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The global biogeochemical cycle of silicon: role of the land-ocean transition and sensitivity to anthropogenic perturbation with a special focus on invasive species

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Silicon, in the form of dissolved silica (DSi), is a key nutrient in marine and continental ecosystems. DSi is taken up by organisms to produce structural elements (e.g., shells and phytoliths) composed of amorphous biogenic silica ($bSiO_2$). Here, we present updated estimates of (1) the reservoir sizes of DSi and $bSiO_2$ on land and in the oceans, (2) the production and dissolution rates of $bSiO_2$ at the earth's surface, (3) the transfer fluxes of DSi and $bSiO_2$ from the continents to the oceans, and (4) the removal of reactive Si by burial in sediments. A steady state model describing the biologically active part of the Si cycle along the land-ocean continuum is then derived for the first time.

Simulations were performed over the next century, starting from an assumed steady state situation in 1950 to assess the effect of three perturbations of the silica cycle. The first two are well demonstrated: the damming of rivers, which enhances the trapping of biogenic silica (BSi) and global temperature rise, which enhances the uptake of dissolved silica (DSi) and BSi dissolution. Simulation results indicate that the building of dams decreases soluble DSi and BSi concentrations along the continuum, while temperature rise leads to a significant increase in DSi and BSi. Combined scenarios show that the effect of damming dominates over short time scales while the effect of temperature rise dominates by the end of the simulations. The last perturbation explored has been suggested more recently (Ragueneau et al., 2005), it deals with the impact of invasive species on Si retention, via increasing biodeposition. A first estimate of the potential importance of this process at global scale is proposed using this simple box model approach.