**Interactive comment on "Long-term volcanic hazard assessment on El Hierro (Canary Islands)" by L. Becerril et al.**

**K. Németh (Referee)**

**Overall Impressions**

**I read the paper "L. Becerril et al., Long-term volcanic hazard assessment on El Hierro (Canary Islands)" with great interest. The paper presented a very interesting approach to understanding volcanic hazards in El Hierro in the Canary Islands. Recent eruptions off-shore of El Hierro place this location in the spotlight of the volcanic community, and there is general interest to understand and characterise the potentially complex volcanic hazards of this volcanic island. This paper is a very well-organised and detailed summary of a volcanic hazards study of El Hierro, and will surely have a great impact on the community of the island in terms how to view, weigh and understand its volcanic hazards. I found this paper to be a very progressive work that combined probabilistic tools with eruption scenario-based methods. Personally I think such an approach is essential, especially in understanding volcanic hazards on volcanic islands, where the complexity of the volcanism can be very high in regard to eruption styles and durations, and the effect of eruptions on the surrounding environments, due to the quickly changing hydrology, topography and structural elements of the island setting. I think this paper sets an example of how to combine probabilistic and eruption scenario-based volcanic hazards studies, and how such abundant data can be used in practical sense; this is critical for end-users who could use such studies for developing volcanic emergency management strategies. I also feel that this paper will be very well cited and potentially will set an example of how pure geological data can be structured into a framework that can be developed further for geomathematical analysis.**

We thank your constructive comments.

**While there is no doubt that such a method is very critical on volcanic islands where dispersed vents form a "volcanic field", such as El Hierro, the proposed method is perfectly adaptable for other dispersed volcanic systems, such as intracontinental volcanic fields (eg. Auckland Volcanic Field in New Zealand). While for me this applicability is evident, and the benefits of using such methods**

**elsewhere are clear, the Authors provide too little to introduce this early in the paper.**

We agree with you and therefore we have provided more information, including more references about the applicability of our work.

**In the Introduction, the Authors state the benefits of this dual approach to understanding volcanic hazards, but I find the examples listed too few and too Canary Islands-specific, which, for me as a reader, does not give a very strong impression that the Authors see the potential of their work in a much broader sense. From the citations it can be seen that there are some examples outside of the Canarian realm, but to spell out those locations, and methods, would have been a good addition. I believe the Authors are missing a great opportunity to make their point in a more effective, convincing and interesting way at the start of the paper. I hope that this will not turn potential readers away.**

Following your comment, we have included more references of other volcanic areas.

**I also found that a little bit more explanation of the definition of "long-term" hazard(s) could have been useful. In general "long-term" can mean many things, and just for clarity it would have been useful to explore and define this term.**

We have added more information related with "long-term".

**In the Introduction, I would have liked to have seen slightly more detail (1-2 extra paragraphs) on the specific hazard susceptibility maps.**

We have written information and references related with "Susceptibility maps"

**A list of the specific hazard types you were aiming to analyse and create a susceptibility map for, with a brief justification as to why those specific hazard types were selected, would be very beneficial and would give the reader an appreciation of the power of the method published in this paper. This is also valid because there is no other section in the paper where such definitions and methodological approaches are described.**

We have listed the hazard type in the introduction section. We also give more information about this topic in the methodological section.

**In the Geological Section, it is stated that El Hierro's recent volcanic eruptions are "monogenetic". Such a term is critical for understanding volcanic hazards, and I think it is essential to provide, in this section or earlier, a definition for the term in this context, as well as describing the eruptions' styles (and their landforms, potential hazards, following a scenario-based approach). Interestingly, in this section I found very little information about the eruption styles of past eruptions (other than a reference to Strombolian style eruptions etc). For clarity it would have been really useful to have more detail about the eruptions (styles, intensities etc) that these "monogenetic" volcanoes produced in the past. Again, I think such a summary would have been a very nice starting point for the reader to understand the volcanic hazards of El Hierro.**

We have provided a definition of "monogenetic" including its corresponding references in the Geological Setting section. Also, we have written a paragraph detailing the eruptions styles and products of the island which has been included in section 3.1 "How: Characterization of the eruptions", because we have considered that this section is more appropriate to remark how the eruptions have been on the island and to better understand their eruptive behavior. A little paragraph of this section has been changed to the Geological Setting section.

**Overall I think, in the first sections, the paper misses great opportunities to convince the reader how and why the proposed method is "revolutionary" and very "progressive". I think there are plenty of good studies published from other volcanic islands, such as Hawaii, Ambrym, Ambae, Tenerife, etc., that could have been compared and contrasted with this work, putting this work on a global level. Unfortunately the Authors missed this opportunity in their Discussion section as well, which I found a bit disappointing. The results and methods the Authors proposed, and very nicely applied to El Hierro could have been far better linked to**

**other dispersed volcanic systems, either on islands or in continental regions. In summary, I think this paper is a very good and progressive contribution; however,**

**I think the Authors missed too many opportunities to make their excellent work even more globally linked and applicable.**

In order to palliate this lack, we have written both in the Introduction and Discussion and Conclusions sections more information trying to make the work more global.

**Some Specific Comments**

**P1800/L20 – some citations would be useful here, at least to some key works that are relevant to the statement.**

We are not sure about what you mean because we do not find any key words in this sentence, neither in the same line of the following page. Please could you specify which words you mean for improving the statement?

**P1801/L11 – an explanation for the long-term hazard would be helpful here (e.g. contrasting with short-term hazards)**

We have followed your suggestion. We have included a paragraph with more information about long term hazard contrasting with short-term.

**P1801/L20 – "Long-term forecasting is based on historical and geological data, as well as on theoretical models, and refers to the time window available before the volcanic system becomes unstable again" – I found this statement difficult to follow, and more explanation would be helpful, especially about the meaning of ": volcanic system becomes unstable again" - what does "unstable" mean in this context?**

We have changed the term "unstable" by unrest episode.

**P1801/L28: – this is a good statement, but I think there would be great value in making the citations a little more global. The work would then be more linked to global research using examples outside of the Canary Islands.**

We agree with you and therefore we have included more references to make our work more global.

**P1802/L3:– "The Canary Islands are the only area of Spain in which volcanic activity has occurred in last 600 yr and represent one of the world's principal volcanic zones" – is "600 yr" a typographical error? Also, the statement that the Canary Islands are one of the "world's principal volcanic zones" is very relative and, without reference points, its meaning is unclear.**

Historical period in Canary Islands dates the last 600 years, because Spaniards arrived there 6 hundred years ago. Before this date native people lived there but they did not

registered documentally any eruption. On the other hand, we have changed the statement to clarify it.

**P1802/L17:– "Despite being small and submarine in nature (Martí et al., 2013), the most recent eruption on El Hierro (October 2011–February 2012) highlighted the need for volcanic hazard studies given the negative impact on tourism and the local economy of any volcanic event : : :" – this is a very important statement. It would have been very beneficial to put this in context, eg. highlighting the commonness, or rarity, of such eruptions from the geological record, highlight the volume (DRE) and the potential hazard (and destructiveness etc.), in order to provide details to justify the need to define the volcanic hazards not only from a probabilistic standpoint but also from an eruptive scenario perspective.**

We have included the following sentence where we try to clarify and justify the importance of the submarine eruption. *"In spite of this eruption was not particullary different from those that have taken place in the Canary Archipelago in terms of magma volume and volcanic products, this eruption marked the end of a 40 years period of quiescence in the Canary Islands"*

**P1802/L15 – "violent Strombolian" – citation is needed here to define in what sense this term is being used.**

We have included references in Geological Setting section about "violent Strombolian" term and also provided information and references in 3.1 section.

**P1802/L18 – "Timanfaya eruption" – please refer to a figure where this location is shown.**

Timanfaya eruption is in Lanzarote Island. We have included it in the text and also drawn in Figure 1.

**P1803/L22 – please cite a key paper to underline the term monogenetic.**

We have included references to underline "monogenetic" term and provided a definition of it.

**P1803/L25 – are the volume data here the volume of the island or the eruptive volume eg. DRE?**

The volume data is referred to the total volume of the island. We have specified it in the text.

**P1804/L27 – what type of structural data are you referring to?**

We are referring to vents, eruptive fissures, dykes and faults. They have been included into the text.

**P1805/L28 – are the volume data DREs? How were the data calculated? A line of explanation would be useful here.**

In this case data volume is related to the total erupted volume, while in Page 1806 line the volume of magma output was converted to Dense Rock Equivalent. We calculate erupted volume using ARCGIS 10.0 by ESRI thought the analysis of Digital Elevation Model (DEM). See text for more explanation.

**In general, the map figures are not frequently referred to. The reader would be able to follow the text better if the map and figure citations were utilised more often.**

Following your suggestion we have referred more the figures on the text.

**P1806/L1-15 – explanation of how the volume calculation was made would be a valuable addition.**

Volume has been calculated subtracting the current DEM topography to the restore paleo-topography. In spite of, due to cartography imprecision and lack of an ideal paleo-topography we assume a reasonable estimate of the erupted volume. We have included this sentence in the text.

**P1806/L14 – what type of lava flow simulation(s) are being referred to? Add citation(s) to the text here.**

We refer to the lava flows simulation in section 6.1. We have changed the sentence in the text to clarify it.

**P1807/L24 – the "nodes" should be introduced first prior to being used in the text. The HASSET section is a simple and easy to follow, well-written part of the paper.**

We have followed your suggestion including a brief explanation of the method that includes the term nodes at the beginning of the section 3.3 “When: Temporal analysis”.

**P1810/L17-20 – “Given the data regarding such episodes in the past geological record, we considered that the offshore zone between the bathymetric line of 200m and the on-shore area near the coast, which already includes several hydrovolcanic edifices, was suitable for the occurrence of such processes (Fig. 3)” – while, in a very first order approach, this is probably a good estimate, I think this issue is far from being resolved. At this stage, it is probably sufficient to assign shorelines as the most susceptible sites for hydrovolcanism, but in the future this need to be evaluated much more carefully. As demonstrated in other locations, there are plenty of other controlling parameters that can create hydrovolcanism, and they could be far from coastlines. Maybe a brief statement about this would be useful here.**

We agree with you. We have done that we have explained in the text as a first approach, nevertheless we have in mind that future work should be focused on a detailed study of this issue.

**P1811/L15 – an explanation of how the volume numbers were obtained is needed here, perhaps with some citations. Also, to make the work globally relevant, some comparison data from similar types of volcanoes would be of use.**

We have explained how our volume numbers have been obtained in section 3.1” How: Characterization of the eruptions”. A brief comparison of volumetric data with other monogenetic volcanic fields has also written in this section.

**P1816/L25 – violent Strombolian is given as the most likely high intensity eruption on the island, but it is not clear (from the text) what is meant by this type of eruption in this context. It would be great to have an example (eg. a type locality on the island) on which the scenario is based. This statement is generally true across the entire paper for other scenario descriptions. On the next line, it is stated that sub-Plinian events should not be discarded. Therefore, it is essential to give definitions in order to be able to distinguish between these two types of eruptions.**

Definitions of both concept following the work of Valentine and Gregg (2008), have been provided, as well as their respective references in section 6.3 Fallout.

**P1818/L1 – it is stated that mafic monogenetic eruptions are the most common, but no citations or data are provided to prove this (eg. refer to the table)**

We have referred the table 1 and included two references.

**P1818/L7 – "violent Strombolian (when hydrovolcanic phases occurred)" – from this statement, it appears that you are stating that violent Strombolian has causal links to hydrovolcanism? This needs to be clarified.**

We have rewritten the sentence to not create confusing to the reader.

**In the Discussion, a broader and more global comparison and evaluation of the method is needed.**

One paragraph has been included comparing our work with others and showing its applicability.