We thank the reviewer for the comments that helped us to improve the manuscript. We have incorporated the comments wherever found applicable. We have particularly refined the introduction, discussion with more research papers and provided more detailed analysis. We reply to the comments as the following. Answer should be read as mentioned in the modified manuscript.

1. **Anonymous Referee #1**

1.1 The introduction hardly points out the relevance of the topic. Furthermore, basics of scientific study design such as hypothesis, research questions and aims do not become clear.

1.2 The study mixes elements of a review with elements of a case study in a way which I find rather inappropriate.

1.3 The title is misleading since the actual dataset is neither sufficient to constrain LIA glacier extents nor related paleoclimate in my opinion.

Answer

1.1 The Introduction has been modified to make it clearer to understand the relevance of the topic, hypothesis, research questions and aims.

Based on the quaternary and Holocene asynchronous pattern of Himalayan glacier, the study investigates on the hypothesis that Himalayan glaciers are asynchronous to Northern Latitude glaciers (European glaciers). The basic research question which is addressed is that when the period of rapid climate change (LGM and Holocene) did not experience synchronicity between Himalayan and northen latitude glaciers, how the period of **none-rapid climate change (LIA)** can have similarity in glacier response. On the part of the relevance and aims of the study; it is clearly mentioned in the introduction that uncertainties persist regarding the timing extent and causes of LIA at regional and global scales. As the available palaeo-climatic proxies for LIA in Indian subcontinent suggest weaker (Thompson et al., 2000; Gupta et al., 2003; Sinha et al., 2011; Yadav, 2011) as well as stronger monsoon (Liang et al., 2015) during the LIA. Therefore, it provides opportunity to examine the discrepancies in the palaeo-climatic proxies across the Himalaya. The study, evaluates the glacio–archaeological feature in the Miyar Basin, Lahul Himalaya, using landform evidence and radiocarbon dating techniques.

1.2 The discussion has been modified and now the review studies and cases studies are separately dealt in different paragraphs and the synthesis is made in one to one cases with proper citations. As

"A focused and combined work on late Holocene glaciation in Himalaya and Tibet orogen is rather difficult to find. However, recent review studies have attempted to generate the chronological history of this region. Xu and Yi, (2014) reviewed available dates of LIA moraines in and across Tibet plateau whereas Chen et al., (2015) synthesised the proxies of moisture/precipitation in China and surrounding regions. Rowan (2016) has provided a review of the geo-chronological evidence for the LIA glacial advances in the Himalaya. Based on the review works of Xu and Yi (2014) and Rowan (2016), Figure 6 presents a combined synthesis of dated chronologies for the last 2000 years available for the Himalaya and Trans Himalayas. It shows two stages of glacier advance i.e. Neoglaciation (between 300 and 900 AD) and Little Ice Age (1300-1900) in this region. Neoglaciation was common

phenomena for Eastern and Central Himalaya, along with few records for the Western Himalaya and Karakoram, whereas it was absent beyond Karakoram (Tian Shan, Qilan Shan, Hengduan Shan, Nyainqentanglha Shan, Pamir). Such spatial pattern indicates that Neoglaciation was result of different climatic mechanisms that dominate in the Western and Eastern Himalaya. The chronological records for the last millennium suggest that peak of LIA existed between 1300 and 1900 rather than 1300-1600 (Rowan, 2016) in the region. However, duration of LIA was shorter (between 1300 and 1600) in the Eastern Himalaya (up to Everest) than the Middle and Western Himalaya and beyond (1300 and 1900 AD) (fig.6). Contrary to extended Neoglaciation fluctuations in Eastern and Central Himalaya, the LIA was relatively more active in the North Western and Trans Himalaya (fig. 5 and fig. 6). Noticeably, the frequency of obtained LIA dates is mainly from Trans Himalaya (beyond Pamir) and Garhwal and Everest Himalaya which enforce the dominance on chronology for the entire region (fig.6).

Available case studies have described the LIA glacial advance in the parts of the Himalaya (Owen et al., 1996a, 1996b; Sharma and Owen, 1996; Derbishyre and Owen, 1997; Lehmkuhl et al., 1998; Owen et al., 1998b, 2000; Taylor and Mitchell, 2000; Owen et al., 2001, 2002a, 2002b; Spencer and Owen, 2004; Owen et al., 2005; Hedrick et al., 2011; Murari et al., 2014; Solomina et al., 2015). However, these studies vary in terms of timing and extent of glacial advance, and most are based on relative rather than absolute chronologies (Mayewski and Jeschke, 1979; Owen et al., 1996a, 1996b; Sharma and Owen, 1996; Derbishyre and Owen, 1997; Lehmkuhl et al., 1998; Owen et al., 1998b, 2000; Taylor and Mitchell, 2000; Mehta et al., 2012).Wherever the numerical dating has been applied, there are only a limited number of dates (≤ 2) (Iwata, 1976; Richards et al., 2000; Owen et al., 2001). In areas where more dates have been produced such as Khumbu (Bendict, 1976; Iwata, 1976; Fushimi, 1978; Muller, 1980; Rothlisberger and Geyh, 1986; Richards et al., 2000), Garhwal (Barnard et al., 2004b; Murari et al., 2014), Milam (Barnard et al., 2004a), Gonga Shan (Owen et al., 2005), most are based on thermo luminescence (TL) and optically-stimulated luminescence (OSL) dating techniques. Though these methods are widely applied globally, they have associated limitations in high energy Himalayan environment in determining ages of such events within millennial scale (Jensen et al., 2000; Wallinga, 2002; Spencer and Owen, 2004; Blair et al., 2005; Bailiff et al., 2014). However, we have used the exposure and luminescence dating techniques where confidently sampled in the same environmental settings and geographical conditions (Deswal et al., 2012)."

1.3 We differ from the reviewer's comment as the present study produce 9 radiocarbon dates based on glacio-archaeological remains along with extensive landform mapping, along with field photographs. The number of produced dates in this study is one of the highest among the published case studies regarding the LIA in the Himalayas.

However, we partially modify the manuscript title as "**Glacio-archaeological evidence of climate during the Little Ice Age in the Miyar basin, Lahul Himalaya, India"**.

2. Anonymous Referee #1

2.1 Literature work Many statements which obviously do not represent original research results of this manuscript are lacking references. In this respect, the chapters 2 (study

area) and 3.1 (mapping methods) require specific highlighting, both not citing a single reference.

2.2 Other statements which are either not the key focus of the paper (e.g. Pleistocene glaciations, P1L22ff, P7L9ff) or of limited informative value (e.g. P1L25ff) are supported by a wealth of literature. In these cases, the reader has hardly any added value and might get the impression that the citations are just to fill up the references list…. also, much key literature is missing, e.g. regarding dendrochronological studies of LIA glaciations and Holocene climate, the heterogeneity in climatic forcing of glacier dynamics over High Asia, existing morphostratigraphies, etc. (cf. literature recommendations at the end of this text).

Answer

2.1 We have incorporated your comments regarding the citation for study area and mapping.

2.2 for the comments we justify that this was incorporated in the study as the formulation of hypothesis of the study is based on the behaviour of Himalayan glacier during the quaternary and Holocene, therefore citation of such behaviour is must including LGM and Holocene.

In the modified manuscript, we have included more paleoclimatic proxies including dendrochronology, speleothem etc.

3. Anonymous Referee #1

3.1 *Method set and uncertainties CRN and OSL dating have made great progress during the last years, CRN is certainly the most promising technique for LIA moraines without tree stands today. The literature used to support the weak and vague argument that these methods have "limitations" (P2L15ff) seem either outdated or inappropriate for the context of LIA glaciers.*

3.2 *By contrast, a critical assessment of the 14C method or discussion of uncertainties is lacking.*

3.3 Dendro methods are key for both paleoclimate and glacier characterization in the LIA context. These are also not even mentioned in the manuscript.

3.4 The assumption that the area was used for agriculture should be supported by sedimentological and pedological analyses.

Answer

3.1 The discussion paragraph (page8; line 6-17) deals with this answer. The LIA "studies vary in terms of timing and extent of glacial advance, and most are based on relative rather than absolute chronologies (Mayewski and Jeschke, 1979; Owen et al., 1996a, 1996b; Sharma and Owen, 1996; Derbishyre and Owen, 1997; Lehmkuhl et al., 1998; Owen et al., 1998b, 2000; Taylor and Mitchell, 2000; Mehta et al., 2012).Wherever the numerical dating has been applied, there are only a limited number of dates (≤ 2) (Iwata, 1976; Richards et al., 2000; Owen et al., 2001). In areas where more dates have been produced such as Khumbu (Bendict, 1976; Iwata, 1976; Fushimi, 1978;

Muller, 1980; Rothlisberger and Geyh, 1986; Richards et al., 2000), Garhwal (Barnard et al., 2004b; Murari et al., 2014), Milam (Barnard et al., 2004a), Gonga Shan (Owen et al., 2005), most are based on thermo luminescence (TL) and optically-stimulated luminescence (OSL) dating techniques. **Though these methods are widely applied globally, they have associated limitations in high energy Himalayan environment in determining ages of such events within millennial scale (Jensen et al., 2000; Wallinga, 2002; Spencer and Owen, 2004; Blair et al., 2005; Bailiff et al., 2014). However, we have used the exposure and luminescence dating techniques where confidently sampled in the same environmental settings and geographical conditions (Deswal et al., 2012).”**

3.2 The answer is dealt in **3**. **Methodology** heading **3.2.2 Laboratory Work** (page4; lines22-24): “The obtained radiocarbon dates were calibrated in the CALIB RADIOCARBON CALIBRATION PROGRAM 1986-2016 using IntCal13 calibration curves (Reimer, 2013). The uncertainties for the calibrated ages are given up to 1σ (Table1).” Further to this the dates had been discussed in detail in **Results; 4.2 Timing of human occupation at *Tharang (pages 6-7, lines 27-34, 1-7 respectively):***

“The chronology of these ruins was established based on the 9 dates extracted from these ruins; comprising bone, wood, charcoal, soil (hearth), soil (cow dung), soil (toilet) and horn (Table1). *Tharang* ruins contain the highest concentration of dates (7 samples), UBA-30069, UBA-30072, UBA-30074, UBA-30075, UBA-30076, UBA-30077, UBA-30078 whereas, UBA-30064 and UBA-30065 were collected from *Patam* and *Phundang ruins* respectively (Table 1). All these samples were obtained from sites within and on the end moraine complex, in comparatively close proximity to the terminus of *Tharang* glacier (4.1 Km). The seven dates of *Tharang* ruins are 838 ±28, 489 ±22, 378 ±27, 327 ±21, 212 ±34, 123 ±22, and 108 ±32 yr BP (Table1). The consistent pattern of Radiocarbon ages; ranging from 838 yr BP to 108 yr BP, from *Tharang* ruins, suggests that the site was a continuous living village between cal AD 1168 and cal AD 1693. As the oldest Radiocarbon age (UBA-30075) 838 ±28 yr BP, at 68% confidence level (1σ uncertainty) has an average age of 1196 AD, spanned from cal AD 1168 to cal AD 1224. Whereas the latest age (UBA-30072); 108 ±32 yr BP, at 68% confidence level (1σ uncertainty) has an average age of 1710 AD, spanned from 1693-1727 AD. Moreover, there are five dates in between; and at 68% confidence level, the average of these five dates are 1430, 1476, 1522, 1664, and 1696 (Table1). Besides, the dates of Tharang, *Patam* ruins received the second oldest radiocarbon age: 654 ±22 yr BP (UBA-30064), with an average age of 1297 yr BP, spanned from cal AD 1289 to cal AD 1305 whereas, *Phundang* ruins received most recent date (UBA-30065) 101 ±27. The date spanned from cal AD 1695 to cal AD 1726, with an average age of 1711”.

3.3 Dendrochronology for the rain shadow zone of Pir Panjal (Lahul Himalaya) is merely available, however the dendrochronology south of of Pir Panjal has been incorporated in the discussion but represents to a very different climatic system (Monsoon Active zone).

3.4 The answer is dealt in the modified manuscript under Results heading **Timing of human occupation at *Tharang*** *(page 6 lines 5-12)*.

4. Anonymous Referee #1

4.1 Lack of focus as well as biased and/or speculative discussion…. the LGM configuration is highlighted (without citing adequate literature... The next paragraph (P5L3-P5L12) presents "middle Holocene" moraines without providing any dating evidence.

4.2 The author's conception of the term "Little Ice Age" is not congruent with widely accepted definitions from the literature….. The author's conception of the term "Little Ice Age" is not congruent with widely accepted definitions from the literature. Despite the typical fuzziness regarding the determination of starting and end points of certain periods (mostly originating from different events and/or dating methods used for definition) I would say that the LIA is generally used for a climatic pessimum lasting from ~ 1300 until ~1900 CE. Glacier advances in the 19th century glacier advances would thus be considered (late) LIA by most authors. The term 'historical glacier advance' which the authors use instead is typically used when referring to glacier fluctuations for which actual observational data exists…

4.3 On the other hand, the 'Medieval Warm Period' (MWP, also referred to as 'Medieval Climate Anomaly') lasted ~1000-1300 CE. The oldest sample (UBA-30075) is thus definitely MWP/pre-LIA, the second oldest (UBA-30064) may arguably be considered MWP as well but that will depend on actual data on late Holocene climate in the study area.

4.4 Figure 2 shows a clear LIA moraine in my opinion (lobate structure just left below the center of the Google Earth image) – with both tributaries of Tharang Glacier united as indicated in the historical map.

Answer

4.1 The modified results under the heading **Glacier Advances and Landforms (page 4-6) refers the relevant literature for LGM and the dates of the Holocene advance (**dated to ~10 ±1.0 ka to 8 ±1.0 ka OSL), terminal moraine of Tharang has yielded 6.6 ±1.0 ka (Deswal, 2012) is well cited.

As far as the speculative discussion comment is concern, we differ from the comment; however more literature has been cited for the argument in the discussion; including dendrochronological, speleothem, and ocean oxygen isotope records which are available across the Indian subcontinent.

4.2 We never mentioned that LIA is not considered between 1300-1900 CE. However, there is spatial variability regarding extent and timing across the Himalaya (fig. 6). Moreover, the connotation of the Historical Advance is made on the basis of the available GTS map (1870s fig. 4) and Harcourt's map (1871) of the study area well mentioned in the results and discussion.

4.3 we agree with the comment and we have specifically mentioned in the results that these two dates belong to MWP.

4.4 The figure2 moraine are marked on the historical map (1874) are not of LIA advance rather belong to Historical Advance only (after 1730) as three ruins settlement along with well-developed irrigation system survived between 1168-1730 (table1) in the end moraine complex of the same glacier.

5. **Anonymous Referee #1**

Conclusions are not supported by data I certainly agree that the mapped structures and archaeological findings indicate certain farming usage. However, to me much evidence (horns, cow dung) seems to point toward pastures rather than agriculture.

Answer

The modified conclusion on page 10 concludes on the basis of the 9 radiocarbon dates and landform interpretation. As far as the pasture activities is concern the explanation is made in the **Results** under the heading **4.2 Timing of human occupation at *Tharang (page 6; lines 11-12).***

6. **Anonymous Referee #1**

Figures Complex, confusing and cluttered figures that are neither self-explaining nor being explained in figure captions. Linkages between different figures (e.g. marking locations of photos and map in overview) as well as figures and text are weak or do not exist.

Answer

We take this comment positively for the betterment of the manuscript and have updated some figures which were necessary.