

Date of Submission	<u>December 15th, 2021</u>
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IPL Project Proposal Form 2020

(MAXIMUM: 3 PAGES IN LENGTH)

1. Project Title: Landslide Risk assessment in the High City of Antananarivo

2. Main Project Fields

Select the suitable topics. If no suitable one, you may add new field.

(1) Technology Development

A. Monitoring and Early Warning, Hazard Mapping, Vulnerability and Risk Assessment

(2) Targeted Landslides: Mechanisms and Impacts

A. Catastrophic Landslides, Landslides Threatening Heritage Sites

(3) Capacity Building

Enhancing Human and Institutional Capacities

B. Collating and Disseminating Information/ Knowledge

(4) Mitigation, Preparedness and Recovery

A. Preparedness, Mitigation, C. Recovery

3. Name of Project leader: William Frodella

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Core members of the Project

Names/Affiliations: Veronica Tofani/UNESCO Chair on prevention and sustainable management of geo-hydrological hazards, University of Florence; Daniele Spizzichino/The Italian Institute for Environmental Protection and Research–ISPRA, Rome; Claudio Margottini/UNESCO Chair on prevention and sustainable management of geo-hydrological hazards, University of Florence; Francois Cristofoli/RC-Heritage consultants, Tamara Teissedre-Philip/Paris Region Expertise Madagascar – PRX; (Representative of the *Région Ile-de-France à Madagascar*).

4. Objectives: (5 lines maximum; what you expect to accomplish?)

The focus of the project is to perform a comprehensive landslide risk assessment in the High City of Antananarivo, for both the protection and conservation of the cultural heritage site, and also for suggesting sustainable mitigation measures as a contribution for the site's management plan. Capacity building with locals will be carried out as a first step for training local expertise in landslide assessment and for enhancing resilience and landslide risk perception of the local High City community.

Background Justification: (10 lines maximum)

The High City of Antananarivo, built on a hilltop elevating above the Ikopa river valley, is renowned for its baroque-style palaces and neo-gothic cathedrals dating to the XIX century. For this reason, is one of the most important cultural heritage sites of Madagascar, and since 2016 is part of the UNESCO Tentative List. During the winter of 2015 cyclones hit the urban area of Antananarivo triggering flash floods and

shallow landslides, while between 2018 and 2019, several rockfalls occurred from the hill granite cliffs. All these landslide phenomena caused evacuees, damage to housings and infrastructures as well as several casualties. In this complex geomorphological setting the rapid and often uncontrolled urbanization, and a not proper land use-planning seriously exacerbates slope instability and soil erosion, posing a high risk to the local population, as well as the High City cultural heritage.

5. Study Area: (2 lines maximum; where will the project be conducted/applied?)

The UNESCO Core-Buffer zones of the High City and surrounding natural and urban areas.

6. Project Duration: (1 line maximum)

The expected project duration will be three years.

7. Resources necessary for the Project and their mobilization

The project will involve the UNESCO Chair and the ISPRA personnel, instrumentation, laboratories and software. Paris Region Expertise (PRX) of Madagascar will offer the necessary logistics and connections with the local administrations (e.g., the Antananarivo Municipality), Universities (Higher Polytechnic School of Antananarivo) and actors involved in risk management BNGRC (*Bureau National de Gestion des Risques et des Catastrophes*). RC-Heritage will provide social/economic analysis. The budget of the Project will be financed by an agreement between the UNESCO Chair and PRX Madagascar.

8. Project Description: (30 lines maximum)

The UNESCO Chair on Prevention and Sustainable Management of Geo-Hydrological hazards will collaborate with PRX, the municipality of Antananarivo and BNGRC (*Bureau National de Gestion des Risques et des Catastrophes*) for assessing landslide risk in the High City, and therefore support the nomination of the site for the UNESCO World Heritage List. The first step will be assessing landslide hazard by integrating field surveys, remote sensing data and geotechnical modeling. In detail, the following steps will be carried out: i) creation of a multi-temporal slope-scale landslide inventory; ii) geotechnical characterization of the involved materials; iii) analysis of landslide susceptibility and 2D/3D stability analysis in soils/loose deposits affected by the shallow landslide phenomena; iv) run-out analysis of mud-debris flows; v) landslide kinematic analysis of the unstable rockmass; vi) simulation of rockfall trajectories; vii) assessment of the landslide triggers by analyzing rainfall data. Detailed topographic data and cadastral data will be integrated with the previously mentioned analysis in a GIS platform to produce thematic maps and databases. Therefore, the vulnerability of the exposed elements and related wealth will be evaluated. In this context the use of EO data can give an important contribution in order to assess the growing urban pressure and climate change. Satellite multi- and hyper-spectral data will be applied in a multi-scale methodology for an updated assessment of land cover-use, for highlighting areas prone to erosion/landsliding, for the evaluation of the urban sprawl in the Antananarivo urban area, as well as for the remote classification of the building vulnerability in the UNESCO core zone.

9. Work Plan/Expected Results: (20 lines maximum; work phases and milestones). 10. Deliverables/Time Frame: (10 lines maximum; what and when will you produce?)

The final goal of the Project is to implement a tailored, innovative and sustainable strategy to be shared with the institutions and actors involved in the protection of the High City of Antananarivo and used as

a tool for land-use planning and management, for the detection of conservation criticalities, as well as for improving the site's resilience to geohazards. The use of open-source data, platforms and tools can promote capacity building of local practitioners and end users (to be trained as local experts) and can facilitate the reproducibility of the methodology in other sites characterized by similar geomorphological, social and urban scenarios. Expected outcomes are also the improvement of the site's touristic fruition in order to support the local economy and stimulate a community empowerment approach to sustainable heritage management.

Hereafter a work plan table, including work packages and the related deliverables is reported:

Workpackages (WPs)		Time table	Year 1	Year 2	Year 3
WP1	Tasks	Landslide hazard assessment (field surveying, data collection, geotechnical analysis and modelling, run-out assessment, analysis of rainfall triggers); Capacity building; Project management.			
	Deliverables	Landslide inventories and landslide hazard maps			
WP2	Tasks	Vulnerability and Wealth assessment of exposed elements (field surveys, topographic-cadastral data collection, GIS integration); Capacity building; Project management.			
	Deliverables	Landslide vulnerability maps; definition of the estimated value for each exposed element or cluster of elements at risk.			
WP3	Tasks	Landslide risk assessment and mitigation			
	Deliverables	Thematic maps, Suggestions for mitigation measures			
WP4	Tasks	Capacity building; Project management; Dissemination.			
	Deliverables	Training of local young professional in landslide risk assessment. Project reports. Scientific publications and participation to scientific venues-forums.			

10. Project Beneficiaries: (5 lines maximum; who directly benefits from the work?)

The actors involved in the protection of the High City Cultural Heritage and civil protection activities, such as Paris Region Expertise (PRX) Madagascar, the municipality of Antananarivo and BNGRC (Bureau National de Gestion des Risques et des Catastrophes). The students of Higher Polytechnic School of Antananarivo as well as all the population of the High City will benefit from the project capacity building and landslide risk mitigation activities.

11. References (Optional): (6 lines maximum; i.e. relevant publications)