MATERIAL AND METHODS

Sampling stations and methods

Marang River is located in Marang district of Terengganu, Malaysia. Water quality sampling was carried out along this river on 13 November 2012 and was repeated on 25 November 2015. Both samplings were during Northeast monsoon period. During this period, the eastern part of Peninsular Malaysia received heavy rainfall and its sea surface temperature declined [10, 6]. Seven sampling stations were selected from downstream to upstream of this river for water quality assessment. The first station is located at the estuary where the meeting point between the ocean and Marang River is situated. The last station is located at upstream where this area is less disturbed by tidal activities. Each station is 2km apart, explaining the total sampling distance along this river as approximately 18km (Figure 1). In this study, tidal activities are considered as one of the factors that influenced river water quality and hydrology of the river. Thus, sampling is done twice where the first sampling is done during low tide and, the other sampling during high tide. Both samplings were done at the same location according to the coordinate pinpointed by Global Positioning System (GPS). The recorded coordinate for each sampling stations is tabulated in Table 1.

Measurement of *in situ* parameters

Parameters such as dissolve oxygen (DO), electrical conductivity (EC), total suspended solids (TDS), salinity and pH were measure using YSI 556 Handheld Multiparameter meter. Turbidity was measured using 2100Q Portable Turbidimeter. Instruments were calibrated before the measurements.

TABLE 1. Coordinate location of each sampling station

Station	Latitude	Longitude
ST1	N 05° 12' 34.9"	E 103° 12' 49.8"
ST2	N 05° 11' 36.41"	E 103° 11' 43.87"
ST3	N 05° 10' 38.51"	E 103° 12' 03.65"
ST4	N 05° 09' 53.16"	E 103° 11' 32.8"
ST5	N 05° 08' 59.55"	E 103° 11' 11.58"
ST6	N 05° 08' 00.29"	E 103° 11' 34.13"
ST7	N 05° 07' 41.04"	E 103° 12' 14.06"

Statistical analysis

One way ANOVA (Analysis of Variance) is used to determine the significant difference between low tide 2012, high tide 2012, low tide 2015and high tide2015 data populations of each parameter based on p-value (P). No significant difference between data populations meaning that there are insufficient evidence to prove the data population means are not similar. Significantly difference explains that there are sufficient evidence to state that at least one data population mean is not the same. Parameters that show significant difference was further analysed by using Tukey Kramer multiple comparison. This method is effective in identifying which data sets have different mean populations. One way ANOVA and Tukey Kramer multiple comparison analysis were performed by using Microsoft Office Excel 2010.

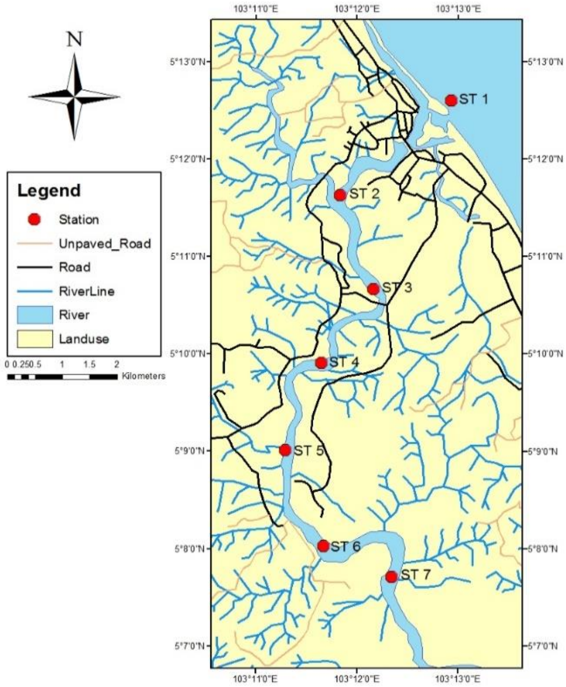

Figure 1. A map showing the seven sampling stations along Marang Rive

RESULTS AND DISCUSSION

Water quality analysis

There were six physicochemical water quality parameters analysed to determine the water quality based on temporal and spatial variations. Six in-situ parameters such as DO, EC, TDS, salinity, pH and turbidity are included.

1. Salinity, Electrical Conductivity (EC) and Total Dissolved Solids (TDS)

The salinity readings for seven sampling stations along Marang River for low and high tides during 2012 and 2015 are illustrated in Figure 2. During 2012, for low tide, salinity readings were ranging from 0.49 – 9.32 ppt with average of 3.26 ppt meanwhile during high tide, salinity readings were ranging from 0.68 – 25.36 ppt with average of 9.37 ppt. During 2015, salinity was ranging from 0.57 – 8.22 ppt with average of 3.26 ppt for low tide meanwhile, salinity were ranging from 0.84 – 13.1 ppt with average of 4.13 ppt during high tide.

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Persian Abstract

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چکیده

یک مطالعه زیست محیطی رودخانه Marang شهر Terengganu درباره تعیین روند تغییرات زمانی و فاصله‌ای کیفیت آب رودخانه در هفت ایستگاه نمونه برداری بین سال‌های ۲۰۱۲ تا ۲۰۱۵ صورت گرفته است. ایستگاه‌های نمونه برداری در امتداد رودخانه از پایین دست تا بالادست انتخاب شدند؛ که فاصله هر ایستگاه تا ایستگاه دیگر ۲ کیلومتر بود. نمونه برداری در هر ایستگاه ۲ بار در طی جزر و مدهای پایین و بالا در نوامبر ۲۰۱۲ انجام شد و همچنین در نوامبر ۲۰۱۵ تکرار شد. هر دو نمونه گیری در زمان باران موسمی شمال شرقی انجام شد. پارامتر های کیفی انتخاب شده‌ی آب مانند شوری، رسانایی الکتریکی (EC)، کل مواد جامد محلول (TDS)، اکسیژن محلول (DO)، pH و کدورت با استفاده از ابزار علمی تایید شده اندازه‌گیری شد. یک روش مقایسه چندگانه ANOVA و Tukey Kramer برای تحلیل آماری استفاده شد. این مطالعه نشان داد که تغییرات زمانی قابل توجهی در میزان اکسیژن محلول و کدورت وجود داشت که از پایین دست به بالادست بین سال‌های ۲۰۱۲ تا ۲۰۱۵ به دلیل افزایش فعالیت‌های استفاده از زمین، افزایش یافته بود؛ در حالی که پارامترهای دیگر نظیر EC، شوری، TDS و pH کاهش یافت. این نتایج نشان داد که تغییرات جهانی همراه با ایجاد طوفان سنگین و پدیده سیل در سال ۲۰۱۴ منجر به بالا آمدن سطح دریا و رقت شوری دریای چین جنوبی شد.