Comment on ‘An overview of the patterned fens of Great Sandy Region, far eastern Australia’ by Fairfax & Lindsay (2019)

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SUMMARY

Fairfax & Lindsay (2019) present an overview of patterned fens in the Grand Sandy Region, eastern Australia, and state that the source of groundwater for the patterned fens in that region is from general discharge of the ‘coastal sand dune systems’, citing McDougall *et al*. (2017). However, our publication is more specific and clearly states that, based on water chemistry data, the source of groundwater for the fens in the Cooloola area is a local perched aquifer. This is supported by other soils-specific references cited by Fairfax & Lindsay (2019) that suggest that the area is associated with perched water tables. Finally, examples of fens on the mainland of Australia highlight that not all fens are in the presence of deep regional sandmass aquifers. In conclusion, we surmise that in order to protect groundwater fed ecosystems, detailed hydrological research is necessary for every specific site.

KEY WORDS: groundwater, groundwater dependent ecosystems

SOURCE WATER FOR PATTERNED FENS

Fairfax & Lindsay (2019) suggest that groundwater discharge from ‘coastal sand dune systems’ is the primary water source for the fens in the Great Sandy Region, specifically citing Coaldrake (1961) and McDougall *et al*. (2017). However, the term ‘coastal sand dune systems’ is broad and can include groundwater from perched aquifers or the deeper basal regional aquifers that are common in coastal sandmasses (Sadat-Noori *et al*. 2016). It is important to be specific on the source aquifer for groundwater dependent ecosystems (GDEs) such as fens, as source aquifer attribution is one of the key data needs to detail the conceptual understanding of the ecohydrogeologic system. In the case of the Cooloola Sandmass, the water in the shallower perched aquifers is generally turbid, tannin-stained and high in specific metals. In contrast, groundwater from the deeper regional aquifer, used by Rainbow Beach township, has a more suitable water quality for urban purposes (Evans 1995). McDougall *et al*. (2017) used water chemistry analysis to highlight the difference between the perched and regional aquifer systems in the Cooloola area and determined that the water chemistry within the fens is more similar to that of the perched aquifers than the regional aquifer. This approach of using environmental tracers (major ions) to identify the origin of groundwater contributions for the fens in the Cooloola region was appropriate as there are a number of monitoring bores within both the perched and regional aquifers to provide reliable results.

The earlier of the two references used by Fairfax & Lindsay (2019) to identify the source aquifer for the fens, Coaldrake (1961), actually states that these particular lowland areas (fens) are either composite groundwater-podzols or peats that have perched water tables and “act as their own aquifers”.

Reeve & Fergus (1982) described the general hydrology of the Cooloola area, but no sampling sites were situated within the fens as their work focused on the creeks, lakes and springs of the area. However, other authors within the same study confirmed that the *Nilkan* soils sampled in the general area of the fens are seasonally wet with perched water tables (Thompson & Moore 1984).

Other examples of patterned fens in Queensland are found on the coast in the Noosa and Mooloolah River national parks as well as Shoalwater Bay Military Reserve (Moss *et al*. 2016, Fairfax & Lindsay 2019). None of these other mainland examples of fens are incised by creeks or adjacent to large coastal sandmasses. The soils at the Cooloola site and the Noosa and Mooloolah River national park sites are podzols with compacted or pan-like layers at depth (Coaldrake 1961, Capelin 1982, Thompson & Moore 1984, Reeve *et al*. 1985). Soil descriptions for monitoring bores adjacent to the fens further highlight these pan-like or indurated layers which are likely to extend out and upslope from the fen, thus extending the area of the aquifer (Queensland Government 2020). As discussed, the use of the term 'coastal sand dune system' encompasses the deeper regional aquifer, which may lead to incorrect determination of the source water for the fens. Use of the term 'local perched aquifers' rather than 'coastal sand dune system' is more appropriate as it aligns with the evidence from soil science and water environmental tracer studies.

Fairfax & Lindsay (2019) also cite two references regarding major differences in groundwater recharge rates and residence times of coastal sand islands. However, they fail to point out that one of these references (Leach & Gallager 2013) relates to a regional aquifer and the other (Sadat-Noori *et al*. 2016) to a perched aquifer on a separate coastal island. The first reference outlines the recharge rate for the regional aquifer for North Stradbroke Island, and the second shows that discharges from a perched aquifer (that sits above the deeper regional aquifer) on Bribie Island can support local lagoons. These perched and regional aquifers have different hydrological properties and behaviour and, therefore, the term 'coastal sand dune system' cannot be used as a 'catch-all' term as it does not adequately describe the differences, nor the GDEs reliant on each aquifer.

CONNECTIVITY BETWEEN AQUIFERS

The statement of aquifer connectivity being confirmed by McDougall *et al*. (2017) is incorrect as no such statement was made in our publication .The water levels of both the fens (authors, unpublished) and the perched aquifer bores are highly responsive to recent rainfall and have very short residence times, whereas the water level within the regional aquifer is related to monthly and annual rainfall patterns (Marshall *et al*. 2018, Queensland Government 2020). Water discharged from the regional and perched aquifers was found to mix only at discrete locations along streams such as Teewah and Searys creeks (McDougall *et al*. 2017, Marshall *et al*. 2018). These creeks do not act as a source of water to the fens as the creeks are incised within the landscape and act as sinks of overland flows from the almost flat topography of the fens, only becoming connected hydrologically after heavy rainfall. Therefore, the fens do not act as significant contributors to baseflow of the creeks as described by Fairfax & Lindsay (2019) as this baseflow is provided by the regional aquifer (McDougall *et al*. 2017). In order to protect these ecosystems, there is more to understand about how coastal sandmass aquifers and perched aquifers behave, and about the effects of groundwater abstraction on wet ecosystems, but it must be based on clear science.

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