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Supervisor Expression of Interest
MSCA-IF Marie Sklodowska Curie Action-Individual Fellowship 2019

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Department Name: Research topic: (https://www.polimi.it/en/scientific-research/research-at-the-politecnico/departments/)	Dipartimento di Ingegneria Civile ed Ambientale Flow and transport processes in porous media. PE10_17 Hydrology, water and soil pollution PE8_3 Civil engineering, maritime/hydraulic engineering, geotechnics, waste treatment PE3_14 Fluid dynamics (physics) PE6_12 Scientific computing, simulation and modelling tools PE4_18 Environment chemistry
MSCA-IF Research Area Panels	☐ CHE_Chemistry ☐ ECO_Economic Sciences ☐ ENG_Information Science and Engineering X ENV_Environmental and Geosciences ☐ LIF_Life Sciences ☐ MAT_Mathematics ☐ PHY_Physics ☐ SOC_Social Sciences and Humanities
Politecnico di Milano Areas:	☐ Cultural Heritage ☐ Smart Cities X Territorial Fragilities ☐ Health ☐ Industry 4.0
Brief description of the Department and Research Group (including URL if applicable):	The research group has major experience in dealing with a variety of conceptual, analytical, numerical, and field / laboratory studies associated with flow and transport processes subsurface porous media. Key research activities include: probabilistic risk assessment of groundwater systems; feedbacks between conventional and unconventional subsurface energy resources exploitation and groundwater resources; uncertainty quantification; well testing; inverse modeling; flow and multicomponent reactive transport process in heterogeneous media under uncertainty; multiphase flows; statistical scaling of hydrogeological quantities; mixing processes in coastal aquifers; enhanced oil recovery; geothermal fluxes at the

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	reservoir and basin scales. The research group is currently coordinating the WE-NEED project (2016-2019), WatEr NEEDs, Availability, Quality and Sustainability, (ERA-NET Cofund Water Works2014) in which the supervisor is directly involved.

Brief project description: (max 1 page)	**Reactive transport of surfactants and agrochemicals in soils and aquifers** The project will focus on the development of innovative models for the prediction of contaminant transport in soils and shallow groundwater bodies. The research will tackle key challenges posed by the complexity of physical and biogeochemical processes that can influence water and fluid dynamics in agro-ecosystems. To meet the current food demand, the agricultural sector heavily relies on synthetic agrochemicals, which enhance crops and orchards yield. Over the years, agricultural soils have been depleted of fundamental organic matter, which supports healthy soil functioning and high mobility of water and air. At the same time extensive use of agrochemicals is posing a threat for soil and groundwater quality (Paris et al., 2018; Silva et al., 2019). Surfactants are increasingly being used in agriculture worldwide. While surfactants may pose a risk to the environment, they are typically ignored in environmental monitoring programs. Similarly, current bioreactive transport models implemented within the agricultural sector neglect fundamental surfactant-driven effects. Surfactants may affect water flow, biological activity, as well as solutes transport through the soil matrix. For example, by enhancing fluid saturation, surfactants hamper oxygen diffusivity from the atmosphere. This effect, together with a higher oxygen consumption resulting from an increased bacterial activity, may lead to production of greenhouse gases in soils and is therefore affecting the sustainability of agricultural practices (Balaine et al., 2013). To preserve the integrity of critical soil and water resources, research on sustainable solutions is urgently needed. This research proposal copes with the complex network of processes driving agrochemicals transport and biodegradation in soils. In particular, we envision to (1) identify crucial trade-offs within the water-soil-air-food nexus and (2) expand our capabilities to sustainably manage the use of surfactants and other synthetic agrochemicals (e.g., pesticides). We will resort to uncertainty quantification methodologies to assess the robustness and reliability of the model structure and parameterization describing these complex physical and biogeochemical systems (Porta et al., 2018). We envision that the output of this research will be encoded into an innovative Probabilistic Risk Assessment (PRA) protocol. In the context of PRA, multidisciplinary knowledge can be combined. This could have relevant effects on the current agrochemicals regulatory process.

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	References Balaine, N., Clough, T.J., Beare, M.H., Thomas, S.M., Meenken, E.D., Ross, J.G. 2013. Changes in relative gas diffusivity explain soil nitrous oxide flux dynamics. Soil. Sci. Soc. Am. J. p. 10. Paris, P., Pace, E., Presicce, D.P., Maschio, G., Ursino, S., Pacifico, R., Esposito, D., Romoli, D., Bisceglie, S. 2018. Rapporto nazionale pesticidi nelle acque. Dati 2015-2016. Rome, ISPRA. p. 100. Porta G., la Cecilia D., Guadagnini A., Maggi F., 2018, Implications of uncertain biogeochemical parameters on a complex reaction network of atrazine biodegradation in soil, Advances in Water Resources, 121, p. 263-276. Silva V., Mol Hans G.J., Zomer P., Tienstra M.,Ritsema Coen J.,Geissen V., 2019. Pesticide residues in European agricultural soils – A hidden reality unfolded, Science of The Total Environment, 653, pp. 1532-1545.