Sewage water impacts on groundwater and coastal canals in Osaka city; high nutrient and flood impacts

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Water pollution by domestic sewage is one of the critical environmental problems in the early stage of urbanization with significant growth of population. In case of Osaka metropolitan area in Japan, the pollution was significant until 1970s, while it has been improved by the development of sewage treatment systems. However, removal of nitrogen needs the advanced process therefore relatively large part of dissolved inorganic nitrogen (DIN) is usually discharged by treated sewage effluent. Besides, increase of sewage-derived pollutant loads through the combined sewage systems during rainfall events is recognized as a new problem in recent years. However, the impacts of sewage-derived loads on the water environment of river and coastal area have not been fully evaluated in previous studies. In the present research, we aimed to examine the dynamics of sewage-derived nutrients in highly urbanized coastal rivers. Study area is located on the coastal area of Osaka bay in Seto Inland Sea, western Japan. Treated sewage effluent is discharged from three sewage treatment plants (KH, SU and SA) to a river and channels. Water and sediment samples were collected and electric conductivity (EC), chlorophyll-a (Chl.-a) and dissolved oxygen concentration (DO) were measured from the discharging points to few kilometers offshore at 100-300 m intervals. Nutrients (nitrogen, phosphorus and silica), nitrogen and carbon contents and stable isotope ratios (δ^{15}N and δ^{13}C) of particulate organic matter (POM) and sediment, nitrogen and oxygen stable isotope ratios (δ^{15}N and δ^{18}O) in nitrate (NO_3^-) were measured. Nitrate-nitrogen (NO_3^--N) concentration were significantly high near the discharging point then it decreased to offshore suggesting that impact zone of sewage effluent is about 1 km from the discharging point. Significant NO_3^--N uptake by phytoplankton as well as dilution process were suggested in the area. However, the impact zone expanded more than twofold during the rainfall event (>20mm/h). Nutrient contents were significantly high both in the sediment and pore water near the discharging points and it caused relatively high diffusion flux to overlying water. It suggests nutrient regeneration process from the sediment is the secondary loading process in the study area.

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