DRONES IN THE SOUTH AFRICAN MARINE ENVIRONMENT

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Drones are versatile machines. They are employed in many novel ways and can lead to huge cost-saving measures, if employed cleverly. Originally drones were earmarked for 'dull, dangerous and dirty' jobs, and even though this is now somewhat of a misnomer (because drones are used for many other reasons these days) the marine environment presents a solid case for the former. In other words, drones are potentially ideal tools for the marine environment, because many related tasks are potentially dangerous and monotonous.

This article explores the potential for the utilisation of drones within the South African marine environment. Although the focus is primarily on airborne solutions, unmanned surface and underwater systems could also be of great benefit and should not be forgotten. But first, let's take a look at what drones being employed in this environment may be up against.

THE SA MARINE ENVIRONMENT

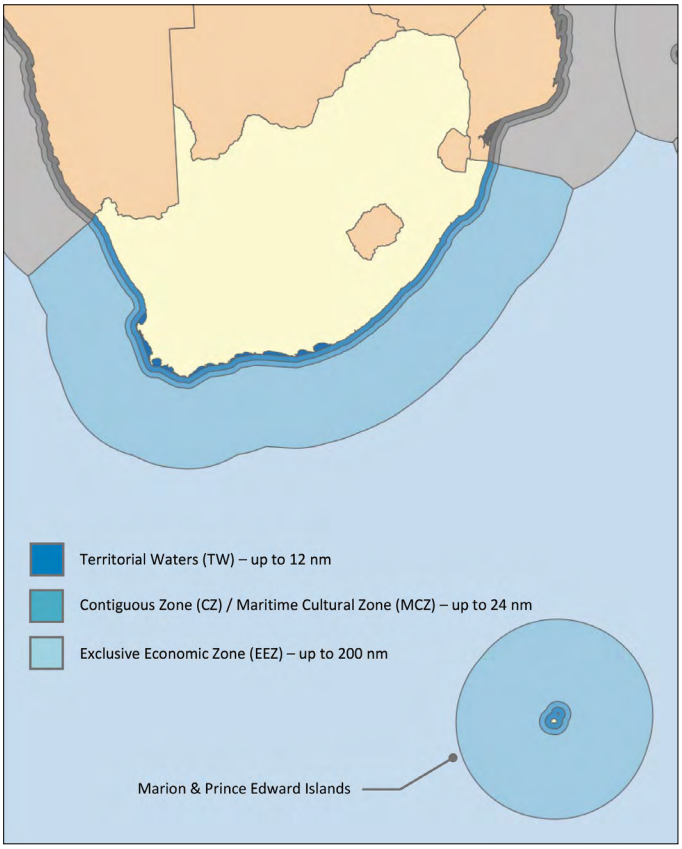
It should come as no surprise that the South African marine environment is one of the harshest in the world. Seafarers of days gone by did not refer to the maritime region around Cape Point as "the Cape of Storms" for no reason; on the west coast we have the cold, stormy Atlantic Ocean and northward-flowing Benguela Current, often host to strong gales and torrential rains. The Atlantic is also a hurricane incubator, but the effects are not immediately felt in South Africa, as most of these tropical storms are located in the northern hemisphere. On the east coast lies the much warmer Indian Ocean bringing with it the south-flowing, coast-hugging Agulhas Current. The Indian Ocean is also an incubator for tropical storms, and the effects are much closer to home, often felt in our climate and, at times, on our coasts.

To the south lies the largest wind-driven oceanic current worldwide: the frigid Antarctic Circumpolar Current. This fast-moving current is home to the infamous "Roaring Forties", a band strong prevailing Westerly winds between latitudes 40o and 50o south, producing gale-force wind conditions throughout the year whipping up the seas, often leading to massive, unpredictable rogue waves.

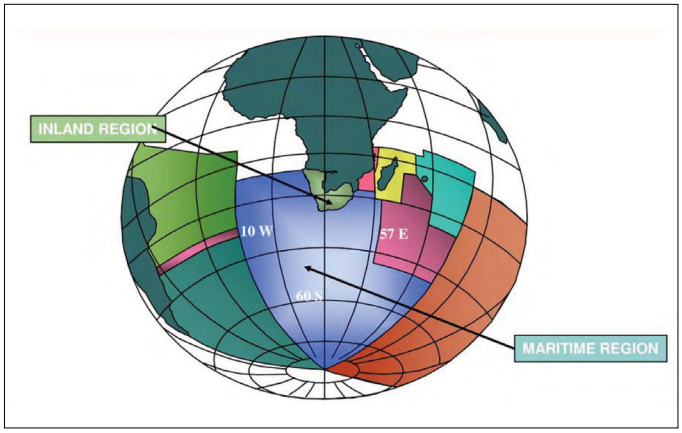
Varied climatic conditions and weather patterns are experienced throughout South Africa's Maritime Regions. These regions include the Exclusive Economic Zone (EEZ) and the Maritime Search and Rescue Region (M-SRR). The maps below are indicative if these, and showcase the enormity of our maritime regions and the equivalent scale of the SA Search and Rescue responsibilities.

Effectively, the SA M-SRR stretches from our shorelines halfway to Australia on the east, halfway to South America on the west and all the way to the Antarctic coastline to the south – much of it across areas replete with harsh oceans where sea surface temperatures drop to as low as -2oC and surface air temperatures range from 10 to -15oC. This creates a potentially lethal situation for anyone unfortunate enough to be exposed to such conditions.

Wind speeds along our coasts (particularly the Western Cape region) can be as high as 160km/h, while wind speeds around the Marion/Prince Edward Island Group (part of South Africa's territorial claim and Exclusive Economic Zone) have been measured gusting up to 200km/h. Marion Island is battered by large swells up to 12m high, and experiences more than 100 cyclones each year. These conditions may be extreme when compared to those at the



Map 1: SA Maritime Claims (Continental Shelf Claim not shown)



Map 2: SA Search and Rescue Regions

South African coastline, but we are responsible for these territories, including any form of economic development and support.

Speaking of economic development, it should be noted that South Africa's 2798km long coastline is not only home to many shipwrecks (courtesy of the above), but also provides a place to live and work for

a large part of the populace. Close on 40% of the national population live within the 100km wide coastal band. The SA marine environment harbours rich biodiversity, as well as minerals and other natural resources, worth exploiting for local economic development. Our EEZ covers an oceanographic area of approximately 1,553,000 km2, and is home to rich fishing grounds, world-renowned shellfish, rare minerals and sources of energy. Coastal mining contributes to more than 7.5% of the national GDP annually, and large quantities of crude petroleum, natural gas, marine diamonds, titanium and zirconium is extracted each year, for both local use and export.

Eight major ports serve the shipping community and act as entry points for commercial goods and people entering the country. South Africa's location halfway between the East and the West has led to the shipping routes around the southern tip of Africa being some of the busiest worldwide, the only other viable alternative being passage through the Suez Canal. An increase in piracy around the Horn of Africa has led to an increase in shipping traffic around the Cape.

South Africa still ranks among the top 12 maritime trading nations, commanding 6% of the total world sea trade.

Currently, piracy at sea is less of an issue in South African waters - being of greater concern in the Mozambican channel and further north along the East African coast - but of major concern is the threat of poaching and illegal fishing. Along our coasts Abalone is constantly under threat and our marine resources are fair game to anyone willing to risk entry into our EEZ with the intent on illegal activities. Illegal entry into via our ports is also of concern, as is the importing and exporting of illegal goods. South Africa is host to many marine parks, marine protected areas and estuaries, where human activity is carefully monitored to help sustain the fauna, flora and sea life within.

The direct and indirect benefits from tourism account for almost 9% of the total national GDP. This is a huge monetary influx for the country, and no doubt the coastal tourism segment makes up a large portion of this figure. Coastal leisure activities are primarily concentrated along the shoreline and within shallower waters (within the 12 nautical mile territorial waters bordering the coastline). Oceanic cruises operate regularly to and from our ports and utilise regular shipping lanes running past the Cape of Good Hope between East and West. The demand has doubled each decade, indicating continued increase in traffic and visitors to our ports and shores.

Aeronautical activity over our oceans is less frequent, but many direct flights to the East and West operate from our airports directly across our territorial waters and across our search and rescue region. The greatest threat to civil and commercial aviation in context of a marine environment is the danger of an incident leading to a forced landing in the sea. This requires an effective and well-equipped SAR initiative to reduce loss of life.

MARINE ACTIVITIES

The activities taking place within our marine environment can be grouped within each of the six primary maritime zones. The table below provides a summary of major marine-based activities and the zones within which they typically occur. Only civil and commercial (non-military) activities have been listed.

Activity	CO	TW	CZ/MCZ	EEZ	CS	SRR
Commercial fishing	•	•	•	•	•	•
Recreational/Sustenance fishing	•	•	•			
Zirconium and Titanium mining	•					
Commercial shipping	•	•	•	•	•	•
Maritime leisure and recreation	•	•				
Commercial aviation	•	•	•	•	•	•
Recreational aviation	•	•	•	•		
Marine diamond mining		•				
Oceanic cruises		•	•	•	•	•
Oil and Natural gas				•	•	

CO: Coasts *TW: Territorial Waters (12nm)*
CZ/MCZ: Maritime Cultural Zone (24nm) *EEZ: Exclusive Economic Zone (200nm)*
CS: Continental Shelf Zone (~350nm) *SRR: Maritime Search and Rescue Region*

DRONES IN THE MARINE ENVIRONMENT

What is important to take from the preceding sections is that we certainly have a very active marine environment. These days, many terrestrial activities benefit following the introduction of commercial drones, their accessibility and ease of use making them valuable tools to both professionals and recreationalists, alike. In the same way, drones could become valuable force multipliers within the marine environment and be used very effectively in support of marine activities in the following ways.

- **Long Range Maritime SAR:** Searching for people or items at sea - especially across open ocean and hundreds of kilometres from the nearest land - can be tedious, time consuming and potentially dangerous to search crews. Drones can extend the search radii during searches, stay aloft for prolonged time periods, continue searches when weather turns hostile, all whilst reducing exposure time for search and rescue crews to the elements. If so equipped, a search drone could air-drop supplies and even inflatable rafts to located survivors.
- **Coastal SAR:** Small drones can be used to deliver life jackets, small flotation devices or other critical items to persons in distress immediately off-shore. A drone of this calibre could be an essential extension to existing rescue services, including the NSRI and on-shore Life Guards.
- **Coastal and Marine Surveillance:** Drones can be used to assist in the monitoring of the health, pollution state and overall condition of our Marine Protected Areas, national parks, estuaries, coastal wetlands, coastal flora and fauna, marine life and the condition of our coasts in general. Airborne drones can cover large and inaccessible areas with ease, providing real-time imagery to operators and interested parties.
- **Maritime Security:** Drones can be used as force multipliers in the provisioning of surveillance to help combat piracy, marine poaching, illegal fishing and illegal entry. They can also be used to survey and help protect our national ports (coastal "points-of-entry") and other shore-located National Key Points.
- **Commercial Fisheries:** In addition to being a tool to help combat illegal fishing activities, drones can also be used to aid the established and legal commercial fishing industry. They can be used to survey and provide data on the health of fishing populations, monitor breeding trends, the movement and location of shoals and assist with general marine resource monitoring.
- **Recreational Fishing:** Drones can be used by recreational and substance fishermen to locate good fishing grounds, and carry lures and bait to potential fishing spots.
- **EEZ Patrol:** Long range, long endurance drones can be tasked to patrol the EEZ to monitor shipping lanes, survey shipping activities, assist with general EEZ security and monitor resources. Drones operating below cloud cover will not be limited by weather phenomena impeding visual surveillance, some of which may hamper satellite services providing the same type of support.
- **Marine Mining Support:** Drones have been used very effectively in support of terrestrial mining operations, and they could be used in support of marine and coastal mining operations, too. Activities could include general resource management, mine surveying, operations monitoring, security support, transporting of tools, spares and even mined raw materials, and maintenance support.
- **Recreational Photography (Tourism):** As an extension of the tourism industry, many tourists, holiday goers and amateur photographers use drones to take photos and shoot amateur video for personal use or sharing via social media. Coastal tourism accounts for a large percentage of total national tourism revenue and small drones will in all probability remain a firm favourite of tech-savvy holiday-goers – which should be

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supported, as long as enforceable guidelines remain in place to curb reckless use.

- **Professional Photography:** The film and media industry have already started profiting from the benefits offered through the employment of drones for photography and professional videography. Utilising this technology in a marine environment would be no different, and would offer the same benefits, most notably accessibility to remote regions that may be impossible (or too expensive) to reach using normal aviation options. Film, TV, online media, printed media, advertising and real estate will all benefit from this technology, whether it is used over terrestrial regions or in a marine environment.
- **Climate, Weather and Sea State:** The introduction to this article showcased the potentially turbulent marine environment under South African jurisdiction. It could be beneficial to use drones to assist with the monitoring of climatic, oceanic and other marine-related weather phenomena. Data captured by airborne or surface (sea-faring) drones could be vital to track weather patterns, draw trends and predict the formation of potentially dangerous or destructive weather or climatic conditions. Drones could be used to monitor and capture data on sea states, ocean and air temperatures, tides, wave patterns, currents, wind conditions, ice flows, rain and cloud formation, weather patterns, severe weather (including cyclones) and provide assistance during severe weather damage control.
- **Disaster Management:** Drones can be essential tools to assist emergency services and control points in the event of a maritime or coastal disaster. This could include flooding, landslides, cyclone or other wind damage, fires, shipwrecks and aviation accidents at sea.
- **Coastal Populace Monitoring and Economic Development:** Drones could be used to monitor coastal expansion and development of coastal regions, monitor the development of illegal settlements, keep an eye on the condition of essential infrastructure, monitor business development and be used to survey construction projects.
- **Medical Support:** Drones can be used to transfer essential medical supplies and samples to inaccessible coastal regions, as well as between shore-located areas and offshore vessels or remote regions (e.g. Marion Island). Drones could also be used in this capacity to transport medical supplies between ocean-faring vessels (ship-to-ship).
- **Commodities and Logistics:** Drones can be used to carry goods, freight and other items of value to inaccessible coastal regions, as well as between shore-located areas and offshore vessels or remote regions (e.g. Marion Island). Drones could also be used in this capacity to transport items between ocean-faring vessels (ship-to-ship).
- **Wreck Surveillance:** Many hundreds of shipwrecks lie dotted along the Southern African coastline, or lie submerged just offshore. Wrecks could be of national importance (of historic value), requiring constant monitoring for condition, or could simply pose a safety risk if it starts to break apart. Drones could be used to monitor the condition of wrecks.
- **Education:** Drones could be essential tools utilised by education institutions; this is true for terrestrial or marine applications. Drones and drone technologies are seen as important factors within Industry 4.0, which showcases “disruptive technologies” such as robotics, smart sensors, the Internet-of-Things, augmented reality and 3D manufacturing – many of which are prevalent in the world of drones. Educators could tap into this resource and, whether the application is terrestrial or marine, could help stimulate young minds towards novel solutions and ultimately a better world.
- **Marine Research:** Drones (airborne, underwater and sea-faring) could be used by research institutions (including the likes of tertiary education institutions, CSIR, IMT, Fisheries, and environmental-, resource- and energy sectors) to gather vital data for research purposes, specifically from inaccessible marine-based areas. ✈