

## **World Centre of Excellence (WCoE) 2017-2020 Progress Report Form 2019**

**1 January 2018 to 31 December 2018**

1. Short Title of WCoE

Methods and tools for landslide forecasting and risk mitigation and adaptation strategies

2. Name of Institution

*Istituto di Ricerca per la Protezione Idrogeologica* (Research Institute for Geo-Hydrological Hazard Protection) of the *Consiglio Nazionale delle Ricerche* (Italian National Research Council)  
| Acronym: CNR IRPI

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3. List of core members

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4. Progress report of activities up to 31 December 2018

Since 2014, CNR IRPI is affiliated to the International Consortium on Landslides (ICL), and contributes to the International Programme on Landslides (IPL). The Institute contributes to the “Landslide teaching tools” initiative, and is leading the IPL project “Towards Improved Landslide Mapping and Forecasting” with the goal of proposing recommendations for the design, implementation and validation of territorial, operational landslide forecasting and early warning systems. On May 2017, at the 4<sup>th</sup> World Landslide Forum in Ljubljana, Slovenia, IPL awarded CNR IRPI the status of World Centre of Excellence on Landslide Disaster Reduction.

In the IPL project “Towards Improved Landslide Mapping and Forecasting”, CNR IRPI executed activities aimed at (i) collecting and analysing information on historical landslides (and floods), (ii) developing criteria and tools for the continuous collection of information on rainfall induced landslides, (iii) testing methods and tools for the analysis of the relationships between rainfall and landslide occurrence, and for the definition of reproducible rainfall thresholds for possible

landslide occurrence, (iv) designing and implementing operational landslide early warning systems (LEWSs), and (v) proposing criteria for the validation of LEWS and their forecasts. Since 2010, CNR IRPI has been developing for the Italian National Department for Civil Protection a national LEWS named SANF, an Italian acronym for *Sistema d'Alertamento Nazionale per la possibile occorrenza di fenomeni Franosi indotti da piogge*. Activities included (i) the design and testing of criteria and tools for the collection of information on rainfall induced landslides in Italy, (ii) the development and testing of methods and tools for the analysis of the relationships between rainfall and landslides (particularly rainfall thresholds), (iii) the implementation of operational procedures for operational landslide forecasting, and (iv) the design and testing of criteria and tools for the validation of the LEWS and its forecasts. The system uses measured and forecasted rainfall, and a synoptic-scale, statistically based landslide susceptibility assessment to provide 24-hour forecasts of probable landslide occurrence that are updated every hour. Efforts are underway to port the system at the regional scale in three Italian regions. A prototype version of the LEWS was deployed for the main Italian Railway company, and a new implementation was started in India, in the framework of the LANDSLIP project (<http://www.landslip.org>).

#### 5. Plan of future activities

Future activities will aim at defining recommendations for the design, the implementation and the validation of operational forecasting and early warning systems for rainfall-induced landslides. New proposals for threshold modelling and critical analyses of existing schemes will be discussed. A review of the existing prototypal and operative LEWSs in the world is in progress, with the aim of evaluating both advantages and drawbacks. The evaluation of the operative and predictive performances of the systems is a crucial point in the definition of an operational LEWS. To move towards the resolution of such issues, an integrated approach between several techniques and tools is required. Future activities of the WCoE will go in this direction. Eventually, guidelines for the development of LEWSs at different operational scales, together with the definition of a common glossary, are planned. Other activities will consist in the evaluation of the expected impact of climate and environmental changes on landslide occurrence, frequency, hazard and risk. Quantitative methods for the regional-scale evaluation of climate impacts on landslides using empirical and physically based approaches will be tested and improved. Finally, CNR IRPI will continue working on the dissemination of information on landslides and their associated risk, with emphasis on the risk to the population, through the “*POpoLazione A RISchio*” (POLARIS) website (<http://polaris.irpi.cnr.it>). The website aims at providing concerned citizens and the media scientifically sound, reliable and updated information on landslide (and flood) risk to the population of Italy.

#### 6. Publications on the topic in 2018

Alvioli M, Melillo M, Guzzetti F, Rossi M, Palazzi E, von Hardenberg J, Brunetti MT, Peruccacci S (2018) Implications of climate change on landslide hazard in Central Italy. *Sci Tot Environ*

630:1528–1543. doi:10.1016/j.scitotenv.2018.02.315

- Gariano SL, Petrucci O, Rianna G, Santini M, Guzzetti F (2018) Impacts of past and future land changes on landslides in southern Italy. *Reg Environ Change* 18:437-449. doi:10.1007/s10113-017-1210-9
- Melillo M, Brunetti MT, Peruccacci S, Gariano SL, Roccati A, Guzzetti F (2018) A tool for the automatic calculation of rainfall thresholds for landslide occurrence *Environ Modell Softw* 105:230-243. doi: 10.1016/j.envsoft.2018.03.024
- Napolitano E, Marchesini I, Salvati P, Donnini M, Bianchi C, Guzzetti F (2018) LAND-deFeND – An innovative database structure for landslides and floods and their consequences. *J Environ Manag* 207:203-218. doi:10.1016/j.jenvman.2017.11.022
- Palladino MR, Viero A, Turconi L, Brunetti MT, Peruccacci S, Melillo M, Luino F, Deganutti AM, Guzzetti F (2018) Rainfall thresholds for the activation of shallow landslides in the Italian Alps: the role of environmental conditioning factors. *Geomorphology* 303:53-67. doi:10.1016/j.geomorph.2017.11.009
- Paranunzio R, Chiarle M, Laio F, Nigrelli G, Turconi L, Luino F (2018) New insights in the relation between climate and slope failures at high-elevation sites. *Theor Appl Climatol*. doi:10.1007/s00704-018-2673-4
- Reichenbach P, Rossi M, Malamud BD, Mihir M, Guzzetti F (2018) A review of statistically-based landslide susceptibility models. *Earth-Sci Rev* 180:60-91, doi: 10.1016/j.earscirev.2018.03.001
- Roccati A, Faccini F, Luino F, Turconi L, Guzzetti F (2018) Rainfall events with shallow landslides in the Entella catchment, Liguria, northern Italy. *Nat Hazards Earth Syst Sci* 18:2367-2386, doi:10.5194/nhess-18-2367-2018
- Rossi M, Marchesini I, Tonelli G, Peruccacci S, Brunetti MT, Luciani S, Ardizzone F, Balducci V, Bianchi C, Cardinali M, Fiorucci F, Mondini AC, Reichenbach P, Salvati P, Santangelo M, Guzzetti F (2018) TXT-tool 2.039-1.1 Italian national early warning system. *Landslide Dynamics: ISDR-ICL Landslide Interactive Teaching Tools*, doi:10.1007/978-3-319-57774-6\_24
- Salvati P, Petrucci O, Rossi M, Bianchi C, Pasqua AA, Guzzetti F (2018) Gender, age and circumstances analysis of flood and landslide fatalities in Italy. *Sci Tot Environ* 610–611:867-879. doi:10.1016/j.scitotenv.2017.08.064
- Samia J, Temme A, Bregt AK, Wallinga J, Stuiver J, Guzzetti F, Ardizzone F, Rossi M (2018) Implementing landslide path dependency in landslide susceptibility modelling. *Landslides* 15:2129-2144, doi:10.1007/s10346-018-1024-y
- Segoni S, Piciullo L, Gariano SL (2018a) A review of the recent literature on rainfall thresholds for landslide occurrence. *Landslides* 15:1483-1501, doi:10.1007/s10346-018-0966-4
- Segoni S, Piciullo L, Gariano SL (2018b) Preface: Landslide early warning systems: monitoring systems, rainfall thresholds, warning models, performance evaluation and risk perception. *Nat Hazards Earth Syst Sci* 18:3179-3186, doi:10.5194/nhess-18-3179-2018