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Interactive comment on "Comparison of monsoon variations over groundwater hydrochemistry changes in small Tropical Island and its repercussion on quality" *by* N. M. Isa et al.

Anonymous Referee #1

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This paper contains an interesting set of data that has the potential to increase our understanding of the hydrochemical processes on small tropical islands. However, as it stands there is inadequate background information provided, and because of this, the processes invoked to explain the water chemistry need much more justification. The paper cannot be accepted in its present form, but if the authors provide the additional data and rethink some of their interpretations, it could become a worthwhile addition to the literature.

1. The authors need to provide detailed information on the geology and hydrogeology of the site. On the Google Earth image of Kapas Island, the coastal outcrops are

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uniformly composed of subvertical thin-bedded strata striking north-south, probably interbedded Permo-Carboniferous sandstones and shales. There is no evidence of granite (despite the statement on p. 6417). In the relatively flat area containing the tourist resort and the bores sampled there is probably a thin surface aquifer composed at least partially of porous coral/shell sand and rubble; I presume that all the bores are screened in this material, which is apparently called the Kapas Conglomerate (p. 6409).

The authors need to provide the thickness, lithology and mineralogy of the surface aquifer, as well as its porosity and permeability. Figure 6 needs to be redrawn as a cross-section with a horizontal scale relative to the coastline, a vertical scale relative to sea level, the ground surface (in m asl) and the base of the surface aquifer. The likely position of the seawater/freshwater interface needs to be added.

It is also necessary to provide some information on recharge to the surface aquifer. Apart from direct surface infiltration, there is likely to be runoff from the basement hills. Does this sink into the surface aquifer or flow across it, or both?

I presume that the tourist resort obtains its water from bores in the surface aquifer. In that case, there should be available data on bore yields; this should be added. The location of these bores needs to be shown on Fig. 2.

2. The authors attribute some of the chemical changes to cation exchange (e.g. of Na for Ca). However, the only minerals that they identify in the aquifer are carbonates, and no significant cation exchange will occur on these minerals. For cation exchange to be an important process, there needs to be a substantial component of clay in the surface aquifer. This could be derived from erosion of the basement aquifer (apparently thin-bedded shales and sandstones). The authors need to show this.

3. The dominant carbonate minerals in the surface aquifer, if it contains coral/shell material, will be aragonite and calcite; dolomite is unlikely. Some of the calcite will be high-Mg calcite containing up to 4% Mg, so dissolution of this will release Mg into

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the groundwater (accounting for the correlation between Can and Mg). Dissolution of calcite and aragonite will release both Ca and HCO3:

$CaCO_3 + H_2CO_3 = Ca^{2+} + 2HCO_3^-$ (this should replace reaction 5)

Normally there would be a positive correlation between Ca and HCO3; the Kapas Island data apparently does not show this (Table 3). However, a standardised Schoeller plot shows that post-monsoon groundwater is enriched in both Ca and HCO3 relative to pre-monsoon groundwater; the enrichment in Ca is greater than expected just from calcite/aragonite dissolution, perhaps due to cation exchange.

4. The authors collected samples in triplicate; this is to be applauded. However, when they plot the data, they should use only the median of each set of triplicates, i.e. 72 points not 216. They also need to present a table with this median data; this should replace Table 2. Charge balances need to be provided for all analyses in the table.

5. The Schoeller plot (Fig. 4) is the single most useful diagram. A second Schoeller plot, with the line for seawater plotted, and all three lines standardised to seawater Cl (this automatically removes the effect of evapotranspiration), should also be added. If the rainfall composition is available, it should be plotted. This will immediately make obvious which elements have been removed/added.

6. Some of the KW6 pre-monsoon samples show a seawater influence, as the authors point out. This implies that the seawater/freshwater mixing zone extends 30 m inland at a depth of only 2 m (this should be shown on the redrawn cross-section). Interestingly, not all the KW6 pre-monsoon samples show this influence. This could be a tidal effect; the authors should investigate this.

7. The molar Na/Cl ratio for the KW6 pre-monsoon samples is $\sim$0.63; for seawater it is 0.86. This indicates a loss of Na, which could be due to cation exchange.

8. The Cl content of the groundwater (in samples not affected by seawater) ranges from 10-56 mg/L, i.e. greater than the likely Cl content of rainfall. This indicates the

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influence of evapotranspiration; given the high humidity (80%), transpiration is likely to be more effective than evaporation.

9. If pollution from sewage is suspected (p. 6415-6416), then NO3 analyses are needed. Interestingly, Table 2 shows that most groundwater samples have low DO and Eh values; either there is a high content of organic material in the aquifer, or this could reflect sewage input. The authors need to explore this.

10. Post-monsoon groundwater is more dilute than pre-monsoon groundwater and has a much less variable composition (Fig. 5). After the average compositions are standardised to Cl, pre- and post-monsoon groundwater have similar levels of K and Na, but the post-monsoon groundwater has higher levels of Ca, Mg and HCO3 (due to calcite/aragonite dissolution). Therefore the effect of rainfall infiltration during the monsoon is to dilute the groundwater (as expected), but also to cause more calcite/aragonite dissolution. This is surprising, and the authors need to investigate the cause. Perhaps groundwater sitting in the surface aquifer since the last monsoon, with more time to dissolve the carbonate minerals, is flushed out by input during the subsequent monsoon.

11. Fig 9 is missing; Fig 8 is duplicated.

12. Much of the material on pages 6413 and 6414 could be deleted.

13. There are many small grammatical errors; if the authors could prevail on a native-English-speaking colleague to check the English expression, this would improve the paper.

Interactive comment on Hydrol. Earth Syst. Sci. Discuss., 11, 6405, 2014.