Moggert-Kägeler, Friedhelm; Salaudeen, Idris

StayAway areas

Hydrographische Nachrichten

DOI: 10.23784/HN121-04

StayAway areas

An article by FRIEDHELM MOGGERT-KÄGELER and IDRIS SALAUDEEN

Various grounding incidents have been reported in different parts of the world's oceans within the last decade, and it is totally agreeable that some waters are more prone to grounding incidents than others. Although there may be different factors responsible for the vulnerability of specific areas to groundings, it is nonetheless evident from several investigation reports that depth anomalies and uncharted obstructions are core issues surrounding a lot of recorded grounding incidents – especially in areas where chart information is poor. This article reveals how ChartWorld uses satellite technology to detect shoals underwater towards supplementing chart information and potentially reducing the events of grounding incidents.

satellite observations | grounding incidents | underwater shoals | chart inaccuracies | depth anomalies | SDB
Satellitenbeobachtungen | Grundberührungen | Untiefen | Kartenungenauigkeiten | Tiefenanomalien | SDB

In den letzten zehn Jahren wurden zahlreiche Grundberührungen in verschiedenen Teilen der Weltmeere gemeldet, und es ist unbestritten, dass einige Gewässer für Grundberührungen anfälliger sind als andere. Obwohl es verschiedene Faktoren geben mag, die für die Anfälligkeit bestimmter Gebiete für Grundberührungen verantwortlich sind, geht aus mehreren Untersuchungsberichten hervor, dass Tiefenanomalien und nicht kartierte Hindernisse die Hauptursachen für viele der gemeldeten Grundberührungen sind – vor allem in Gebieten mit unzureichenden Karteninformationen. Dieser Artikel zeigt, wie ChartWorld die Satellitentechnologie zur Erkennung von Untiefen unter Wasser einsetzt, um die Karteninformationen zu ergänzen und die Zahl der Grundberührungen zu verringern.

Authors
Friedhelm Moggert-Kägeler is Solutions Director Maritime Spatial Data at 7Cs GmbH in Hamburg.
Idris Salaudeen studies Hydrography at the HCU in Hamburg.

mo@sevencs.com

1 Background

The StayAway areas project by ChartWorld was first initiated when some members of the ChartWorld group encountered a marine investigation report disclosing how poor position accuracy of charted obstructions had played a certain role in grounding incidents of some vessels.

Ship grounding incidents (foundered/sunk/submerged ships) were reported to be the main cause of total losses in 2020. As high as 2,703 shipping incidents were reported in 2020, among which 49 of them led to total losses within the same period (AGCS 2021; Lloyd's Intelligence 2021).

The South-east Asian region, especially South China, Indochina, Indonesia and the Philippines were reported to be the main hotspots for incidents resulting in total losses globally (Fig. 1). This region accounted for one-third of all the total losses reported in 2020 (16), with incidents up slightly (from 14) in 2019 (AGCS 2021; Lloyd's Intelligence 2021).

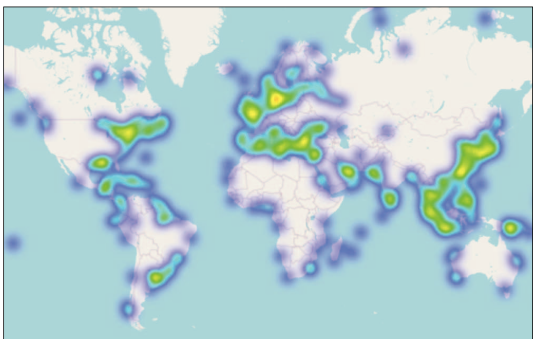

Fig. 1: Heat map showing a global overview of navigation incident hotspots (Gard 2021)

While there could be several other factors responsible for grounding incidents, chart inaccuracies stand out as one of the most prominent factor. This prompted the group's efforts towards developing a solution that resolves the problem.

Our team was curious to discover how satellite-derived bathymetry (SDB) technology, could be instrumental in reducing the risks of the event of grounding incidents in the future, while improving navigation safety for mariners. So, the team decided to investigate the details of two grounding incidents – the container ship *Kea Trader* (2017) and the motor tanker *Pazifik* (2018).

The grounding location of the *Kea Trader* vessel was visualised and reviewed compared to available chart information in ECDIS, and it was stunning to see the extent of the reef that the ship had hit. The reef was nicely depicted (Fig. 2), and it was discovered that the provided data could even be used to chart the surrounding areas of the vessel's grounding location.

Since the investigation delivered great results and gained a lot of traction within the company, it was decided that the team execute a Pilot Project covering a larger area to clear any doubts and solidify possible suppositions.

2 The pilot project

For the pilot project, the team mainly considered the Java Sea area of South-east Asia region – which covers several grounding incidents that have happened in recent times. The team requested a strategic partner, EOMAP, to retrieve and process the relevant satellite data for the considered region, and that the data be further enhanced to reveal all the underwater shoals that were detected from the processed satellite images of the area.

The finished data was then converted into an ECDIS suitable format and attributed accordingly. This allowed the team to load the data in ECDIS for further comparative analysis with official ENCs covering the pilot project area. The finished processed data from initial satellite observations is what is henceforth referred to as the »StayAway area« data.

Basically, the pilot project investigations were tailored towards identifying the following objectives for StayAway data set:

- If the shoals and underwater features detected in the final StayAway data set have an equivalent depiction in the official ENCs, and vice versa.
- If underwater features that have not been charted accurately or not even charted at all can be detected in the StayAway data set.

The findings from the pilot project investigations were summarised into categories and they are outlined in Fig. 3.

The final StayAway data set processed from the satellite data detected a total of 4,724 shoals or shallow areas. Most of the shallow areas were close to the shoreline and were not relevant to navigation. In the ENCs covering the pilot project area 381 shoals were charted. However, only 92 of the ENC charted shoals could be matched to a great extent. The remaining 289 shoals are either slightly misplaced or potentially at another location. These locations are where the uncertainty and risks are to be expected and mariners must be aware that shoals may not have been charted at all.

A projection of the test area results from the pilot project upon global coverage simply implies that there are several thousand detectable shoals out there underwater, that are potentially misplaced or even uncharted in official ENCs available today.

3 The StayAway areas concept: bird's eye analogy

The bird's eye view analogy can be used to simplify the concept of the StayAway areas. The analogy describes a hypothetical situation where the mariner is equipped with an aerial view of the chart domain. This is as though the mariner was looking from above and has bird's eye view of the area to be navigated. This way, the mariner now has a better perception of the location and extent of underwater shoals that could obstruct navigation and can easily make informed decisions to avoid these shoals during route planning or in transit during the voyage (Fig. 4).

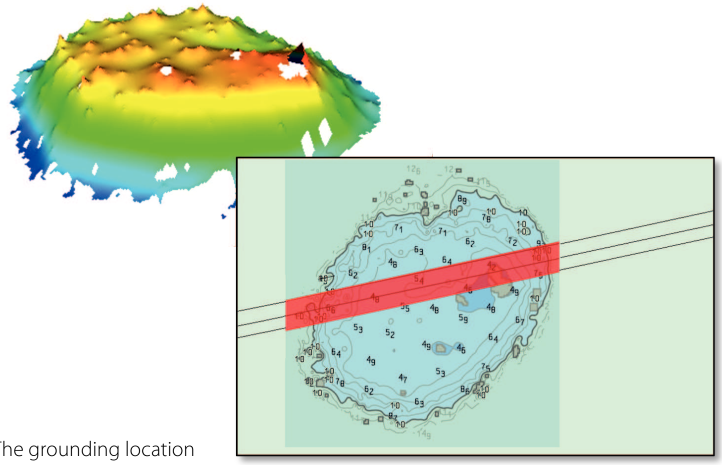

Fig. 2: The grounding location of the *Kea Trader*

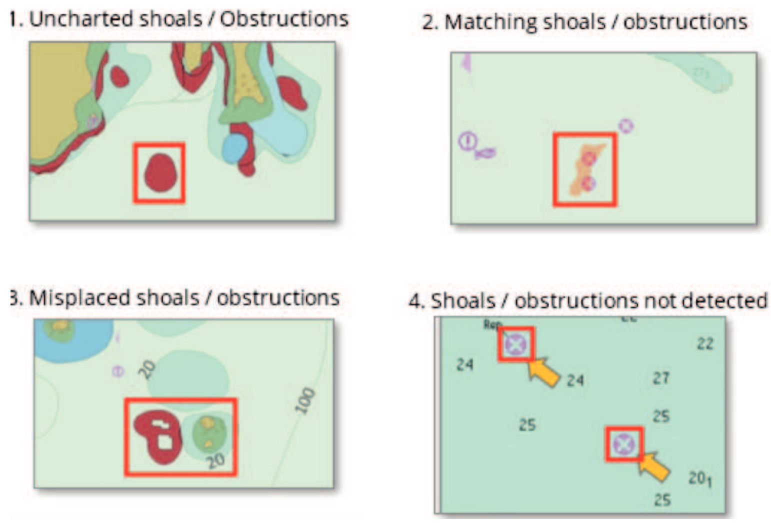

Fig. 3: The findings from the pilot project

Fig. 4: Bird's eye view analogy

An on-voyage simulation of StayAway data overlayed on ENCs in ECDIS is depicted in Fig. 5. The illustration shows the »vessel in motion« while highlighting the vessel's »original heading« as well as its »adjusted heading«. The reddish-coloured features in the illustration represents uncharted shoals that have been detected in StayAway data but are missing or inadequately represented in the ENCs.

As seen in the illustration, the vessel is bound to cross existing shoals (not visible in the ENCs) following the original heading, causing a high risk of grounding. However, StayAway data makes the existing shoals visible in the vessels line of transit, and the mariner becomes aware of the potential dangers (uncharted shoals) existing in the planned route of the vessel and adjusts the vessel route to ensure safe passage.

The StayAway concept is therefore greatly appealing because underwater shoals could be detected from optical satellites in space and could be processed into S-57 compatible user charts. The StayAway user charts can then be overlayed in ECDIS as supplementary information to ENCs, so that mariners have a better sense of the location and extent of underwater shoals that may be missing or inadequately depicted in the ordinary regular charts and can avoid (or »StayAway« from) these potential dangers during route planning or while in transit.

4 Case study reviews

A few selected incidents that occurred prior to the development of the StayAway service were reviewed. These case studies were further evaluated against data sets from the newly developed StayAway service to derive a broader perspective on the reliability of the StayAway data set with respect to previous real-life cases of grounding incidents (https://cio-plus.chartworld.com).

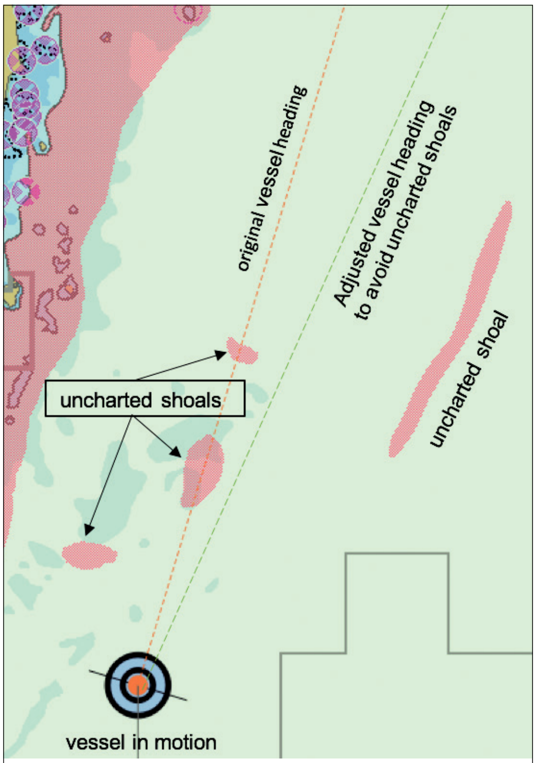

Fig. 5: StayAway overlay depicting uncharted shoals in ECDIS

The results of the case study reviews revealed that the underwater hazards and/or shoals that caused the prior incidents were either uncharted or misplaced in the ENCs, although depicted adequately in the StayAway data set. The underwater hazards that had caused the grounding incidents became visible in their full extents once the StayAway data was loaded into ECDIS and overlayed on the ENCs. In fact, the positions (lat/lon) given in the investigation reports for all the reviewed case study incidents fall within the extents of the shoals detected in the StayAway data set.

Hence, the team came to the conclusions that it is possible to

- locate shoals and underwater rocks based on satellite imagery,
- show the real extent of features rather than showing them as points,
- determine positions of features that are in poor CATZOC areas more precisely,
- make hidden uncharted shoals visible in ECDIS.

While StayAway data set may appear to be a good tool for post incident investigations and analysis, discussions on the possibility of StayAway data being helpful to prevent such incidents from happening in the first place, or even if StayAway data could be used for route planning and ECDIS-alert functions, were questions we aimed to answer reviewing these case studies.

5 Accuracy of SDB

First encounters with SDB data revealed that the degree of vertical and horizontal accuracy differs a lot. Under ideal conditions the accuracy of depth information derived from optical satellite images follows the formula 0.5 m + 0.1 × depth (approximately 2.5 m accuracy at 20 m depth). The horizontal accuracy however is close to image resolution, e.g., 2 m, 5 m, 10 m. Usually in ENCs that use SDB data as source respective areas are encoded with CATZOC C (which is the equivalent of ±500 m position accuracy and ±3 m depth accuracy).

Apparently, the horizontal accuracy of the SDB source data is better than what is usually expected from CATZOC C bathymetry in ENCs. This realisation presented a fantastic opportunity on another unique use case of satellite data. The opportunity that (despite the limited vertical accuracy of SDB data) the data could be developed into an excellent tool for precise localisation of underwater hazards in waters with sufficient clarity.

More interestingly, a full SDB process would not be required for this project, since the goal is to simply detect the location of underwater shoals and portray the extent of these shoals more adequately as compared to how they may appear on an ENC. For this reason, free satellite data is sufficient for use to achieve the project goal without having to run a full blown SDB process. Which in turn, saves costs and efforts, yet produces brilliant results.

The mere knowledge of the existence, location and extent of underwater obstructions – shoals, reefs, rocks (without knowing the exact depth of the obstruction) – is sufficient and valuable information for mariners, to make informed decisions to avoid or »stay away« from the path of the obstruction during transit. This is the unique value that the CIO+ StayAway service offers (CIO: chart information overlay).

6 Setting up the StayAway area service

It is one thing to process optical satellite images and try to detect underwater hazards at known positions (i.e., where vessels grounded) in hindsight. However, it is a completely different thing to set up an earth observation based service that provides information about uncharted underwater hazards and advises mariners to »stay away« from them. For such service to be accepted by mariners for route planning and route monitoring tasks, certain aspects need to be considered.

The pilot project was successful and the project results satisfied intended objectives to detect shoals and underwater obstructions using earth observation methods. A multi-criteria suitability analysis was then developed to determine suitable regions for which StayAway data could be obtained.

Although, the goal is to eventually offer a global service which has a larger coverage beyond the pilot project and provides added value for decision makers within the maritime navigation sector, while also facilitating improved safety of navigation.

However, the choice of current suitable regions for the StayAway areas service was ultimately determined by the following three criteria:

Technical feasibility

These are the several technical factors that affect the end result of satellite-derived bathymetry. Some of these factors concurrently determine the feasibility of the StayAway areas project. The major technical factor considered for this project is water visibility in areas of interest. This is a physical property of water known as turbidity. Turbidity plays an integral role in the detection of underwater features (reefs, shoals, rocks, etc.) using optical satellites.

Areas of good water visibility are more suited for obtaining StayAway data compared to areas of bad water visibility. Simply put – the clearer the water, the better the chances of detecting underwater obstructions for StayAway areas data. Therefore, the solution only works best in regions where the waters are less turbid and clear enough for optical satellites to capture shoals and underwater obstructions.

CATZOC – Category Zone of Confidence

The IHO CATZOC scheme is a guide to mariners on the degree of confidence they should have in the adequacy and accuracy of charted depths and their positions in an Electronic Navigational Chart (IHO 2020). Therefore, the Zone of Confidence (ZOC) assigned for a chart area is a general description of the quality of data for that area, i.e., ZOC areas of any ENC indicates the level of accuracy of the charted depth Information in that ENC.

ENC data quality have been classified into zones (ZOCs) by the IHO based on a combination of these factors – Depth accuracy, Position accuracy and Seafloor coverage. The resulting ZOC classes are:

- high accuracy depth information (ZOC A1 and A2),
- medium accuracy depth information (ZOC B),
- poor accuracy depth information (ZOC C, D and U).

In order to achieve conciseness of results, eliminate redundancy and avoid repetition of already detected underwater features for this project, it only made sense that to leave out areas of high accuracy depth information (ZOC A1 and A2), and rather focus on areas of medium accuracy depth information (ZOC B) and poor accuracy depth information (ZOC C, D and U). Hence, the CATZOC criteria considered for the StayAway areas project was restricted to ZOC B, C, D and U.

Traffic density

The last criteria considered was the amount of marine traffic in the regions of interest. Since the maritime transport sector is of great commercial inclination, and vessels are mainly prone to transit areas of commercial relevance, it is only logical that any service developed for the maritime sector is tailored towards areas of high traffic density. Hence, more focus was placed on regions of significant vessel activities as this is key to the viability of the StayAway areas service. To achieve this, vessel traffic data was used to highlight and determine suitable regions for the StayAway service, giving priority to regions of significant vessel traffic activities.

Based on the considered criteria, the most suitable regions for the StayAway service were determined. However, the team decided to launch with two main regions for a start, after which more regions will be included. The two regions currently consid-

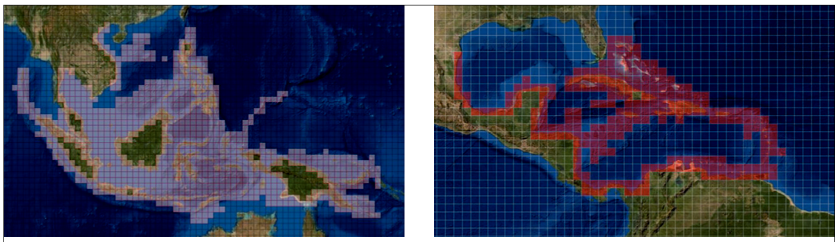

Fig. 6: Southeast Asia (left) and The Caribbean (right)

ered for the StayAway service are: Southeast Asia and The Caribbean (Fig. 6).

7 How does it work?

Vessels have to be registered for the CIO+ service from ChartWorld to receive StayAway overlay information. Registered vessels can send the route of their next voyage to ChartWorld by means of the on-board chart ordering tool or via the voyage planning software ChartWorld provides. Then StayAway area features in the vicinity of the planned route are automatically retrieved from the StayAway area database (Fig. 7) and compiled into an overlay chart. This overlay chart can be made available in various ECDIS user chart formats. Next, the overlay charts are sent back to the vessel and installed on the on-board ECDIS system. Then the tailored StayAway data can be visualised as overlay together with the electronic charts (Fig. 8). In some ECDIS brands even alert and route check functions will respond to StayAway area features.

Conclusion

Satellite imagery is useful to locate shoals and underwater hazards that pose dangers to maritime navigation. The technology is the core driver of the StayAway areas concept. Based on this technology, uncharted shoals can be made visible on ENCs of poor accuracy and inadequate chart information, using StayAway data. In fact, StayAway data does not only make uncharted shoals visible on ECDIS, but it also depicts the real extent and location of underwater features more precisely as compared to how these features may be displayed on ENCs (mostly depicted as point features).

The approach to generating StayAway data is even more convenient and cost effective since it utilises freely available satellite data and does not require running a full SDB process to detect potentially uncharted shoals that may pose dangers to navigation. Hence, StayAway areas is a unique innovative concept that offers added value to mariners to help locate the positions of underwater features more precisely in areas of poor CATZOC ranking on ENCs. This in turn supplements official chart information, improves navigational safety and possibly reduce the occurrence of grounding incidents in the future. //

References

AGCS (2021): Safety and Shipping Review. Allianz Global Corporate & Specialty, www.agcs.allianz.com/news-and-insights/reports/shipping-safety.html

GARD (2021): Incident hot spots – a global overview of navigation incidents. GARD, www.gard.no/web/updates/content/32293819/incident-hot-spots-a-global-overview-of-navigation-incidents-

IHO (2020): Mariners Guide to Accuracy of Depth Information in Electronic Navigational Charts (ENC), S-67. IHO, Monaco

Lloyd's Intelligence (2021): Casualty Statistics – Total losses over the last decade. Lloyd's List, https://lloydslist.maritimeintelligence.informa.com/sectors/casualty

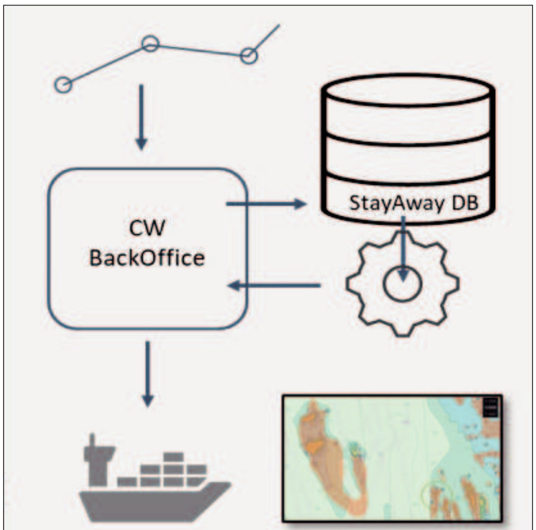

Fig. 7: Process of the StayAway service

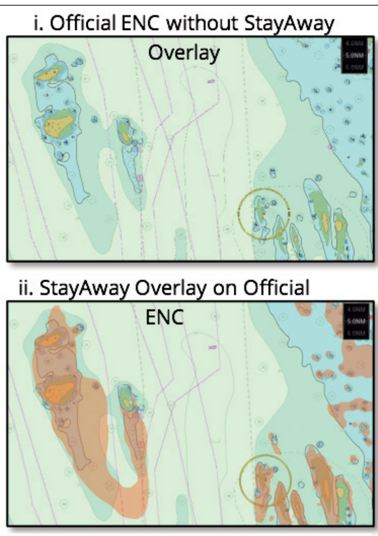

Fig. 8: StayAway data visualised as overlay (bottom)