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Main components and characteristics of landslide early warning systems operational worldwide

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During the last decades the number of victims and economic losses due to natural hazards are dramatically increased worldwide. The reason can be mainly ascribed to climate changes and urbanization in areas exposed at high level of risk. Among the many mitigation measures available for reducing the risk to life related to natural hazards, early warning systems certainly constitute a significant cost-effective option available to the authorities in charge of risk management and governance. The aim is to help and protect populations exposed to natural hazards, reducing fatalities when major events occur.
Landslide is one of the natural hazards addressed by early warning systems. Landslide early warning systems (LEWSs) are mainly composed by the following four components: set-up, correlation laws, decisional algorithm and warning management. Within this framework, the set-up includes all the preliminary actions and choices necessary for designing a LEWS, such as: the area covered by the system, the types of landslides and the monitoring instruments. The monitoring phase provides a series of important information on different variables, considered as triggering factors for landslides, in order to define correlation laws and thresholds. Then, a decisional algorithm is necessary for defining the: number of warning levels to be employed in the system, decision making procedures, and everything else system managers may need for issuing warnings in different warning zones. Finally the warning management is composed by: monitoring and warning strategy; communication strategy; emergency plan and, everything connected to the social sphere.
Among LEWSs operational worldwide, two categories can be defined as a function of the scale of analysis: “local” and “territorial” systems. The scale of analysis influences several actions and aspects connected to the design and employment of the system, such as: the actors involved, the monitoring systems, type of landslide phenomena addressed and variables to be considered for correlations. The characteristics of LEWSs at local scale are strongly affected by numerous constraints and factors, from time to time different, related to the characteristics of the problem they address. Monitoring measures, variables and correlation laws considered for the design and employment of local LEWSs, strongly depends on the type of landslide to be addressed. On the other hand, territorial LEWSs mainly deals with rainfall-induced landslides characterized by fast slope movement. These systems have become a risk management approach, employed worldwide over areas of relevant extension. Before 2005 only few experiences of LEWSs at a regional scale were carried out, such as in: Hong Kong, China; Zhejiang Province, China; San Francisco Bay, California, USA; Appalachians, USA; Oregon, USA; Rio de Janeiro, Brazil. Since the beginning of the XXI century, increased knowledge on rainfall-landslide correlations and upgraded technologies in weather forecast have promoted the development and improvement of territorial LEWSs around the world.