.

- *Biodiversity loss* [species extinction rate million per year],
- *Land use* [percent land converted],
- *Freshwater use* [human consumption in cubic kilometers per year] and
- *Nitrogen and Phosphorus cycles* [flow rates into oceans]

The remaining two major processes lack sufficient data and scientific research is needed to quantify threshold indicators.

- *Aerosol loading* [particle concentration in atmosphere PM_{10}]
- *Chemical pollution* [amount emitted to or concentrated in the environment]

For three of the above mentioned processes set, thresholds have already been crossed, i.e., biodiversity loss, climate change and nitrogen pollution, while the others are close to meeting the same fate.

Current challenges in Aruba

Aruba is challenged to follow the international trend and take account of its nature and environmental issues (Nos Aruba 2025)[9] but the Aruban government recognized the opportunities and promised additional advancement. In 2010 the Aruban Government committed to become independent from oil import and goals are set to have 50% of its energy sustainably developed by exploitation of renewable energy resources (Wind, Sea and Sun) by 2025.

Aruba receives on a regular basis requests from the UN and other international bodies to provide information on its natural resources, the state of its environment (*Global Assessment of Environment Statistics and Environment-Economic Accounting, Nov. 2006)* or the statistics on the use of water and energy resources *(United Nations Annual Questionnaire on Energy Statistics, Dec. 2008; Global consultation of the International Recommendations for Water Statistics, Oct. 2009.)*.

[8] http://www.footprintnetwork.org/en/index.php/GFN/

[9] Nos Aruba 2025. (n.d.). Source: http://www.nosaruba2025.aw/

To adequately support these requests and accommodate the current developments, it is important to have the information readily available and an efficient monitoring system installed. At present, public environmental information support is diffuse, scattered or incomplete, as participants have their administration not yet in tune with new developments or still feel hesitant to exchange their in-house information.

At the commercial market, investors already started to engage in environmental matters. There is a fast developing 'green' market and new economic opportunities lay ahead. Green thinking is not any more the pre-occupation of environmentalists. Stakeholders are fast to realize, that the change in public opinion can be turned profitable.

For Aruba, in particular because it is strongly dependent on the tourism industry, it is important that Aruba exports the image of environmental awareness. On a small Island as Aruba, nature is a scarce commodity and the friendly and safe atmosphere of a '*scenic and nature friendly Aruba*' benefits a healthy tourism industry. This issue of a nature friendly ambience is not just confined to the National Park Arikok or the future Marine Park, but tourists expect to observe this image all over the island and it encompasses the urban habitat as well as the typical suburban and Cunucu landscape.

Relative to the nine dominant environmental issues of today, Aruba is confronted to most of these in a direct manner. *Ocean acidification, nitrogen, sulfur and phosphorous waste* is a direct threat to coral reefs, *land use* and *biodiversity loss* are issues to be felt directly in today's level of urbanization and habitat degradation. All potable water in Aruba is derived from a salt water desalination plant that runs mainly on fuel combustion and more than any other country, until this day, *drinking water* and *oil import* is strongly linked together. Aruba suffers from a huge *waste load* due to the presence of the recent oil refinery and the absence of a well-structured (chemical) waste policy and education thereof of the public behavior. This all said, however, the current Cabinet Eman is aware of these issues and is engaged to tackle these issues in the near future.

Outline of Environmental Statistics

In 2007 the Central Bureau of Statistics proposed recommendations (CBS, 2007)[10] to improve its structure of information supply and add Environmental Statistics to its main sectors of statistics in Tourism, Socio-Economics, and National Accounts.

We will evaluate international standards and frameworks to implement environmental information supply in the economy as well concretize what the near-future activities of Environmental Statistics in Aruba will be, in the following.

1. Establishment of a Central Environmental Database (CED)

A first step will be the assessment and structuring of available information. In Aruba, much thematic information is already available, though scattered and not easily accessible. It is important to complete this picture, bring parties and information together and establish a central database that will be open for all participants to identify further requirements. The implementation of a framework for data collection and monitoring will have to ensure that information remains up-to-date.

In the past, already some progress has been made to develop an environmental assessment of environmental information (KuN/VROM, 1995[11]; RuG/VROM, 2000)[12]. We will use these insights and attempt to build on them.

The following is just a short listing of examples of a thematic information output.

*Example of categories of **Environmental themes** to organize in a national environmental database:*

Climate & Atmosphere
- *Water, soil and air quality*
- *Eutrophication/ Acidification*
- *Temperatures Humidity & Precipitation*
- *Wind direction and speed*

Land Habitats & Vegetation Types
- *Mangrove/ Thorn-Scrub/ / Semi-Desert*
- *Cacti fields, Forest, etc.*

[10] CBS. (2007). *Master plan CBS 2007.*

[11] *Kath. Universiteit Nijmegen/VROM (1995). Milieumonitoring op Aruba. Hengst. J and D. Reehorst)*

[12] RuG/VROM. (2000). *Development of an Environmental Assessment Method for Aruba: Taking Stock of the Terrestrial Environment.*

Marine & Freshwater Habitats
- *Coral beds (types) and underwater objects*
- *Water depths & Sand banks*
- *Tanki's, Dry stream beds, Well's, Salt plains*

Geology& Landscape
- Sand, Soil and Rock formations
- *Minerals & Soils*
- *Sand excavations*
- *Barranca's & Dunes*
- *Caves*
- *Cactus fences & Stonewalls*

Ecological Hotspots
- *Beaches and Marine environment*
- *National Park area*
- *Corridors in the (sub)urban Habitat*

Cultural & Historical locations
- *Cas di torte, Historical constructions, Aloe fields*
- *Indian sites and caves*

Breeding Locations
- *Bubali Bird Sanctuary*
  - *Blue Heron/ Green Heron/ Cattle Egret/ Snowy Egret*
- *Saltpans (Palm Beach and Malmok)*
  - *California light house/ Spanish Lagoon/ Park Arikok*
- *Tern Island*
  - *Royal/ Sandwich/ Cayenne/ Least & Common Tern*
- *Beaches*
  - *Sea Turtles: Hawksbill, Loggerhead, Leatherback, Green turtle*

Endemic animal & plant Species
- *Aruba Island Rattlesnake/ Cascabel (Crotalus unicolor)*
- *Aruban cat-eyed snake/ Santanero (Leptodeira bakeri)*
- *Dori (Pleurodema brachiops)*
- *Bats nectar-feeding & insect-feeding*

Exotic (invasive) animal & plant Species
- *Cane Toad/ Sapo (Bufo marinus)*
- *Johnstone's frog (Eleutherodactylus johnstonei)*
- *Red Palm Weevil (Rhynchoshperos ferrugenues Oliv)*

Disease Vectors
- *Dengue mosquito (Aedes Aegypti)*
- *Screwworm (Cochliomyia hominivorax)*
- *Rat (Rattus novegicus)*

As policy-makers' main interest are socioeconomic issues, concerns in the ecosystem may be better understood in view of some typical 'drivers' of change.

*Examples of categories of **Environmental Concerns** that would link information directly to the decision-making processes:*

Green growth
- *Water, Energy and Waste accounts*
- *Air pollution and greenhouse gas accounts*
- *Green policy instruments and measures*
- *Habitat fragmentation*

Emergency planning
- Biohazards, toxic waste
- Objects of potential obstruction or risk during emergency planning - vegetation, soil, drainage and waste water constructions, etc.

Epidemics and Health
- Vectors of parasitic, bacteriological and viral diseases
- Pollution, greenhouse gasses (PM_{10} particles, CO_2, N)
- Aerosols, chemical contaminants (fertilizers, biocides, P)

Environmental protection (jurisdiction) and management
- Endemic flora, fauna and the ecological landscape
- Habitat corridors and Nature disturbance
- (Hazardous) Waste generation and Re-use
- Carbon footprint and pollution
- Invasive animal and plant species
- Condition of water systems (rooien, tanki's)
- Marine environment, water depth and coastal currents

Urbanization, transport and land use
- Habitat destruction, ecosystem fragmentation
- Land coverage, erosion
- Noise, Pollution and Waste hindrance
- Energy and Water consumption and production

Agriculture and harvesting development
- Soil quality and soil structure
- Erosion and groundwater levels
- Hunting, fishing and overexploitation
- Import Invasive plants and seeds

Geology and Mining
- Mineral and sand exploitation and scenery protection

Cultural and Historical preservation
- Location and condition of (remnant) sites with cultural or historical value

Tourism and Health
- Hindrance (light, sound, waste, smell and traffic)
- Green awareness (recycling, waste)
- Scenery and landscape
- Animal protection and welfare (breeding sites, stray dogs)
- Disease vectors
- Condition of marine waters, beaches and coral reefs

As processes can be linked to several topics, the above categorization is not strict. Information on some of these subjects is already in one way or the other available in Aruba at the departments of CBS, DLV, DOW, DNM, DLLV or DIP but the underlying data is often not coherent, compatible, up to date or easily available to other departments. The real gain is of course when the data are linked and analyzed in view of current topics of debate.

On the international level, the same reasoning is followed. In order to retrieve an *index on environmental pressure* the EU proposed 5 major strands of environmental policy[13]:

[13] http://www.cros-portal.eu/content/gdp-and-beyond-measuring-progress-changing-world

- Climate change and energy use
- Nature and Biodiversity
- Air Pollution and Health Impacts
- Water use and Pollution
- Waste generation and use of Resources

It is important to develop a monitoring structure or framework by which such data can be collected and integrated into a central environmental database (semi-) automatically and preferably near-real time. The common denominator by which all information is linked together is the exact location and timing of the event. The requirement is to add and/or use information via an internet access protocol and some specific authorization rules. The monitoring system can consist of 'ad libitum' records or based on a time-scheduled survey (including satellite interpretation). The data input itself can be done via predefined data-entry programs, for instance online. An important element of successful data integration from different sources is the monitoring of the process itself. In the establishment of a coherent central database someone will be in charge with the compatibility issues of the different data. The CBS has the necessary experience and interests to fulfill these tasks.

We propose the organization of the above-mentioned *environmental themes* in central databases that might, dependent on the subject and project, be linked together in terms of the above-mentioned topics of *Environmental Concerns*.

2. Progress conform the system of Environmental Accounts (SEA)

A distant goal is the development of a System of Environmental Accounts (SEA) that can be complemented to the System of National Accounts (SNA). The idea is to retrieve relevant information about for instance the efficiency of resource usage or the carbon footprint of the Aruban economy and translate such physical or even qualitative information into monetary units that fit the SNA. The goal is to improve the sustainable character of economic activities by including environmental values.

It is questionable whether such integration of data in Aruba will be feasible in the years to come, as it requires a thorough integration and knowledge of environmental data that at this moment is far from being achieved. Nevertheless, we like to explain the challenge as we think it may enhance and eventually be requisite to the information exchange with the rest of the world. What we can do now, in the years to come, is built our environmental knowledge (database) in such a way that the information that we collect is suitable and can be linked to a future SEA.

A number of indicators, as depicted in the next section, have to be adapted or developed in order to comply with the requirements of the System of Environmental Accounts. There is an important difference between the common interest of environmental statistics and the production of Environmental Accounts. Environmental accounts depict the concept of completely consistent environmental resource accounts (i.e. all definitions, classifications, and handling is consistent between the accounts of different resources) that link to a *residence based concept* of the SNA accounts (i.e. not just the territory resources are included but all resources that link to all *economic activity* of the resident institutions; thus those in a country (territory) but also those that reside abroad). So, even if we have some information about for instance water and energy statistics, this still does not mean that we just can use these for the system of Environmental Accounts as such. A prerequisite for the establishment of for instance water or energy resource accounts that fit the system of EA is the establishment of a very comprehensive environmental statistics database.

We will describe the conditions for setting up a SEA and the types of resource accounts and corresponding indicator sets that may be required.

On a global scale, a number of environmental issues deserve special attention. Countries are expected to participate and build some level of knowledge on greenhouse gas emissions and air pollution, resources (economy-wide material flow accounts), green policy expenditures and benefits, rate of urbanization, water and energy household, species protection and habitat management, etc. Following the frameworks provided by international organizations, authorities are asked to organize their information in a framework that encompasses the environment as well as the economy (EEA, 2013)[14].

[14] EEA. (2013). *Environmental Pressures from European Consumption and Production.* Copenhagen: European Environment Agency.

The framework concept as visualized below serves the flexibility of the system. Consequently, governments are to collect data on a number of predefined environmental topics but the comprehensive frameworks allow them to integrate more locally relevant data sets. This can best be done along the lines of the local thematic approach, whereby the themes are to be chosen on the basis of distinct and recognizable processes.

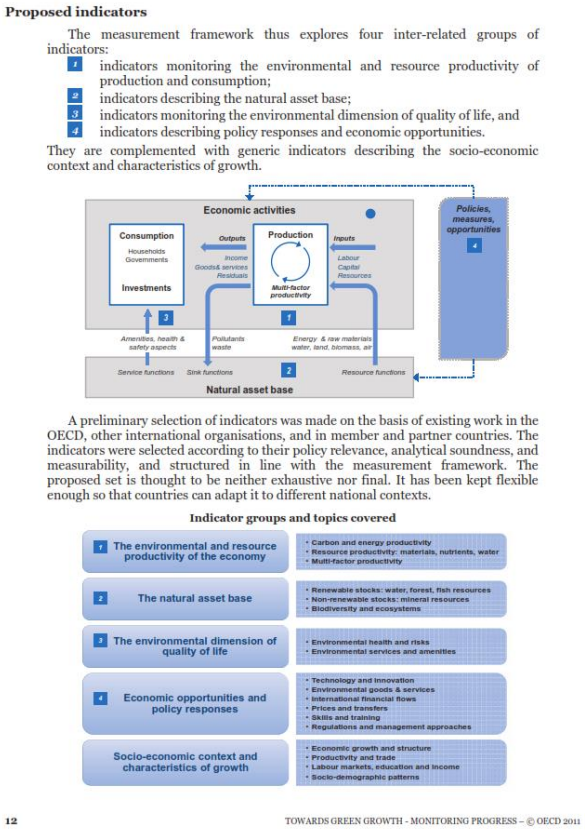

Figure Graphic representation of the measurement framework as it is proposed by the OECD (OECD, 2011).

For example, for Aruba, a special topic may involve population health and the spread of some vector-borne diseases. Information is required about a number of related aspects, i.e. local infrastructure, location of still waters, quality of house construction, topography, wind direction, rainfall, vegetation type, drainage systems, distribution of cesspits, or even the distribution of residence locations of specific school children, etc., etc.. This information is not only important to determine the effects and risks of spreading of the disease but can help to prevent it. For the establishment of a resource account, information about the costs of prevention, costs of treatment, prevention and disease control, etc. is required as well.

3. The Relevance of Local Environmental Indicators

In line with the thematic representation, as argued before, the establishment of a system of indicators would meet the terms of international expectation. We should choose and confine to a framework model that can provide a good portrayal of the local situation and the actual processes involved, but also that secures optimal international connection and support. In addition, the dissemination of information must be simple and easily be understood. In practice this means that the information to the indicators must be easily collectible and understandable and be suitable for policy-making as well. The set of indicators that we like to pursue is based on the OECD framework. As an example, in The Netherlands such a concept has already undergone much development and can be considered a pioneer in the establishment of a set of Green Growth Indicator scores (CBS-NL, 2012)[15].

But first, for the local evaluation, the process of how to establish a system of environmental indicators needs some additional explanation. We have to understand what type of environmental information is relevant and appropriate for the local situation and what other factors may play a role.

A suitable Index falls within the following scope:

- is relevant to the Aruban situation
- covers the themes that have become significant to the international community
- is easy to understand and translate into policy-instrumentation

Indicators are often to a lesser or greater extent built from complex formulas, as is the case for example with the GDP and CPI Index. Such indicators reflect the state and growth of the economy. Likewise, our interest is to retrieve similar measures for the status of the environment or the degree of sustainability that it supports (*green growth index*). In ecology, well-known indicator species exist that reflect typical situations in the wild. For instance,

[15] CBS-NL. (2012). *Environmental Accounts of the Netherlands 2011*. Retrieved from http://www.cbs.nl/nl-NL/menu/themas/natuur-milieu/publicaties/milieurekeningen/publicaties/archief/2012/2012-environmental-accounts-of-the-netherlands-2011-pub.htm

the presence of some plant communities signifies a certain degree of disturbance. Such a single indicator provides insight in a complexity of variables. Unfortunately, a unified sustainability index or index for sustainable growth does not exist, but there may be a number of indicators that come close to what we strive for (*biodiversity index, land conversion Index, Urban PM_{10} particle exposure Inde*x, etc.).

As information is always related to ***time and place***, it is important to define the circumstances of measurement. For example, the usage of for instance satellite images for determination of changes in vegetation and land coverage is only suitable if similar situations are measured (measurements during dry seasons).

An indicator needs to be defined carefully, as an indicator tells something about the *state* of a system but nothing about the factors or processes that underlie such state. For instance, a change in vegetation coverage tells something about the dynamics in the landscape, but says nothing (yet) about the processes that have caused the changes. A certain plant species may be disappearing by the loss of groundwater, the spread of a disease or human action. For policy-making, these processes need to be discernable, however.

For these reasons, environmental indicators have to be organized into a (multidimensional) framework of indicator sets and knowledge bases as to ensure that a network with various levels of information offers a better description of both the status and the underlying processes that may be required for a specific policy goal.

The network of indicators is to be defined first instance on the basis of urgency or availability of data. The framework will grow more extensive as new information enhances the knowledge base.

4. The Dissemination in Grids

We have to identify where Geographical Information System (GIS)[16] technology can improve the quality and productivity of environment statistics. Spatial embedding of data is important and allows the information from different fields to become linked by a common geographical component. Many statistical agencies worldwide are strongly intertwined with a GIS department.

At the moment, in an FDA funding application, the CBS with the support from the departments DIP, DOW and DLV, applied for the means to establish an exchange network of GIS-based information. The CBS has done, and should continue to do, the pioneering work for this so-called National GIS. Collaboration offers many benefits (FDA proposal 'Terms of Reference for a National GIS in Aruba' by Ruud Derix, 2010). The proposal includes an enhancement of available GIS tools that would benefit Environmental Statistics as well. The natural environment relies on a sophisticated tool to disseminate its spatial data as the common system of classification of administrative units does not fit the requirements (it only enables reference to the built-up areas of Aruba that can be referred to with an address direction).

The proposed collaboration and the integration with environmental statistics would bring the desired analytical and research oriented tools.

The GIS system not only allows for efficiency and effectiveness of information exchange, but also provides the means for data analysis and data storage.

Current GIS software at the CBS concerns an older version of MapInfo. Information is stored with a spatial component in so-called *tab-files* that exist in non-earth projection coordinates. The GIS system was introduced at the CBS in 1999 in order to prepare for the Census. The spatial information was designed mainly from CAD layers from the Department DLV and was kept up to date by regular fieldwork and the updating of addresses, streets, etc.. The initial idea was to provide the necessary means to support the Census and all future survey investigations. In the ensuing years, the GIS system continued to be built with an emphasis on the spatial representation of the Aruban residential- and business-address directory.

The potential of a modern GIS system offers many analytical tools but unfortunately these are not brought into play at the CBS. In essence, in previous years, the GIS unit employed support at a more

[16] A GIS (Geographic Information System) is a computer-based tool, which enables the linking of information from many different fields on a geographic basis. Layers with information from for instance, socio-economic, environmental and topographic surveys are brought together on a common spatial scale. Linked in this manner, the GIS system provides additional information and opportunities for research.

accommodating manner (visualization of data) by recasting the results of investigation from other CBS units and a number of third party stakeholders in a spatial context on the map of Aruba.

The implementation of GIS based of Environmental Statistics however offers the following opportunities:

1. Visualization of the data (orient towards easy identification and localization).
2. Automated calculations of additional parameters (calculate distances and summery statistics)
3. Analyses of (complex) interactions between objects (assist in the search of patterns, trends and distributions)
4. The use of models for planning and prediction (model the effect of changes in the environment).
5. Management of geo-information between different stakeholders (ease communication, version control and monitoring)

Environmental data cannot always easily be linked to socioeconomic data because both fields are to some extent spatially separated. Also, environmental data often refer to concentrations or areas without a strict border. A common solution is to disseminate environmental data on the basis of a ***reference raster of grids***. Areas are split in small squares and different data can be presented similarly in an aggregated manner. Modern GIS techniques offer a wide range of possibilities to analyze spatially distributed environmental and socio-economic data, but this usage of grids is easily understood and directly convertible to/from other analysis software.

The EU, in cooperation with the EEA (European Environmental Administration) encourages the use of Grid reference systems to their federated states and are currently working on a proposal for an ISO standard: "*EEE recommends the use of multipurpose ETRS89 Lambert Azimuthal Equal Area 52N 10th grid.*

The European Environmental Administration *have developed a tool to create a grid (EEA Fishnet Tool v1) using the ESRI ARCGIS software system. The tool will create a polygon or line shape file with an ETRS-LAEA grid in accepted size, as defined by EEA.* ".

In Aruba, we cannot use this same grid because we are too far to the West, but a similar projection of geographical data as in the EU is certainly possible.

At present, no ***Grid Standard*** is known to exist in the Caribbean, but we developed and use an own *Grid Reference System* at the CBS already.

Therewith, first steps have been made already with the establishment of an ***Aruban Reference Grid*** *system*. We have already tested the use of this grid reference representation on the basis of a small set of environmentally oriented data from the Census and the Aruban Bird Count (Derix et al. 2013; Derix, 2010).

Final Remarks

In conclusion, Aruba experiences strong economic progress but faces increased loss of environmental quality and quantity. A major source of income is derived from tourism and is based on the Aruban scenery, beaches and hospitality. The environment is an important asset in the Aruban economy, but information about environmental issues is scattered between departments and institutions, not up to date, difficult to access and often incompatible. The unit of Environmental Statistics serves to support monitoring, centrally store, and disseminate environmental information. With the current expertise[17] at the CBS we already created good opportunity to start to implement an environmental framework (Horizon2020 funding proposal together with 25 international research institutes/partners) that will support the sustainable socioeconomic aspirations of the Aruban Government as well as international expectations.

[17] **Relevant publications by the Author:**
2009 Terms of Reference 'Nationaal GIS systeem voor Aruba". FDA aanvraag in 3 delen (White paper CBS Aruba)
2010 "Gas, Water and Electricity Expenses by Aruban Households in 2010". Ruud Derix, CBS, Aruba. http://www.cbs.aw/
2013 The National Bird Count in 2011 in Aruba". Derix et al. CBS, Aruba. http://www.cbs.aw/
2013 "Car Ownership in Aruba: Prevalence of a high level of motorization" Ruud Derix, CBS Aruba (http://www.cbs.aw)
2013 "Daily Traffic between School, Work and Home I Aruba: The mobility of vulnerable Households" Ruud Derix, CBS Aruba. http://www.cbs.aw)