OLCI/MERIS as a Tool for Defining the Riverine Impact on the Coastal Water Quality

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River waters provide the major link between the catchment and the coastal waters. Extensive monitoring of coastal waters is needed to address the requirements of national and international legislation (e.g. EU directives) and to reliably determine the impact of riverine nutrient fluxes on the coastal water quality. We present methods developed for these purposes using MERIS instrument time series, but also directly applicable for the forthcoming Sentinel 3/OLCI instrument data. We examined the relationship between catchment characteristics (based on GIS data), modelled riverine nutrient fluxes, and Earth observations (EO) of turbidity in coastal waters. For defining the influence of land cover to the water quality on estuaries, the combined use of all available data sources, such as automated discharge information, models, EO and GIS data, is important.

The study area is located in the northern Baltic Sea. Data on river discharges was obtained from 23 catchments along the Finnish coast equipped with measurement stations. Turbidity was calculated from images by the MERIS instrument (years 2003-2011, using C2R processor from the BEAM software). EO dataset covers the coastal waters of Finland. To describe the catchment characteristics, statistics of the available land use data of were calculated. The utilized GIS land use data consisted of for instance Corine Land Cover 2006 (CLC2006), shoreline, top soil and field plot register data. Altogether, the catchments (n = 94) varied in their morphometric and land-use characteristics and covered 65% of Finnish territory and 72% of the Finnish catchment area of the Baltic Sea. In addition, the available information from nutrients was included in catchment characteristics. The riverine fluxes of nitrogen (N) and phosphorus (P) [kg/m²/a] were modelled with the so called 'concentration-discharge-model' using quality checked water quality measurements from period 2000–2011. With the purpose of examining the effects of different kinds of catchments on the turbidity values of the receiving sea water, the catchments were divided into classes according to their main land use characteristics.

A multivariate regression was utilized to study the relationship between land use, nutrient fluxes and turbidity on the coastal waters. The outcome was that the statistics calculated from the land use data, such as the percentages of agricultural fields, lakes, rivers and soil complemented with the modelled nutrients showed clear relationship ($r^2 = 0.72$) with the EO turbidity values observed at the estuaries.

We also studied the correlations between the observed automated river discharge data and coastal EO observations of turbidity. The correlations between the two data sources were dependent of the volume of discharge and the size and the characteristics of the catchments.

To identify the influence of river outflow on the coastal water quality, cross-sections starting from the outlet of the catchment and extending to open sea were generated using EO turbidity observations. The cross-sections proved to be useful tools for defining the spreading and impact of riverine nutrient fluxes (Fig 1). Finally, maps describing the impact area of incoming river water to the coastal waters were formed (Fig 2 and Fig 3). These impact maps were calculated using the annual maximum of observed EO turbidity values, separated to four discrete classes. The developed methods, impact maps, transect and correspondences between discharge and coastal turbidity values are currently utilized in the monitoring of coastal waters nearby river sites.
Fig 1. Example of annual median turbidity (MERIS observations) plotted against the distance from catchment outlet.

Fig 2. In this map, the classification based on catchment characteristic is shown together with the impact areas determined from EO turbidity.

Fig 3. Examples of annual impact maps derived from maximum observed turbidity (MERIS).