Comments and Questions

Referee #2

1. **In general, this study seems like an interesting case study, but not one that would be applicable to a general worldwide journal audience. The procedures are fairly basic (sampling for typical water characteristics, saturation index calculations for certain minerals), and the study area is confined to a very small locale (6 wells along a 120-m line). The authors claim that the study is general to small tropical islands, but the nature of the study is too confined to be able to support this claim. The results may not even be applicable to the remaining sections of the island, let alone to other islands, especially since the wells were drilled in low-lying, densely-populated areas (although the population density is not reported). In reality, the study is performed along a 120 m stretch of a single island, with hundreds and thousands of other tropical islands experiencing different climatic patterns and human influences. Also, Kapas is located at the monsoon interchange (as stated on page 6410), and hence results seem to be applicable only to islands at this location. Overall, this manuscript reports a local case study that is not applicable (or at least cannot be proved to be applicable) to other study sites worldwide. Hence, the rating of "poor" in terms of Scientific Significance (see ratings above).**

Kapas Island is the best location of developing area to explain the hydrochemical changes of groundwater and its affects to the seasonal variation. As the study location is concentrated at the low-lying area, it suffices the study to claim as the whole island since Kapas Island is a small island with a single groundwater aquifer. Information in this study act as baseline materials to other small tropical island that are normally had a similar aquifer types and parent's bedrock.

Answer in text;

"Study location at Kapas Island has been concentrate at the low-lying area will suffice to support the whole island since Kapas Island is a small island (based on its size) with a single groundwater aquifer. This study also represents other tropical islands that are normally had a similar aquifer types and parent's bedrock. It is suitable to acknowledge the climates where islands in the tropical region most probably facing similar events of monsoon changes as the seasonal variations are dominated by precipitation."

"To date, the previous studies carried out on small tropical island's aquifer have explored into the issue of groundwater pollution regarding seawater intrusion. This study offers a better understanding on the groundwater hydrochemistry of a pristine environment by providing a better interpretation of the results and enhancing the use of selected variables in hydrochemistry studies, as a source tracer for groundwater contaminations. The present study also compromises with the quantitative and qualitative outputs where the quantitative issues have exemplified the hydrochemistry concerns based on the concentration of elements in the groundwater, signifying

the differences of mechanisms in both the spatial and temporal scales and elucidating the groundwater status based on the established guidelines. Meanwhile, the qualitative issues include the evidence of affected areas, the comparison with previous researches on the groundwater study and either to create new databases or to improve the existing guidelines especially on small tropical islands. This information will be of value in setting the priorities and allocating the resources within the regulatory agency by contributing as a baseline data of hydrochemistry in small tropical islands. It would be fruitful to pursue further research in terms of the management concerns by certifying the ongoing profits from a myriad of tourism activities as long as the natural ecosystem remains unharmed."

2. **Even when results are reported, the authors do not go into great detail about the CAUSE of the results. On pages 6415 and 6416, the authors state that the evaporation process "may" contribute to salinization, and that infiltration of leachate from sewage piping systems "may" contribute to salinization. These are stated, but not tested nor is information given that could support the hypotheses. The authors must state substantiated causes for the conditions observed in the groundwater. Without a firm grasp on the causes, water management practices cannot be adjusted. Otherwise, the study is merely a chemical analysis of water. The authors do state that Na and Cl increases in significance during the dry season. However, I think it is quite intuitive that Na and Cl would increase in importance during the dry season, as the freshwater lens thins. Groundwater chemistry analysis is not needed to demonstrate that freshwater volumes in the aquifer decline during the dry season. Besides being intuitive, this has been shown in hundreds of other studies.**

The objective of this paper is to determine the hydrochemical changes of groundwater and its affects to the seasonal variation. Since present study is to focus on the hydrogeochemistry of monsoon changes, the anthropogenic impacts were excluded along with the statement of sewage influents. Na and Cl explanation is vital to this study as the groundwater composition usually reflects to its aquifer bedrock. Since Kapas Island was dominated by Ca-HCO_3, the existence of Na and Cl need to be discussed especially during pre-monsoon.

Answer in text;

"The high concentration of seawater elements of Na and Cl during pre-monsoon can be explained by the salinization process in the groundwater where it is also manifested by significant positive correlations with salinity ($r = 0.7, 0.7; p<0.01$). The increase in Na concentration could be due to the cation exchange of Na (residual from an inundation event/big wave that binds onto the aquifer matrix) with Ca^{2+} ion during the groundwater mixing process.

The mechanism can be expressed in Eq. 2; where X represents the aquifer matrix (Solid phase particularly Silicate (Si) – since Si is dominant in Kapas Island after Ca as illustrated by SEM-EDX). It explains that Ca^{2+} ion replaced Na from the aquifer matrix and released Na^{+} in the groundwater. The existence of Si also can be seen in ionic ratio and saturation index subsection where certain ratios explain the Si weathering. The effect of climate change can also be seen by the drop of water tables as shown in Fig 8."

$$\frac{1}{2}Ca^{2+} + Na - X \leftrightarrow Na^{+} + \frac{1}{2}Ca - X_2 \qquad \text{Eq. 2}$$

3. **The implications of the study are not clear. The water collected from the six boreholes is fresh (all less than the freshwater limit of about 0.89 ppt, used in many other island hydrologic studies) in each of the 216 samples during both the dry season and wet season, and no data are available regarding other contamination (fecal coliforms, nutrients, trace metals, etc...). Hence, there is no indication that the water is not safe to drink (or that there is limited amount) during both the pre- and post-monsoon seasons. So how can results lead to better water management, particularly in regards to the tourist industry (which the authors point out is the reason for the study in the first place)? If there are no problems, how will the information "be of value in setting priorities and allocating resources within regulatory agency", as stated by the authors on Page 6420?**

Since present study is to focus on the hydrogeochemistry of monsoon changes, the anthropogenic impacts were excluded along with the statement of sewage influents. Where, the sewage influences usually described the amount of the total coliform and nutrients in the groundwater. The hydrochemical composition of groundwater is controlled by many factors that include the mineralogy of the aquifer, climate variability and topography. These factors can combine to create diverse water types that change in groundwater composition spatially and temporally as the present study did. The potable limit of groundwater based on the major ions concentration and physical properties (*in-situ* parameter) has been added in Table 3 as the indication of the water safety for human consumption.

Answer in text;

"To date, the previous studies carried out on small tropical island's aquifer have explored into the issue of groundwater pollution regarding seawater intrusion. This study offers a better understanding on the groundwater hydrochemistry of a pristine environment by providing a better interpretation of the results and enhancing the use of selected variables in hydrochemistry studies, as a source tracer for groundwater contaminations. The present study also compromises with the quantitative and qualitative outputs where the quantitative issues have exemplified the

hydrochemistry concerns based on the concentration of elements in the groundwater, signifying the differences of mechanisms in both the spatial and temporal scales and elucidating the groundwater status based on the established guidelines. Meanwhile, the qualitative issues include the evidence of affected areas, the comparison with previous researches on the groundwater study and either to create new databases or to improve the existing guidelines especially on small tropical islands. This information will be of value in setting the priorities and allocating the resources within the regulatory agency by contributing as a baseline data of hydrochemistry in small tropical islands. It would be fruitful to pursue further research in terms of the management concerns by certifying the ongoing profits from a myriad of tourism activities as long as the natural ecosystem remains unharmed."

4. **In regards to the quality of the water (in terms of salinity), the authors do not provide information regarding the thickness of the freshwater lens. They report only borehole depth and water table elevation, but not the depth at which the groundwater transitions from being fresh to being brackish. This is very important in terms of the quantity of groundwater that is available for use during the seasons of the year. Particularly since the context of the manuscript is providing enough clean, fresh water for the high-activity tourism season (e.g., Page 6407: the authors state that heavy withdrawals and overpumping leads to salinization in the aquifer...), it seems that this information is vital. It would also help with explanation of the chemistry results, particularly in regards to the increase of Na and Cl during the dry season.**

Related table and figure has added. Table 1 and Figure 10

Answer in text;

"Only samples from KW 6 during the pre-monsoon were isolated from others, which portray a slight interference of seawater, either the interference from the transition zone since KW 6 is approaching towards this particular zone or it could be tidal effects. This can be proven as the Cl concentration correlates well with the seawater component; Na ($r = 0.907$; $p<0.01$). The groundwater samples from the post-monsoon indicate that the groundwater was in a freshening status in which the high Cl concentration (pre-monsoon) was diluted due to the heavy rainfall. Fig.10 describes the interference of the approaching transition zone during pre-monsoon (1) and the widened aquifer during post-monsoon due to recharge by rainfall (2)."

Table 1 The description of the hydrogeological properties in Kapas Island

Hydrology	**Mean**
Temperature	30.12 °C
Annual Precipitation	2274.66 mm/year
Annual Evapotranspiration	50% of annual precipitation
Groundwater recharge rate	467 m^3/day
Groundwater discharge rate	1.6 m^3/hour
Transmissivity	2.62 m^2/hour
Permeability	1.4 x 10^{-4} m/s
Porosity	0.14 – 0.49 *n*
Max. aquifer thickness	27 – 29 m
Natural groundwater run-off	7.5 m^3/hour
Hydraulic gradient	2.9 x 10^{-3}

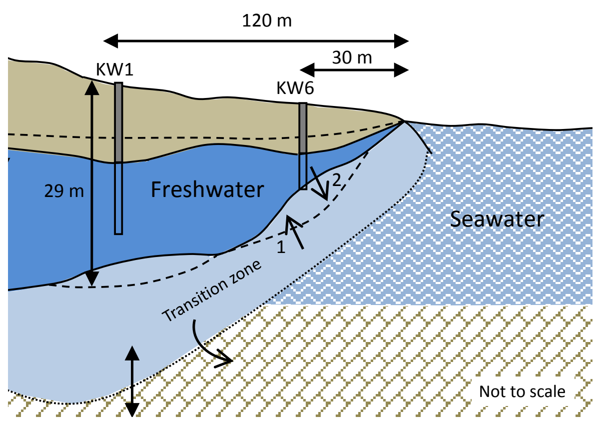

Fig. 10. The cross-section of KW 6 during the monsoon interchanges. Over the groundwater extraction during pre-monsoon, were narrowed the freshwater lens (1). Meanwhile, the opposite event reveals the widening of the aquifer storage during post-monsoon (2)

Minor comments

a. **The abstract needs to mention the island that is studied! (Kapas)**

The amendment has been done.

Answer in text;

"The study on the spatial and temporal distributions of groundwater hydrochemistry in Kapas Island is important as their insular character may expose the groundwater aquifer to too many sources of pollution, especially salinization. A total of 216 groundwater samples were collected from the monitoring boreholes during two different monsoon seasons; pre- and post-monsoon. In all, the data of groundwater concentration have illustrated a trend of Ca>Na>Mg>K and $HCO_3>Cl>SO_4$ *dominations with the major findings derived from two different groundwater types. Pre-monsoon reported the domination by the Na-*HCO_3 *and Ca-*HCO_3 *types while post-monsoon was only dominated by the Ca-*HCO_3 *type."*

b. **The first few sentences of the Introduction are too familiar, and the English needs to be check rigorously (and throughout the manuscript). "the cult of busy life" in particular needs to be changed.**

The amendment has been done and English has been checked

Answer in text;

"Small tropical islands which are mostly under development commonly function as places of attraction which help boost the tourism industry. Since these islands are always crowded, including with the local community, the most crucial need for life in these islands happens to be water. The situation can get interesting and complicated at the same time, when small tropical islands especially Kapas Island are reported to experience a scarcity of surface water where the entire area depends on the groundwater as their primary water resource. "

c. **Page 6406: "small tropical islands are known..." Please define small in terms of scale. A few square kilometers? Tens of kilometers? Many "small" islands do have surface water, but it depends on how you define "small".**

Answer in text;

"Kapas Island is located at 5° 13.140' N, 103° 15.894'E (Fig. 2) and was classified as a small island based on its landmass of about 2 km^2 *(Abdullah, 1981; Shuib, 2003; White et al., 2007)."*

d. **Page 6407: "heavy withdrawals" and "over-exploitation": aren't they the same thing?**

The amendment has been done.

Answer in text;

"According to Gaye (2001) and Rosenthal (1988), other factors affecting groundwater salinization include the inflows of saline water during heavy withdrawals of fresh groundwater."

e. **Page 6407: "evaporated salt": salt does not evaporate. But salinity can increase as the water is evaporated.**
f. **Page 6407: "from inundation": are you referring to salt spray, or wave over-wash? Please be more specific, and cite specific examples of inundation occurring.**

The amendment has been done.

Answer in text;

"Groundwater salinization also results from the dissolution of salt (residual salt from the evapotranspiration process during the wave over-wash event) that accumulates in the subsoil over long periods of time (Payne et al., 1979; Benyamini et al., 2005) or the flushing out of salt by the precipitation from airborne salts, soil and surface area. Furthermore, the salinization of the groundwater might change the normal groundwater constituents and the suitability for drinking purposes and domestic use."

g. **Page 6408: Ranges of rainfall depths are provided for the dry season and wet season, but there is not indication as to where these depths were measured. I assume the authors are providing data from Kapas, but this is not stated. In general, refrain from including detailed information about the study area in the Introduction, especially if the study area has not yet been mentioned!**

The amendment has been done.

Answer in text;

"Kapas Island is located at 5° 13.140' N, 103° 15.894'E (Fig. 2) and is classified as a small island based on its land mass of about 2 km² (Abdullah, 1981; Shuib, 2003; White et al., 2007). The climate is a typically tropical climate with an annual rainfall of between 451 and 1102 mm, which is influenced by the monsoon blowing from the middle of November to January. Fig. 3 shows the distribution of the annual rainfall in Marang, Terengganu from 2000 to 2012 where heavy rainfalls were recorded at the end of every year. These rainfall data were obtained by the authority of the Department of Irrigation and Drainage Malaysia where the hydro-metrological sets have been installed nearby."

h. **Page 6408: "a national view": which nation are you referring to? I assume Malaysia, but this is not stated. Besides, it the study is aimed at a national view, there perhaps it is not appropriate for a general journal readership.**

The amendment has been done. The nation is referring to Malaysia and this study also referring to other small island with the similar geology characteristic and climate.

Answer in text;

"The lack of knowledge concerning these systems could limit the ability to take actions about groundwater pollution in small islands. It is important to carry out detailed groundwater studies, such as groundwater monitoring and assessment, to recommend alternatives that aim at detecting and reducing such risks. Hence, with precise and suitable facts, it could offer an explanation and solution to the sector responsible for the variation of groundwater constituents."

i. **Page 6409: "and modeling": What modeling are you referring to? Groundwater flow, contaminant transport, climate, etc...?**

The amendment has been done. The modeling has change to saturation index.

Answer in text;

"The objective of this study is to reveal the important information of groundwater in Kapas Island, which applies to most of the study specifications listed above (Hydrogeochemistry, groundwater quality, mineralization process, seasonal effects and saturation index)."

j. **Page 6409: first time that "Kapas Island" is mentioned. Probably does not belong in the Introduction, or perhaps the last paragraph when outlining the objectives of the paper.**

The amendment has been done in Introduction section also in the objective sentences.

Answer in text;

"Small tropical islands which are mostly under development commonly function as places of attraction which help boost the tourism industry. Since these islands are always crowded, including with the local community, the most crucial need for life in these islands happens to be water. The situation can get interesting and complicated at the same time, when small tropical islands especially Kapas Island are reported to experience a scarcity of surface water where the entire area depends on the groundwater as their primary water resource."

"The objective of this study is to reveal some important information about the groundwater in Kapas Island, which applies to most of the study specifications listed above (Hydrogeochemistry, groundwater quality, mineralization process, seasonal effects and saturation index)."

k. **Page 6409: "can be applied in other tropical islands": Please be more specific. To what specific geographic locations would information be applicable?**

The sentence has been rephrased for its original meaning.

Answer in text;

"Developing areas such as Kapas Island can pose a problem in managing the sustainability of groundwater due to the distance, also, there is lack of expertise and information about other tropical islands which can be applied in Kapas Island. "

l. **Page 6409: "concerning groundwater in small tropical islands": Again, this study is extremely limited in terms of scale (only 120 m line of wells on one island), and cannot be generalized as the authors attempt to do.**

The amendment has been done.

Answer in text;

"The study location at Kapas Island which concentrates on the low-lying area will be suffice to support the whole island since Kapas Island is a small island with a single groundwater aquifer. This study also represents other tropical islands that normally have similar aquifer types and parent's bedrock. It is suitable to acknowledge the climates where islands in the tropical region most probably face similar events of monsoon changes as the seasonal variations are dominated by precipitation."

m. **Page 6410: the authors have a general conceptual model of small island hydrogeology (Figure 1). However, a detailed schematic of the hydrogeology of Kapas is needed. The authors then can refer to this throughout their discussion.**

Related figures have been added. Figure 2 and Figure 5.

Answer in text;

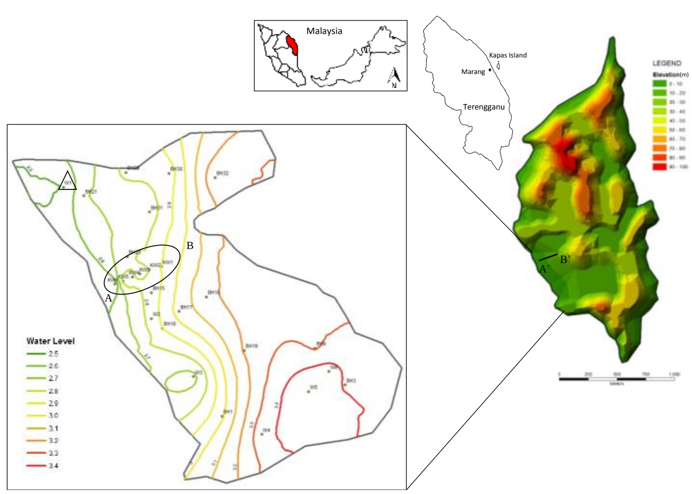

Fig. 2. Schematic map showing the geographical locality of Kapas Island and the constructed monitoring boreholes

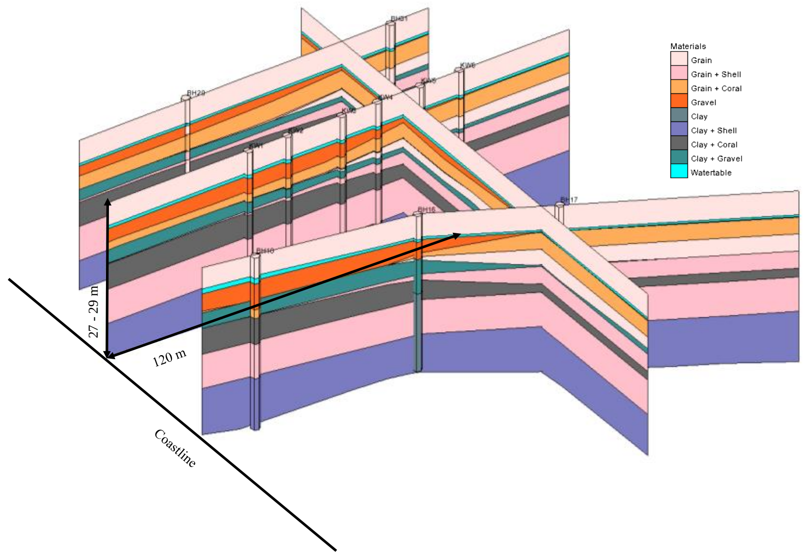

Fig. 5. The cross-section of study location in Kapas Island (KW 1, KW 2, KW 3, KW 4, KW 5 and KW 6). Other boreholes were abandoned (BH10, BH16, BH17, BH20 and BH31). The max aquifer thickness is the calculation of Ghyben-Herzberg equation and resistivity report from Kura et al. 2014

n. **Page 6410: the last paragraph of Section 2 should be the first paragraph of the section. Better to start with basic geographic location, and then move into the geologic details.**

The new arrangement has been made in the site description section.

Answer in text;

"Kapas Island is located at 5° 13.140' N, 103° 15.894'E (Fig. 2) and is classified as a small island based on its land mass of about 2 km² (Abdullah, 1981; Shuib, 2003; White et al., 2007). The climate is a typically tropical climate with an annual rainfall of between 451 and 1102 mm, which is influenced by the monsoon blowing from the middle of November to January. Fig. 3 shows the distribution of the annual rainfall in Marang, Terengganu from 2000 to 2012 where heavy rainfalls were recorded at the end of every year. These rainfall data were obtained by the authority of the Department of Irrigation and Drainage Malaysia where the hydro-metrological sets have been installed nearby. Kapas Island experiences a constant mean temperature of 29.88 °C, varying from 28 °C to 31 °C, and has an average daily relative humidity of around 80 %.

The topography of Kapas Island includes a hilly area (maximum height approximately 100 m) which covers 90 % of the island, while the rest is a relatively low-lying area (Fig. 2). The land use of Kapas Island, excluding the hilly area, shows that about 8 % of the area is comprised of secondary forest, while the sandy coastal area constitutes only 2 %."

- **o. Page 6410: "bimonthly" should be "semi-monthly"**
- **p. Page 6411: Equation at the top of the page should not be included. Instead, state the calculations in the text.**

The amendment has been made.

"The sampling design for this study was based on spatial and temporal scales. A total of 216 groundwater samples with replicates were collected bimonthly/semi-monthly (two times a month) from six constructed boreholes (specifically KW 1, KW 2, KW 3, KW 4, KW 5 and KW 6) during the pre-monsoon (Aug 2010 – Oct 2010) and post-monsoon (Feb 2011 – April 2011). The calculation of 216 groundwater samples works as follows; 6 monitoring boreholes times with triplicate times with 6 sampling campaigns and times 2 seasons; 108 groundwater samples of each monsoon. It has to be clear that the triplicate times here represent the groundwater samples were taken in three different sample bottles rather than divided into three sections from a single bottle. The discussion of this paper is based on monsoons rather than each monitoring borehole since the objective is to focus on the hydrogeochemistry of monsoon changes."

- **q. A Page 6411: Typically when taking groundwater samples for chemical analysis, a more rigorous procedure is followed to make sure that the water being sampled comes from within the aquifer (rather than just pumping for 10-15 minutes...this might be adequate, but data are required to show that water characteristics have stabilized through time as pumping continues...without this quantitative procedure, the results may not be valid).**

The procedures of pumping activity (10 – 15 minutes) are enough for precaution of collecting the representative groundwater samples in Kapas Island. During this period of times (max. 15 minutes), the electrical conductivity (EC) reading was used to show that the groundwater characteristics have stabilized.

Answer in text;

"Prior to the collection of the groundwater samples, the samples were pumped out for about 10-15 minutes to avoid any stagnant and polluted water that might interfere with the physicochemical measurement and the equilibrium of the chemical condition of the water. During this period of times (max. 15 minutes), the electrical conductivity (EC) reading was used to show that the groundwater characteristics have stabilized."

r. **Page 6412: Which laboratory was used for major ion analysis? Is it certified?**

The amendment has been made.

Answer in text;

"For analyses of the cations, groundwater samples were filtered through a 0.45µm Millipore filter and immediately acidified with HNO_3 (pH < 2) to prevent bacterial development, to block the effects of oxidation and to prevent the adsorption or precipitation of cations in the groundwater samples (Appelo and Postma, 2005). Pre-treated samples were kept in a cool box before being transported to the hydrogeology laboratory in the Faculty of Environmental Studies, Universiti Putra Malaysia for major ions analysis using a flame atomic absorption spectrophotometer (FAAS, Perkin Elmer, Massachusetts, USA).

The preservation and data collection of samples were done precisely to ensure the quality of data. In-situ devices were calibrated with buffer solutions before and after the field sampling to ensure that they functioned properly and accurately. The accuracy checks were undertaken to obtain a reliable analytical dataset by checking the procedure of blank measurements and a three-point calibration curve when using the FAAS. The annual preventive maintenance for the FAAS was done to receive the accreditation for the system and approval of the laboratories from governmental bodies under the certification of ISO 9001:2008."

s. **Equations (1)-(3) are basic to any water chemistry handbook, and probably should not be included in a journal paper. If any, only Equation (3) should be included.**

The amendment has been made.

Answer in text;

"In particular, the equilibrium of minerals is related to water interaction. Some minerals, such as NaCl, react faster upon contact with water. If the dissolution and precipitation occur in the same amount, an equilibrium is obtained. The fundamental tenet to any description of equilibria in water is the law of mass action (Appelo and Postma, 2005). As an analogy to the law of mass action, one can calculate with the activities, to gain the Ion Activity Product (IAP). Comparing the IAP with the K (equilibrium constant), this leads to an expression of the saturation condition, or the saturation index (SI). In PHREEQC software, the SI can be calculated based on Eq. 1."

$$\mathrm{SI} = \log\left(\frac{\mathrm{IAP}}{\mathrm{K}}\right) \qquad \textit{(Eq. 1)}$$

t. **Page 6413: The use of geochemical modeling and calculating SI values should be mentioned previously, perhaps in the Introduction. And also state WHY these are used.**

The amendment has been made.

Answer in text;

"For this study, the SI for the selected minerals was calculated to gain a better understanding of the hydrochemical processes that take place in the aquifer during the mixing of freshwater and seawater. PHREEQC software was used to set up the hydrogeochemical components of the groundwater, especially the saturation parameters for carbonate minerals (calcite, aragonite and high-Mg minerals), to test the mineral saturation and to eliminate the reactions that are thermodynamically invalid. A negative SI value defines the dissolution process, a positive SI value explains the precipitation process, while a 0 value of SI indicates the equilibrium state of carbonate minerals."

u. **A Page 6414: When presenting results, also include the standard deviation. And then discuss results (for example, why is there such a large difference between min and max DO, for each of the boreholes?)**

The amendment has been made.

Answer in text;

"The results with average, SD, median and range values are presented in Table 3. For pre-monsoon, the average temperature and DO values are 30.43 °C (SD; 1.3) and 2.97 mg/L (SD; 2.1), respectively. The EC is in the range of 0.41 to 0.91 mS/cm (SD; 0.2). TDS is in the range of 204 to 455 mg/L, with an average of 281.85 mg/L (SD; 74.6). The average salinity value in the groundwater is 0.27 ppt (SD; 0.07), while the pH and Eh have the average values of 7.12 (SD; 0.2) and 4.03 mV (SD; 9.7), respectively. Data for post-monsoon show the average temperature and DO are 29.34 °C (SD; 0.9) and 3.85 mg/L (SD; 2.3), respectively. EC has recorded an average of 0.39 mS/cm (SD; 0.06) while TDS is in the range of 158.8 to 276.0 mg/L (SD; 28.2). Low salinity has been reported to have an average of 0.19 (SD; 0.03). The averages of pH and Eh are 7.22 (SD; 0.08) and -1.85 mV (SD; 5.1), respectively. Each parameter shows a significant difference ($p<0.01$) between monsoons after the ANOVA test. Since post-monsoon tends to experience heavy rainfall, the temperature decreases as the weather becomes cold. The DO concentration is relatively low during pre-monsoon because the groundwater is in a closed system. Therefore, the increased DO during post-monsoon is due to the heavy rainfall which carried the O_2 together into the aquifer. EC has a positive correlation with TDS ($r = 0.999$; $p<0.01$). EC and TDS values represent ions in the groundwater as they are strongly correlated with the major ions ($p<0.01$; Table 4) except for SO_4. Salinity values show a significant decrease from pre- to post-monsoon due to the heavy rainfall which diluted the salinity. pH explains the

acidity/basicity of water where both monsoons were under neutral condition while Eh refers to the redox-potential process. The detection of sulfide odors in certain groundwater samples has revealed the existence of hydrogen sulfide (H_2S) where at the same time, experiencing the unpleasant odors of H_2S during the sampling campaign, one which is described as the most likely product from the sulfide reduction process."

"Table 3 present the concentration of major ions based on different monsoon. Pre-monsoon present Ca and Na with mean concentration of 44.7 (SD; 25.8) and 19.1 mg/L (SD; 14.5), respectively, while, compared to post-monsoon, Ca and Na were drastically increase and decrease with average value of 83.4 (SD; 12.6) and 7.64 mg/L (SD; 3.9) respectively. Low concentration of Mg and K was recorded in most cases with average value of 5.1 (SD; 2.5) and 1.1 mg/L (SD; 0.9) during pre-monsoon whereas, 6.3 (SD; 2.7) and 0.4 mg/L (SD; 0.5) during post-monsoon respectively. HCO_3 is the dominant anion in both monsoons, with an average of 379.2 (SD; 121.9) and 274.55 mg/L (SD; 41.2) respectively. The mean values of Cl shows decreasing level from 43.7 mg/L (SD; 30.6) during pre-monsoon to 18.6 mg/L (SD; 4.9) during post monsoon. Same pattern goes to SO_4 where the average value was 14.4 mg/L (SD; 7) in pre-monsoon and 10.3 mg/L (SD; 5.3) in post-monsoon respectively."

v. **Page 6414: At some point, the reader needs to know the potable limit of groundwater (in terms of ppt), so that the results shown in Table 2 can have some context.**

The amendment has been made in Table 3.

Answer in text;

Table 3 Descriptive analyses of *in-situ* and major ions in groundwater samples (n = 216)

Pre-monsoon		Mean	SD	Median	Min	Max	WHO, 2010
Temperature	°C	30.43	1.34	30.20	27.80	35.10	NA
pH		7.12	0.16	7.16	6.68	7.64	6-9
EC	mS/cm	0.56	0.15	0.55	0.41	0.91	1.5
Salinity	ppt	0.27	0.07	0.26	0.20	0.45	NA
DO	mg/L	2.97	2.12	2.21	0.63	8.46	NA
TDS	mg/L	281.85	74.64	273.50	204.00	455.00	1000
Eh	mV	4.03	9.71	1.30	-7.50	32.30	NA
Ca	mg/L	44.67	25.81	39.25	10.40	145.20	200
Mg	mg/L	5.12	2.51	4.20	1.62	10.40	150
Na	mg/L	19.10	14.49	12.39	0.80	58.80	200
K	mg/L	1.13	0.87	0.85	0.03	3.89	200
HCO_3	mg/L	379.19	121.87	342.82	241.56	893.04	NA
Cl	mg/L	43.69	30.64	33.24	11.49	141.96	250
SO_4	mg/L	14.36	7.04	12.50	1.00	30.00	250

w. Page 6415: "mixed with the brackish water": the authors refer to Figure 1, but information regarding the actual freshwater lens thickness within the vicinity of the boreholes is not reported. Information regarding the lens thickness must be reported so that the reader can decided if up-coning of the transition zone indeed is a cause of aquifer salinization.

Related figure has been added. Figure 10.

Answer in text;

"The scatter plot of the Cl/HCO_3 ratio vs. Cl (Fig. 9a) explains the groundwater status in which the distribution shows a positive correlation with an r value of 0.964 ($p<0.01$). Only samples from KW 6 during the pre-monsoon were isolated from others, which portray a slight interference of seawater, either the interference from the transition zone since KW 6 is approaching towards this particular zone or it could be tidal effects. This can be proven as the Cl concentration correlates well with the seawater component; Na ($r = 0.907$; $p<0.01$). The groundwater samples from the post-monsoon indicate that the groundwater was in a freshening status in which the high Cl concentration (pre-monsoon) was diluted due to the heavy rainfall. Fig.10 describes the interference of the approaching transition zone during pre-monsoon (1) and the widened aquifer during post-monsoon due to recharge by rainfall (2)."

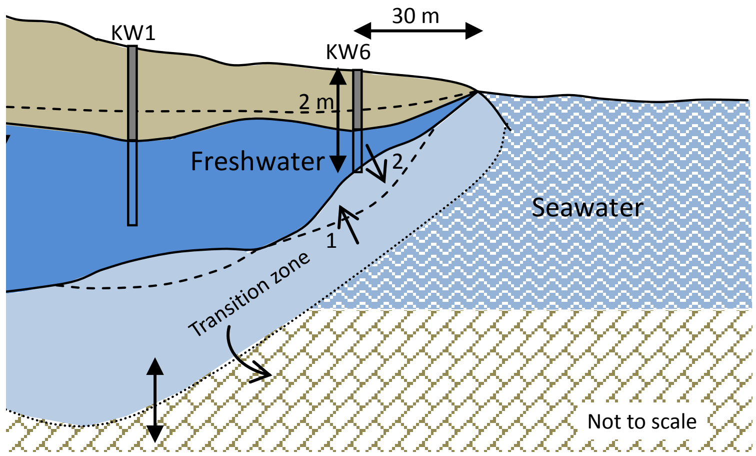

Fig. 10. The cross-section of KW 6 during the monsoon interchanges. Over the groundwater extraction during pre-monsoon, were narrowed the freshwater lens (1). Meanwhile, the opposite event reveals the widening of the aquifer storage during post-monsoon (2)

x. **Page 6416: "clearly explained the important roles of rainfall as its' groundwater recharge": Rainfall is the only source of recharge. This is obvious, and hence this sentence can be deleted.**

The amendment has been made.

Answer in text;

"As rainfall (recharge) continues to be observed during monsoon interchanges, seawater elements as well as domestic pollutants can be removed by widening the aquifer storage, furthering the distance of the transition zone and increasing the groundwater table level where the average elevation is 1.21 m."

y. **Page 6418: The authors need to explain why there is more precipitation during the post-monsoon. Again, showing results is one thing; explaining the CAUSE of these results is quite another matter, but must be included.**

The amendment has been made.

Answer in text;

"Tropical regions are influenced by the South-West Monsoon (pre-monsoon; May to September), mostly during the dry season and the North-East Monsoon (post-monsoon; November to March), particularly the wet season (Desa and Niemczynowicz, 1996; Wong et al., 2009). During the dry season (rainfall: 2.5 -27 mm), groundwater is more susceptible to salinization problems as it is characterized by low precipitation with high ambient temperature as well as high evapotranspiration rate. On the other hand, the post-monsoon is related to an event after high precipitation (rainfall: 451-1102 mm), where it could influence the quantity of recharge and the quality of groundwater in small islands as precipitation events can lead to an improvement in the quantity and quality of the groundwater (Amer, 2008; Saxena et al., 2008; Aris et al., 2007; Aris et al., 2010b)."

z. Figure 9 is the same as Figure 8

The amendment has been made.

Answer in text;

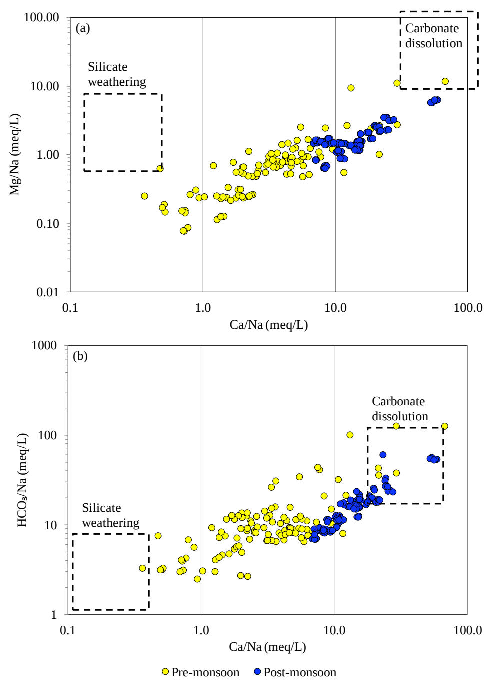

Fig. 12. Scatter plot of molar ratio of (a) Na-normalized Ca vs. Mg and (b) Na-normalized Ca vs. HCO_3

aa. Figure 10: need much more narrative and explanation in the text

The amendment has been made.

Answer in text;

"The illustration of SEM-EDX (Fig. 13) is used to support/justify the existence of carbonate minerals – $CaCO_3$ and $CaMg(CO_3)_2$– which has been used to describe the groundwater mechanisms throughout the paper. Ca is present as the highest peak which explains the major elements in the Kapas Island aquifer. Following the Si, it is a basic element that should be found in a coastal area and in other minor elements – C, O, Mg, Al, S and K. "

"The increase in Na concentration could be due to the cation exchange of Na (residual from an inundation event/big wave that binds onto the aquifer matrix) with Ca^{2+} ion during the groundwater mixing process. The mechanism can be expressed in Eq. 2; where X represents the aquifer matrix (Solid phase particularly Silicate (Si) – since Si is dominant in Kapas Island after Ca as illustrated by SEM-EDX)."

bb. Page 6419: avoid the use of the word "excellent" when describing your own research

The amendment has been made.

Answer in text;

"To date, the previous studies carried out on small tropical island's aquifer have explored into the issue of groundwater pollution regarding seawater intrusion. This study offers a better understanding on the groundwater hydrochemistry of a pristine environment by providing a better interpretation of the results and enhancing the use of selected variables in hydrochemistry studies, as a source tracer for groundwater contaminations. The present study also compromises with the quantitative and qualitative outputs where the quantitative issues have exemplified the hydrochemistry concerns based on the concentration of elements in the groundwater, signifying the differences of mechanisms in both the spatial and temporal scales and elucidating the groundwater status based on the established guidelines. Meanwhile, the qualitative issues include the evidence of affected areas, the comparison with previous researches on the groundwater study and either to create new databases or to improve the existing guidelines especially on small tropical islands. This information will be of value in setting the priorities and allocating the resources within the regulatory agency by contributing as a baseline data of hydrochemistry in small tropical islands. It would be fruitful to pursue further research in terms of the management concerns by certifying the ongoing profits from a myriad of tourism activities as long as the natural ecosystem remains unharmed."

Table 1 The description of the hydrogeological properties in Kapas Island

Hydrology	**Mean**
Temperature	30.12 °C
Annual Precipitation	2274.66 mm/year
Annual Evapotranspiration	50% of annual precipitation
Groundwater recharge rate	467 m^3/day
Groundwater discharge rate	1.6 m^3/hour
Transmissivity	2.62 m^2/hour
Permeability	1.4 x 10^{-4} m/s
Porosity	0.14 – 0.49 *n*
Max. aquifer thickness	27 – 29 m
Natural groundwater run-off	7.5 m^3/hour
Hydraulic gradient	2.9 x 10^{-3}

Table 2 Location and depth of boreholes at Kapas Island

Station	Station's Coordinate		Distance from coastline (m)	Depth of boreholes from surface (m)
KW1	05° 12.999 N	103° 15.799 E	119	11.5
KW2	05° 12.996 N	103° 15.787 E	98	9.1
KW3	05° 12.992 N	103° 15.778 E	83	3.5
KW4	05° 12.989 N	103° 15.771 E	68	3.0
KW5	05° 12.985 N	103° 15.762 E	48	2.9
KW6	05° 12.982 N	103° 15.754 E	31	2.5
W1	05° 13.045 N	103° 15.720 E	55	-

Table 3 Descriptive analyses of *in-situ* and major ions in groundwater samples (n = 216)

Pre-monsoon		Mean	SD	Median	Min	Max	WHO, 2010
Temperature	°C	30.43	1.34	30.20	27.80	35.10	NA
pH		7.12	0.16	7.16	6.68	7.64	6-9
EC	mS/cm	0.56	0.15	0.55	0.41	0.91	1.5
Salinity	ppt	0.27	0.07	0.26	0.20	0.45	NA
DO	mg/L	2.97	2.12	2.21	0.63	8.46	NA
TDS	mg/L	281.85	74.64	273.50	204.00	455.00	1000
Eh	mV	4.03	9.71	1.30	-7.50	32.30	NA
Ca	mg/L	44.67	25.81	39.25	10.40	145.20	200
Mg	mg/L	5.12	2.51	4.20	1.62	10.40	150
Na	mg/L	19.10	14.49	12.39	0.80	58.80	200
K	mg/L	1.13	0.87	0.85	0.03	3.89	200
HCO_3	mg/L	379.19	121.87	342.82	241.56	893.04	NA
Cl	mg/L	43.69	30.64	33.24	11.49	141.96	250
SO_4	mg/L	14.36	7.04	12.50	1.00	30.00	250

Table 3 continued

Post-monsoon		Mean	SD	Median	Min	Max
Temperature	°C	29.34	0.90	29.00	27.90	32.20
pH		7.22	0.08	7.23	7.04	7.41
EC	mS/cm	0.39	0.06	0.37	0.32	0.55
Salinity	ppt	0.19	0.03	0.18	0.15	0.27
DO	mg/L	3.85	2.31	2.74	1.23	10.17
TDS	mg/L	193.50	28.18	187.00	158.80	276.00
Eh	mV	-1.85	5.09	-1.90	-13.20	9.90
Ca	mg/L	83.43	12.60	84.12	53.62	116.07
Mg	mg/L	6.32	2.74	5.64	3.53	15.44
Na	mg/L	7.64	3.86	6.84	1.84	18.26
K	mg/L	0.42	0.45	0.29	0.05	2.48
HCO_3	mg/L	274.55	41.20	263.52	229.36	505.08
Cl	mg/L	18.63	4.96	17.99	10.00	32.99
SO_4	mg/L	10.31	5.26	9.00	1.00	25.00

Table 4 Correlation coefficient for groundwater samples of Kapas Island (n = 216)

Pre-monsoon

	Temp	pH	EC	Salinity	DO	TDS	Eh	Ca	Mg	Na	K	HCO_3	Cl	SO_4
Temp	1				0.235*				-0.241*			0.475**		
pH		1	-0.814**	-0.806**		-0.813**	-0.949**	-0.274**	-0.396**	-0.494**	-0.619**	-0.464**	-0.521**	
EC			1	0.998**		0.999**	0.882**	0.15721	0.356**	0.731**	0.455**	0.459**	0.775**	
Salinity				1		0.999**	0.876**		0.347**	0.740**	0.445**	0.461**	0.781**	
DO					1						-0.261**			-0.235*
TDS						1	0.882**		0.355**	0.735**	0.453**	0.464**	0.778**	
Eh							1	0.231*	0.371**	0.547**	0.648**	0.548**	0.592**	
Ca								1	0.538**					
Mg									1					
Na										1		0.253**	0.907**	0.390**
K											1	0.395**		-0.254**
HCO_3												1	0.358**	
Cl													1	0.368**
SO_4														1

Table 4 continued

Post-monsoon

	Temp	pH	EC	Salinity	DO	TDS	Eh	Ca	Mg	Na	K	HCO_3	Cl	SO_4
Temp	1	-0.617**	0.482**	0.485**	-0.271**	0.477**	0.616**	-0.266**	0.195*		0.545**	0.397**	0.421**	-0.229*
pH		1	-0.731**	-0.715**	0.450**	-0.720**	-0.998**	-0.225*	-0.572**		-0.410**	-0.406**	-0.363**	
EC			1	0.994**	-0.442**	0.999**	0.724**	0.507**	0.876**	0.616**	0.245*	0.580**	0.613**	
Salinity				1	-0.422**	0.994**	0.708**	0.497**	0.865**	0.626**	0.232*	0.581**	0.612**	
DO					1	-0.444**	-0.445**	-0.281**	-0.514**			-0.214*	-0.321**	0.484**
TDS						1	0.714**	0.508**	0.876**	0.626**	0.238*	0.577**	0.611**	
Eh							1	0.212*	0.560**		0.414**	0.406**	0.363**	
Ca								1	0.705**	0.454**	-0.301**	0.278**		
Mg									1	0.700**	0.203*	0.450**	0.543**	
Na										1		0.277**	0.564**	0.511**
K											1	0.249**	0.638**	
HCO_3												1	0.465**	
Cl													1	
SO_4														1

Temp = Temperature
Correlation value (upper triangle)
Significant value (p<0.01**, p<0.05*)

Table 5 Summarized results of the ionic ratio

Station	Cl/HCO_3		Ca+Mg		SO_4+HCO_3		Ca/Mg	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
KW 1	0.331	0.062	4.485	1.669	5.715	0.615	6.085	3.037
KW 2	0.318	0.058	3.554	1.259	5.831	1.710	6.163	2.240
KW 3	0.298	0.044	3.126	1.443	4.708	0.333	6.322	2.233
KW 4	0.214	0.064	3.541	1.563	4.991	0.486	7.486	2.705
KW 5	0.318	0.160	3.717	1.525	6.239	3.013	9.550	3.944
KW 6	0.476	0.378	3.578	1.475	6.209	2.002	8.248	3.147

Table 5 continued

Station	Ca/Na		HCO_3/Na		Mg/Na		Mg/Ca	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD
KW 1	6.796	3.243	9.835	3.849	1.227	0.601	0.192	0.061
KW 2	8.840	6.904	14.099	10.375	1.360	0.898	0.180	0.072
KW 3	9.625	11.322	20.105	30.470	1.871	2.787	0.197	0.132
KW 4	19.848	18.569	24.599	15.834	2.363	1.898	0.168	0.110
KW 5	10.546	7.928	14.329	10.535	1.073	0.834	0.126	0.066
KW 6	8.381	6.399	12.360	8.233	0.891	0.575	0.160	0.122

Table 6 Saturation index (SI) for carbonate minerals in Kapas Island

Station		Calcite	Aragonite	Dolomite
KW 1	Mean	0.20	0.06	-0.16
	SD	0.16	0.16	0.30
	Min	-0.18	-0.32	-0.81
	Max	0.40	0.25	0.26
KW 2	Mean	0.02	-0.12	-0.52
	SD	0.23	0.23	0.34
	Min	-0.78	-0.92	-1.25
	Max	0.25	0.11	-0.03
KW 3	Mean	0.03	-0.11	-0.51
	SD	0.26	0.25	0.35
	Min	-0.57	-0.71	-1.10
	Max	0.34	0.20	-0.05
KW 4	Mean	0.13	-0.01	-0.38
	SD	0.19	0.19	0.19
	Min	-0.29	-0.43	-0.71
	Max	0.34	0.20	-0.05
KW 5	Mean	0.18	0.04	-0.38
	SD	0.22	0.22	0.38
	Min	-0.35	-0.49	-1.21
	Max	0.85	0.71	0.62
KW 6	Mean	0.08	-0.06	-0.53
	SD	0.28	0.28	0.39
	Min	-0.44	-0.58	-1.18
	Max	0.61	0.47	0.43