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SADCO

SADSO

A decade of current measurements from the RV Meiring Naudé

Measured flow velocities are key components to describing and analysing the dynamics of the oceans. Between 1970 and 1980 a large number of such measurements were done along the east coast of South Africa using innovative methodology. This data has been dormant for about 20 years and has now been loaded onto the database.

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Need for estimates of current speed

Most of the currents in the world are wind driven. Over vast areas of the ocean the trade winds move the water equatorward and westward, causing the large gyres in the ocean basins. In terms of velocity and transport these currents are intense (> 1 m/s) and represent the largest flows in the world.

Density currents are created by the thermohaline characteristics of the sea. Well-known examples are the flow of highly saline water from the Red Sea into the Indian Ocean, and from the Mediterranean into the North Atlantic. Similar currents are created at the poles, where cold, saline water sinks to great depths and move equatorward. Except in cases of topographic constriction these currents are generally slow, compared to the wind driven currents (especially the western boundary currents).

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In terms of impact,

- large ocean currents are key components in the global balance of heat and mass
- Smaller-scale currents help to disperse pollution, the effluent from pipelines, and oil spills.
- Currents at the sea bottom move sediment and give rise to underwater dunes, some of which have been observed in the vicinity of the Agulhas Current.
- Fast-flowing currents can aid shipping by saving fuel and expediting passages. If currents interact with storm waves, wave heights can be enhanced and become a danger to shipping.

Current recording methods up to about 1970

Measurements of ocean currents are classified as Lagrangian and Eulerian. The Lagrangian method tracks a water particle on its way, and examples of this method would be the deployment and tracking of floats (surface or subsurface). Local examples have been the deployment of small floats that were tracked by motor boats or even remotely by optical means (e.g. rangefinders).

The Eulerian method fixes the observer at a point and records the speed and direction of the water passing by. An example of this is a moored current meter.

Another method uses the electric current created in the sea (a conductor) in the presence of the earth's magnetic field, to infer the flow velocity. The instrument used is referred to as a GEK (geomagnetic electrokinetograph).

Combined with an independent, accurate navigational method, “dead reckoning” of vessels can be used to estimate the ship's set, which in turn provides some insight into the flow speeds (excluding the effect of wind).

Currents can also be derived from geostrophy, where the density distribution is related to the speed. In the open ocean the recording of the density fields (from measurements of temperature and salinity) has for many decades been the only method to estimate current velocities.

Methodology since 1970

Present methodology includes the following examples

- Older type, single point, rotor current meters. (Fig. 1)
- In water depths where rotor-type current meters are affected by the wave orbital motion, vector-averaging electro-magnetic or acoustic current meters are employed.
- Where profiles of currents are required, arrays of single-point current meters have been replaced by Acoustic Doppler Current Profilers (ADCPs). These are either deployed on a mooring (mostly looking up), or on a vessel (looking down).
- In the Lagrangian mode, buoys are tracked by satellite to provide coverage in deep-sea areas (Fig. 2).
- Geostrophy is still used extensively in deep-sea areas.
- Surface currents can also be measured in the proximity of the coast with the use of high-frequency radar. South Africa does not have any of these installations.
- Surface flow speed and direction has been derived from sequential infrared images (so-called feature tracking).
- Through satellite altimetry, the topography of the sea surface can be measured, and the surface inclination relative to the geoid can be used to calculate the surface current speed. This data type has been used extensively to support global numerical models.

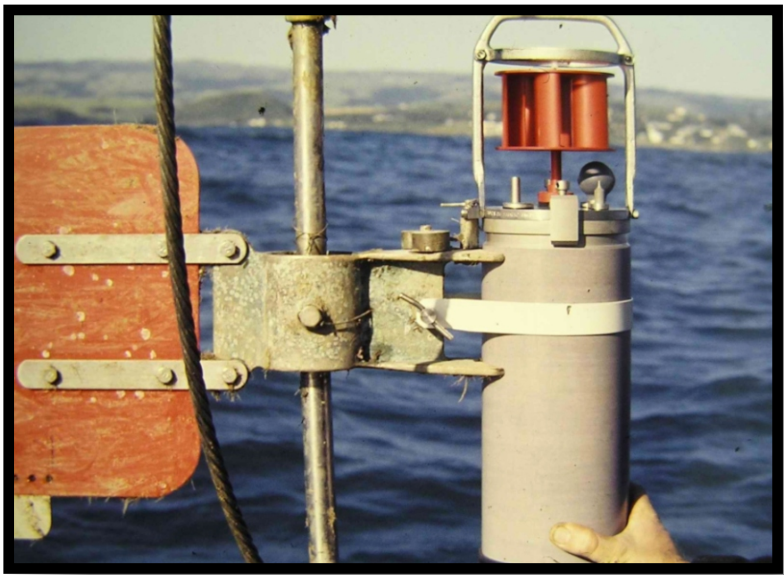


Fig. 1: Example of a rotor-type current meter and directional vane (1976)

Fig.2: A satellite-tracked buoy with drogue being prepared for launching on the RV Meiring Naudé (1975)

Method employed on the RV Meiring Naudé

A brief description is provided here of the methodology for measuring currents on board the *Meiring Naudé*.

The *Meiring Naudé* was a small (30m, 350t) research vessel of the CSIR (Fig. 3). Built in 1967 she operated along the east and south coasts of South Africa. She was equipped with state-of-the-art technology (Fig. 4) to measure the surface, sub-surface and bottom characteristics.

In the late 1960s and 1970s there was an urgent need to obtain direct and accurate insight into flow velocities. This was the time of studying effluent disposal off the KwaZulu- Natal coast, and the building of Richards Bay.

Because of the variability of the flow in which the vessel operated, measurements of current velocity had to be accurate and fast (to avoid the mixed spatial-temporal distortion that occurs when a vessel surveys a system that varies on the same time scale as the coverage of the vessel). Time and depth constraints thus prevented a vessel from anchoring during stations.

The methodology comprised basically the suspension of a current meter at various depths from the vessel, with on-board recording of the data through a conducting cable. The current meter was integrated into a hydrosonde (Fig. 5) that could provide a full suite of parameters (depth, temperature, current speed and direction were obtained in real-time, while samples were taken for subsequent analyses of salinity, nutrients, and oxygen).

Current information presently in SADCO.

Current velocity data presently stored in SADCO have been derived from:

- Current meters deployed by the CSIR (e.g. Eckart Schumann), 1970s and 1980s.
- Current meters deployed by Marine and Coastal Management (e.g. Grev Nelson), 1980s and 1990s.
- Current meters deployed in the deep sea by researchers from overseas organisations.
- ADCP data collected off the east coast (Mike Roberts).
- SADCO has for some time reported on the large amount of ship-borne ADCP data residing with MCM, but this data has not been processed yet.

Fig 3: The RV Meiring Naudé in Durban

The water depths prevented the vessel from anchoring on station, so the vessel was allowed to drift freely.

The method assumed that

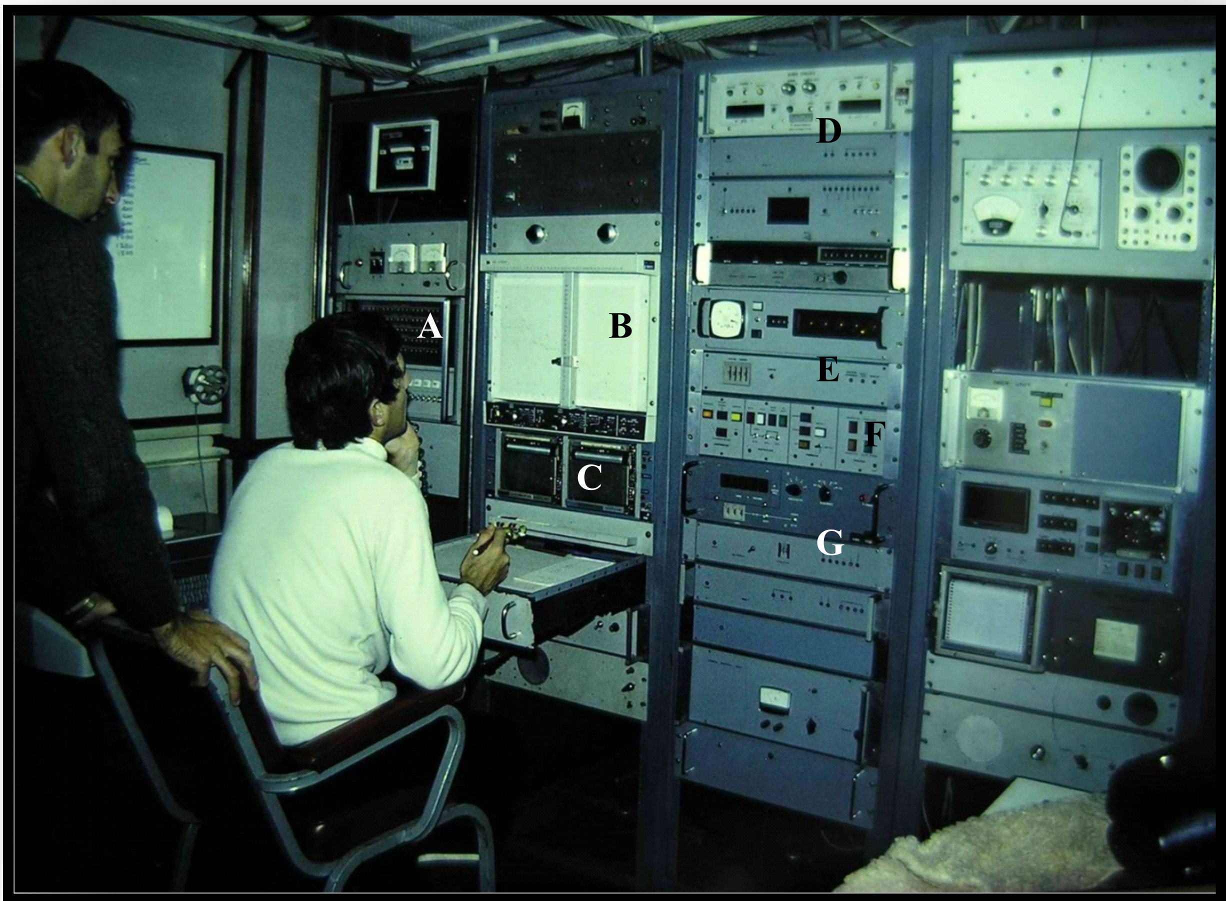
- The suspended hydrosonde and the ship were rigidly coupled (e.g. the hydrosonde was not swaying or yo-yo-ing (the winch was fitted with a swell compensator and the vessel had an anti-roll tank).
- The drift of the vessel could be recorded, so that the measured flow speeds (relative to the vessel) could be converted to absolute velocities.

To measure the ship's drift was initially done through simple triangulation of the vessel's position relative to two shore-based tellurometer stations. The tellurometer system was quite accurate but manpower-intensive. The DECCA navigation system introduced in the country in the early 1970s required no manpower, but was less accurate and inconsistent at certain times during the day.

From 1972 onwards use was made of a small, highly portable radar transponding system that could provide the desired sub-meter accuracy tens of kilometres offshore any time of day or night, with minimal manpower requirement. Measurements were confined to the proximity of the coast, but the speed of operation allowed currents to be measured rapidly while recording the ship's drift during the duration of the station.

The whole system was controlled, integrated and all data recorded by a Hewlett-Packard mini computer (already installed before 1970!)

Fig 4: Part of the oceanographic control room of the RV Meiring Naude, where surface and subsurface oceanographic data collection was controlled. A HP minicomputer for measurement management and data logging; B temperature XY recorder; C current velocity recorder; D automatic radar transponding system; E cable speed and strain; F control box for selection of station and measurement sequence; G DECCA navigator system.



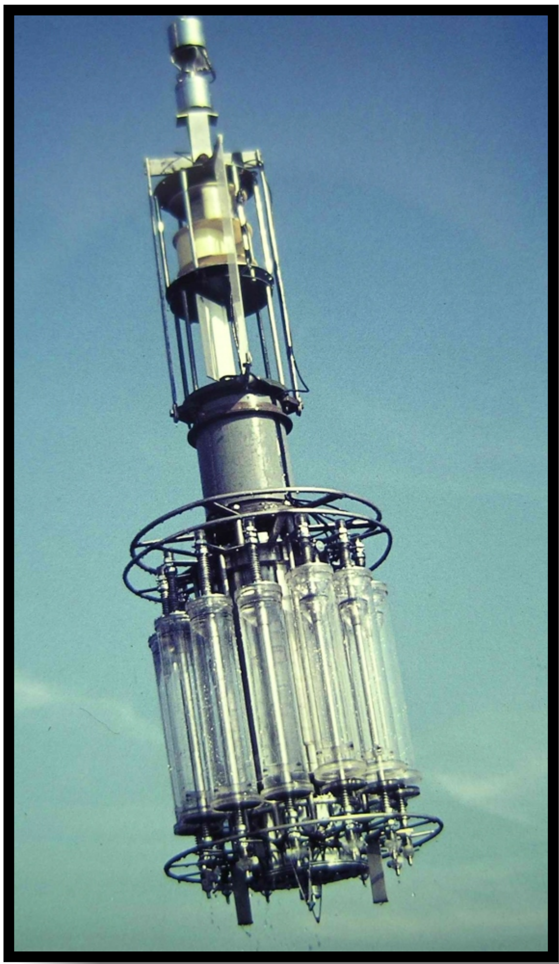


Fig 5: CSIR-designed hydrosonde to record current speed and direction (rotor and vane assembly), depth, and temperature. Samples (for analyses of salinity, nutrients and oxygen) were taken with the rosette sampler.

Although measurements could be done to any depth, it was found that below about 300m depth the hydrosonde movement became somewhat detached from the movement of the vessel in high-shear conditions, and this tended to limit the vertical range of the instrument.

This innovative data provided extensive insight into the shelf circulation off the east coast of South Africa, at a time when the information base on currents was non-existent. The direct measurements of current velocity were also matched with geostrophic calculations to "calibrate" geostrophy in areas where the "depth of no motion" could not be determined. This was then applied to obtain the first detailed insight into the volume transport of the Agulhas Current.

The system was eventually discontinued in the late 1970s as expeditions moved progressively into the deep sea and the hydrosonde was replaced by high-accuracy profilers such as a CTD (the first ones of which were imported to the country by MCM and CSIR in the late 1970s).

Examples of use of the data

- Current measurements were used extensively to describe the flow in the proximity of Richards Bay, Durban and Port Edward by Pearce (*J mar Res* **35**, 4, 731-753, 1977) in 1970-1975 (e.g. Fig. 6).
- An example of measurements of current velocity off Port Edward (about 32° S on the east coast of South Africa) around 1974 is portrayed in Fig. 7.
- Estimates of the volume transport of the Agulhas Current were partially based on current speed measurements (*Deep-Sea Res.*, **27**, 557-563).
- Other regular measurements between Kosi Bay and Port Elizabeth provided insight into the characteristics of the Agulhas Current. These measurements were constrained by the distance offshore, and the availability of suitable navigation for the offshore region (e.g. *J geophys Res.*,**84**, 3776-3778).

Extraction procedure

The data can be obtained as with normal hydrographic stations, namely by extracting the particular cruise of the *Meiring Naudé*. The extraction will include all parameters available on that station.

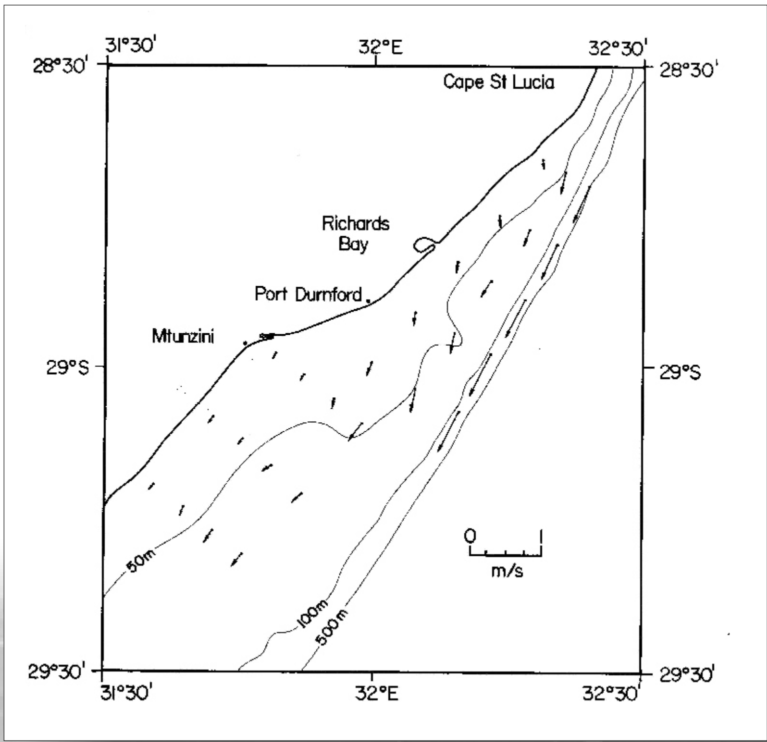


Fig. 6: Shelf current velocities measured in the vicinity of Richards Bay (1970)

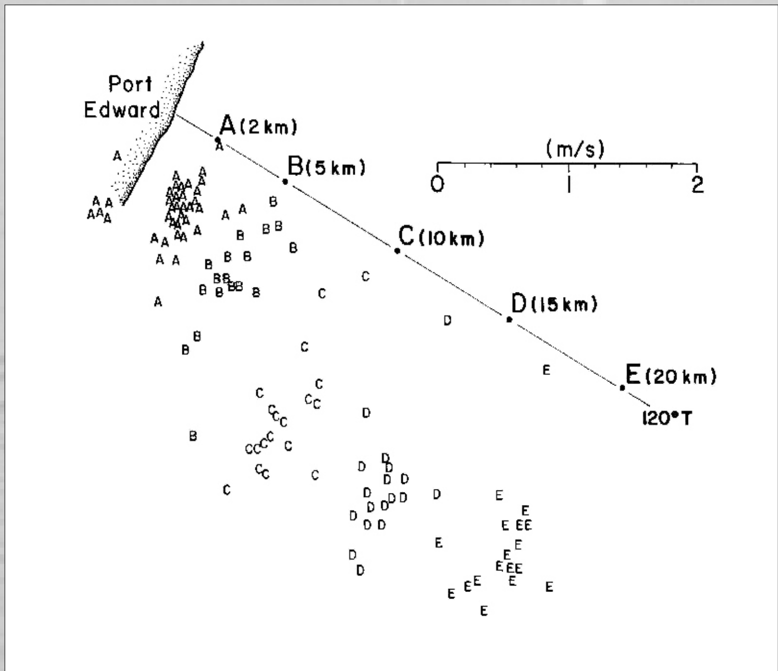


Fig 7: Current velocities measured off Port Edward. Each character denotes the end point of a velocity vector starting at the corresponding station position (on the transect running at 120° T off Port Edward)

Status of OBIS on marine biological data from Africa

There is a need to "put Africa on the map" in terms of marine biodiversity. The sub-Saharan node of OBIS has been started a few months ago, and is making strides to capture as much data as possible from anywhere in Africa.

[A slightly revised contribution will appear in the forthcoming SANCOR Newsletter]

Introduction

It is believed that the decrease in biodiversity globally is a serious challenge to humankind, making it of prime importance to establish a baseline of the present status of biodiversity. It has been demonstrated that the amount of marine information emanating from the African continent is quite meagre, especially in the light of the extensive biodiversity thought to occur in this region. A special effort is therefore required to ensure that relevant marine information is captured and made available to scholars and decision makers.

As has been announced in previous Newsletters, CSIR/SADCO has been contracted to establish and host a major marine biological data base (**AfrOBIS**) for sub-Saharan Africa. This initiative forms part of OBIS (**Ocean Biogeographic Information System**), which in turn is the marine component of the **Global Biodiversity Information Facility** (GBIF) and the data management component of the **Census of Marine Life** (CoML), a global programme to determine the biodiversity status of the world's oceans.

The global OBIS effort has been rolled out through seven regional "nodes", each one collating data from organisations and data providers within a specific "target area". The **AfrOBIS** target area agrees more or less with the SADCO target area (10º N to 70º S; 30º W to 70º E, extending from Senegal in the west to Somalia in the east, including islands).

OBIS is already the largest and most authoritative, on-line, global database for marine biodiversity data and continues to expand rapidly. By the end of 2004 the system contained over **five million records of over 40 000 species.** The aim of OBIS is to become the primary source of data on distribution of marine species worldwide and to provide sophisticated online mapping and analysis tools (such as correlation of distribution to environmental parameters).

Data submitted to OBIS will be made freely available to all users. Requests for output data can be submitted on-line to the regional node website (see below for URL), and a global answer will be provided virtually immediately.

Present status of AfrOBIS (October 2005)

- The web-site has been established (**afrobis.csir.co.za:8000**).
- The data provider software has been installed and activated. This will allow the international OBIS to web crawl through regional nodes' databases at regular intervals, and upload data to the central server (this is required to expedite global searches).
- Software, to load local data onto AfrOBIS, has been written.
- Descriptive information on AfrOBIS has been installed on the international OBIS server.
- Two temporary digitisers have been appointed at Iziko Museum, Cape Town, to assist with the digitisation and entering of the data held by that organisation, and transfer of this data to AfrOBIS.
- Data has been received from SAIAB (South African Institute for Aquatic Biodiversity), and is being prepared for loading.
- The Natal Museum has agreed to supply data to AfrOBIS.
- Acquisition of data from other museums and data providers is being negotiated.

Do you have data to contribute?

The process of identifying other data providers from both South Africa and (especially) the rest of Africa, remains our highest priority. Those organisations with substantial amounts of data (as reported during the 2003 CoML workshop in Cape Town) have been identified, and are in the process of being contacted.

A process was recently started to contact possible data providers in Africa. Attendance lists of biogeographic workshops were used to identify possible data holders. Fig. 8 indicates the countries that have been contacted.

Organisations in South Africa and Africa (within the target area), as well as scientists involved with large programmes (e.g. the Benguela Current Large Marine Ecosystem programme, MCM, CSIR, ORI) that have marine biodiversity data and who have not been contacted yet are invited to contact either Prof Charles Griffiths (Chair of the Africa Committee of CoML, griffith@egs.uct.ac.za) or Dr Marten Grundlingh (manager of SADCO and AfrOBIS, mgrundli@csir.co.za), to arrange the submission of their data.

Requirements to contribute data

- The main requirement of data providers is that they should be prepared to share their data openly with colleagues all over the world.
- The data should be captured with a **lat/long position** (this seems to be one of the single issues that has held back previous digitisation. Often observations are reported as having been located "Off Danger Point", or "5 miles west of Hondeklip Bay").
- The requirements of the data scope/format can be obtained from Ursula von St Ange (uvstange@csir.co.za).

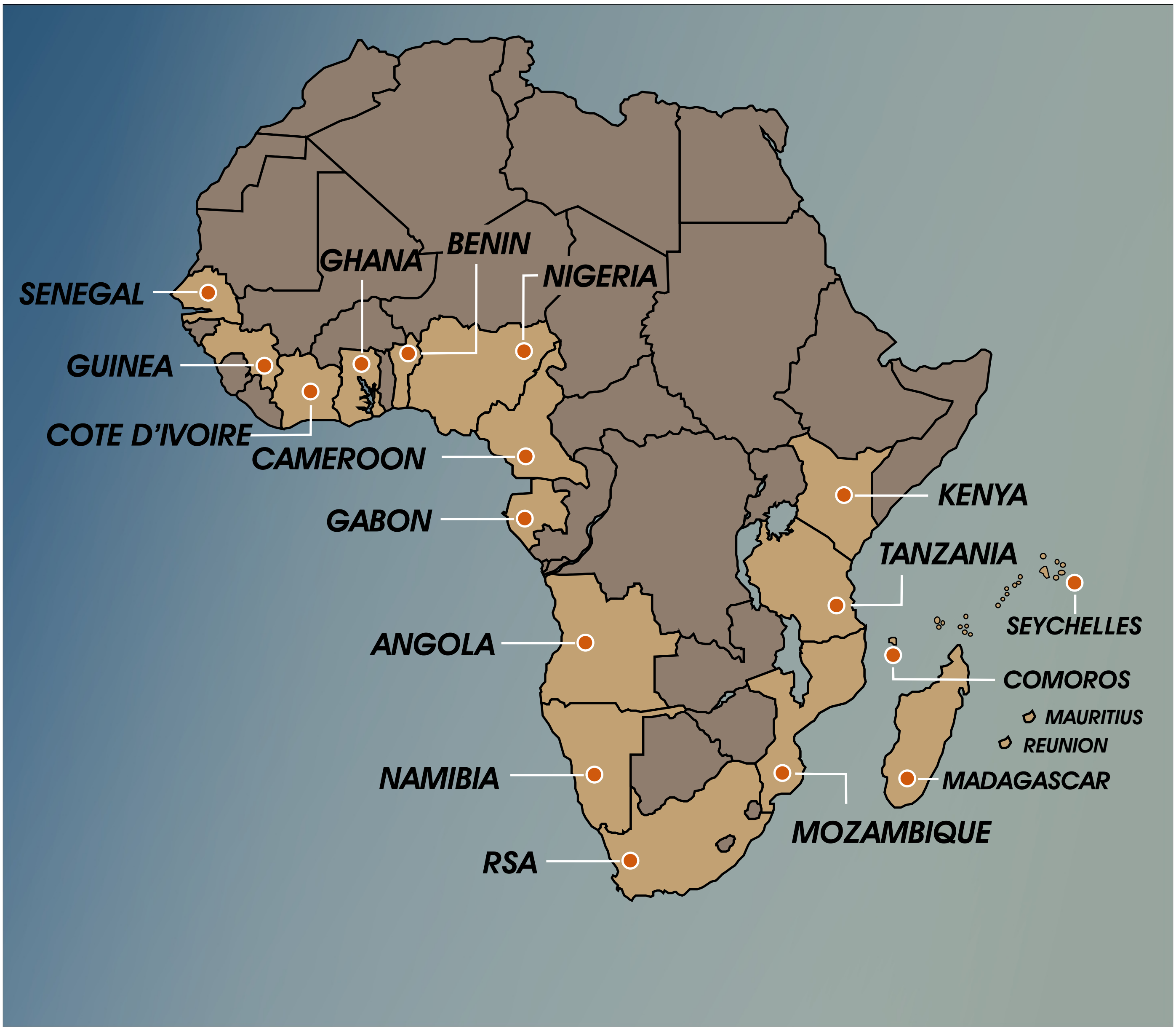


Fig 8: Countries that have been contacted as part of the AfrOBIS data scouting process.

AfrOBIS data will be compatible to data internationally. For the first time, the extent of common occurrences of species on a global scale will be available at our fingertips virtually immediately. OBIS will represent a powerful, global tool to all students of marine biodiversity.

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