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A step forward toward the high-resolution assessment of virtual water flows at the company's scale

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Through the international trade of agricultural goods, water resources that are physically used in the country of production are virtually transferred to the country of consumption. Food trade leads to a global redistribution of freshwater resources, thus shaping distant interdependencies among countries. Recent studies have shown how agricultural trade drives an outsourcing of environmental impacts pertaining to depletion and pollution of freshwater resources, and eutrophication of river bodies in distant producer countries. What is less clear is how the final consumer – being an individual, a company, or a community- impacts the water resources of producer countries at a subnational scale. Indeed, the variability of sub-national water footprint (WF in m^3/tonne) due to climate, soil properties, irrigation practices, and fertilizer inputs is generally lost in trade analyses, as most trade data are only available at the country scale. The latest version of the Spatially Explicit Information on Production to Consumption Systems model (SEI-PCS) by Trase provides detailed data on single trade flows (in tonne) along the crop supply chain: from local municipalities- to exporter companies- to importer companies – to the final consumer countries. These data allow us to capitalize on the high-resolution data of agricultural WF available in the literature, in order to quantify the sub-national virtual water flows behind food trade. As a first step, we assess the detailed soybean trade between Brazil and Italy. This assessment is relevant for water management because the global soybean flow reaching Italy may be traced back to 374 municipalities with heterogeneous agricultural practises and water use efficiency. Results show that the largest flow of virtual water from a Brazilian municipality to Italy -3.52e+07 m^3 (3% of the total export flow)- comes from Sorriso in the State of Mato Grosso. Conversely, the highest flow of blue water -1.56e+05 m^3- comes from Jaguarão, in the State of Rio Grande do Sul, located in the Brazilian Pampa. Further, the analysis at the company scale reveals that as many as 37 exporting companies can be identified exchanging to Italy; Bianchini S.A is the largest virtual water trader (1.88 e+08 m^3 of green water and 3,92 e+06 m^3 of blue water), followed by COFCO (1,06 e+08 m^3 of green water and 6.62 m^3 of blue water) and Cargill (6.96 e+07 m^3 of green water and 2.80 e+02 m^3 of blue water). By building the bipartite network of importing companies and municipalities originating the fluxes we are able to efficiently disaggregate the supply chains , providing novel tools to build sustainable water management strategies.