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Landslide management through the design and implementation of an early warning system

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Within the framework of landslide management, early warning systems (EWSs) are an alternative and cost-effective means to reduce the risk with a low environmental and economical impact. In some cases they can even be the only solution, for instance when a landslide is so large that it cannot possibly be stabilized, when in an area there are too many unstable slopes and there are not enough financial resources to take care of them all individually, or when the residual risk after remediation works is still unacceptable.
An EWS for a rockslide (at Torgiovannetto, Central Italy) has been designed after a period during which monitoring, landslide characterization and the definition of risk scenarios have been carried out. It consists in a 182 000 m3 rock wedge threatening two roads which are important for local transportation. The present work encompasses and describes all the components of the EWS, including the geological knowledge, the risk scenarios, the kinematic characterization of the landslide, the choice and installation of the monitoring system, the setting of appropriate alarm levels, the definition of plans of civil protection and so on. The focus is on practical and logistical issues met in all these phases and the counter-measures adopted.
At present the system consists in 13 wire extensometers, 1 thermometer, 1 rain gauge and 3 cameras, in part connected through a wireless sensor network. Should a velocity threshold be exceeded by two or more sensors, the attention level would be entered, causing improved monitoring and surveillance. In case the behaviour of the landslide changes and, by using expert judgement and forecasting methods, an imminent failure is hinted, then an alarm is issued and the upper road is closed. The EWS has been designed by stressing the importance of redundancy, simplicity, communication and minimizing the probability of false alarms.
Although site-specific, this system can be useful when facing similar situations, in particular because, differently to many other works that focus only on social or technological issues, this one gives importance also to geological and procedural considerations. Therefore some solutions can be widely applicable, even in different contexts.