

Necessity of combining geochemical and geomorphic processes addressing pollution problems in the fluvial system of the Ganga Plain, India

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The Ganga Plain is one of the largest alluvial plains of the earth. It is a huge natural laboratory to test a number of hypotheses on sedimentary and geochemical processes of past and present. For several decades, the indiscriminate use of the drainage basin of Ganga Plain for the disposal of domestic and industrial wastes has adversely effected the quality of water, sediments and agricultural soils. The mobilization of various metal pollutants in sediments of this highly dynamic fluvial system is a complex process in which sediment-water movement is extremely variable due to their continuous input from the Himalaya and southern India under changing hydrological conditions (e.g. Monsoon).

The present study was aimed at quantifying the level of geogenic and anthropogenic metal pollutants (Al_2O_3 , Cd, Co, Cr, Cu, Fe_2O_3 , Ni, Pb, Sn, and Zn) in different hydraulic conditions (e.g. Monsoon), and their dispersion and mobilization processes in various eco-compartments (sediment, water and soils) of the fluvial system of the Ganga Plain. This plain has different geomorphic surfaces and features whose role and control on dispersion patterns of metal pollutants in sediments and soils has been demonstrated.

In sediments, about 90 % of the contents of Cd, Cr and Sn, 50–75 % of Cu, Zn and C-org, and 25 % of Co, Ni and Pb; and in soils about 90 % of the contents of Cr and Sn, about 75 % of Cd, and about 25 % of C-org, Cu, Ni, Zn respectively are of anthropogenic origin. Surface and pore water of this area are contaminated with highly toxic organotin compounds i.e. dimethyltin, monobutyltin, dibutyltin and tributyltin compounds.

Five geochemical domains (geochemical terrains) have been delineated on the basis of geomorphology,

sedimentation processes and hydrological characters of the study area (Fig. 1). These domains are independently operating systems and impart their own geochemical characters, i.e. concentrations, transport and mobilization of metals. Each domain contributes its own anthropogenic inputs of metals and their enrichments to the sediments including interelemental correlations.

The role of Monsoon rain on metal concentrations and their transport and accumulation in sediments and soils is discussed. Monsoon rain reduces the contents of Al_2O_3 , C-org, Co, Fe_2O_3 , Ni and Pb and enhances the contents of Cd, Cu, Cr, Sn and Zn in sediments of post-Monsoon period. In soils, it reduces the contents of Al_2O_3 , Co, Fe_2O_3 , MnO and Ni while it enhances the contents of C-org, Cd, Cu, Cr, Pb, Sn, and Zn in post-Monsoon period. Despite the changes in concentrations, metals dispersion patterns in each domain remain same both in pre- and post-Monsoon periods which indicate that the geochemical and sediment-geomorphic processes operating for the metal dispersion and mobilization in sediments are persistent even after large scale sediment-water movement and reworking of the sediments during Monsoon period.

Control of grain size fractions of the sediments in retaining metals are also discussed. Both fine (<20 μm) as well as coarse grain size fractions (>125 μm) of the sediments are characterized by high contents of these metals and organic carbon due to the unusual chemical and mineralogical composition of the sediments. The distribution patterns of the metal concentrations in grain size fractions of the sediments is of parabolic nature in both pre- and post-Monsoon seasons.

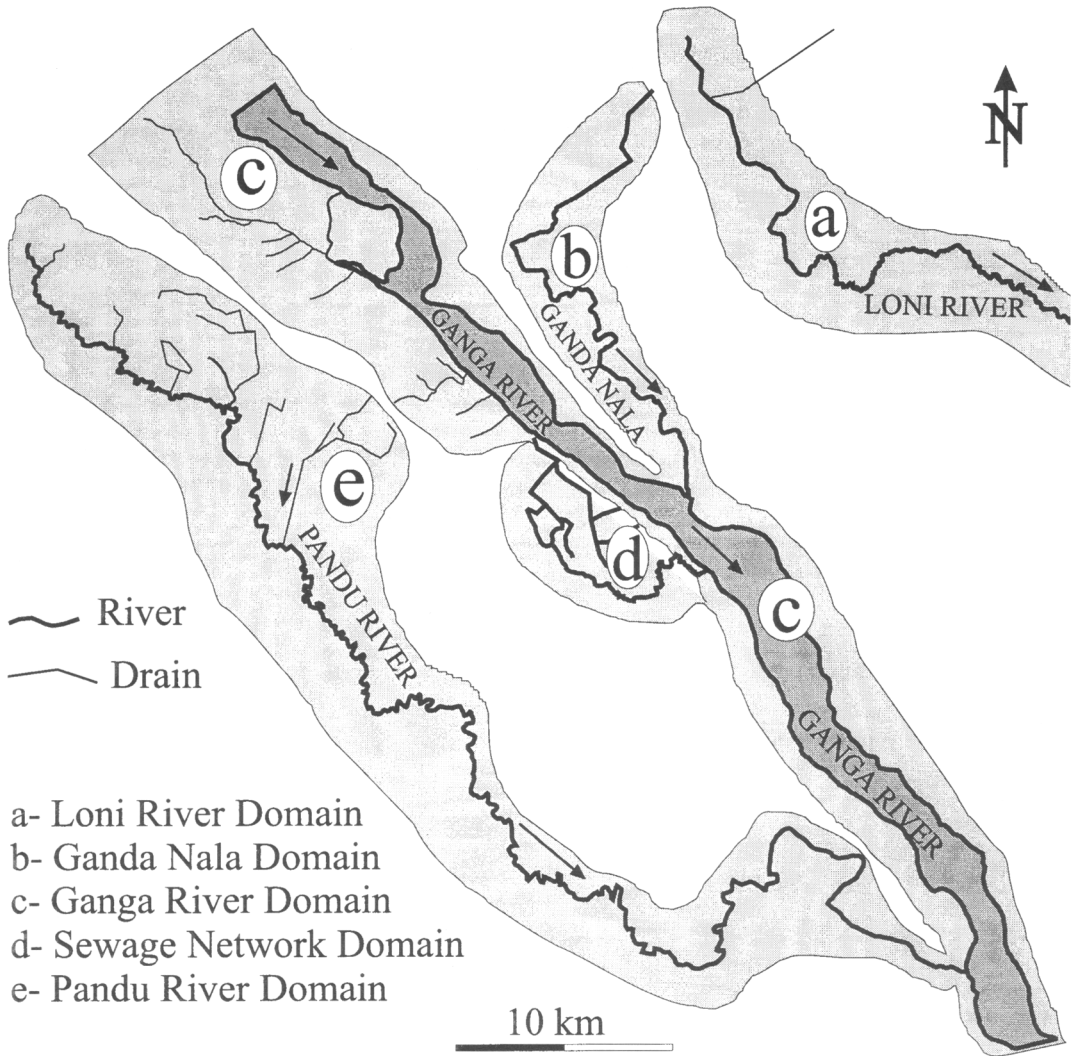


FIG. 1. Demarcation of five independent geochemical domains in the Kanpur-Unnao industrial region of the Ganga Plain, India.

Severe pollution problems in fluvial system of Ganga Plain should not only be evaluated by geochemical processes, but also by elaborating sediment-geomorphic processes which play an important role in metal concentrations and their

dispersion patterns. The present data insist for immediate control measures for the exceptionally severe metal pollution in Kanpur-Unnao region of the Ganga Plain.