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Good Practices in Environment Statistics
- the Example of Mauritius

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1. Introduction

Mauritius is located in the Indian Ocean, in the eastern part of Madagascar which is in turn found in the same direction from the African continent. In Mauritius, the National Statistical System (NSS) includes various data producers in line ministries and other public institutions; data users in and outside government; data suppliers like establishments and enterprises; and research and training institutions like universities *(Figure 1)*. Statistical reforms aim to enhance the system and prepared the country to subscribe to IMF's Special Data Dissemination Standard (SDDS) in order to provide investors with adequate statistics. This has increased the country's rating and facilitated the country's access - for both public and private sector - to international capital markets, thus potentially attracting higher levels of foreign investment.

The Central Statistics Office (CSO) of Mauritius started work on the development of environmental statistics in 1994. This was done further to the demand from planners, policy makers in environmental and related socio-economic field, students and the general public. In 1999, a Statistics unit was subsequently created at the Department of Environment of the Ministry of Environment. This is a current practice in the country whereby line ministries collaborate with the CSO by hosting a statistics unit within their locals and providing all logistic supports.

2. The need for Environment Statistics

Mauritius has a growing economy of an average 5% in GDP per year over the last 4 decades. The developments have incurred considerable changes in the environment and ways are underway to adjust to these changes. The pressures caused to the environment continue and are now exacerbated by the impact of climate change. In order to ensure good governance in keeping with today's economic, social and environmental challenges, departments with vertical responsibilities have now to work in partnership with several organizations. Statistics has therefore entered into a pivotal role to assist efficient policy decisions.

It is well known that the Environment is very broad and complex. The Ministry of Environment and Sustainable Development of Mauritius prepared a National Environment Action Plan (NEAP) in 1999 which serves as a guideline to identify areas of concern. Several other works followed and among the most recent ones are the Consolidated Strategy for the Ministry and the National Environment Strategy (NES). The need for data can be felt with the creation of new divisions of the ministry, particularly the climate change division.
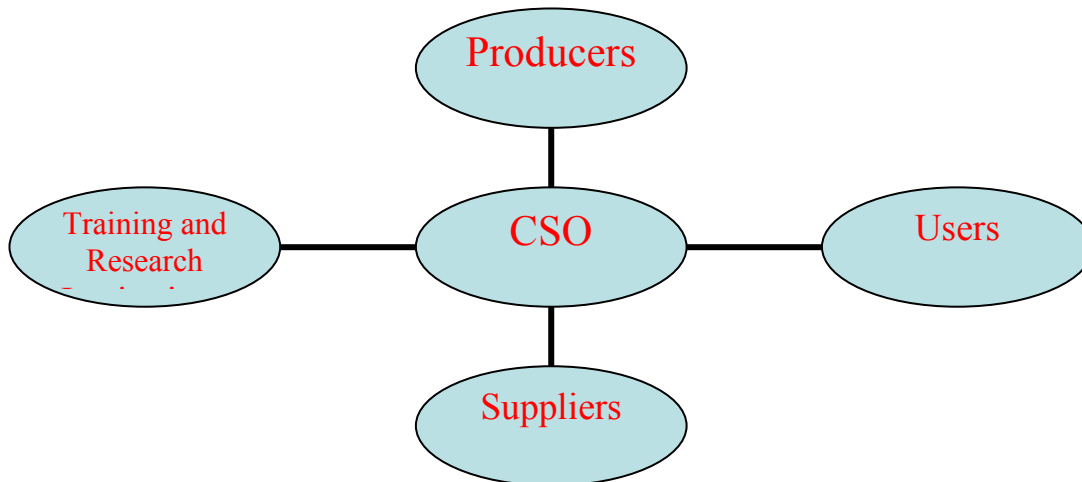
Figure 1: National Statistical System (NSS)

A User Survey was carried out in year 2006 to find out about the user's needs for good, relevant and timely environment statistics. The survey results showed that users represented around 85% of from central Government excluding educational institutions; 4% each from banks and media and 7**%** from parastatal bodies. The main reasons for using the publication were for policy making (30%), Press (11%) and other purposes such as references for information (26%). More than three quarters of the respondents stated that they were aware of the Internet edition. Around half of the respondents also accessed information on Environment through the CSO website.

The Environment statistics Unit also actively participates in national, regional and international projects and initiatives dealing with different issues such as climate change, coastal zones, biodiversity, sustainable development and land based activities, among others. The platforms around these project activities form an important part of advocacy and data sharing.

3. The Frameworks/Models/Information Systems adopted

Available Frameworks: A framework, in principle should include a thorough inventory of all relevant existing information together with actual and potential suppliers of data and related database and meta-database. There should be room for environmental surveys, indicators to monitor trends and impacts of measures as well as dissemination of data on the status of the environment.

In Mauritius, after the creation of the Environment Statistics unit, some data were initially collected from administrative sources, based on the NEAP and other tables found in various consultants' reports. Reference was also made to the format of UNSD which carried out the data collections every two years. Some years later, the following handbooks and Manuals from the UNSD was adopted:

- *A Framework for the Development of Environment Statistics (FDES)*, Statistical Papers, Series M, No.78
- *Concepts and Methods of Environment Statistics: Statistics of the Natural Environment*, Studies and Methods, Series F, No.57

- *Concept and Methods of Environment Statistics: Human Settlements Statistics*, Studies and Methods, Series F, No.51

In order to keep track of innovations in the field, other frameworks were also consulted. The most prominent one found and applied was the Driving Force-Pressure-State-Impact-Response (DPSIR). The simplified version of the DPSIR, namely the Pressure-State-Response (PSR), was sometimes applied to satisfy user needs. The frameworks provided the breeding ground for developing the environment statistics that were most needed and applicable to the country's expectations. A hybrid was developed to bridge the FDES and the DPSIR/PSR as shown in the following table:

Table 1 – The FDES, PSR and Hybrid

A: FDES

Components of the environment	Information categories			
	Social and economic activities, natural events	Environmental impacts of activities/ events	Responses to environmental impacts	Stocks, inventories and background conditions
1. Flora	*e.g, Deforestations*	*e.g Agricultural lands,*	*e.g Protected areas*	*e.g Forest area*
2. Fauna	*Fish catch,*	*Biodiversity loss*	*EIA and PER*	*Species distrubutions*
3. Atmosphere	*Temperature,*	*Air quality,*	*Air quality monitoring*	*Climate,*
4. Water	*Water abstraction,*	*Water quality,*	*Standards for water quality*	*Water balance,*
5. Land	*Land use,*	*Solid wastes generation*	*Landfilling*	*Land availability*
6. Human Settlements	*Energy consumption*	*GHG Emissions*	*Land use planning*	*Populations, Infrastructure*

B: PSR

	Pressure	State	Response
1. Flora 2. Fauna 3. Atmosphere 4. Water 5. Land 6. Human Settlements	Indicators used to monitor the causes of environmental problems	Indicators used to monitor the conditions, practices and activities related to known environmental problems	Indicators used to monitor the measures and responses of society and policy makers, such as sectoral regulations to the impacts on the environment

C: Bridging table

DPSIR ↓	Information categories			
	Social and economic activities, natural events	Environmental impacts of activities/ events	Responses to environmental impacts	Stocks, inventories and background conditions
1. Driving Force/Pressure	✓			
2. State				✓
3. Impact		✓		
4. Response			✓	

Causal Chain Analysis and Root Cause Analysis: The causal chain analysis show the major perceived problems and issues to determine the primary, secondary and root causes for those problems/issues associated with the environment. Root causes tend to be more systemic and fundamental contributors to environmental degradation and therefore, interventions and actions directed at the root causes are more sustainable and effective than interventions directed at other causes. These can also be considered as frameworks for developing environment statistics. Below is an example of a Root Cause Analysis:

Table 2 - Physical impacts and Root causes in the human environment and the economy

Issues	Physical Impacts	Root Causes
Growth in coastal population and urbanization	▪ Limited land; ▪ Water pollution; ▪ Beach erosion ▪ Accessibility	▪ Inadequate planning of land use; ▪ Unsustainable Industrial development; ▪ Buildings/structures on the coastline; ▪ Hotels development
Sites of religious or cultural significance	▪ Weathering ▪ Neglecting by communities and local authorities	▪ Lack of funds for restoration ▪ No interest from public

Human Health	▪ Infections disease propagation ▪ Economic loss	▪ Lack of hygiene ▪ Climatic factors ▪ Inadequate sensitisation
Economy	▪ Lower economic growth ▪ Livelihood on certain jobs threatened ▪ Unemployment	▪ Lack of investments ▪ Lack of diversification of the economy ▪ Inadequate Job recycling

Media Approach: The statistics compiled has also been considered from the media approach so that the data is trimmed to focus on current needs of and relevance to the country. This approach comprised the bottom up system of the environment starting from the underground media, then passing through the soil/sub-soil media, the land surface, water/aquatic/marine environment to the air and to finally end up in the atmosphere, both lower and upper (including the stratosphere). Thus we may find activities/events such as quarrying, land use, water quantity and quality, meteorological phenomena and atmospheric emissions.

The National Greenhouse Gas Inventory: The Computation of the annual inventory of greenhouse gases (GHG) can be considered a major breakthrough in Environment Statistics. The Environment Statistics Unit, together with the Energy Statistics Unit, of Mauritius, embarked on the compilation of GHG inventories in the early twenties. This proved to be an integrated and important part of environment statistics where much data is used in inventorying GHGs. The Guidelines and Good Practices developed by the Inter-Governmental Panel on Climate Change (IPCC) and the Software by the United Nation Framework Convention on Climate Change (UNFCCC) act as frameworks and information system respectively, for the compilations.

The Environment Information System (EIS)

The EIS is a computer-based web system that provides information about the state of the environment and the rates at which it is changing, in an attempt to manage the environment effectively. This system makes credible, up-to-date, and easily understood and interpretable environmental information available at all levels of society so that each and everyone can take personal responsibility for their own environment and participate effectively in decision making. EIS provides the appropriate platform to promote sustainable development through information exchange and promotion of partnership and networking at national, regional and international level. It has been proposed that the required information management will be achieved by developing a set of environmental indicators and by establishing a framework to coordinate data collection and analysis activities. The environmental information would need to be centralised within the EIS and made available to decision makers (government, private sector and individuals). Accordingly there have been a number of processes to develop a set of appropriate environmental indicators for Mauritius to be used in the State of the Environment (SOE)

reporting, and to develop the functional specifications for a web based data entry and display system to enable this data to be collated and made accessible.

The main activities that were undertaken for the project are: (1) Development of Environmental Indicators to regularly monitor and manage critical environmental resources; (2) Signing of Memorandum of Understanding with all data custodians which defines the detailed responsibilities of involved parties for the supply and use of the data requested, the frequency and quality assurance required for these parameters, and the mechanisms for regularly updating them. (3) Development of the EIS Software.

The EIS project uses a web based data entry system to enable the various data custodians to be responsible for the quality and content of their data. There are various levels of password security built into the data entry system to allow read-only, data entry or total access to the system. The environmental indicators by theme are (1) Atmosphere - Emission Rates of Greenhouse Gases, Change in Energy Intensity in different sectors of GDP, Number of Environmental Complaints, Growth of Air Pollution Sources, Ambient Air Quality, Noise Pollution Status and Sources; (2) Fresh water - Water Demand Management or Sustainable water potential, Terrestrial Aquatic Biodiversity, Ground Water Pollution, Environmental Pollution Load from Waste water pollution; (3) Land and Soil - Sustainable Crop Yield, Soil Erosion and Soil Fertility Loss, Quantity of Solid Waste and Waste Management, Loss Wetlands, Land Use Changes; (4) Biodiversity - Ratio of Endangered/ Threatened Species to total species of Flora and Fauna, Dominance of Exotic Species among Nature Species; (5) Marine Resources and Coastal Pollution - Marine Fish Biodiversity, Degradation of Coastal Zone: Coral and mangrove are State of Fish Stocks, Vulnerability zones of Coastline, Coastal Water Quality, Flow of Tourist and its Sustainability; (6) Quality of life - GDP per Capita, GDP Growth in each Sector, Unemployment Rate, Adult Literacy Rate, No. of Food Poisoning Cases, Life Expectancy at Birth, Diseases Rate of Communicable and Non Communicable Diseases, National Environmental Health Expenditure/Environment Protection.

Geographical Information System (GIS)

Under the Capacity Building Programme of the Ministry of Finance and Economic Development, the CSO hired the services of a private international consultant to implement the CSO GIS Project. This project aims at developing a GIS to capture, process, display and analyse geographically reference information in various fields and produce dissemination tools such as CD, Interactive website etc. The ultimate aim is to allow users to create interactive queries in a user friendly manner by making use of GIS. In Environment Statistics this type of system is vital for presenting data and information for effective policy decisions, among others.

4. Methodologies and Sources of data

As environment statistics are multi disciplinary covering a wide range of diverse subjects, the data sources and methods of compilations are also varied. Information, according to components of the environment and information categories of the FDES, is extracted

from the various digests of statistics published by the CSO and from the databases and reports of the following ministries and departments:

The Flora: The Forestry Service of the Ministry of Agro-Industry and Food Security is the main producer and provider of statistics on this part of environment statistics. The forestry sector includes all activities dependent on forests, trees and other woody vegetation, and all industries based on them. The sector has numerous interactions and linkages with other sectors, such as agriculture, water, environment, tourism and communications. The principles or premises that provide the foundation for forestry policy in Mauritius comprise, among others, assessing the forest estate (extent, forest type, etc.) and designating the forest estate into classification of functions – productive, protective, conservation, recreation and ecotourism. The important contribution of the environmental functions of forests in water conservation, flood control, combating soil erosion, biodiversity conservation and support for tourism – an increasingly important sector in the island's economy, contribute to generate important data for environment statistics. The quality of the data can be considered ***very good***.

The Fauna: This part draws most of its statistics from the Ministry of Fisheries and Rodrigues which operates the Albion Fisheries Research Centre which carries out the research, development and management functions. During the course of its activities, the centre generates much data which are compiled by its own statistics and data records section. These activities include monitoring of existing fishing activities (including fishing vessels) and fish stock assessment (artisanal, banks and tuna), Surveys and charting for new or untapped resources or fishing grounds, Ecological surveys to monitor and collect base line data on coral reefs and water quality with a view to conservation of aquatic biodiversity and the marine environment. The quality of the data can be rated as ***good.***

The Atmosphere: This part obtains data mainly from the Meteorological Services. Environment statistics uses mainly data on rainfall, temperature, sunshine and humidity. The general functions of the Meteorological Services are provision of meteorological services for Government ministries, departments, local authorities, the media and the general public, agricultural and industrial interests and tourism as well as maritime and aeronautical navigation. This includes collection, processing and publication of meteorological observations. The other data in this category includes atmospheric emissions such as greenhouse gases which are inventoried by the CSO itself. Data quality can be considered ***very good***.

Water: The Water Resources Unit (WRU), established in May 1993, is responsible for the assessment, development, management and conservation of water resources in the Republic of Mauritius. Its main objectives include study and formulation of policy in relation to the control and use of water resources for the provision of water for domestic, agricultural, industrial and commercial supply and for hydro-electric power and irrigation, land drainage and land reclamation, flood control, the development of fisheries, the protection of wild life, afforestation and the control of soil erosion. It also

involves investigation on water resources and collection of data with any correlations and interpretations with regard to those resources. The WRU prepares an inventory of water resources and keeps the inventory continuously up to date. It is also responsible to ensure that appropriate measures are taken for the prevention of pollution of water resources. Research and investigation on the economic use of water is also carried out as well as grant of rights for the use of water and issue of permits, licences and concessions for this purpose. All these generate important **Water Statistics**. Data quality can be considered ***good.***

Land: This part relies mainly on data from Land Use and Solid Wastes. The Solid Waste Management Division of the Ministry of Local Government is a major provider of data and has as functions to**:** Develop/review Solid Waste Management programmes and policies; identify new disposal sites, manage and control existing temporay dumping sites, transfer stations, landfill and supervise the sites; Coordinate waste collection operations carried out by Local Authorities and other organisations; investigate and report on complaints received from the public and media. Data quality can be considered ***good.***

Human Settlements: This part derives most of its data from the CSO itself and comprises the energy, transport and communications, housing and population as well general indicators. Data quality can be considered ***very good***

The data suppliers therefore can be summarized as from the following organizations: Ministry of Public Utilities; Ministry of Industry, Small and Medium Enterprises, Commerce and Cooperatives; Ministry of Labour, Industrial Relations and Employment; Ministry of Health and Quality of Life; Ministry of Local Government; Ministry of Environment and Sustainable development; Central Water Authority; Central Electricity Board; Meteorological Services and National Transport Authority.

Additional Statistics

- Additional statistics includes those on Coastal Zones, Sustainable Consumption and Production (SCP), Climate Change (CC), Sustainable Development (SD) and National Greenhouse Gas (GHG) Inventory
- Development of the Environment-Economic Accounts(EEA) for Water, Energy use and Atmospheric Emissions, and Material Flows
- The Environmental Information System (EIS) *(See Annex I).*
- Participation in National Oceanographic Data Centre and the Clearinghouse Mechanism (CHM) *(See Annex II).*

5. Data processing and analysis

Data are compiled and tabulated by using the Excel software. All statistical analysis of any surveys is made through the use of the SPSS software. Greenhouse gases are computed by the
UNFCCC Software for National Greenhouse gas (GHG) Inventories.

6. Dissemination

6.1 Publications

Two of the most important documents released on an annual basis are the "Economic and Social Indicator on Environment Statistics" and the "Digest of Environment Statistics". Both are available as printed copies as well as on line versions to be found at http://www.gov.mu/portal/goc/cso/ei843/toc.htm and http://www.gov.mu/portal/goc/cso/report/natacc/environ08/toc.htm.

7.   Conclusion

The NSS can be used as a stepping stone to develop an Environmental Statistical System (ESS) which can encompass all the systems/models and frameworks described in the paper. The number of environmental indicators compiled is small but quite substantial environmental parameters are used. Each organisation has its own database using its own archival formats which complicates the issue of data availability, quality and access. However, with appropriate institutional set ups, exchange of data at national level can be well organised. A set of Good Practices are proposed as follows:

Good Practices for Environment Statistics

Good Practice 1: *CSO to collaborate with line ministry by hosting a statistics unit within their locals and providing all logistic supports.*
Good Practice 2: *Define needs for Environment Statistics*
Good Practice 3: *Identify users of Environment Statistics (User Surveys)*
Good Practice 4: *Adopt/Develop frameworks/Models for Environment statistics*
Good Practice 5: *Facilitate data producers/suppliers in creating databases and adopting frameworks/models*
Good Practice 6: *Participate actively in national, regional and international projects where available data are used and additional data are produced and experiences are shared*
Good Practice 7: *Set up appropriate data sharing mechanisms (e.g MOUs)*
Good Practice 8: *Make appropriate use of technologies (GIS, Web, etc)*
Good Practice 9: *Ensure good data quality*
Good Practice 10: *Ensure quality and timely data dissemination*

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8.   References

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Annex I

The list of EIS indicators is given below:

- THEME: **Atmosphere**
- - Emission rates of Greenhouse Gases
- - Change in energy intensity in different sectors of GDP
- - Number of environmental complaints
- - Growth of air pollution sources
- - Ambient air quality
- - Noise pollution status and sources

- THEME: **Freshwater**
- - Water demand management for sustainable water potential
- - Terrestrial aquatic biodiversity
- - Groundwater pollution
- - Environmental pollution load from wastewater pollution (COD, SS, N, P, SO4, pesticides, metals, etc.)

- THEME: **Land and Soil**
- - Sustainable crop yield
- - Soil erosion and soil fertility loss
- - Quantity of solid waste and waste management
- - Loss of wetlands
- - Land use changes

- THEME: **Biodiversity**
- - Ratio of endangered/threatened species to total species of flora and fauna
- - Dominance of exotic species among native species
- - Economic loss due to ecological damage by cyclones

- THEME: **Marine Resources and Coastal Pollution**
- - Marine fish biodiversity
- - Degradation of coastal zone: coral and mangrove
- - State of fish stocks
- - Vulnerability zones of coastline
- - Coastal water quality
- - Flow of tourist and its sustainability

- THEME: **Quality of Life**
- - GDP per capita
- - GDP growth in each sector
- - Unemployment rate
- - Adult literacy rate
- - Number of food poisoning cases

- - Disease rate of communicable and non-communicable diseases
- - National environmental health expenditure / environment protection

Example of data collection standard for EIS

RESPONSIBLE INSTITUTIONS

- **Responsible Ministry**   :Ministry of Finance & Economic Development
- **Data Custodian**   :Central Statistics Office
- **Support Data Provider**   :Central Electricity Board

NETWORK DESIGN	FIELD DATA COLLECTION
Station Location / Spatial Representation / Geographical Coordinates / Parameter Selected / Sampling Frequency / Measurement techniques	*Field Measurement / Field Data Recording including dates and Time / Sample Preservation / Sample Transfer (if any) / Quality Control*
- Data on the whole of Mauritius will be provided, with latitude 20° and longitude 57° - Information on the following shall be provided: 1) Energy used by each sector, namely: - Manufacturing - Transport - Domestic - Commercial - Agriculture 2) GDP generated by each sector, namely: - Agriculture, hunting, forestry and fishing - Mining and Quarrying - Manufacturing - Electricity, gas and water supply - Construction - Wholesale and Retail trade, etc - Hotels and Restaurants - Transport, storage and communications - Financial intermediation - Real estate, renting and business activities - Public administration and defence, etc - Education - Health and social work - Other community, social and personal service activities, etc - FISIM (Financial Intermediation Services Indirectly Measured) 3) Electricity (Kw/hr) produced from bagasse and coal by Sugar Estates and by Independent Power Producers - Information shall be updated yearly - Total Electricity consumption shall be obtained from Electricity bills - Total sales of fuel for each sector mentioned at (1) above shall be obtained from petroleum companies - GDP for each sector mentioned at (2) above shall be retrieved from the Digest of National Accounts from the CSO	- Annual surveys shall be effected through questionnaire to collect information on bagasse consumed by the sugar industry - Quarterly return shall be obtained from petroleum companies for consumption of fuels - Monthly return shall be received from CEB for electricity sales and consumption of oil - Quarterly return shall be obtained from trade statistics for imports of petroleum products - Annual GDP figures shall be obtained from CSO - Survey data shall be recorded in datasheets - Electricity sales by type of tariff in different sectors shall be obtained from the CEB - Fuel oils consumption for different sectors shall be obtained from petroleum companies - Electricity produced from bagasse and coal by Sugar Estates and by Independent Power Producers shall be recorded - GDP by each sector shall be provided - The returns and questionnaires obtained shall be edited and checked for completion, correctness and consistency - Wrong information and data outliers shall be identified and corrected / rejected - The tabulations generated shall be checked for their "totals" against the returns - The energy data shall also be cross-checked from secondary sources

• Bagasse consumed shall be estimated from the annual energy survey of the Sugar Estates	

Annex II

NATIONAL OCEANOGRAPHIC DATA CENTRE

- The National Oceanographic Data Centre (NODC) operates as the national oceanographic data archive of Mauritius. It was officially established in November 1999 at the Mauritius Meteorological Services within the guidelines of the Ocean Data and Information Network for Africa second phase project (ODINAFRICA-II) with satellite stations at the University of Mauritius, Albion Fisheries Research Centre and Mauritius Oceanography Institute.
- The mission of the NODC is to enhance oceanographic services and promote further marine research by making available, to policy-makers and the marine communities, ocean data and products, in real and non-real time, for the efficient management and sustainable development of coastal and marine resources. The Clearinghouse Mechanism under the Western Indian Ocean Land Based Project (WIO-Lab), uses GIS data.
- A national committee oversees the development of the NODC and comprises representatives of:
  • Albion Fisheries Research Centre of the Ministry of Agro Industry & Fisheries
  • Central Informatics Bureau
  • **Central Statistics Office**
  • Department of Environment
  • Mauritius Oceanography Institute
  • Meteorological Services
  The Committee regularly meets to review progress of ongoing activities and plans follow-up actions. (URL: http://nodc.intnet.mu)
- **Ocean Data Management**
- The Ministries/Institutions are responsible for the collection, quality control, archival and dissemination, according to a data exchange policy scheme, of the following ocean data in Mauritius:
  • Chlorophyll data
  • Coastline and shoreline
  • Coastal Typology
  • Currents
  • Educational resources
  • Integrated coastal Area Management
  • Marine organisms/Biological data
  • Nutrients
  • Ocean productivity
  • Ocean station data
  • Plankton
  • Profile data
  • Regional data
  • Salinity
  • Satellite data
  • Taxonomy