Near real-time detection of abnormal vessels’ behaviours and vessel sourced pollution in Sri Lanka's maritime zones: An investigation

W K M Mahindapala
Arthur C Clarke Institute for Modern Technologies, Katubedda, Moratuwa, Sri Lanka

mhndpl@yahoo.com

Abstract. The largest ecosystems on Earth are the oceans and it is essential to conserve and sustainably use these vital resources. Waste created by the activities on land and sea, leads to the destruction of the ecosystems. As Sri Lanka is an island in the Indian Ocean, with rights to a vast sea area that extends from the shores, it is mandatory to sustainably manage its marine environment. Regular, systematic reviews of the state of marine environment provide an understanding of the various aspects of marine environment change and the implications for sustainability. Space borne platforms provide Earth observation data collected by different types of sensors, at regular intervals for the management of Earth environment. Earth observation data acquired with Synthetic Aperture Radar (SAR) technology has become useful for the detection of marine pollution during the day and night, regardless of cloud covers. However, availability of near real-time data is important for prompt detection and response. Revisit time of a satellite is an important factor and satellite constellations are used to further improve revisit times, for example, Copernicus Sentinel-1 satellite constellation can provide SAR data with a high revisit time. The research aims to explore the use of near real-time Sentinel-1 SAR data with automated mechanisms, for information extraction that supports early detection of abnormal vessels’ behaviours and vessel sourced pollution in Sri Lanka's maritime zones.

1. Introduction
This study has been motivated by an interest in the detection of vessel sourced pollution in the vast sea area surrounding Sri Lanka; with Earth Observation (EO) Copernicus Sentinel-1 Synthetic Aperture Radar (SAR) data. As distinct from dumping, vessel sourced pollution is caused by navigation and transportation, e.g., oil pollution from tankers [1]. Oil pollution can occur at any time, and therefore, SAR data is useful as SAR on EO satellites can penetrate clouds and collects data during day and at low visibility times (dawn, dusk and night). Automatic identification systems (AIS) facilitate vessel identification via VHF in 30 NM range and, long-range detection of AIS via communication satellites [2]. Therefore, AIS data helps detect vessels that indicate their presence with the AIS. The objective of this study is, investigating the use of near real-time Sentinel-1 SAR data with automated mechanisms, for information extraction that supports early detection of abnormal vessels’ behaviours and vessel sourced oil pollution in Sri Lanka's maritime zones.

2. Recent events
• Cargo vessel accident in Rumassala coast, Galle in the southern sea area on 18 July 2019.
• Oil spill along the western coast between Mt. Lavinia and Wellawatte on 01 June 2019.
• Oil pipeline burst event occurred in the western coast on 8 September 2018.

3. Data, tools and methods for knowledge capture
Search on the Copernicus open access hub for Sentinel -1 SAR GRD data that corresponds with the dates of the above events. Use common Constant False Alarm Rate (CFAR) algorithms to process and analyze the data; and visualize the results by application of different polarizations, for vessels and oil spills detections with the assumptions and the factors of oil spills and oil tankers called on the local ports, e.g., a minimum oil tanker length of 70 m. Table 1 shows the Copernicus Sentinel data, processed by ESA; that was used in this study, as there is no close corresponding data for the events.

Table 1. Details of Sentinel 1 (12-day), 5 m x 20 m ground resolution data.

| Dataset & Type         | Date       | Sensing: HHMMSS (UTC) | Ingestion: HHMMSS (UTC) |
|------------------------|------------|------------------------|-------------------------|
| S1A_IW_GRDH_1SDV       | 2019 July 01 | 00:25:26 – 00:25:52    | 2019 July 03 / 15:55:50 |

4. Results and Discussion
At present, about eight slices of GRDH SAR data cover the land and the contiguous zone (figure 1 (a)), with a time gap of approximately 12 hrs, between descending and ascending passes of the Sentinel 1A. The data was made available about 02 days and 16 hours, after sensing. The Copernicus hub allows concurrent downloads but it is difficult to download more than two slices per day. Demand for data access will go up with the increase of the number of satellites in the constellation. A Sentinel data mirror site linked through a research network helps increase the number of concurrent downloads and speed up data access time. It is possible to automate data processing work flows but data access speed and time, act as bottle-necks. Visualization by combining different information layers, such as maritime boundary, lagoon, coral reef, vessel, oil spill and AIS, in the correct order; supports reduce uncertainty in decision making. Triangles on figure 1 (b) show the ships’ positions on SAR image, and the associated latitude and longitude values can be compared with the values of other systems, e.g., AIS, to provide more details, e.g., vessel type or to indicate exception information. Also, the presence of an oil spill area (figure 1 (c)) close to a vessel might indicate the vessel responsible for the spill.

Figure 1. (a) Maritime zones and Sentinel 1A data slices (b) Black triangles are the detected vessels with latitude and longitude values (c) Unverified spills look-alike (zoomed area marked on (b)).

References
[1] Stephenson M A 1992 UQLawJl 7 123
[2] ITU 2007 Report M.2084-0 (2006) 1