The range calculated external hazard values between 0.06 and 0.38 with a mean value of 0.22 (Table 2). The mean value of the external hazard index of 0.22 at all sampling locations is less than the recommended limit of unity (1). This deterioration values in these locations is due to the lower activity concentration of ^{238}U, ^{232}Th and ^{40}K. This relatively lower contribution to the hazard index due to the ^{238}U is lower followed by the contributions of ^{232}Th and ^{40}K. Furthermore, the less value of H_{ex} due to ^{40}K was not from the same origin source as ^{238}U and ^{232}Th. It has been proven that there is no significant and negative correlation between ^{40}K-^{238}U (r = 0.2298) and ^{40}K-^{232}Th (r = 0.1192). In estimating of H_{ex} found that ^{238}U and ^{232}Th are contributed to the significant value as a result, there has a strong positive correlation with Pearson's correlation coefficient, r = 0.8285 (Figure 2) between both radionuclides in the sediments. This can be implied that very strong relationship shows both ^{238}U and ^{232}Th contributed the emission of significant radiation to all locations.

In the other word, the good strong positive correlation was observed between ^{238}U and ^{232}Th because uranium and thorium come from decay series and occur together in nature (Irena et al., 2012). While, the very weak negative correlation was observed between ^{40}K-^{238}U and ^{40}K-^{232}Th due to ^{40}K origin is a primordial radionuclide and totally was not come from different decay series, which does not undergo any radioactive decay process (Chandrasekaran et al., 2014). This radionuclide was also in accordance with the results (Chen et al., 2001; Elejalde et a., 1996). Therefore, pre conclusion can be made based on our finding that these study areas confirmed not pose radiological risks to the surrounding people, fisherman, divers or who-else presence in this area owing to the harmful effects of ionizing radiation from the natural radionuclides in sediment.

Table 3: Pearson's correlation coefficient (r) for relationship of radiological parameter and radionuclides

Radiological Parameter	**Activity Concentration (Bq/kg dw.)**		
	^{238}U	**^{232}Th**	**^{40}K**
Radium equivalent activity concentration index, Ra_{eq} (Bq/kg dw.)	r = 0.8712 (+ correlation)	r = 0.9678 (+ correlation)	r = 0.0671 (+ correlation)
Absorbed dose rate, D_{adr} (nGy/h)	r = 0.8484 (+ correlation)	r = 0.9469 (+ correlation)	r = 0.1503 (+ correlation)
Annual effective dose rate, D_{aedr} (mSv/y)	r = 0.8484 (+ correlation)	r = 0.9469 (+ correlation)	r = 0.1503 (+ correlation)
External hazard index, H_{ex}	r = 0.8645 (+ correlation)	r = 0.9633 (+ correlation)	r = 0.0894 (+ correlation)

Cluster analysis of dendrogram

Cluster analysis is a method to classify similar observations into a number of clusters based on the observed value of several variables for each individual or average. Each individual within a cluster is same but dissimilar from each other (Sinharay, 2010). Thus, type of hierarchical cluster is a statistical technique for grouping same variable within cluster based

on dissimilarities or distance between variable (Yim and Ramdeen, 2015). It can be generated via dendrogram to display the linkage within variable at increasing dissimilarity.

In this study, the averages for 7 parameters i.e. ^{238}U, ^{232}Th, ^{40}K, Ra_{eq}, D_{adr}, D_{aedr} and H_{ex}were classify into three major clusters. Cluster I consisted of ^{238}U, ^{232}Th, D_{adr}, D_{aedr} and H_{ex}; the cluster II set for ^{238}U and Ra_{eq} and cluster III only for single member of ^{40}K. The most significant way to show dissimilarities each average of parameter are by compute square Euclidean distance and the derived dendrogram is shown in Figure 4. This showed the parameter of cluster I was closely distance of result, followed by cluster II. Meanwhile, ^{40}K was identified in cluster III which is far distance result from other parameter. Interpretation from this cluster analysis can be made that D_{adr}, D_{aedr} and H_{ex} are the main contributions hazard effects to the human beings are due to ^{238}U and ^{232}Th present in the study area, while Ra_{ex} due to clearly high concentration of ^{238}U. Generally, ^{40}K found to be higher at study area, rather it was not significant in contributing radiation dose to study area. Therefore, in this current study found that ^{238}U is a key radionuclide has a possibility contributed the radiation dose hazard effect to the study area.

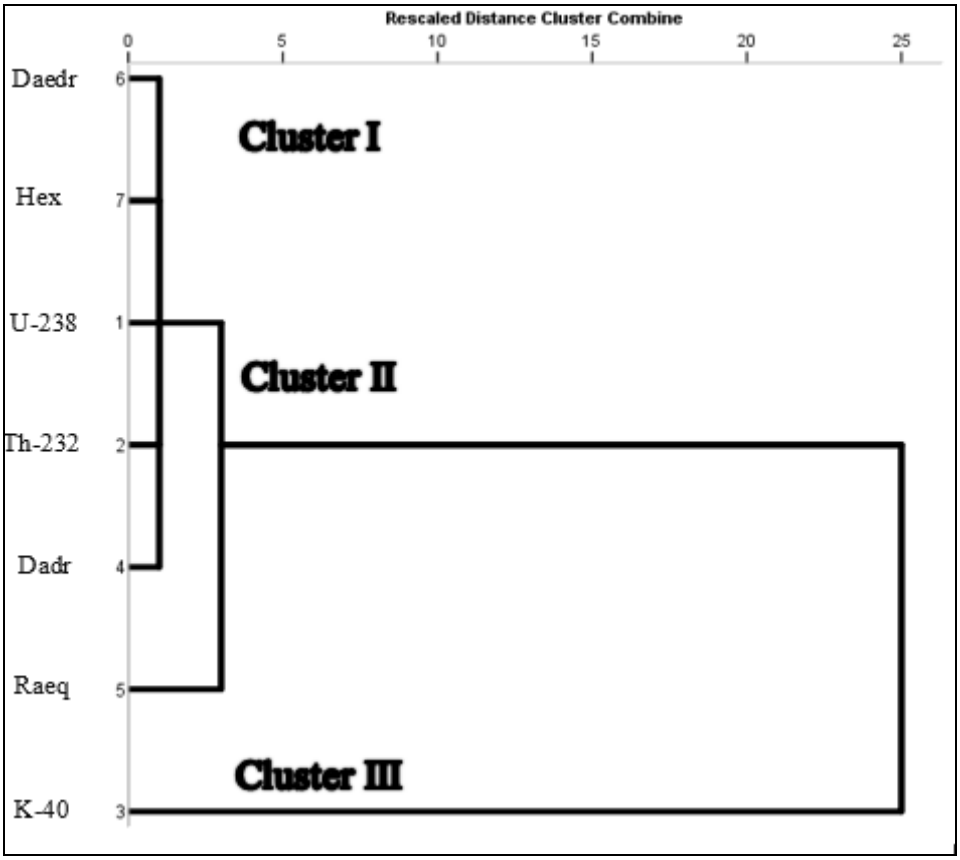

Figure 4: Dendrogram shows the clustering of radionuclides, Ra_{eq} and radiological hazard index

CONCLUSION

The evaluation of radium equivalent activity (R_{aeq}), absorbed dose rate (D_{adr}), annual effective dose rate (D_{aedr}) and external hazard index (H_{ex}) were lower than their maximum

permissible limits. This indicates that the potential dose rates to human from the surface sediment radioactivity levels of ^{238}U, ^{232}Th and ^{40}K in the east coast of Peninsular Malaysia have strictly been not present significant risks to human health. Absolutely, it can be confirmed that the surrounding people, fisherman, divers or who-else presence in this area were not posed radiological risks owing to harmful effects of ionizing radiation from the natural radionuclides in sediment. Furthermore, these sediments are suitable and safe to use for any activity purposes.

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