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Source identification by GIS-based receptor model applied to diffuse water pollution by perfluorinated compounds in Tokyo Bay Basin, Japan

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The worldwide contamination of biota by perfluorinated compounds (PFCs) was reported in 2001. These compounds have been used for 60 years as surface active agents for car wax, carpet, paper, aqueous film-forming foam for fire-fighting, etc.

Among them, perfluorooctane sulfonate (PFOS) is speculated to be highly persistent, bioaccumulative and toxic (PBT) compound. Afterwards, PFOS and its synthetic starting material, perfluorooctyl sulfonyl fluoride (PFOSF), have been designated as persistent organic pollutants (POPs) by the Stockholm Convention on POPs in 2009. Therefore, to efficiently reduce PFC pollution, an understanding of PFC source and its contribution to the pollution is of great interest.

Several studies have reported the widely distributed PFC pollution in aquatic environment, and it makes the identification of PFC sources and the mitigation of PFC pollution difficult. Thus, we developed a GIS-based receptor model for the source identification of the diffuse water pollution by PFCs (Fig. 1).

Major components of the GIS-based receptor model were the collection of monitoring data (receptor data) of PFC pollution and the preparation of the corresponding geographic information that was extracted from a constructed GIS database. Exploratory analysis of the pollution factors was then conducted by multiple linear regression analysis. Spatial distribution of the pollution factors was calculated using the regression model and visually expressed using GIS. Among the 35 types of PFC homologues measured in the survey of the Tokyo Bay basin, 18 homologues were analyzed statistically. The pollution by PFOS was well explained by the ratio of arterial traffic area to basin area, and the 84% variance of measured PFOS concentration was explained by 2 geographic variables (arterial traffic area and population). Source identification by the GIS-based receptor model was shown to be effective, especially for the diffuse pollution, like PFC pollution.
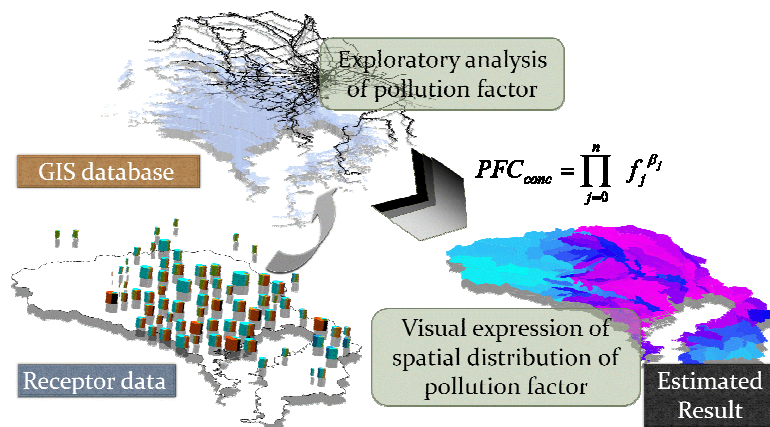

$$PFC_{conc} = \prod_{j=0}^{n} f_j^{\beta_j}$$

Fig. 1 Schematic illustration of the GIS-based receptor model

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