

There is no bibliography about general research of processes leading to rockfall or about the precursory signs of rockfalls. The sentence I 22 "The evolution of these cliffs and their collapse is well known among the scientific community" has to be proved.

Thank you for your note: we added few more references to better explain our sentence:

- A. Sansò P., Gianfreda F., Leucci G., Mastronuzzi G.: Cliff evolution and late Holocene relative sea level change along the Otranto coast (Salento peninsula, southern Apulia, Italy). *J Geophys Res.* 9-12:42–53, 2016
- B. Adams P.N., Storlazzi C.D., Anderson R.S.: Nearshore wave-induced cyclical flexing of sea cliffs. *J Geophys Res.* 110(F2):F02002, 2005
- C. Stephenson W., Naylor L.: Rock coast geomorphology. *Geomorphology* 114(1–2):1–100, 2010
- D. Sunamura T.: *Geomorphology of rocky coasts.* Wiley & Sons, Chichester, UK; p. 1–314, 1992
- E. Fazio N.L., Perrotti M., Andriani G.F., Mancini F., Rossi P., Castagnetti C., Lollino P.: A new methodological approach to assess the stability of discontinuous rocky cliffs using in-situ survey supported by UAV-based techniques and 3-D finite element model: a case study. *Engineering Geology.* 260:105205, 2019

I 32 : retreat rates should be given

The average retreat rate estimated in the area by means of geomorphological analysis is approximately equal to 0.10-0.15 m/year (see Lollino et al. 2021).

I 37 : what is the evolution?

Thank you: we removed the sub-sentence "*geomorphological evolution and*" for the sake of clarity.

I 38 : what are the fallen volumes?

In the last years, a couple of rockfall events were detected: the first one, occurred in November 2019, involved a rock volume of 300 m³, whereas a second event in December 2020 involved a smaller volume, equal to 15-20 m³.

I 54 : what is the precise frequency?

We have not made explicit the frequencies because we can modify them according to our needs. Currently, videos are taken constantly (24/7) while shots from both webcams are taken every 300 seconds; Raspberry Camera shoots every half hour.

I 66 : "neighboring" : could you be more precise because weather data could be specific to a place.

You are absolutely right: weather station is located at latitude 40°16'02.0"N and longitude 18°16'02.0"E and is at 0 m a.s.l. Its name is "Stazione 491 Melendugno" and it is 14 km as the crow flies from our monitoring site.

I 76: ICC techniques should be developed.

We have made our sentence clearer, modifying line 55/56 from "*This can be achieved either manually or using artificial intelligence techniques (i.e. Image Cross-Correlation - ICC) [...]*" to "*This can be achieved either manually or using artificial intelligence techniques (i.e. Image Change Detection) [...]*" and line 75/76 from "*Based on such information and the application of ICC techniques [...]*" to "*Based on such information and the application of Image Change Detection techniques [...]*".

I 76 : "+- 30%" : how do you calculate the error margin?

We added a reference to explain this and we modified line 76 from “[...] *a volume of the collapse equal to 300 m³ ± 30% was estimated*” to “[...] *we estimated a volume of the collapse equal to 300 m³ ± 30% following the methods described in (Giordan et al. 2020)*”.

- A. Giordan D., Dematteis N., Allasia P., Motta E.: Classification and kinematics of the Planpincieux Glacier break-offs using photographic time-lapse analysis. *Journal of Glaciology*, 66(256), 188-202, 2020

I 94 : the discussion should have perspectives of the results. There is currently very poor.

Thank you for your suggestion; since this is a brief communication we had to be very concise but, for the sake of clarity, we added a sentence on line 106: “*Moreover, despite being a low-cost solution, this system demonstrated a lot of potential, especially in flexibility and adaptability, since it allows to readily estimate the volume of the fallen blocks as well as the evolving failure mechanism of the examined coastal sector and, as such, the potential evolution of the coast retreat. As a consequence, it could be easily applied to the monitoring of different coastal areas subject to rockfalls*”. The potential application of the described monitoring system to detect precursory signs of incipient rockfalls is currently being verified in our test site and will be discussed in a future work.

This brief communication presents an interesting monitoring approach, but the scientific presentation could be more sophisticated in general. A clear description of how the monitoring could be applied for predicting purposes specifically would be of interest to the reader. In some parts, a distinction between promoting and triggering processes could be advantageous.

Thank you for your positive comment. We apologize about the limited scientific discussion presented in the manuscript, but this is related to the limited space available in a brief communication, so we focused on the presentation of the monitoring system and the interpretation of the results recorded so far. However, the monitoring system discussed here is based on the integration of advanced optical systems and traditional crack-meter devices. Currently, such integration of monitoring techniques allows detecting the failure mechanisms active in the study area, the rock volumes involved and the promoting factors which favor such processes. Moreover, it let us derive a quantitative assessment of the evolution of rock displacement trend over time, via the crack-meter measurements, which could be related to specific triggering environmental factors (i.e.: rainfalls, temperature, wave storms...). Therefore, prediction can be mainly pursued by means of the information gained via the crack-meter, although some precursory signs can be identified by means of the optical techniques, but, in the near future, computer-vision techniques applied to the digital images could be also used to derive information on the potential evolution of the rock cliff in near-real time.

A detailed discussion regarding the promoting and triggering factors related to the rockfalls active in the study area is reported in (Lollino et al. 2021). Promoting factors are supposed to be represented by the cliff geometry, the fracturing degree, the geostructural and lithological setup, the rock mechanical properties, whereas the triggering factors can be primarily identified in significant wave storms, but also rainfall events and temperature variations.

I 14 / 16 / 95 : you only use 1 crack-meter

Yes, you are right. We modified the sentences you reported to use the singular. Moreover, we added a sentence at the end of the discussion to underline the reason of our choice of using a single crack meter (*"The choice of using a single strain sensor is only due to the fact that we are experimenting a very low-cost monitoring system; in other cases, this system can be extended with as many crack-meters as needed"*).

I 17 / 29 : the precursor signal is a result of the triggered instability, not the other way round

Thank you for your reporting: we modified both sentences changing "[...] *that may trigger* [...]" with "[...] *that could be triggered by* [...]".

I 24 : subclause needs rearrangement

We modified the sentence: "*Actually, brittle failures frequently occur along these cliffs [...]*" has been changed to "*Along these cliffs, brittle failures are frequent [...]*".

I 32 / 37 / 61 : position of expression of time

Thanks: we moved "*in the last decades*", "*in the last years*" and "*in real time*" at the end of the corresponding phrases.

I 36 : how is brittle failure characterized in rock of low mechanical strength?

Laboratory testing carried out by the authors on rock samples taken from the study area (or of the same typology) has confirmed that even rock of low mechanical strength can exhibit brittle failure (Lollino & Andriani 2017, Perrotti et al. 2020).

- A. Lollino P., Andriani G.F.: Role of Brittle Behaviour of Soft Calcarenes Under Low Confinement: Laboratory Observations and Numerical Investigation. *Rock Mechanics and Rock Engineering* volume 50, pages 1863–1882, <https://link.springer.com/article/10.1007/s00603-017-1188-0>, 2017

I 41f : is there literature on this topic?

Thank you for your note: we added a few more references to better explain our sentence:

- A. Intrieri E., Gigli G., Nocentini M., Lombardi L., Mugnai F., Fidolini F., Casagli N.: Sinkhole monitoring and early warning: An experimental and successful GB-InSAR application. *Geomorphology* 241, 304–314. <https://doi.org/10.1016/j.geomorph.2015.04.018>, 2015
- B. Allasia P., Godone D., Giordan D., Guenzi D., Lollino G.: Advances on Measuring Deep-Seated Ground Deformations Using Robotized Inclinator System. *Sensors*, 20, 3769. <https://doi.org/10.3390/s20133769>, 2020
- C. Herrera G., López-Davalillos J.C.G., Fernández-Merodo J.A., Béjar-Pizarro M., Allasia P., Lollino P., Lollino G., Guzzetti F., Álvarez-Fernández M.I., Manconi A., et al.: The differential slow-moving dynamic of a complex landslide: Multi-sensor monitoring. In *Proceedings of the 4th World Landslide Forum, Ljubljana, Slovenia, 29 May–2 June 2011*

I 54 : what means “regularly analyzed”?

For the sake of clarity, we removed “regularly”.

I 56 : how did you use ICC?

We have made our sentence clearer, modifying line 55/56 from “*This can be achieved either manually or using artificial intelligence techniques (i.e. Image Cross-Correlation - ICC) [...]*” to “*This can be achieved either manually or using artificial intelligence techniques (i.e. Image Change Detection) [...]*” and line 75/76 from “*Based on such information and the application of ICC techniques [...]*” to “*Based on such information and the application of Image Change Detection techniques [...]*”.

I 73 / 84 / 104 : It is to expect that rockfall frequently happens during severe storms and bad weather conditions. How do you deal with that?

You are absolutely right. Currently, we have started the procedures with the local authorities to have the possibility to connect our system to the public power grid but bureaucracy is terribly slowing us.

I 79 : do you mean “anthropogenic”?

Yes, thanks. We modified the wording.

I 83 : how is the opening trend measured by the crack-meter used for predicting an imminent failure?

First of all, we have to say that the data recorded with the crack-meter until now is not sufficient either to derive a clear displacement trend or to predict imminent failures. Moreover, the purpose of our monitoring

system is to obtain an indication of a relationship between the displacement trend measured by the crack-meter and on-going cliff failures, to be related with the information gained from the digital images. In other words, we are using optical images for monitoring rock cliffs where crack-meter measurements represent a sort of validation through conventional devices.

I 96 : "a couple of years" = 2 years

We changed "[...] *a couple of years* [...]" with "[...] *the last two years* [...]", to be clearer.