

IPL Project Proposal Form 2021

(MAXIMUM: 3 PAGES IN LENGTH)

1. Project Title: Landslide Risk assessment in AIUla Archaeological sites – Kingdom of Saudi Arabia
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 Claudio Margottini

Affiliation: UNESCO Chair on prevention and sustainable management of geo-hydrological hazards, University of Florence), Contact: (Via G. la Pira 4, Firenze 50121; Mobile: +39 348 7371805)

Core members of the Project:

Names/Affiliations: Daniele Spizzichino - The Italian Institute for Environmental Protection and Research – ISPRA, Rome, Italy);

José Ignacio Gallego Revilla (Royal Commission of AIUla, Executive Director, Kingdom of Saudi Arabia, Tel. +34651309284 / +966553565026, j.revilla@rcu.gov.sa),

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

The focus of the project is to mitigate the risk from rockfall in the spectacular cultural heritages of AIUla archaeological area (HEGRA, DADAN and AIUla old Town), as well as to rise the awareness against geomorphological processes within the site's management plan. Capacity building with local authority will be carried out as a first step for training local expertise in landslide risk assessment and for enhancing resilience and landslide risk perception of the local Oasis community.

5. Background Justification: (10 lines maximum)

The AIUla heritage site is one of the most important cultural heritages of the whole Saudi Arabia. Located at 1.100 km West from Riyadh, AIUla covers an archaeological area of more than 22.000 mq (2,2 ha), where it is possible to walk in a luxuriant oasis passing by ancient world heritage site through rock cut landscape shaped for thousand years. Its best-known site is Hegra, the first UNESCO World Heritage Site in Saudi Arabia, main southern city of the Nabataean kingdom, and a Roman outpost, that conserves over 130 monumental tombs with elaborated facades carved into the sandstone rock. In

addition to Hegra, AIUla hosts a number of fascinating historical and archaeological sites such as its Old Town, surrounded by an ancient oasis; Dadan, the capital of the Dadan and Lihyan kingdoms, considered one of the most developed cities of the first millennium BC in the Arabian Peninsula. Such sites are mainly rock-cut settlements and then affected by rockfall and weathering/erosion in their evolution and conservation. Evidences of rockfall and potential new collapses are widely spread all over the territory. They may involve both cultural heritages and/or pedestrian paths where visitors are standing by. This is creating a great concern for both conservation of monuments and safeguard of tourists. Volume of blocks span from large size (tens of cubic meters) to minor ones less than a cubic meter, still very dangerous for people/visitors passing very close.

To ensure long-term conservation of sites affected by natural threats, detailed investigations and monitoring techniques, both related to internal parameters (mechanicals and physical) and external agents responsible of their conservation, are required.

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

The project will cover the 130 Nabatean tombs of Hegra, the 1,7 km long cliff of Dadan, where mainly Dadanite tombs are located as well as a huge archaeological quarry, and in the surrounding of AIUla old Town;

7. Project Duration: (1 line maximum)

The expected project duration will be three years.

8. Resources necessary for the Project and their mobilization

The project will involve the UNESCO Chair and the ISPRA personnel, instrumentation, laboratories and software, as well as the contribution of other Italian Universities such as Milano Bicocca, Bologna and Roma "La Sapienza". The Royal Commission of AIUla will offer and host the necessary logistics and connections with the local administrations, as well as archeological support during field survey also by the involvement of different other institution (e.g. AFAIUla). The project is funded by the Royal Commission for AIUla (RCU), with the aim of a safe touristic exploitation of the site.

9. Project Description: (30 lines maximum)

The UNESCO Chair will collaborate with RCU, for assessing landslide risk in AIUla heritage sites. 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 slope-scale landslide inventory for all the selected sites; ii) geotechnical characterization of the involved materials; iii) analysis of landslide hazard and 2D/3D stability analysis in weak rock masses affected by the rock fall phenomena; iv) landslide kinematic analysis of the unstable rock mass; v) simulation of rockfall trajectories. 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 in situ GBR interferometry can give an important contribution in order to assess potential deformation patterns along open wide area, and to guarantee sustainable tourist exploitation.

10. 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 in the Kingdom of Saudi Arabia, to be shared with the institutions and actors involved in the protection of AIUla heritage sites 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. Expected outcomes are also the improvement of the sustainable and safety site’s touristic exploitation in order to support the local economy and stimulate a community empowerment approach to sustainable heritage management.

In the following table a preliminary work plan, including workpackages and the related deliverables is reported:

Time table

Workpackages (WPs)			Year 1	Year 2	Year 3
WP1	Tasks	Field survey and identification of endangered areas in Dadan, Hegra and AIUla Old Town. Landslide hazard assessment (field surveying, data collection, geotechnical analysis and modeling.); TLS acquisition; Definition of a monitoring network. Capacity building; Project management.			
	Deliverables	Landslide hazard maps and general master Plan for mitigation measures;.			
WP2	Tasks	Vulnerability assessment of exposed elements (field surveys, topographic-cadastral data collection, GIS integration); Installation of a monitoring network; Project management.			
	Deliverables	Collection and elaboration of monitoring network.			
WP3	Tasks	Landslide risk assessment and mitigation; Collection of monitoring data; Scaling unstable blocks and preliminary intervention.			
	Deliverables	Thematic maps and design, Suggestions for mitigation measures.			
WP4	Tasks	Consolidation of unstable areas; Project management; Dissemination.			
	Deliverables	Project reports. Scientific publications and participation to scientific venues-forums.			

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

The Royal Commission for AIUla is the main beneficiary of the project, since it is responsible for the conservation and management of the archaeological site. The project is also providing an innovative approach in conservation of rock-cut heritage sites that may be applied in other sites of the region, for the benefit of local restorers and conservators. Local and Governmental authorities will finally benefit from this project, having a site protected for the medium-long term and allowing tourists to visit the area in a safer manner.

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

J.I. Gallego, C. Margottini & D. Spizzichino, D. Boldini, J. K. Abul (2022) Geomorphological processes and rock slope instabilities affecting the AIUla archaeological region. TC301 geotechnical engineering

for the preservation of monuments and historic sites. Naples, June 2022.

Margottini C., Spizzichino D., 2022. Weak rocks in the Mediterranean region and surroundings: Threats and mitigation strategies for selected rock-cut heritage sites, *Engineering Geology*, Volume 297, 106511, ISSN 0013-7952 <https://doi.org/10.1016/j.enggeo.2021.106511>.

Margottini C., Spizzichino D. 2021. Traditional Knowledge and Local Expertise in Landslide Risk Mitigation of World Heritages Sites. In: Sassa K., Mikoš M., Sassa S., Bobrowsky P.T., Takara K., Dang K. (eds) *Understanding and Reducing Landslide Disaster Risk*. WLF 2020. ICL Contribution to Landslide Disaster Risk Reduction. Springer, Cham. https://doi.org/10.1007/978-3-030-60196-6_34;