APPLICATION OF SEDIMENT FIGERPRINTING FOR ESTABLISHING SUSPENDED SEDIMENT SOURCES WITHIN THE VELESA RIVER BASIN (WESTERN EUROPEAN RUSSIA)

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INTRODUCTION

Both mechanical and geochemical composition of suspended sediment in a river depend upon relative contribution of different sediment sources within a basin, its temporal and spatial variability. It can be controlled by natural basin characteristics including bedrock and surface geology, topography, active geomorphic processes, hydrometeorological regime, soil and vegetation cover or by human activities within a basin including spatial and temporal patterns of land use and different types of pollution sources (Walling, 2013). Limited availability and highly variable quality of worldwide sediment monitoring data, numerous tracing properties and methods used pose a problem of selecting reliable, robust and convenient approaches for sediment source discrimination (Chalov *et al.*, 2017). Here we present an attempt to use a combination of geochemical, radionuclide and physical sediment fingerprinting approach (Collins *et al.*, 2017) to evaluate sources of suspended sediment for the Velesa River – one of the left tributaries of the Zapadnaya Dvina River within the Russian part of its basin.

STUDY AREA

Our investigations concentrated within the relatively small Velesa River basin (main river length 114 km, basin area 1420 km^2, average annual discharge at mouth 13.4 $m^3 s^{-1}$). It is characterized by low topography range (<50 m) determined by predominance of the Late Pleistocene glacial and glaciofluvial deposits and topography. Underlying bedrock geology is represented by gradual eastward dip of monoclinal beds of Palaeozoic marine deposits (limestones, dolomites, clays, marls). According to the available remote sensing (RS) data, the basin land cover is dominated by mixed and pine forests with huge open peat bogs. Land use is mainly limited to timber harvesting, with small clusters of cultivated lands and pastures along the main roads and settlements. Modern fluvial activity is limited to main river channels and low-density network of gullies. Taking into account this preliminary considerations, the following potential sediment sources have been considered: 1) channel bank erosion (undercut floodplain and terrace banks); 2) tributary channel bed incision; 3) small tributary gullies; 4) cultivated areas; 5) active timber harvesting territories; 6) unpaved road erosion.

METHODS

Fieldwork preparations included analysis of the existing information on geological and geomorphic structure and soil cover of the Velesa River basin, interpretation of the RS data for land use classification and selection of the most appropriate sampling locations. Source and

suspended sediment sampling involved two main stages – mainly following recession of the spring snowmelt floods in May 2017 and 2018 with limited additional sampling between those. In total 29 source samples and 42 sediment samples (21 from main channel bars and 21 from fresh post-flood overbank deposits) were taken in May 2017. At the same time 4 time-integrated suspended sediment samplers were installed in order to collect integral samples over the summer low-water period. Those were extracted in October 2017. The May 2018 sampling campaign involved sampling of freshly deposited spring flood sediment only. There were 7 samples from main channel bars (CBS) and 15 samples from overbank deposits (ODS) found on different floodplain levels taken from various locations along the Velesa River. Additionally, several samples were collected to characterize the easternmost part of the Zapadnaya Dvina basin. Those included 2 CBS and 4 ODS from its other left tributary Mezha (upstream and downstream from the district centre town of Nelidovo, main potential pollution source), 1 CBS and 2 ODS from the Obsha River, main left tributary of Mezha. Except for the 4 time-integrated samplers, at each sampling location 3 subsamples were taken that were packed and labelled separately in order to assess possible local variability. Each subsample was taken with controlled volume (plastic domestic sewage tube closing plug with internal diameter 108 mm and depth 36 mm) except the several cases with very fine overbank deposits layers over a floodplain grass cover where amount of sample taken was 'as much as possible'. In the laboratory samples were oven-dried (105°C), sieved to separate >2 mm fraction and representative subsamples were taken for determination of: 1) mobile forms of selected elements by atomic-absorption spectrometry; 2) total concentration of selected elements by X-ray fluorescence; 3) selected radionuclide activity by gamma-ray spectrometry; 4) particle size by laser diffraction.

CONCLUSIONS

Short-term program of evaluation of suspended sediment origin within the relatively small Velesa River basin will provide valuable information on spatial and temporal variability of contribution of different sources under conditions of limited difference in terms of both bedrock and Quaternary geology, topography and land use. Samples analysis for the 2018 and data processing are still in progress. However, available preliminary results show that floodplain bank erosion and sediment export from small tributaries are the most important sediment sources.

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