# SATELLITE MONITORING OF THE NORD STREAM GAS PIPELINE CONSTRUCTION IN THE GULF OF FINLAND IN 2010-2011

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## ABSTRACT

To assess the impact of construction of the Russian section of the Nord Stream gas pipeline on the formation of fields of suspended matter in the eastern Gulf of Finland a daily satellite monitoring was organized in the period from 12 May to 31 December 2010 and from 1 April to 30 November 2011. The objectives of the monitoring included: (1) identification of the spots of turbid waters in the vicinity of the pipeline and in the surrounding waters of the eastern Gulf of Finland, (2) determination of natural areas of suspended matter distribution, (3) separation of the effects of anthropogenic impact on the marine environment and natural processes responsible for an increase in the water turbidity, and (4) monitoring of the transboundary transport of turbid waters.

For this purpose, we used all informative (cloudy free over the pipeline route) satellite images, obtained with the Moderate Resolution Imaging Spectroradiometer (MODIS, spatial resolution 250-1000 m), installed on the satellites Terra and Aqua (NASA, USA), and the Medium Resolution Imaging Spectrometer (MERIS, 260 m) on the Envisat satellite (ESA). Over the years, these devices were widely used to determine the spatial distribution of suspended matter in the ocean and seas, and provided an estimate of their concentration. In addition, the Advanced Synthetic Aperture Radar (ASAR Envisat) was used to determine ice cover and the position of the ice edge in the Gulf of Finland.

Over the entire period of satellite observations only a few cases of local patches of water with high concentration of suspended matter can be attributed to the construction of the pipeline (only in the vicinity of Portovaya Bay), however, its concentration was less than that agreed by the State Environmental Expertise of the Russian Federation. All other detections of turbid waters, crossing the pipeline, were of natural origin (wind-wave mixing, river plumes, transboundary transport, ice). Our conclusions were confirmed by the turbidity maps of Gulf of Finland presented at the web site of the Finnish Environment Institute (SYKE, www.environment.fi/turbidity). Satellite images also confirmed that the natural processes of sediment resuspension in the Gulf of Finland waters have a much larger scale and intensity than the observed effects of pipeline construction. Increased turbidity of water through natural processes can to a thousand times be greater than the anthropogenic impact as a result of pipeline construction.

Transboundary transport of suspended matter is an important factor in increasing the turbidity of water in the vicinity of the pipeline in the Gulf of Finland. Note also that the meso-scale and small-scale vortex structures (eddies, jets and dipoles with a characteristic horizontal scale of 5-30 km) significantly influence the redistribution of

suspended matter in sea water and can advect turbid waters at distances of 50-100 km from the shore.

Comprehensive satellite monitoring of suspended matter distribution and water dynamics in the Gulf of Finland, combined with numerical modelling and analysis of meteo information can distinguish and quantify the effects of anthropogenic impacts and natural processes, as well as to track transboundary transport of turbid waters, which is extremely important when working in close proximity from the sea waters of neighboring countries.