-Rev2: In the modeling, 70% of the inventory were used as training set and the other 30% as validation set – explain why those values were used.

- Authors Reply: We acknowledge the reviewer doubt. The 70/30 partition was chosen because is in agreement with the commonly used partitions used for landslide susceptibility models training and validation. (as an example please see: https://www.mdpi.com/2220-9964/9/12/696)

-Rev2: L 42 – Classical references as Sunamura (1992) and Trenhaile (1987) are much more meaningful in this context. Other suggestion: Hampton & Griggs (2004).

- Authors Reply: - Done. In the revised version of the manuscript this text section will be rewritten as "These processes result essentially from the interaction of sub-aerial, marine and anthropogenic processes (Trenhaile 1987, Sunamura 1992, Hampton & Griggs 2004, Greenwood & Orford, 2007),"

-Rev2: L 44 – In the reference it is suggested to ad "e.g. Marques, 2009" but also other relevant references as Teixeira (2006, 2014), Moore and Davis (2015), Gilham et al., (2018) among others.

- Authors Reply: - We agree and thank the reviewer suggestion. In the revised version of the manuscript this text section will be rewritten as "the fast dynamic evolution imposes restrictions on the way the human occupy coastal areas (Teixeira 2006; Marques 2009; Teixeira 2014; Moore and Davis 2015; Gilham et al. 2018)"

-Rev2: L 60-62 – The landslide predisposing factors which have been used in published studies are listed along specific cliff factors as the cliff toe protections. This requires some separation, due to the specific context of sea cliffs and also because it was found that the factor is relevant in these studies (Marques et al,. 2011, 2013; Marques, 2018, Guilham et al., 2018, Letortu et al., 2019, Queiroz and Marques, 2019).

- Authors Reply: - We agree and thank the reviewer suggestion. In the revised version of the manuscript this text section will be rewritten as "These factors, although they depend on the scale of analysis and type of landslides, include generally: elevation, slope angle, slope aspect, slope perpendicular and profile curvature, topographic wetness factor index (TWI), topographic position factor index (TPI), slope over area ratio (SOAR), solar radiation, faulting, lithology, lithological layers tilt, precipitation, streams, land-use patterns, NDVI or vegetation density factor, grain size, and spring presence. (e.g. Van Westen et al. 2008, Reichenbach et al. 2018, Pereira et al. 2020) and when specifically related with sea cliffs susceptibility assessment include also the cliff edge height, coastal slope toe protection (e.g. Marques et al,. 2011, 2013; Marques 2018; Guilham et al. 2018; ; Letortu et al. 2019; Queiroz and Marques 2019)."

-Rev2: L 71 – For sea cliff susceptibility, the terrain unit discussion and one solution were presented in Marques et al. (2011, 2013), which were published before Epifâneo et al. (2014).

- Authors Reply: - Done. In the revised version of the manuscript the references will be listed as "(Van Den Eeckhaut *et al.* 2009, Marques *et al*,. 2011, 2013, Epifânio 2014, Corominas *et al.* 2014, Zêzere *et al.* 2017)."

-Rev2: L 95 – The phrase seems out of context.

- Authors Reply: Done. The phrase "The field observations are useful for every type of landslide studies except for small area or single landslide studies (Shano et al 2020)." was removed from the revised version of the manuscript.

-Rev2: There is a lack of clarity on the study area: it is referred in several parts of the paper that study focus on the coastal area, but in Line 107 is stated that the focus is on landslides at the sea cliffs. Later, in lines 113 and 114 and Fig. 1, the coastal subsystems include sandy coast, rocky coast, and anthropic coast. The rocky coast corresponds to sea cliffs or includes sections of low height rocky coast, with no well-defined cliff. It is important to clarify and to use uniform designations along the paper.

- Authors Reply: We acknowledge the reviewer comment. The study area is defined by the sea cliff sectors located along the rocky coast subsystems of the Essaouira coastal area. As recommended, we will clarify and use uniform designations along the revised version of the manuscript.

-Rev2: L 121-129 – Rewrite and clarify the setting of the study area and be more specific on the geological structure et relations with geomorphology.

- Authors Reply: In the revised version of the manuscript this text section will be rewritten as "Geologically, the study area is located in the Atlantic Atlas which is considered the westernmost part of the High Atlas mountains (Weisrock 1980), whose northern part, the largest (Haha and Chiadma) plateau, drop gently from SE to NW, in accordance with the overall structural framework…"

-Rev2: L 130- 166 – The text chaotic and requires clarification, a deep reformulation, and the use of shorter periods.

- Authors Reply: In the revised version of the manuscript this text section will be rewritten as "To the south, a coastal basin with original sedimentary material known as "Haha Basin" (Dufaud et al. 1966), is related to the opening of the North Atlantic, which is generally consistent with the end of the Triassic (Choubert et al, 1971; Hallam, 1971; Le Pichón, 1971, Weisrock 1980). It consists mainly by sandstones, pelites, conglomerates, and red salt clays, with essentially continental facies.From the Lower Liassic to Upper Cretaceous succeed more or less deep marine sedimentations."

-Rev2: L 143 – extensional instead of distensional; NNE-SW ??? correct.

- Authors Reply: - We thank the reviewer observation. We change it to ", includes the extensional faults fundamentally oriented NNE-SSW"

-Rev2: L 144 – What is the second direction – only one was indicated above.

- Authors Reply: The other one is linked to the opening of Atlantic. The text was modified to turn clear this question. We change it to "the second direction, WNW-ESE, related to the opening of the Atlantic, is more and more evident…"

-Rev2: The rainfall data would be better expressed with the inclusion of graphs instead of descriptive and incomplete data.

- Authors Reply: We think there is no need to add graphs. We tried to improve the description and we consider that in this revised version is clear enough taking into consideration the contribution of this factor in this study.

-Rev2: L 216 – 231 – The hydrogeological information is relevant for the sea cliffs evolution?

- Authors Reply: We think it is relevant especially in the southern part, we explained some links between hydrogeological description and the lithological information collected on springs as a possible driver: "… the presence of springs, we localized 9 springs, 4 of them concentrated around Timzeguida Oufettas village which has locally a visible impact on landslides occurrence especially considering the presence of marls, which are becoming more sliding in contact with the water. Other springs are located in the southern part except one in the north between Bhaybeh beach and Sidi Ishak village. There are considerably affect the mechanical processes that lead to slope failure and the subsequent movements of landslide in the post-failure phase, especially where we have marls or clays."

-Rev2: L 246 - 247 – What was the threshold percentage of unstable area in each terrain unit to be considered unstable.

- Authors Reply: We considered the presence or absence of landslides, each terrain unit contain a polygon of a landslide is considered unstable.

-Rev2: The aerial photographs and satellite images area coverage for the landslides inventory construction should be included in table 1. This is important because any inventory is incomplete by its own nature and depends heavily on the database available. It is also important to clarify that the inventory is of the historical type, with no past date of occurrence limits, and it is also useful to point out its limitations.

- Authors Reply: The aerial photographs and satellite images area cover all the study area and data sources used will be included in Table 1 as suggested. Regarding the question if the inventory is of the historical type, is not. We used mostly recent images to map the landslides. Nevertheless, we consider that for larger deep-seated landslides the inventory is quite complete, since landslide features associated to these landslides tend to remain for long time in the landscape. For shallow and smaller landslides, we assume some uncertainty on the number of landslides mapped, even so, the fact that cliffs are not explored for agriculture and the driest climate could also allow the maintenance of these landslides features on the landscape for a significant time from occurrence, given that way more consistency to the landslide inventory.

Table 1 will be reformulated as exemplified bellow.

Table 1: Data sources Table

Data type	Data denomination	Source	Scale / resolution / Duration
Topographic maps	Sidi Ishaq 2008	National Agency of Land Conservation, Cadastre and Cartography (ANCFCC)	1/25000
	Berrakat Erradi 2008		
	Sebt Akermoud 2008		
	Bir Kaouat 2008		
	Moulay Bouzarqtoune 2008		
	Jbel lahdid 2008		
	Essaouira 2008		
	Chicht 2008		
	Ras Sim 2008		
	Essaouira El Jadida 2008		
	Sidi Kaouki 2008		
	Tidzi 2008		
	Sidi Ahmed Essayeh 2009		
	Tafdna 2009		
Geological maps	Tamanar map		1/100000

	Taghazout map	Ministry of Energy and Mines, Water and Sustainable Development	1/100000
	Marrakech map		1/500000
Aerial photographs	Mission TAMANAR 07/2016	National Agency of Land Conservation, Cadastre and Cartography (ANCFCC)	1/7500
Meteorogical data	Adamna station	Hydraulic basin agency of Tensift (ABHT)	1977-2015
	Igrounzar station		1968-2015
	Talmest station		1984-2015
	Chichaoua station		1965-2014
	Abadla station		1969-2014
Satellite images	Sentinel	https://scihub.copernicus.eu/ (Copernicus 2021)	10 m
	High resolution Ortho-imagery	https://earthexplorer.usgs.gov/ (USGS-EROS 2018)	0.3 m
	Digital elevation model	https://search.asf.alaska.edu/ (JAXA/METI 2020)	12.5 m

-Rev2: L 295 – 296 – phrase seems incomplete.

- Authors Reply: Done; it’s only because of comma instead of point. The phrase will be replaced by “obtained at the weather stations and projecting them using the Inverse Distance Weighting (IDW) interpolation. While field survey, topographic maps (1:10,000) and DEM were used for identify and map the stream networks.”

-Rev2: Table 2 – Replace “limstone” by limestone.

- Authors Reply: - Done

-Rev2: L 312 – The references deserve improvement: Lee and Pradhan (2007), Shahabi et al. (2014), Wang et al. (2016) studied sea cliffs? Proper references include Marques et al, 2011, 2013; Epifâneo et al., 2013, 2014.

- Authors Reply: We thank the reviewer observation. The references list will be like this “This method was successfully applied to coastal areas worldwide (Marques et al, 2011, 2013; Epifâneo et al., 2013, 2014).”

-Rev2: Figure 5 – Replace the pie plots by bar or column plots.

- Authors Reply: We believe that, by a typo, the reviewer is referring to figure 4 and not figure 5. The pie plots are in figure 4 and not figure 5. Yes, we can replace them by bar or column plots.

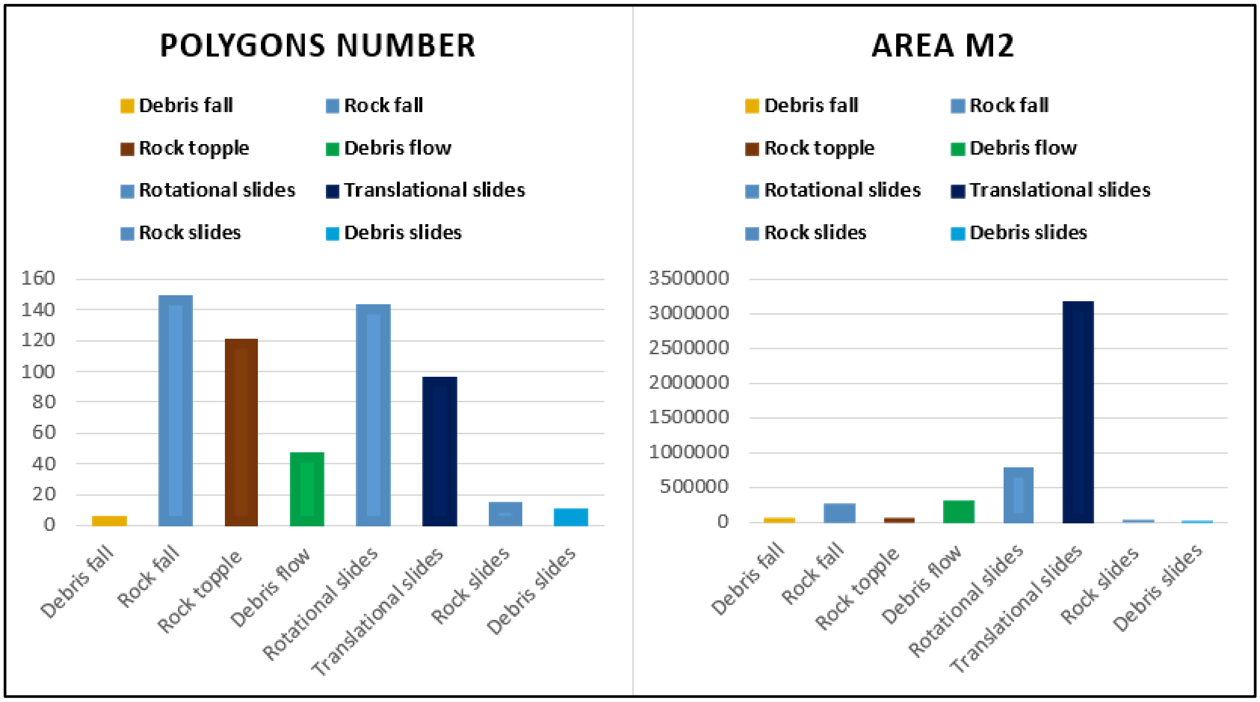

Figure 4: The relative distribution of landslides by type and area in the ETU of the study area

-Rev2: L 417 – What is "limestone barre"? Clarify.

- Authors Reply: It is a cretaceous formation with limestone, looks like a continuous barre (band or visible layer) in the cliff area.

-Rev2: L 528 – Clarify "the respective average of the unstable area, are located more to the souths of study area."

- Authors Reply: - Done. This phrase in the new version of the manuscript will be placed as "The approach was done individually for each type of landslide studied, and shows that, for all type of landslides, the unstable areas (classified as non-stabilized) are located more to the south units of study area."

-Rev2: Although involves some additional work, it would be useful to have the AUC of the ROC curve of each individual factor, at least for all types of movements, to enable the assessment of the more important susceptibility predisposing factors, which could be improved in further studies, in order to obtain better models.

- Authors Reply: We agree with the reviewer suggestion and in the revised version of the manuscript we could include the AUC of the ROC curve of each individual factor, at least for the model with all types of movements, in order to assess the more important susceptibility predisposing factors for instability.

-Rev2: One other aspect to address is the validation method: using one part of the inventory to build the model and the other part for validation is a statistically sound method of validation, but it only indicates that the landslide inventory is robust enough and that the inventory partitions are representative samples of the total inventory and have similar relations with the landslides predisposing factors. However, as showed in Queiroz and Marques (2019) a temporal partition of a cliff failure inventory (1947-1980 and 1980-2012) led to very high success ROC AUC values, but to poor prediction rates, which raises fundamental doubts for the true prediction of future evolution behavior of sea cliffs based on its past evolution (as in Guilham et al., 2018). It is the reviewer opinion that this matter should also be subject of discussion and a subject for future work.

- Authors Reply: We acknowledge the reviewer comment, and we totally agree. In fact, the temporal resolution of landslides in our coastal landslide inventory do not allow to apply a temporal partition of the inventory dataset. That is the reason for which we apply a random partition to generate training and validation landslide groups. This is a potential source of uncertainty and will be properly addressed and discussed on the results section. We will use the reviewer comment/description, which we thank, to better address/guide this potential source of uncertainty. this aspect,

-Rev2: The validation process is also a matter of debate in the discussion part of the paper.

- Authors Reply: We acknowledge the reviewer comments. The landslide inventory partition in training and validation groups were selected randomly. The 70/30 partition was chosen because is in agreement with the commonly used partitions used for landslide susceptibility models training and validation (as an example please see: https://www.mdpi.com/2220-9964/9/12/696). And the time dependent validation was not possible with the available dataset.

-Rev2: In the various model results classification why were used the IV values instead of a classification based on the ROC curve results, with limits of unstable areas of, for example 50%, 65%, 80%, 95% of the correctely predicted unstable terrain units.

- Authors Reply: We understand the reviewer doubt, and it could be possible to rank susceptibility that way from lower to higher scores of IV using breaks in the ROC curves. Nevertheless, we adopt this criterion sustained on the IV values due to their simple meaning. According to Zêzere et al (2017), for example, the relevance of any independent variable to discriminate stable and unstable areas is as greater as its distance from the 0 value of IV. When the score is negative it means that the presence of the variable Xi is favorable to slope stability. Positive scores mean a positive relationship between the presence of the variable and the landslide occurrence, as high as the higher the score. Information values equal to zero means no clear relationship between the variable and the landslide occurrence. We will improve this aspect, according this description in the new version of the manuscript.

-Rev2: In the paper is missing a discussion of the results obtained and a comparison with other studies of the same type carried out in other coastal cliffs.

- Authors Reply: In the new version of the manuscript we will include a discussion section to properly discuss main source of uncertainties and comparison of results with other studies.