Referee's report of 'Bioturbation enhances C and N contents on near-surface soils in resource-deficient arid climate regions but shows adverse effects in more temperate climates' submitted by Diana Kraus et al. to EGUsphere.

In this paper, the authors investigate the effect that excavating animals have on physical (grain size: silt, clay and sand) and chemical (macronutrients such as carbon (C), nitrogen (N) and phosphorus (P) soil properties along an ecological gradient. They predict that bioturbation will increase 1) the proportion of fine-grained soil and 2) C, N and P content in disturbed soil compared to undisturbed soil. In addition, they expect that these effects will be greater in arid regions compared to regions with more temperate climate. They find that bioturbation had no effect on the physical soil properties. However, they state that disturbed soils had higher content of C and N compared to undisturbed soils.

Where this paper is informative, provide an overview of the literature and show an understanding of the research topic, I feel there are several problems with this study.

General comments:

1) The authors do not provide the reader with all background information needed for him/her to understand and follow the story. For example, there is no information on what animals are the bioturbators in this study. Is this paper about invertebrates or vertebrates disturbing soil? Depending on what type of animals are excavating soil, the extent of them digging may most likely differ significantly.
2) Hypothesis 3 is very similar to hypotheses 1 and 2 and needs to be more specific.
3) In the Method section the authors mention they used three study sites for this paper with arid, semi-arid and Mediterranean climate. However, there is no info what study site (i.e. Pan de Azucar, Santa Gracia and La Campana) belongs to what climate. This info can only be found in the legends of the figures.
4) No info is provided on the size or volume of the mounds, or the percentage of the landscape that is covered by mounds. However, this may be important for small- and large-scale landscape effects. Also, how far away from mounds were the 'control' soil samples collected? How fresh/old were the samples collected from the mounds?
5) Results are often based on 'raw data' in the supplemental material (Table S1 and S2) and graphs, but often lack statistical analysis to back them up. When statistics are provided the results turn out to be relatively weak or non-significant.
6) Some tables in the supplemental material are not mentioned in the text and could be omitted (i.e. S4, S6, S9). In general, tables could be combined, e.g. for silt/clay/sand and C/N. Info in some tables is missing, e.g. S3: no info on clay; S5, S7 and S8: the study site 'La Campana' is mentioned in the legend but not in the actual table. Other tables need more info: S2: how was the '%input' calculated and what does it mean? S10: what does '(zono-)biome' mean?
7) The results of the physical soil properties have been omitted from the discussion and are not mentioned at all. However, this should be discussed nonetheless.

Specific comments:

Introduction

Line 95: Hagenah and Bennett 2013 worked in the Fynbos region which has a more Mediterranean-type if climate (MAP: 471 mm, MAT: 11-24 °C). Calling it 'arid region' is incorrect.
Line 101: there is an extra space after …'from'. I would remove the commas in front of/behind 'arid'. There should be a comma behind 'regions'.
Lines 103-105: I do not understand this sentence. That needs to be rewritten.
Lines 106-107: There is a mistake in this sentence. It should either read 'we aim to analyse **if**

the magnitude of the impact… or 'we aim to analyse **to what degree the** impact of bioturbation…'
Lines 109-110: ..' where bioturbation activity and its effects will appear on a larger scale'. What do you mean by this. This needs to be clarified.

Results
Lines 238-240: C and N increased along a climate gradient from Azucar to Campana. I do not see that in the figure provided. There are no stats to back this up.This is what I see in the graph: St. Garcia: lowest, Azucar:medium, Campana: highest.
Lines 240-246: No stats are provided to back up this statement.
Lines 249-250: …'we present just silt, C and N here'. I do not understand what you mean by this. Please clarify.
Lines 252-253: ….' Pan de Azucar explaining 5% of the model variation'… I do not see that in Table S5.
Lines 253-256: ….'silt content decreased in Santa Gracia and La Campana'… If the results are non-significant then there is no difference.
Line 255: 'In all research sites, the silt content increased with increasing hillslope'. What does that mean biologically? Is this relevant for your study?
Lines 257-258: I do not understand what you are saying here since you speak in 'stats terms'. Rather write in a way that the reader can understand the biological meaning of the results.
Line 258: …'31% of the variation'….Where can I find this value? It is not in Table S7.

Discussion:
Lines 287 and 289: should be 10% for semi-arid zone and 44% for Mediterranean zone according to the table provided.
Lines 298-307: Depending on the 'age' of the mound soil that was collected, one should see a difference between disturbed and undisturbed soils. Maybe samples collected in this study were too old?
Line 224-335: A lot of excavating animals dig in the soil in search for food, and not for shelter. However, since no info is provided what animals created the mounds in this study, it is hard to tell.

Table 1
The legend is missing info on the climate type of the three study sites.
The annual precipitation given for 2019 is rather low compared to the average which explains why 'La Campana' has been categorised as 'Mediterranean' climate (here: 63.8 mm, MAP: 367 mm).

Figure 1
More info needs to be provided in the figure legend. For instance, what are the stripes within and outside of the boxes for?

Figure 3
This figure is too small compared to figures 1 and 2. The way it is set up now, it is hard to read.