Reviewer #3
Thanks to this review, we added and clarified specific changes.

The manuscript "Pollen-based reconstruction of Holocene vegetation and climate in Southern Italy: the case of Lago di Trifoglietti" by Joannin et alii provides new important data on the Holocene vegetation history of Southern Italy. Despite the very high quality of pollen analysis, the manuscript shows a major weakness in the quantitative reconstruction of the past mean annual precipitation by means of the Modern Analogue Technique (MAT), which has been extensively used to detect and support climate changes from the pollen record. Such reconstructed precipitation values, ranging from 500 to 900 mm, appear too low to support the local presence of dense woodlands dominated by Fagus sylvatica and Abies alba throughout the Holocene. This raises doubts on the accuracy of the applied methodology to reconstruct the palaeoclimate.
I recommend publication pending on a major revision of the work taking into account the following general comments and detailed remarks.

General comments
- The authors state that a mountain forest ecosystem dominated by beech and fir trees was established in the surroundings of Lake Trifoglietti since at least 11,000 cal. BP and lasted until the Late Holocene. This assumption contrasts with the reconstructed mean annual precipitation rates (Fig. 9), which are too low (500 mm<Pann<900 mm) to support the local presence of this type of vegetation throughout the Holocene. According to Quézel (1998, Forêt méditerranéenne 19,2, p. 93- 104), firs are very demanding from the standpoint of water requirement. At present the natural populations of Mediterranean Abies live in areas where mean annual precipitations are above 1000 mm. Blasi (2005, Il Fitoclima d'Italia) includes the forest coenoses dominated by Fagus with Abies alba in Calabria within very humid ombrotypes of the supratemperate bioclimate ("Supratemperato ultraiperumido-iperumido" and "Supratemperato iperumido"). Ducci et alii (1998, Forêt méditerranéenne 19,2, p. 153-164) show the climate parameters of the natural populations of Abies alba, which are characterized in Calabria by very high mean annual precipitations (>1800 mm). Hence, it is difficult to hypothesise in a recent past an adaptation of these vegetation types to the precipitation range proposed in the present study. Moreover the mean annual precipitations produced by MAT are rather far from the present day values. The record (Fig. 9) is therefore unable to replicate the current precipitation variability displayed by the ombrothermic diagram of the meteorological station chosen as reference (see Fig. 3). As the authors give major emphasis to this quantitative reconstruction, I suggest them to explain accurately the quality of their data in paragraph 3.3.3, also adding lines concerning the detailed procedure undertaken to obtain them.
This last point is now answered in the response to Fletcher's comments and in the text added in part 3.3.3. For the main part of this comment, please see the common response in Laura Sadori's comments.

- In section 4.2.4 the authors reconstruct the fluctuations in water depth at Lago Trifoglietti, as reflected by variations in the hygrophilous taxa (Figs 7 and 8), through the ratios of indicators of lake development and those characteristic of peatland. The authors use Alnus, Botryococcus and fern (Osmunda and monolete spores) for their function. Although the hygrophilous conenoses evolution is consistent with a quite convincing hydrosere succession,

one should be cautious in choosing the above mentioned indicators for quantitative hydrological reconstructions, since their development may be not unequivocally related to water level variations. For example, the development of Osmunda may also reflect the establishment of local oceanic climate conditions rather than hydrological dynamics of the lake. Osmunda can grow in different micro-habitats, with soils characterized by different moisture conditions, within the same area (e.g. under-wood, or spring and stream present in the area, see P 2228, L 1-2). The local record of Alnus may also be increased by wind-transported pollen from well-development alder coenoses elsewhere in the region. Reille (1984, Pollen et Spores 26, 43-60) suggests that Alnus experienced a typical Subboreal development in the Mediterranean domain. This is evident in many sites of the northern and central Tyrrhenian Sea as already discussed by Di Rita et alii (2010, Journal of Paleolimnology 44, 51-67). The authors should take into account this hypothesis, the more so that they state that "Pollen catchment is likely to include lower-altitude vegetation signals due to the topography of the Catena Costiera Mountains and by ascending air flow along the slopes" (Page 2234, Lines 21-23). Moreover, they should explain why other aquatic indicators have not been considered in their water-depth reconstruction.

The reviewer points that the curve obtained from hygrophyllous taxa is convincing but asks for more reserve considering the possible effects of other factors when aiming to quantify hydrologic evolution. We agree, but have to clarify that the values obtained are arbitrary and on a logarithmic scale so that quantification of water-depth in meters is not provided. Principal component analysis applied on the dataset first clearly opposed Botryococcus and Alnus/Osmunda, then Alnus and Osmunda. The group named aquatic is intermediate in the first ACP. It means that it indicates an intermediate state of the lake evolution, but, we couldn't integrate this group in our equation as it did not help to build a convincing curve.

In general, Osmunda is growing thanks to (1) the presence of an oceanic climate and (2) the dynamic of the lake ecosystem. (1) In this part of Calabria, oceanic climatic conditions are optimal for Osmunda development. Osmunda is also present in other areas of Italy where such conditions prevail. For example, it is the case in Lazio where Osmunda lives with other species (Betula pendula, Quercus frainetto and Q. petraea) that need the oceanic climate. (2) Presence of Osmunda is associated to riparian forests and wetlands (Landi and Angiolini, 2010) which are by nature long-lasting azonal formations being influenced by the level of the water. Plant communities are generally stable until hydrological conditions change. In case of more frequent flooding associated to permanent water riparian and wetland formations regress toward herbaceous formations (AA.VV, 1999).

We did not discuss about a regional development of Alnus in southern Italy. At Monticchio, Allen et al. (2002) excluded Alnus from the pollen sum because it is confined to wet ground at the lake margins and is not a component of the regional forest. To our point of view it is difficult to assess a regional widespread of Alnus from our site as alder development is very linked to local conditions as the drying of the lake. This interpretation can also be applied to Canolo Nuovo which is at a similar altitude. This hypothesis is also based on the direct link between strong reduction in Alnus abundance in the upper part of the diagram that occurred when the villagers cut the Alnus trees on the peat. The paper from Di Rita et al. (2010) on the Tiber delta hypothesis that the development of this tree associated with other riparian taxa during the interval 5100-2900 cal. BP is linked to an increase of the water level. Here, Alnus development is clearly associated with changes in the lithology and may be driven by changes in water level due to the delta development and/or by taphonomical bias. In this paper, references cited point to an increase in riparian taxa (not only Alnus) around

5ka, but it did not concern the entire interval 6000-0 cal BP as recorded in Trifoglietti. Neither statistical observations nor comparison with other records (for example Monticchio) yield to think that the main Alnus component is not local.

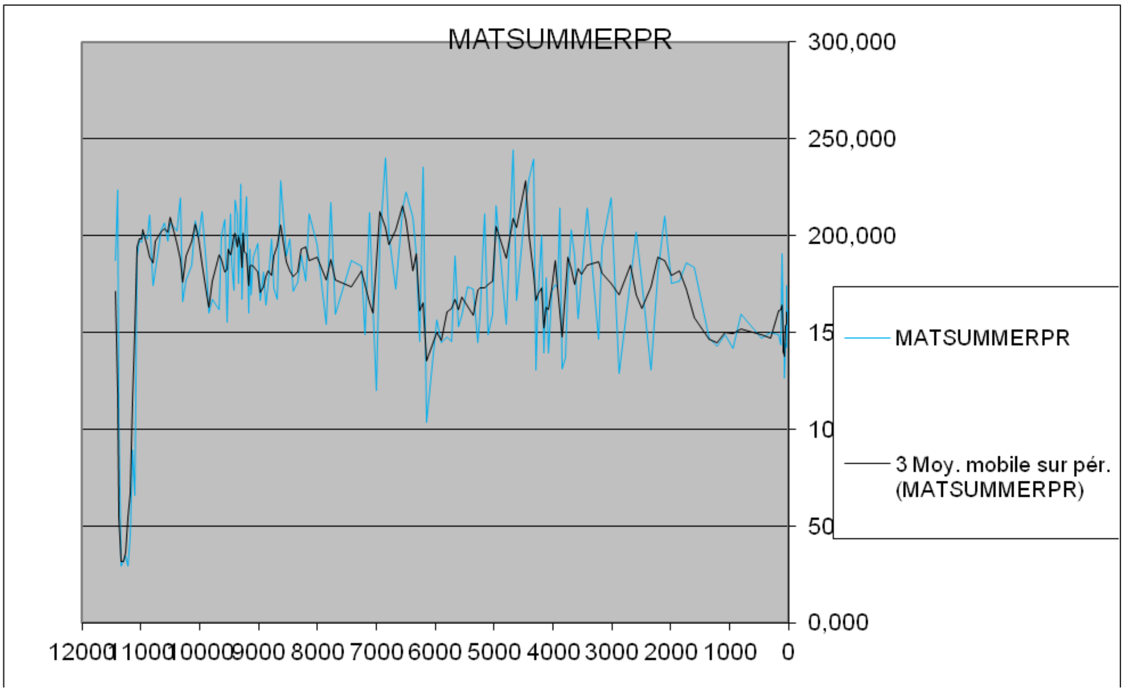
AA. VV. 1999. Ricerca sugli habitat prioritari presenti in Italia (II fase). Foreste alluvionali residue dell' Alnion glutinoso-incanae(91E0). Società Botanica Italiana. Ministero dell'Ambiente- Servizio Conservazione della Natura.
Landi, M., and Angiolini, C.: Osmundo-Alnion woods in Tuscany (Italy): A phytogeographical analysis from a west European perspective, Plant Biosyst., 144, 93-110, 2010.

- In some parts of the discussion the authors rely on their reconstructed palaeoclimate and palaeoenvironmental record more than on the pollen record. This is the case, for instance, of the vegetation development recorded at Trifoglietti from ca 5200 to 3500 cal. BP (Zones T6-T9). From 5200 to 4300 the authors hypothesise a more humid climate than in the preceding phase on the basis of an increase in the reconstructed water depth, in spite of a clear reduction of AP frequencies between ca. 5000 and 4600 mainly related to low values of moisture-demanding trees (Fagus and Abies). The associated increase in NAP percentages was tentatively attributed to a development of both Phragmites and aquatic sedges consistently with the increased water level, while the clear decrease in AP was simply interpreted by the authors as a bias in APwa percentages partly influenced by autocorrelation between percentages due to high amounts of aquatic plants and Osmunda. However, the increase in Poaceae and anthropogenic indicators and the low frequencies of Fagus and Abies may also be interpreted as decreased humidity and/or increased human activity that should be considered in the discussion.

We didn't discuss about an increasing human impact at that time because 1) the low frequencies of Fagus and Abies only concern the interval 5000-4600 cal BP, 2) we cannot avoid the possibility that poaceae are in fact phragmites as reported in the manuscript, and 3) because the increase in anthropogenic indicators is not corroborated by an increase in cereal. Moreover, with the decrease recorded in the MAT and WAPLS Pann reconstruction, this phase seems more climatically-related.

From ca. 4300 to 3500 the authors suggest drier climate conditions on the basis of the reconstructed Pann between 4400 and 4000 cal. BP and by the reconstructed water depth between 4000 and 3500 cal. BP. The pollen record partly contrasts this interpretation, since high amounts of Fagus and Abies between ca. 4600 and 4000 indicate forest development under humid conditions. An accurate description and interpretation of the signal recorded in the pollen diagrams of Southern Italy during the climate oscillation occurred at around 4 ka BP would be very useful to assess the amplitude and magnitude of this event and the regional environmental response.

Thanks to this comment, we had a closer look to this point. In fact, water depth is certainly more related to summer precipitation as generally accepted and as we observed in the figure below (not present in the manuscript because it will be published in the same volume in Peyron et al). During this interval (4600-4000), WAPLS reconstruction records more Pann triggered by winter precipitation and therefore closely follow Fagus and Abies abundances.



- The data are sometimes difficult to read. The comparison between Figs 7 and 8 reveals a discrepancy in the percentage values both in the Aquatics and AP records, particularly appreciable in zones T6 and T7. These different frequencies do not depend on the depth/age conversion, but possibly on a different composition of the aquatics in the two records. Please explain the nature of these differences.
We have been again through data and software (Tilia, Illustrator) in order to correct this mismatching between the two figures.

- The chronological limits of the early, middle and late Holocene are not clear. For example, in the section 5.1.3 the early Holocene ranges from 11,000 to 9000 cal. BP (P 2244 and L 5-22), while in the section 5.2.1 it includes also the time interval 9000-6000 cal. BP (P 2246-2248).
We added 5.2.1 Early and Mid Holocene

- I suggest producing a concentration diagram of the most important pollen taxa and ecological groups. This would be useful to interpret the data when problems of pollen percentage representation are envisaged.
We have provided concentration for all pollen grains counted. However, we prefer to not go further as we observed a correlation between series of sample preparation and concentrations. Unfortunately, this step cannot be corrected.

- We added the requested references even they are from lowlands: Caroli and Caldara (2007); Di Rita et alii (2011); Calò et alii (2012

Detailed remarks corrected
Title: We used "Lago Trifoglietti".
Page 2224, Line 23-25: *the pollen record approximately starts with the possible PBO oscillation. The authors do not have evidence of what happens before, so I suggest them to mitigate the phrase "marked decline in timberline altitude".*
This interpretation has been based on at least two samples that precede the PBO.

P 2227, L 19: *"Carta dei suoli Regione Calabria, 2007" it is not reported in the reference list.*
We change ARSSA, 2003 - I suoli della Calabria. Carta dei suoli in scala 1:250.000 della Regione Calabria.

P 2228, L 21: Helichrysum italicum.
P 2229, L 3: builds up.
P 2229, L 16: change "sedgebed" with "sedge bed".
P 2230, L 10: The cores were split…
P 2231, L 4: program Calib 6.0 (Stuiver and Reimer 1993); in Radiocarbon 35, 215-230. IntCal09 Calibration dataset (Reimer et al., 2009).
P 2231, L 8: *Please indicate which program was used to calculate and plot the age-depth model and motivate the choice of a cubic-spline interpolation method.*
The reference given in the text provides all requested information. We change to: The age-depth model (Fig. 5) is constructed using a mixed-effect regression model according to the procedure standardised by Heegaard et al. (2005).
P 2231-2232 (Section 3.3.2): *Here the authors should better define which taxa and/or groups are excluded from the main pollen sum for the calculation of the relative frequencies, since the text is vague. Please include a detailed list of the excluded pollen and other palynomorphs.*
We think that everything is already written in this sentence: "A sum of at least 300 terrestrial pollen grains was counted, excluding dominant terrestrial taxa along with water and wetland plants, as well as pteridophyte spores." The dominant taxa changed along the samples (*Fagus*, *Quercus*, *Abies*, *Alnus*).

P 2231-2232: *In the same Section 3.3.2 the authors should also better clarify the composition of the APt and APwa percentages. The percentages of APwa are calculated excluding also Aquatics and Eupatorium from the NAP. Instead APt are calculated including all NAP. For this reason in some parts of the diagrams AP without Alnus show rates higher than the total AP (Figs 7 and 8). This complicates the readability of the data.*
Of course it is not easy to deal with two curves but it is not correct to use only one curve when local and regional vegetation mix like at Trifoglietti.

P 2232, L 12: "Plantago major/P. media" is maybe more correct.
P 2232, L 12: delete "and spore producers:"
P 2234, L 20: write Quercus robur tp., as in Fig. 6, instead of Quercus caduc.
P 2234, L 24: The Osmunda percentages (10-30%) are... instead of "The Osmunda pollen..."
P 2235, L 25: Cichorioideae
P 2236, L 20: Madonie Mountains
P 2236, L 25: sclerophyllous
P 2237, L 13: Zone T-7 (ca. 5100-4650 cal. BP)
P 2237, L 19: *What is meant by "filter role of the Alnus fen"?*
We erased this sentence because it was over interpreted.
P 2238, L 25: Asteroideae
P 2240, L 7-9: *This phrase is a bit confused. Please rewrite it, adding a complete math function if possible.*

We rewrote it: Finally, a ratio which combining the two previously defined ratios, is generated in order to infer environmental evolution; this uses a logarithmic representation illustrated in Figure 9D.

P 2244, L 16: Ostrya/Carpinus orientalis

P 2244, L 19: sclerophyllous

P 2246, L 13: “inland” instead of “onland”

P 2248, L 10-15: between 6800 and 6500 cal. BP the anthropogenic indicators are not particularly developed with respect to other time intervals. On the basis of the AP decrease and the continuous records of anthropogenic indicators and cereals one could infer human impact also between 9600 and 9000 cal. BP. I suggest adding archaeological references in the discussion of the phase between 6800 and 6500 cal. BP.

This point is discussed in the response n°3 of the reviewer 4.

Table 1: 14C with 14 in superscript

Figure 1: we added the reference of Lago Battaglia.

Figure 3: *include the recorded time interval for the ombrothermic diagram*.

We added: Ombrothermic diagram of the meteorological station of Fagnano Castello, about three km from Lake Trifoglietti. This station is on the eastern side of the mountain range, and the record ran for 42 years (1921-1968, Ciancio, 1971).

Figure 5: *quote the program used to plot the age-depth model and explain what envelopes represent.*

We used illustrator and the envelop correspond the 2σ ranges as it is explained in the text

Figure 7: we added a calibrated timescale.