Biogeosciences Discuss., 8, C1669–C1674, 2011
www.biogeosciences-discuss.net/8/C1669/2011/

Biogeosciences Discussions

Interactive comment on "Responses of woody species to spatial and temporal ground water changes in coastal sand dune systems" *by* C. Máguas et al.

C. Máguas et al.

cmhanson@fc.ul.pt

Received and published: 24 June 2011

We gratefully acknowledge helpful comments which have all been integrated as outlined below:

Referee 2

1) The authors need to do a better job of presenting the overall scope of their research. As it stands, this is a case study for sand dune vegetation but the general relevance of the observed mechanisms is unclear.

In our opinion the manuscript falls within the scope of Biogeosciences (interactions between plant functional groups and plant response to hydrological changes) and represents an advance to the state of knowledge of plant functional response to artificial lowering of GW levels. Accordingly to referee suggestions, a particular emphasis was given to the fact that the scope of this work is a better understanding the general impact of changes in GW availability in water-stressed ecosystems (in this case a sand dune system) and the differential response of different of plant functional with different ecological strategies. The following paragraph was added: The main objective of this work is to study the general impact of changes in GW availability in water-stressed ecosystems (coastal sand dunes) in terms of interactions between plant functional groups and plant response to hydrological changes. The manuscript was refocused accordingly through the text, in particularly the introduction and Discussion

2) The important hypothesis 1 was never tested. I.e. there is no statement in the manuscript explaining if and how the 5 plant species differ in ground water use.

Accordingly to the reviewer comments we reworked the initial text in the Introduction: Mediterranean conditions with a strong seasonality often raise the question on the distinct specific responses of different functional groups to a common shortage of a particular water source. Given the particular conditions of artificial lowering of GW levels of this study, we hypothesized that species which have consistent access to GW (i.e. phraetophytes and trees with long and well developed root systems) might be less affected by seasonal drought but more susceptible to the lowering of the GW levels; on the contrary drought adapted shrubs with limited or no access to GW will be less affected by a lowering in GW.

Given the fact that in the discussion it was already mention how the results follow the initial hypothesis, we did not change the text in the discussion section:

Further we pointed out more clearly in the discussion how the results follow the initial hypothesis In agreement with our original hypothesis one, species with deep roots (P. pinaster and M. faya) were the most sensitive to GW drawdown while shallow rooted

BGD

8, C1669–C1674, 2011

Interactive Comment

species (like Corema album) were less affected by changing GW availability. Both of the native tree species, P. pinaster and M. faya, had large variation in GW use across microsites (from almost 100

3) A two-pool model was used to calculate the and d18O of precipitation as the other end-member. Using precipitation as one end-member of the model and not surface soil water might introduce substantial uncertainty to the estimates of isotope composition of precipitation water could differ substantially from soil water (soil water can become evaporatively enriched). I fear that these uncertainties challenge the presented results. The authors acknowledge these uncertainties, yet data on surface soil water would be critically important to evaluate the accuracy of the estimated ground water use.

According to the literature, we follow the well established model developed by Phillip and Gregg (2001). In fact, we have used a simple, two-ended linear model, which allows for calculations of the fraction of only two source in the plant, as unfortunately, surface soil water samples were not available in the current study. In this pure sandy soil it is not straight forward to extract sufficient soil moisture from upper soil layers and digging deep profiles, effective storage and transport to 400km remote lab was not possible in the current study. We agree that it would have been most desirable to have good soil profile data. Nevertheless, simple two end-member model mixing models are often used to quantify source contributions to a mixture. With the combining mixing model sources developed by Phillips and Gregg (2001) or the IsoError we may calculate the mean and the standard error of the fractional contributions based on the uncertainty generated by the variability of both sources (Phillips and Gregg, 2001). Thus, model uses a statistical error propagation calculation to put error bounds (confidence intervals) around these estimates. Indeed this is one of the most common and widely used models for studying water sources in plants, which present formulas for calculating variances, standard errors (SE), and confidence intervals for source proportion estimates that account for the observed variability in the isotopic signatures for the sources as well as the mixture. With this it is possible to interpret our results and to assess the relative importance of: (1) the isotopic signature difference between the sources, (2) isotopic signature standard deviations in the source and mixture, (3) sample size, (4) analytical standard deviations, and (5) the evenness of the source proportions, for determining the variability (SE) of source proportion estimates. Fortunately the ground water isotope signature in this system is always the most negative d18O source. Thus we believe that in spite of the uncertainty to the estimates of Moreover, the isotopic signal from sap water is clearly a function of the site hydrology and determined by sampling the plant's water at intervals from the time the rain falls to the time when the plant water comes back to the isotopic value of the groundwater, runoff, or soil water. Knowing that in a water-stressed environment, the most stable water source is groundwater, and that our aim was to evaluate within a plant community different strengths and functional responses we do think that is still possible to use the above approach and perform the estimation of the main contribution to each source mixture.

4) A central question of this study is how plants respond to changes in the ground water table. However, ground water depth is not presented numerically. Fig. 4, which shows the spatial and seasonal variation in ground water depth with color imaging, is nice but not very useful. I would recommend to show numeric values for ground water depth and to include these values into the analysis. E.g. does the

We decided not to incorporate such data in this paper and use rather a spatial distribution in GW changes and to highlight the spatially heterogeneity concerning ground water depth. In fact given such large variability, only a spatial model could give us such information. Clearly our point was not to relate the data with the absolute changes in GW depth but rather the relative seasonal change. However, it will be possible to add that information in a small table with the piezometric variation, since we have data of 14 piezometers which were distributed in the study area. However, the five sampling sites were selected in this area according to the presence of studied species and not to the presence of a piezometer, thus the estimates of groundwater depth for each site

BGD

8, C1669–C1674, 2011

Interactive Comment

are associated with some uncertainties.

5) Some results are greatly overstated. E. g. p.8 line 13-15. The authors state a clear seasonal difference in the observed source water used by the plant community. I cannot find this difference anywhere. Tab 1 shows that only 2 our of the 5 species show significant seasonal differences.

Following both referees, this sentence was changed to: According to the observations during two different seasons (Spring and Summer), plant species present a higher variability in xylem ïĄď18O during summer period. Xylem δ18O values indicated that most species utilized a mixture between GW and precipitation during spring, (Fig. 3). During summer drought, due to the combination of decreasing GW levels and no significant precipitation, plants tended to have ïĄď18O signatures, which differed from GW signatures, and a larger variability was observed when compared to spring period (Fig. 3).

E. g. p. 8 line 30 cont. I do not see where the authors demonstrate that a lower GW table leads to increased vulnerability to drought.

According to the referee comment, this sentence was re-phrased: During summer, with the lowering of GW, plants in sites A and B showed a larger enrichment in δ18O (relative to spring values), indicating a more limited use of GW .

I have trouble understanding the definition and analysis of the “microsites”. When I read the paper I had the impression that the authors established 5 sites that varied in ground water depth and used this as a gradient to test their hypothesis. In this context, I do not understand the purpose of discussing patterns at the individual sites in terms of “microsite” comparisons.

One innovative aspect of this research is that plant community not only responded according to functional traits (root system development, water use strategies), season, but also to microsite hydrological characteristics. According to this study we considered

BGD

8, C1669–C1674, 2011

a Microsite as a small area where different species are located, with distinctive access to GW. To clarify this to the reader we have included a brief definition about what we consider a microsite in the MM section: “In this study, Microsite is considered a small area where different species are located, with distinctive access to GW. “

In our study we never consider the possibility to study the differences along a gradient (salinity, distance to the sea, etc). Rather than focusing the attention of the reader to a particular gradient, species vary their response according to the GW use local experience, independently of any type of gradient; meaning that responses to GW changes not only changes according to season and physiological traits, but also to previous experienced conditions. Thus during Spring, species such as P. pinaster and M. faya, presented a significant correlation between experienced GW use and changes in pre-dawn water potential and/or carbon isotope composition; higher limitation to GW lead to higher stomatal regulation and lower base water potential.

Indeed, one of the most important challenges in ecology is to evaluate some of the key aspects that create and are responsible for the high variability of plant response; in this case the existence of a spatial heterogeneity and the establishment of microsites in respect to GW access was one of the key aspects.

Interactive comment on Biogeosciences Discuss., 8, 1591, 2011.

Full Screen / Esc

Printer-friendly Version

Interactive Discussion

Discussion Paper