DiSTAR Dipartimento di Scienze della Terra, dell'Ambiente e delle Risorse
UNIVERSITÀ DEGLI STUDI DI NAPOLI FEDERICO II
SCUOLA POLITECNICA E DELLE SCIENZE DI BASE

PhD programme in Earth, Environmental and Resources Sciences

Instructor(s)	Pantaleone De Vita, DiSTAR-UNINA
Course Title	Hillslope hydrology for estimating hazard to rainfall-induced shallow landslides
Total Number of Hours	12
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Course Description

The course introduces to rainfall-induced shallow landslides through examples of major events that highlight their widespread occurrence and the related high risk due to the high velocity and destructive power. These landslides depend on the ubiquitous occurrence of ash-fall pyroclastic soils or regolith deposits covering mountain slopes under the effects of heavy rainfall and predisposing soil hydrological conditions. The course provides the fundamental concepts needed to understand the hydrological processes controlling landslide initiation, including water potential and flow in saturated and unsaturated soils, hydraulic properties of porous media, and laboratory and field methods for their assessment. It illustrates slope-scale processes such as infiltration, runoff, percolation, and throughflow. The second part focuses on Landslide Early Warning Systems (LEWSs), covering empirical rainfall-threshold models and physics-based approaches relying on detailed geological and hydrological reconstructions. The course concludes with research results on rainfall-induced shallow landslides occurring in regional geomorphological frameworks of the Campania region.

Course Contents

1. Soil water potential and flow in the unsaturated domain (2 h)
2. Hydraulic properties of porous media in saturated and unsaturated domains (2 h)
3. Slope hydrological processes (2 h)
4. Empirical and physics-based models for the recognition of Landslide Early Warning Systems (LEWS) based on hydrological monitoring (2 h)
5. Rainfall-induced debris flows of the peri-volcanic mountain slopes of Campania region (4 h)

Learning Outcomes

By the end of the course, doctoral students will be able to:

- Understanding of rainfall-induced shallow landslides — ability to recognize their mechanisms, triggering factors, and geomorphological context.
- Knowledge of soil hydrology — comprehension of water potential, unsaturated/saturated flow, and hydraulic properties of porous media.
- Competence in laboratory and field techniques — methods for estimating hydraulic properties and monitoring hydrological conditions.
- Interpretation of empirical rainfall-threshold models (Intensity–Duration, Cumulated Rain–Duration).
- Critical evaluation of landslide early warning systems (LEWS) and their operational use.

Teaching Format

For example: lectures and discussion of scientific papers.

Essential Bibliography

- Lu, N. Godt J.W. (2013). Hillslope Hydrology and Stability. Cambridge University Press
- Selby, M.J. (1993). Hillslope Materials and Processes. Oxford University Press.
- Tufano R., Formetta G., Calcaterra D., De Vita P. (2021). Hydrological control of soil thickness spatial variability on the initiation of rainfall-induced shallow landslides using a three-dimensional model. Landslides. Published online. doi:10.1007/s10346-021-01681-x.
- De Vita P., Fusco F., Tufano R., Cusano D. (2018). Seasonal and event-based hydrological response of ash-fall pyroclastic cover in Campania (southern Italy) for debris flow hazard assessment. Water MDPI, 10(9): 1-23. doi:10.3390/w10091140.
- Fusco F., Allocca V., De Vita P. (2017). Hydro-geomorphological modelling of ash-fall pyroclastic soils for debris flow initiation and groundwater recharge in Campania (southern Italy). Catena, 158: 235–249. doi: 10.1016/j.catena.2017.07.010.
- Napolitano E., Fusco F., Baum R.L., Godt J.W., De Vita P. (2016) - Effect of antecedent-hydrological conditions on rainfall triggering of debris flows in ash-fall pyroclastic mantled slopes of Campania (southern Italy). Landslides, 13, 967-983. doi: 10.1007/s10346-015-0647-5.
- De Vita P., Napolitano E., Godt J.W., Baum R.L. (2013). Deterministic estimation of hydrological thresholds for shallow landslide initiation and slope stability models: case study from the Somma-Vesuvius area of southern Italy. Landslides, 1-16, ISSN: 1612-5118, doi: 10.1007/s10346-012-0348-2.

Assessment Method

Not determined