The complexities of validating sargassum forecasts

Las complejidades de validar los pronósticos de sargazo

La complexité de la validation des prévisions relatives aux sargasses

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EXTENDED ABSTRACT

Eleven years after its initial arrival in 2011, the Caribbean continues to struggle with extraordinary volumes of pelagic sargassum advecting into the region from the North Equatorial Recirculation Region (Chávez et al. 2020; Wang et al. 2019). This phenomenon has resulted in numerous impacts, some positive, most negative. Sargassum itself, is not harmful but in such large quantities can pose a threat to both coastal ecosystems and humans (United Nations Environment Programme 2018). Forecasting sargassum influx events has become essential for supporting management efforts and adaptation to this new climate induced threat by determining the severity of impending sargassum influxes. This is particularly important for tourism and fisheries stakeholders who are negatively impacted by sargassum influx events and for entrepreneurs looking to develop businesses utilizing sargassum who need advanced notice of its arrival. Several forecast models have been developed, but so far they lack quantitative validation. For example, the Centre for Resource Management and Environmental Studies – University of the West Indies (CERMES-UWI) in conjunction with The University of Southern Mississippi provides 3-month sargassum influx forecasts for the Lesser Antilles island chain (https://www.cavehill.uwi.edu/cermes/projects/sargassum/outlook-bulletin.aspx). However, the accuracy of these forecasts remains undocumented. This study provides the first validation of the CERMES sargassum forecast model at the island-level using a full year of ground-truthing data collected at an index monitoring beach on the exposed east coast of Barbados using our standardized SargAdapt Sargassum Monitoring Protocol for beaches (SMP-beach) to monitor the volume of stranding sargassum (Small et al. 2022).

The forecast is initiated by obtaining an open-access seven-day composite AFAI satellite image from the MODIS satellite which is made available through the Optical Oceanography Laboratory of the University of South Florida website (https://optics.marine.usf.edu/). The forecast model is based on 20 years of ocean drifter data including a +0.5% wind addition to better simulate the surface currents that transport sargassum from the satellite-determined locations at sea. Our forecasting

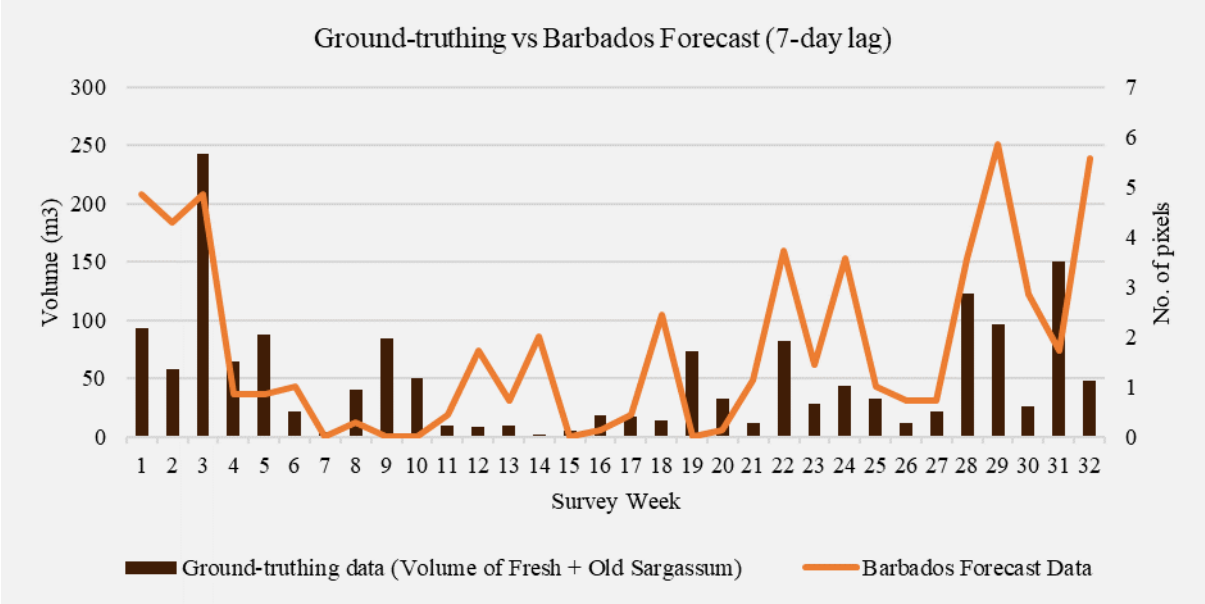

Figure 1. Comparison of the volume of sargassum collected from beach monitoring at the index beach of Barbados over a year and the number of sargassum pixels identified in the forecast model for Barbados lagged by a week.

program identifies sargassum locations (sargassum pixels) within the satellite images and focuses on projected arrivals of each sargassum pixel at northern, middle and southern sectors of the Lesser Antilles island chain (Johnson et al. 2020). The forecasting program predicts the sargassum tracks over 90 days, recording the location and date when each pixel crosses the 60°W meridian into a sector. This provides an index of sargassum abundance for each of the three groups of islands. For this island-level validation, we used only Barbados (centrally located) and an 83 km-long 'finishing line' located at 15.25°W, 20 km off the east coast of the island. The volume of recently stranded sargassum ('fresh gold' and 'old gold' sargassum classes, see Small et al. 2022) was calculated weekly or biweekly for one year from 9 July 2021 using the standardised SMP-beach which monitors a 100m-stretch of beach, measuring the height of freshly stranded sargassum along five transects perpendicular to the waterline. This allows an average height to be calculated which is multiplied by the surface area of beach covered by recently stranded sargassum to provide an accurate estimate of the volume.

For the forecast validation analysis, the forecast data were smoothed using different methods and decimated to match the weekly ground-truth time series. Correlation of the two series with lagging by different time periods produced a best fit when the forecast led ground truth by one week (Figure 1). Linear regression analysis indicated a relatively strong positive correlation between the two (R = 0.493, P = 0.004) meaning the 'peaks' and 'valleys' align fairly well as seen in Figure 1. On the other hand, the R-squared value which is an index of variance, was not very strong (0.243) (Figure 2). This suggests that the forecast is adequately predicting the timing of influx events but less accurate with regard to their amplitude. Moreover, the fact that the best fit was obtained with a one-week lag suggests that the forecast is predicting sargassum influxes one week too early and may therefore require the wind in the current forecast model to be decreased from 0.5% to 0.25%.

This is the first quantitative attempt at validating the Regional Sargassum Outlook Bulletin forecast at the island level. Overall, the forecast adequately predicts the severity of sargassum influxes for the month but less so at higher resolution (daily) predictions. There are many reasons for the mismatch between the forecast and beach monitoring efforts which need to be further assessed. For example, the satellite images only pick up relatively large sargassum rafts; therefore, smaller rafts which are not picked up would not be included in the forecast leading to an underestimation of the volume of sargassum influx predicted to impact countries. On the other hand, all sargassum arriving offshore does not necessarily strand. This is because local currents, wind and waves, which are poorly understood, influence the movement of sargassum from offshore to onshore. As such, the forecast could be overestimating the volume of sargassum influx expected to impact coastlines. Additionally, the current level of monitoring to ground-truth the forecasts is too limited both temporally and spatially. Ideally, beach monitoring should be done every day and multiple beaches should be monitored. Standardized monitoring of stranded sargassum

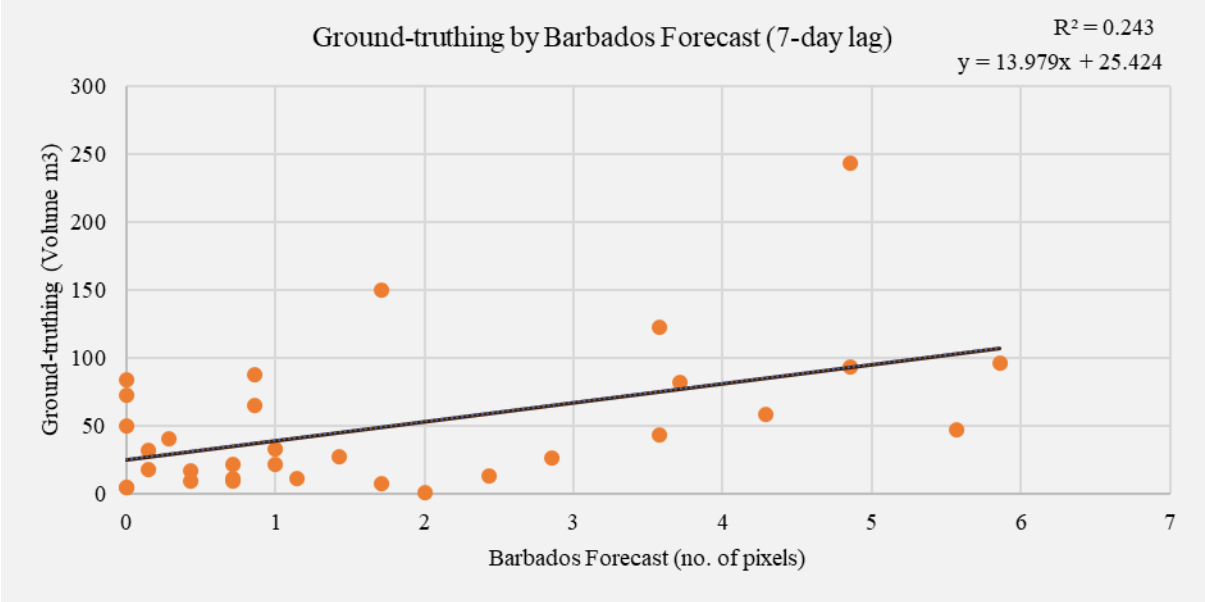

Figure 2. Linear regression results comparing the volume of sargassum collected from beach monitoring at the index beach of Barbados over a year and the number of sargassum pixels identified in the forecast model for Barbados lagged

across more countries in the Lesser Antilles islands needs to be done. In this regard, training of regional stakeholders in the SMP-beach is already underway as part of the SargAdapt and Darwin-Plus projects. The forecast could also be improved by adding growth and mortality parameters to more accurately depict living sargassum as the forecast currently monitors inert pixels of sargassum. Lastly, the amount of 'wind stress' added to the model needs to be refined based on the fact that the forecast appears to be predicting sargassum arrival one week too early. We are working on backtracking with various model wind stresses in order to check the model parameters.

KEYWORDS: sargassum, forecasting, Caribbean, beach monitoring, forecast validation

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