

Masters project: Pollution spreading in porous media

When a wet portion of the soil gets dry, say after some hours of sunshine following a storm, thin liquid films remain on the surface of the soil grains. These thin films bring an interesting consequence: they can interconnect different parts of the soil, like a whole set of water bridges forming a large network of water streets and avenues. Plant roots can use this network to obtain nutrients from far away, but pollutants can also take a high-speed road to spread quickly in the soil (see figure). In this project, we are interested in understanding the dynamics of the transport of polluted water through a network of thin water films in a porous medium. This is analogous to the scenario in which some polluted water is spilled on the ground and starts to seep through the porous space. We will employ artificial porous samples in our study (either made of glass or 3D printed in a transparent plastic) which allow us to directly track the motion of the pollutant. We have observed that the residual water content in the sample (how wet or dry the soil is) plays a key role in the pollution spreading dynamics. We have found that for intermediate residual water content, the thin liquid films in the sample behave as a network of tiny pumps, which act to spread the pollution very quickly. Once this behavior is properly understood, we believe it will allow us to understand how we can make use of the thin film network for soil remediation measures. The same transport mechanisms that aid the pollution spreading can be tailored to spread a cleaning agent in the soil, to remediate the damage caused by the pollution.

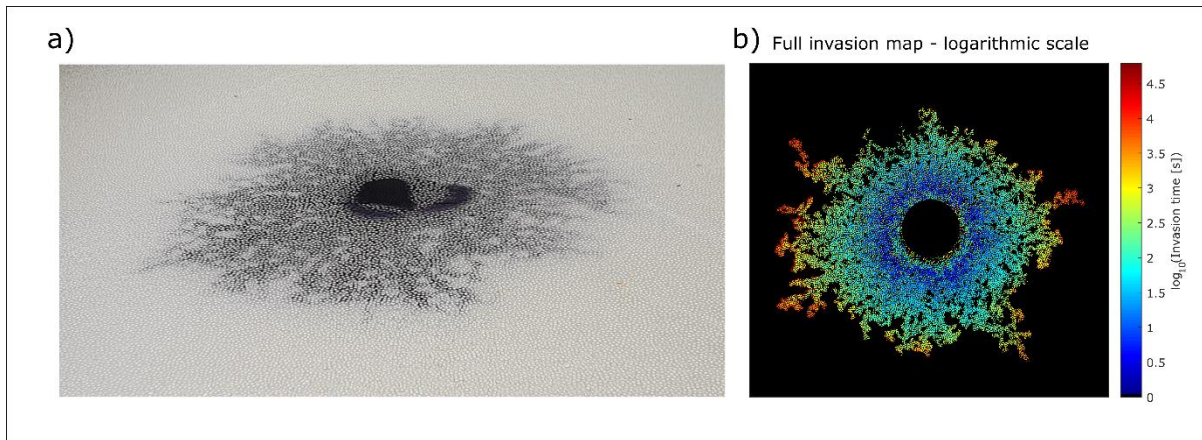


Figure: a) Experiment illustrating how a source of pollution (central dark blob) spreads through a partially wet porous network (here made of glass beads). Water films covering the internal surfaces of the porous medium can act as a fast pathway for the spreading of pollution. b) Spatiotemporal invasion map of a typical experiment. The color code shows the time (in seconds, logarithmic scale) for the pollution to reach a given point in the network.