

Reply to the invited review by Warren Eastwood

We thank Warren Eastwood for critically reading the manuscript and sharing his comments with us. We hope our reply and suggested alterations will be to his satisfaction. We also give thanks for the multitude of minor comments, which have all been implemented and will not be discussed in the following text.

- In view of the fact that parts of the paper rely upon charcoal data as a proxy for fire as a local or regional driver of environmental and landscape change, I would have liked to have seen continuous and contiguous charcoal counts rather than interval charcoal counts from pollen slides as reported in the paper's methodology. The use of interval charcoal counts from pollen slides could potentially mean that some fire events have been missed and, more importantly some of the studied pollen levels may have responded to these 'missed' fire events. Therefore, the authors are not availing themselves of the full range of evidence.

This comment, which mirrors those of Neil Roberts and the anonymous reviewer, indeed highlights a flaw in how the CHAR analysis was presented in our text. As the time and means to perform a contiguous analysis of the 3.7m Gravgaz and 6m Bereket cores was not available to us, the choice was made to use the pollen samples to produce a discontinuous record. Although we do not state that we have a continuous fire history, the fact that we do not has not been highlighted sufficiently, nor have the resulting limitations in the use of this type of analysis been properly presented. Furthermore, a fire frequency in fire events per time period, while being a standard output of the CHARAnalysis, should not be presented as a result. We agree that an extensive overview of individual fire frequencies cannot be made on the basis of a discontinuous charcoal record.

However, while CHAR is best suited for records featuring continuous/contiguous sampling (the chances of missing a fire event growing larger as time interval between samples increases), this does not mean that a CHAR analysis is useless when a discontinuous record is used. Even if some individual, especially regional fire events (microscopic charcoals) are missed, a longer 50-100 yr period characterized by many fires (as occurred at several times during the Bronze and Iron Age at the study area -see Kaniewski et al., 2008; Quaternary Research., 70-2) may still be detected. The average sampling interval for the Gravgaz record is of 6.7 cm or 46.6 year per sample. For the Bereket record, the average sampling interval is 13.5 cm or 56.9 year per sample. We must consider the current record does not provide a record of each local and regional fire event, but we consider it detailed enough to support our hypothesis that the major fire periods observed from the Brone Age to the end of the BO Phase, were absent during the most recent 2000 years, despite multiple instances of a resurgence in agriculture and forest clearance. A visual description of both cores in the field also did not reveal any charcoal layers, further supporting the notion that fire activity was limited after the end of the BO Phase.

The result of the Neighbour Joining and Cross Correlation analyses also show no significant relationships between the charcoal and pollen records throughout the post BO Phase period, further indicating the limited role of fire in vegetation and environmental change. Although, as explained in the manuscript, fire activity can result in rapid sedimentation events due clearance of the vegetation, none of the sedimentation events that did not coincide with a charcoal peak showed a vegetation response conform that which one could expect after a fire.

We acknowledge that the manuscript does not sufficiently highlight the limitations of the CHAR analysis when used with a discontinuous charcoal record. The relevant texts in the materials and methods section shall be adapted in order to give a clear overview of both the limitations and the possibilities of the CHAR analysis. The discussion chapter (more specifically section 5.2.) will be rewritten to focus more on the general post-disturbance vegetation succession, and the numerical (NJ, CC) analyses. Any notion of an average fire frequency is removed from figure 5, as we agree such a value cannot be calculated based upon the data used. The previously unused visual description of both cores will now also be explicitly mentioned.

- Considering socio-economic and political drivers to be subsidiary to climate drivers risks the paper being labelled as environmental or deterministic in its philosophical approach and I believe that the authors need to exercise caution in this respect. There is no reason

why socio-economic and political drivers cannot act in concert with climatic drivers (a probabilistic approach); as it would appear with respect to the environmental and landscape changes that occurred during the 7th C AD as the authors outline in their concluding section.

We are aware of the fact that an environmental/climatic approach risks to be labelled as deterministic, especially nowadays when human activities more than natural causes are held responsible for global climatic changes. It is easy to avoid determinism by observing a certain vegetation change and simply state in the conclusions that it was caused by man, climate, or both. But such an approach hardly contributes to the understanding of past environmental change. It is our intention to attempt to further our insight into the driving forces behind environmental and land use change.

Changes in human impact (e.g. socio-economic/political changes) and climatic change are the most important driving forces behind vegetation/landscape change, either alone or acting together. At every important shift in the palynological and/or sedimentological record, it is important to consider both climate as well as socio-economic/political change as possible driving forces behind a change in land use by the local population, and also consider the possibility that it need not be just one or the other factor which is responsible, but that more factors can act together.

For a thorough climatic versus human approach, robust chronologies are needed from the local environmental as well as from the local socio-economic changes. This is unfortunately only exceptionally the case. In our case, the results of the Holocene article by Bakker et al (2012) provides a detailed overview of the timing and impact of climate change on the vegetation. These findings are further supported by the dendroclimatological data of Touchan et al (2007). For an overview of socio-economic/political changes which may result in a shift in land use, we rely on the most recent insights concerning the archaeology and history of the city and territory of Sagalassos, and the surrounding regions. However, it must be said that, especially for the local changes in land use in the Bereket and Gravgaz basins, the level of detail greatly lags behind the level of detail available for our climatic record.

We tried to avoid a deterministic approach which assumes every change is caused by climate unless proven otherwise. Instead we tried to formulate the most likely scenario based on the totality of the currently available data. In our approach, if –for instance- evidence for one factor is lacking, but a change in the other factor does coincide with an observed shift in land use, it still doesn't automatically prove that this second factor *must* be the real and sole driving force, but it is considered to be the most realistic scenario. In some cases, we have to consider that both climate as well as socio-economical/political change acted together. This was done for the situation in the mid 7th century AD, where a climatic dry trend as well as the Arab invasions (both proven to be able to cause a shift from crop cultivation to pastoralism, similar to that observed at Sagalassos) occur simultaneously. However, this was the only instance for which a hypothesis which leans toward one particular factor was not deemed more probable.

It is our opinion that we have done enough to ensure we were not overly deterministic or environmental in our discussion, but will nevertheless critically reread the discussion section and make our approach more clear where this is considered necessary.