Available online at www.sciencedirect.com
ScienceDirect
ELSEVIER
Desalination 226 (2008) 256–261
DESALINATION
www.elsevier.com/locate/desal

Diffuse sources of nitrogen compounds in the Sava river basin, Slovenia

Andreja Drolc[a]*, Jana Zagorc Koncan[b]

[a]National Institute of Chemistry, Hajdrihova 19, SI-1000 Ljubljana, Slovenia
Tel. +386 1 47 60 238; Fax +386 1 47 60 300; email: andreja.drolc@ki.si
[b]University of Ljubljana, Faculty of Chemistry and Chemical Technology, Askerceva 5, SI-1000 Ljubljana, Slovenia

Received 12 December 2006; revised accepted 30 January 2007

Abstract

The enrichment of natural waters by nutrients from different sources has been associated with eutrophication in many Europe river basins. Materials accounting is a multidisciplinary approach to identify precisely the sources of pollution and to assess the most efficient preventive means to avoid these problems. A methodology for the evaluation of nitrogen balance was developed and applied for a case study on the Sava river basin, Slovenia. Total emission of nitrogen into the Sava river basin was estimated to be 18.6 kilotons per year. The results indicate that at present level of treatment and today's agricultural practice, the main sources of nitrogen originate from process wastewater management (62% from point sources and 4% from diffuse sources when compared to the total emission) and agriculture (3% from point sources and 28% from diffuse sources again compared to total emission). Atmospheric deposition contributes relatively in a small percentage of the total loading (3%). The results of the study showed that besides the reduction of point sources by implementing nutrient removal technologies, the management of agricultural pollution should become a major task with the aim to reduce the total load of nitrogen to river system.

Keywords: Diffuse pollution; Nitrogen; Sava river basin

1. Introduction

The significance of eutrophication, which is the enrichment of natural waters by nutrients, primarily nitrogen in marine waters but also phosphorus in low salinity waters, has been associated with increased primary productivity and nuisance algal growth in the coastal zones of a number of Europe's seas [1]. Nitrogen emission causes water quality problems on local scale and eutrophication problems in larger basins and coastal areas [2–5]. The major sources of pollution with nitrogen originate from direct discharges from industry and wastewater treatment plants and

*Corresponding author.

Presented at the 10th IWA International Specialized Conference on Diffuse Pollution and Sustainable Basin Management, Istanbul, Turkey, 18–22 September 2006.

0011-9164/06/$– See front matter
doi:10.1016/j.desal.2007.01.244

also from diffuse (nonpoint) sources of pollution. The main sources of diffuse nitrogen pollution are from agricultural activities and unsewered urban settlement. The significance of diffuse pollution was first recognised in the early 1970s when improvements in wastewater treatment at point sources failed to fully produce anticipated improvements in stream and river water quality. The control of nonpoint sources as compared to point sources is much more complex and difficult in that nonpoint sources involve complex transport and transformation through different media, that is air, soil and water. Pollution from nonpoint sources arises over an extensive land area and is also defined by meteorological events. Compared to traditional point sources, where treatment is the most effective method, abatement of diffuse pollution focuses on land use, good agricultural practices, and surface water management [6].

Many European sea areas have large multinational catchments so rehabilitation of the coastal areas calls for a wide nitrogen emission reduction program, based mainly on river basin borders. The management of transboundary nitrogen pollution issue requires among others understanding of nitrogen balances in catchment areas and countries of the basin, the identification of major quality problems emerging and the evaluation of options for nitrogen emission reductions. Related environmental problems need an efficient tool to identify the main sources of pollution and to design remedial actions.

In accordance with great public concern about nutrient emissions to the environment and consequent eutrophication problems, the European Union (EU) has approved specific directives relating to nitrates and phosphorus in an attempt to control the problem through medium and long-term measures. With the implementation of the European Water Framework Directive, river basin management plans remain the central instrument for achieving the environmental objectives of the framework directive. A river basin management plan includes the identification of significant human pressures and impacts on water bodies and a programme of measures to achieve or maintain its good ecological condition for all European aquatic ecosystems by the year 2015. Due to severe ecological impacts related to eutrophication of rivers, nutrient pollution can be seen as an important human pressure on surface waters, and nitrogen and phosphorus management will surely be of utmost importance for European states in the next decade. Interest is being given to diffuse source nutrient pollution in all EU countries, as most of them have already established treatment facilities for point source pollution in the past years, in accordance with national and EU legislation.

In this paper, the methodology of materials accounting is developed to establish total nitrogen balance and to identify main sources of pollution in a river basin. Application of the methodology for development and evaluation of nitrogen balance is illustrated by means of a case study on the Sava river basin, Slovenia. The study focuses on the development of total nitrogen balance in a selected river basin to qualitatively and quantitatively asses all sources of pollution and pathways to environment. The objective is to get an overview of all sources of pollution in order to identify polluters and to take appropriate action for nitrogen emission reduction.

2. Methodology

Materials accounting is an innovative, multidisciplinary approach to identify precisely the causes for surface and groundwater pollution problems and also the most efficient preventive means to avoid these problems. The methodology has been widely applied to establish nutrient balances [7–10].

A conventional methodology considers only water and is based on the development of an inventory of nutrient related activities in the watershed and estimates of losses to water. This method can lead to emission estimates but is