

PHYSICAL CHARACTERISTICS AND OCEAN ACIDIFICATION

Suspended particulate inorganic matter (turbidity)



Scottish Government
Riaghaltas na h-Alba
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Key message

Suspended particulate (inorganic) matter (SPIM) is used as an indicator for seawater clarity, also referred to as turbidity. The highest SPIM concentrations are found in coastal regions with high riverine input e.g. the Solway, Forth and Tay regions; offshore regions have consistently lower SPIM. There is some seasonality with SPIM higher in winter-time.

Background

Seawater clarity is often assessed based on the concentration of suspended particles in the water column, also called turbidity. This suspended particulate material (SPM) includes mineral particles, as well as living and dead plankton. Here, suspended particulate inorganic matter (SPIM), measured by ocean colour satellites from space, is used to summarise the turbidity in Scottish waters.

Increased turbidity of marine waters has the potential to impact the productivity of photosynthetic marine organisms, by reducing the amount of light that passes through the water

column. However, suspended particles may also increase the nutrient concentrations and therefore positively affecting primary producers.

SPIM can be brought from land to sea by freshwater outflows (river or sewage discharge), and can also be re-suspended from the sea bed into the water column by turbulent mixing (from tidal currents and wind). SPIM can also be affected by activities on the sea bed e.g. dredging, trawling and marine construction. Due to these processes, shallow, coastal waters generally have higher SPIM concentrations than deep, offshore regions.



Satellite ocean colour measurements allow for the observation of SPIM on a large spatial scale, but often include some degree of temporal averaging and interpolation to deal with cloud cover. Moreover, algorithms to derive SPIM concentration from satellites are often developed for specific regions and may not yield accurate results in other regions.

The assessment of turbidity was undertaken by Marine Scotland Science, based on data compiled by CEFAS (Centre for Environment, Fisheries and Aquaculture Science) for the [Marine Online Assessment Tool](#).

Results

The 1998-2015 climatological average shows there is a marked difference in SPIM concentration between the north/south and coastal/offshore regions within Scottish waters (Figure 1). Turbidity is highest in the coastal areas with high freshwater input i.e. Solway Firth, Clyde, Argyll and Forth & Tay river plume. The more northerly coastal regions have lower SPIM loads than the southerly regions. The offshore regions have lower SPIM than the coastal regions. Compared to the southern North Sea, the northern North Sea has much lower concentrations of SPIM.

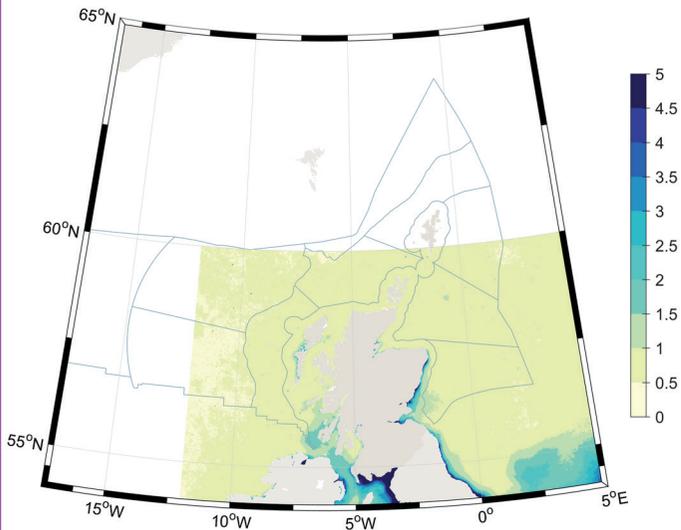


Figure 1:
SPIM concentrations (mg/l) in Scottish waters, climatological average 1998 - 2015

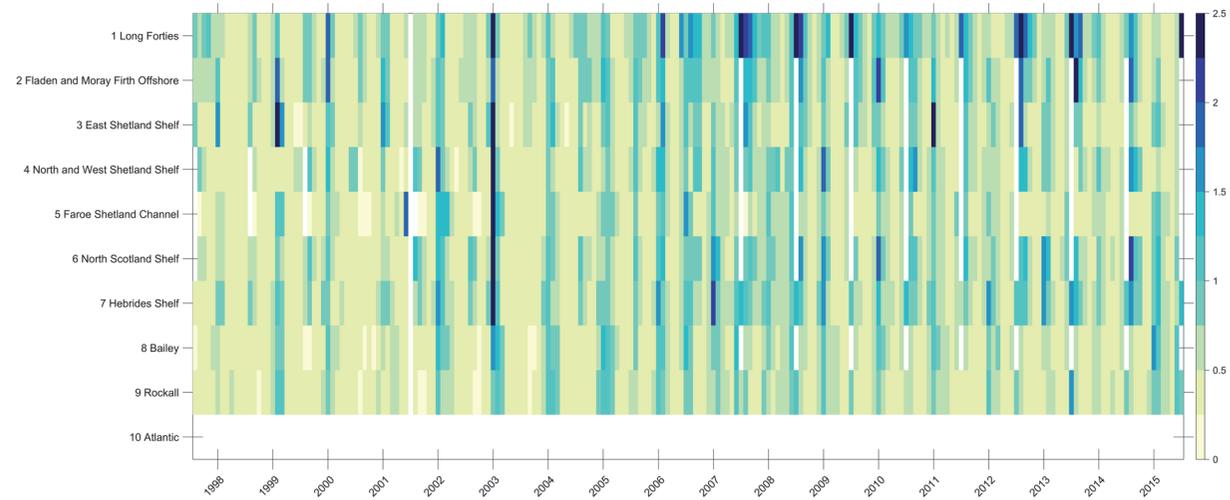


Figure 2:
Monthly average SPIM concentration (mg/l) by OMR 1998-2015

Offshore Marine Regions

Overall the monthly average of SPIM in the OMRs is <1.5 mg/l year round. All regions appear to increase in SPIM in the summer months, highest in June (Figure 2). A winter peak in SPIM is most pronounced in the Long Forties region from 2006 onwards. However, high SPIM in the summer months may be an artefact of the method and algorithm used to estimate SPIM from ocean colour data.

It is not appropriate to assess trends using this data set, due to the poor spatial coverage of some regions. Data for December are missing for 7 out of 10 regions from 2007 onwards (most likely due to cloudiness and winter sun angle reducing observations).

Scottish Marine Regions

In general, SPIM concentrations in the SMRs are higher than in the OMRs (note the colour bar change in Figure 2 and Figure 3). This is due to their general shallower bathymetry and closer proximity to sources of land run-off. The Solway Firth has by far the highest SPIM concentrations, on average between 4 and 6 mg/l (Figure 3) but greater than 20 mg/l during isolated events (potentially linked to high river run off). The high SPIM concentrations in the Solway can last for several months at a time. Relatively high SPIM concentrations (>3mg/l) occur in the Forth & Tay, Clyde, Argyll and North East regions, but to a lesser extent compared to the Solway, in both length of time

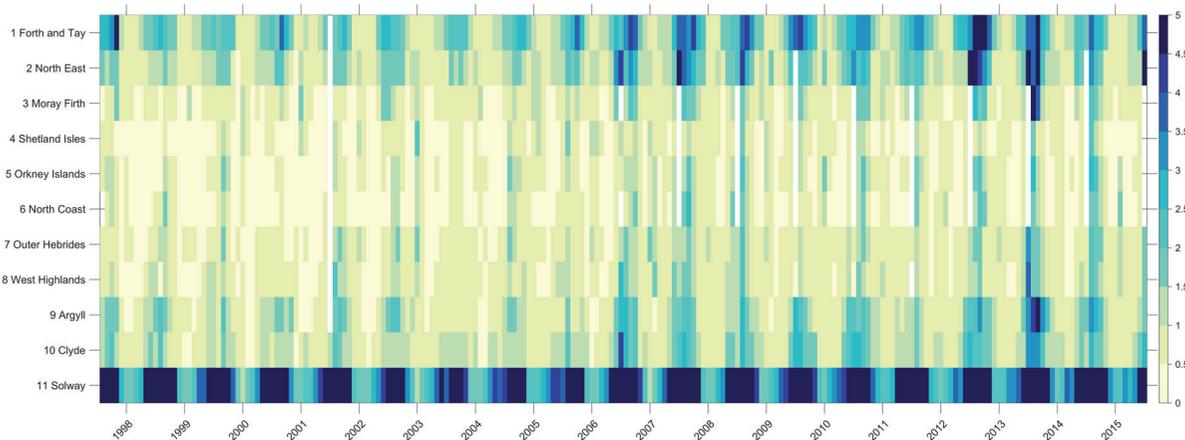


Figure 3:
Monthly average SPIM concentration (mg/l) by SMR 1998-2015

SPIM is high and average SPIM concentration. Highest SPIM occurs in the winter months as more river run off means more sediments are washed down to the sea. Also, stronger winds and waves and storm events act to re-suspend sediment from the shallow coastal waters.

There are missing data for northerly coastal regions in December 2007 onwards.

The high SPIM concentrations in the Solway and Forth & Tay (and to a lesser extent North East) regions are most likely due to the large estuaries in these regions.

Conclusion

The highest SPIM concentrations occur in the coastal regions with high river influx and during the winter months.

In general, most regions have low SPIM concentrations (<3mg/l) on average.

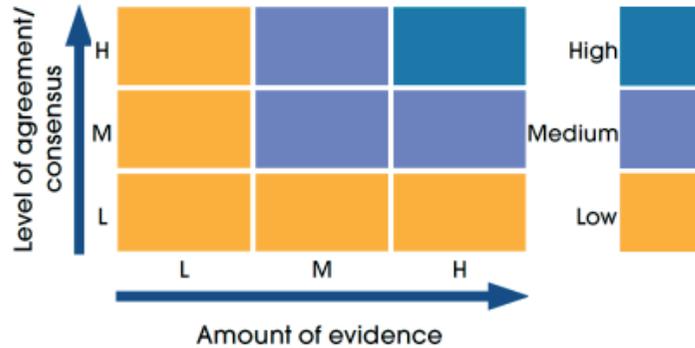
Due to the nature of the observations there is limited confidence in offshore regions, although these are also where SPIM concentrations are lowest.

Knowledge gaps

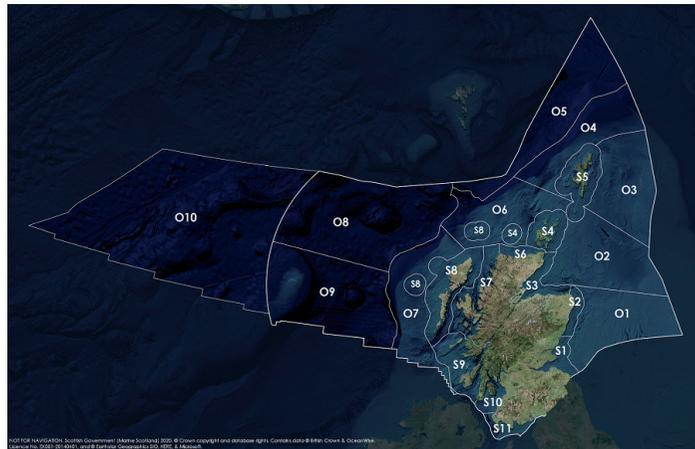
Three main knowledge gaps have been identified:

- lack of ground-truthing of data in Scottish waters for ocean colour algorithm;
- lack of data for offshore marine regions, particularly in the winter months;
- restricted spatial extent of current data set - limited conclusions can be drawn particularly for Hatton, Faroe-Shetland Channel, North & West Shetland Shelf, Shetland and East Shetland Shelf.

Overall confidence



Assessment regions

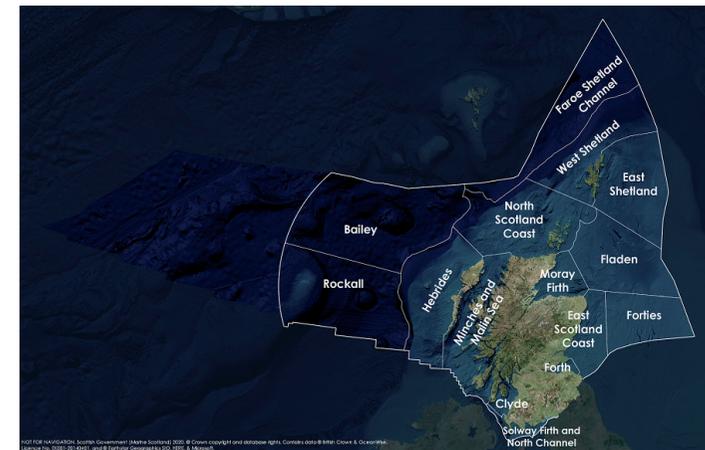


The Scottish Marine Regions (SMRs; S1 - S11) and the Scottish Offshore Marine Regions (OMRs, O1 - O10)

Key: S1, Forth and Tay; S2, North East; S3, Moray Firth; S4 Orkney Islands, S5, Shetland Isles; S6, North Coast; S7, West Highlands; S8, Outer Hebrides; S9, Argyll; S10, Clyde; S11, Solway; O1, Long Forties, O2, Fladen and Moray Firth Offshore; O3, East Shetland Shelf; O4, North and West Shetland Shelf; O5, Faroe-Shetland Channel; O6, North Scotland Shelf; O7, Hebrides Shelf; O8, Bailey; O9, Rockall; O10, Hatton.



Biogeographic, Charting Progress 2 (CP2) Regions. These have been used as the assessment areas for hazardous substances.



Scottish Sea Areas as used in Scotland's Marine Atlas 2011. These are sub divisions of the biogeographic, or Charting Progress 2 (CP2), Regions.