VRIJE UNIVERSITEIT BRUSSEL

The faculty of Engineering of the Vrije Universiteit Brussel invites you to attend the public defense leading to the degree of

DOCTOR OF ENGINEERING SCIENCES

of **Katoria Lesaalon Lekarkar**

The public defense will take place on **Thursday 10th September 2026 at 4:15pm** in room **D.2.01** (Building D, VUB Main Campus)

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DYNAMICS OF SUBSURFACE WATER IN A CHANGING CLIMATE: A CROSS-SCALE ASSESSMENT OF VADOSE ZONE CONTROLS ON WATER AVAILABILITY AND CLIMATE ADAPTATION IN BELGIUM

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Abstract of the PhD research

In many parts of Belgium, water management has traditionally focused on draining excess water from the landscape. Urbanisation, has further reduced the capacity of some landscapes to store water. As dry periods become longer and more frequent, there is growing emphasis on increasing the sponge function of the soils by giving it time and space to infiltrate, yet the dynamics of water in this critical zone are difficult to monitor.

This dissertation brings this hidden part of the water cycle into view by following water across different scales. It begins with laboratory experiments and field measurements that assess the potential of low-cost soil moisture sensors. The results show that these sensors can track relative changes as soils become wetter or drier, although estimating the actual amount of water requires calibration that accounts for soil properties. The research then expands to the national scale, using hydrological modelling to examine past droughts and future groundwater recharge across Belgium. Model results indicate that soil moisture droughts have occurred more frequently since 2011, while future projections suggest that groundwater recharge may become increasingly concentrated in winter and spring.

Finally, the thesis introduces SPONGE, a hydrological model developed to quantify the hydrological benefits of nature-based landscape water retention measures.

The findings show that the path to climate-resilient water management in Belgium depend on understanding and strengthening the natural water storage function of soils.