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Exploring the correlations between common UV measurements and chemical fractionation for natural waters

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ABSTRACT

Chemical fractionation is a powerful tool for unravelling the reasons behind water treatment problems such as the formation of disinfection by-products (DBPs). This technique can however be costly and time-consuming. Hence, exploring quick affordable surrogate measurements to this technique is of great importance for water treatment operators. In this study, the correlations between aquatic carbon fractions and single wavelength and UV ratios of A_{254}, A_{280}, A_{254}/A_{204}, A_{250}/A_{365} and A_{254}/A_{436} were examined for seven water bodies located in South-east Queensland, Australia. It was observed that A_{254}/A_{204} has a strong and significant correlation with hydrophobic/hydrophilic ratio ($R^2 = 0.984$). A_{250}/A_{365} exhibited a weak but significant correlation with the same fraction ratio ($R^2 = 0.687$) suggesting that the chemical fractions cannot be assumed of a certain molecular size. A_{254}/A_{436} had a weak and insignificant correlation with carbon fractions ($R^2 = 0.0506$). The hydrophobic fraction of the seven water bodies showed a strong and significant correlation with A_{254} ($R^2 = 0.968$) and A_{280} ($R = 0.958$). The diverse carbon source of the tested water bodies confirms the reliability of the observed correlations. The results of this study highlight the potential use of UV absorbance as a real-time technique for monitoring the structural change of aquatic carbon.

Keywords: DOC; Chemical fractionation; Hydrophobicity; Hydrophilicity; Single wavelength UV and UV ratio

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1. Introduction

Natural organic matter (NOM) is a ubiquitous heterogeneous mixture present in terrestrial and aquatic systems. NOM is derived from either vegetative debris and terrestrial sources (allochthonous) or microbial activities (autochthonous) [1]. The source of NOM has a pivotal role in natural and man-made systems. In aquatic ecosystems, NOM represents the source of carbon for living organisms and it can bind to inorganic pollutants controlling their transport and fate [2]. Also, the presence of NOM in water treatment

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systems causes detrimental problems such as production of unpleasant odours and tastes [3], fouling [4] and the formation of carcinogenic DBPs [5]. Hence, understanding the structure of NOM has become imperative for the environmental scientist and the operators of water treatment industries, particularly drinking water production [6,7].

NOM can be broadly classified into dissolved organic carbon (DOC) and particulate organic carbon (POC) [8]. These two categories are operationally defined. DOC is the carbon fraction that passes through a filter with porosity of 0.45 μm, while POC is the fraction retained by such a filter. POC represents a small fraction of the TOC in water (below 10%) [8]. Removal of POC from water is easier than DOC, which makes the latter the main concern from water treatment perspective.

DOC can further be classified into subgroups depending on the molecular size and physiochemical properties. DOC is commonly segregated into size-based groups using size exclusion chromatography and serial filtration with selected pore size filters [9,10]. The size of molecules can only govern their filterability through membrane/multimedia filters via sieving mechanisms [11]. In addition, the aforementioned segregation techniques have the disadvantages of introducing artefacts to the treated samples [12,13]. Hence, obtaining knowledge of DOC molecular structure can be more beneficial, especially when designing an efficient treatment scheme. The complex structure of DOC can be unravelled based on elemental composition, functional groups or compounds classification. Elemental and functional group analyses such as the use of nuclear magnetic resonance spectroscopy and gas and liquid chromatography are expensive and require extensive sample manipulation [10,14]. Such analyses are hard to adapt for industrial routine measurements. Less complicated DOC structural analysis that can easily be integrated into industrial measurement protocols is the use of resin fractionation [15].

The resin fractionation technique classifies DOC into three main groups hydrophobic, hydrophilic and transphilic based on their affinity to a series of ionic and non-ionic resins. This technique dates back to the 1960s when the product of Rohm and Haas Company (XAD-1) was tested for separating organic materials from sea water [16]. Since then, resin fractionation has been undergoing various developments and amendments [17–20]. Recently, Chow et al. [15] proposed the use of a rapid fractionating technique that was based on previous fractionation schemes [19,20]. In this rapid fractionation method, DOC is fractionated into four fractions: VHA (adsorbed by DAX-8); SHA (adsorbed by XAD-4); CHA (adsorbed by IRA-958) and NEU which was not adsorbed by any of the used resins. The chemical classes of these fractions are presented in Table 1.

Fractionation techniques have been applied to gain insight into the most commonly encountered problems in drinking water treatment such as fouling and DBPs formation. Raspati et al. [21] reported that the VHA fraction was the major foulant in micro- and ultra-membrane filtration, particularly with hydrophobic membranes, whereas NEU seemed to be the dominant foulant for hydrophilic membranes. VHA was also found to be the main contributor to DBPs formation which is believed to be due to the fact that this fraction is rich in reactive sites (activated aromatic rings) [2–4]. Chemical fractionation has also been applied for identifying DOC fractions that are amenable to coagulation. It was observed that the removal of the hydrophobic fraction (VHA + SHA) increased by increasing the coagulant (alum) dosage up to the optimum level, while the removal of CHA fraction peaked at low and high dosages [15]. The same study also showed that NEU was the least amenable to alum coagulation. It was suggested that the removal of the hydrophobic fraction in coagulation takes place through two distinct mechanisms: charge neutralization under acidic conditions and adsorption (sweep flocculation) under alkaline conditions [7].

Despite the useful implementation of the fractionation technique for understanding water treatment challenges, this technique has disadvantages of altering DOC structure (esters hydrolysis [13]) and having a long turnaround time [15]. So, finding a method to

Table 1
Proposed structure of natural organic matter (NOM) fractions [4,22]

Fractions		Class of organic compounds
Hydrophobic fraction	VHA SHA	Humic acids, fulvic acids, C5–C9 aliphatic carboxylic acids, 1- and 2-ring phenols, proteinaceous compounds, 1- and 2-ring aromatic except pyridine and amines
Hydrophilic fraction	CHA NEU	>C5 aliphatic carboxylic acids, short-chain aliphatic amines, polysaccharides, amino acids, carbohydrates aldehydes, ketones, alcohols, proteins, <C9 aliphatic amines and <C5 aliphatic amides

allow quick surrogate measurements for the fractionation technique would clearly be beneficial to water treatment operators. This study was designed to investigate the possibility of applying UV absorbance measurements as a potential alternative to the fractionation technique. UV absorbance measurements that were examined in this study included common single wavelength analysis of A_{254} and A_{280} and UV ratios of A_{254}/A_{204}, A_{250}/A_{365} and A_{254}/A_{436}. The correlations between UV ratio components and their counterparts of DOC fractions were also investigated to further understand the correlations between the ratios. These UV measurements were chosen in this study due to their common use in characterizing aquatic organic carbon in terms of humification, aromaticity, functional groups, molecular size and colour [5]. The relationships between DOC fractions and UV measurements for seven Australian water bodies were studied and correlations were obtained. The DOC of the selected water bodies varies between being allochthonous, autochthonous or a mixture of both. Such variation is helpful for measuring the consistency of the obtained correlations.

2. Materials and methods

2.1. Water samples

It is known that the structural characteristics of aquatic DOC depend strongly on source materials, geology and topography of catchment [10]. Hence, in this study, water samples were collected from seven

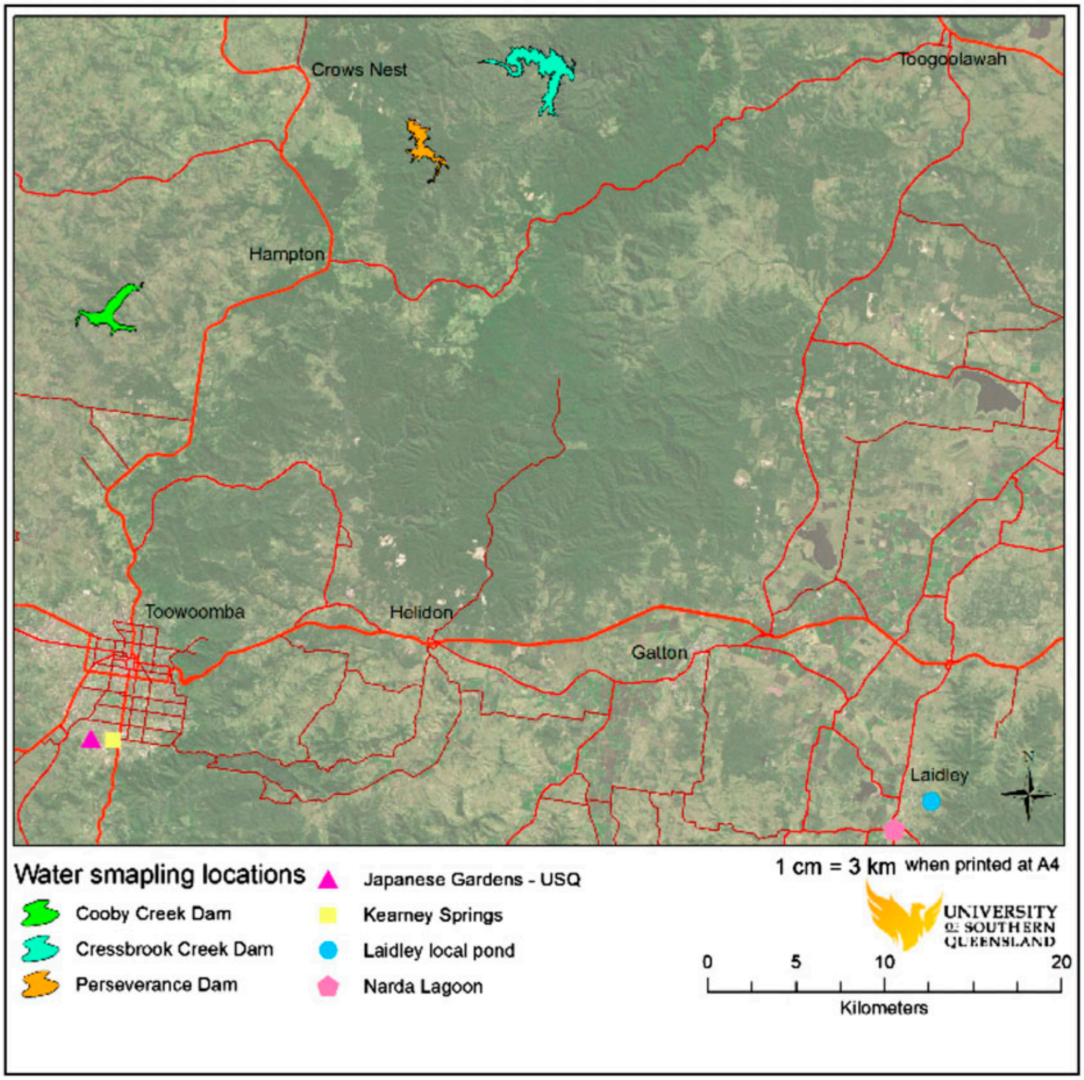

Fig. 1. Sampling sites.

Table 2
DOC and interfering ions concentrations of water samples

Water body	pH	DOC (mg/L)	Iron (mg/L)	Nitrate (mg/L)	Chloride (mg/L)
Narda lagoon	6.90	9.81	0.37	n.a	39
Cressbrook lake	7.90	6.05	0.13	0.39	40.4
Perseverance lake	7.88	2.93	0.09	n.a	31
Cooby dam	9.10	8.15	0.10	n.a	131
Kearnys spring	9.43	9.14	1.63	0.37	107
Japanese garden	7.57	3.30	0.40	n.a	88.4
Laidley local pond	6.45	32	4.73	0.38	32

Note: n.a indicates that the concentration of the ion is below the detection limit of measurement method.

locations at South-east Queensland (SEQ) to investigate the effect of such variety in DOC sources on the correlation between the spectroscopic properties and chemical structure of DOC. The geographical location of the water bodies is illustrated in Fig. 1. DOC concentration of water bodies and their content of UV interfering ions are shown in Table 2.

Lake Cressbrook, Lake Perserverance and Lake Cooby are major water storages for drinking water production in Toowoomba, Australia. The carbon sources in these storages are mostly generated from eucalypt woodland and soil. Kearney Springs and the Japanese Garden are recreational water ponds in which the main sources of carbon are grassland and bird manure. All of the aforementioned water bodies are lightly coloured. Narda lagoon and Laidley local pond are dark brown water. The carbon in Narda lagoon is originated from acacia and eucalyptus trees, grass and sawdust produced from sawmill located in its proximity [23]. The carbon sources of Laidley pond are originated from spotted gum bark, leaf litter and animal manure.

2.2. Analytical methods

2.2.1. DOC measurements

The DOC of water samples was measured by high-temperature combustion method using total carbon analyser (TOC-VCSH, SHIMADZU, Australia). The DOC of each sample was measured in duplicate. At least three injections of each measured sample were made, which resulted in coefficient of variance lower than 0.02. Water samples were filtered through 0.45-μm glass fibre filters using syringe filter holder prior to the DOC measurements.

2.2.2. UV–vis spectroscopy analysis

JENWAY UV–vis spectrophotometer model 6,705 equipped with a single cell holder was used for measuring the absorbance of water samples. Quartz cuvette with path length of 1 cm was used for measuring UV–vis measurements of filtered water samples (0.45 μm). The samples' filtrate was scanned in wavelength range of 200–500 nm.

The pH of water samples was adjusted to 6–7 using 0.1 N HCl or NaOH. The concentrations of interfering species (e.g. nitrate and iron) were measured using ion chromatography system ICS-2000 and atomic absorption spectrophotometer AA-7000 (SHIMADZU, Australia).

The interfering effects of nitrate and chloride in the water samples were insignificant due to their low concentration (Table 2) [5]. It is worth mentioning that the concentrations of the other interfering ions such as bromide sulphate and phosphate were very small under the detection limit of ICS-2000, and hence their interfering effect can be ignored. The concentration of iron in the water samples was below the effective interference limit for most of the water samples <0.5 mg/L [24] except for Laidley local pond and Kearnys Spring samples which were on average of 4.73 and 1.63 mg/L as shown in Table 2. The possible interference of iron was dealt with by subtracting spectrum of iron(III) solution from that of the water sample containing high levels of iron [24]. Iron in the form of ferrous ion has a very little effect on UV absorbance [25], thus its interference is neglected in this study. Iron(III) solution was prepared from AR grade ferric chloride anhydrous (Sigma-Aldrich, Australia).

2.3. Fractionation process

The fractionation procedure performed in this study was based on the rapid fractionation technique proposed by Chow et al. [15]. Fig. 2 shows graphical representation of the fractionation process. Deionized water produced by Millipore system was used to carry out washing of chromatography columns and adsorbent resins. Three polymer-based resins, namely

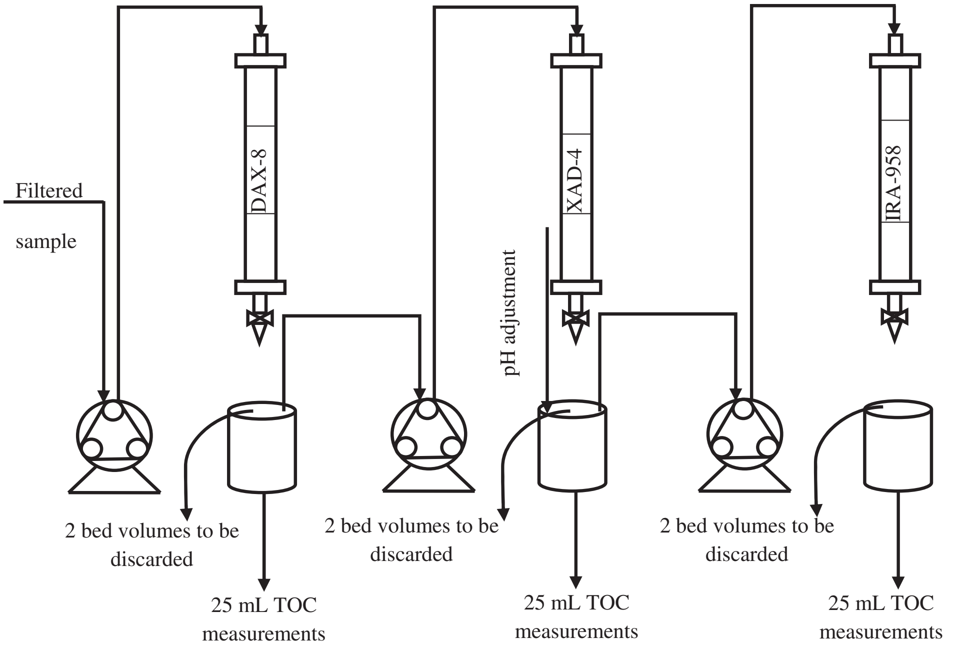

Fig. 2. Illustration of fractionation process.

Supelite™ DAX-8, Amberlite® XAD-4 and Amberlite® IRA-958 were used for fractionating the DOC of water samples. Three chromatography columns with 20 cm length and 1 cm inner diameter were used to accommodate the resins. The columns were set with a series of three peristaltic pumps (Cole-Parmer, Australia).

Virgin resins were wetted and cleaned in 500-ml glass beakers by successive washing with HPLC grade methanol and deionised water for 1 h. Each washing cycle involved gentle stirring for a minute followed by settling for 15 min for methanol and 8 min for deionized water. After the last cycle of washing, the resin slurry was decanted into a pre-cleaned column by 0.1 N NaOH and deionised water. The performance of the cleaning process was tested by running deionized water through the columns of the virgin resins and an aliquot of the eluent of each column was collected for DOC and UV measurements.

In a typical fractionation run, water sample of 250 mL is filtered through 0.45-μm cellulose nitrate membrane and acidified to pH 2 using concentrated HCl acid. The filtered acidified sample is passed through DAX-8 column at a rate of 1.6 mL/min (0.2 bed volume/min as recommended in [15]). The first two bed volumes of 16 mL were discarded from DAX-8 eluent. A sample of 25 mL of the eluent was collected for DOC and UV measurements, and the remaining DAX-8 eluent was pumped through XAD-4 column at the same flow rate as DAX-8 column. Two bed volumes were discarded from XAD-4 eluent and 25 mL of the sample was collected for DOC and UV analyses. The remaining of XAD-4 eluent was then adjusted to pH 8 using 1 M NaOH and pumped through IRA-958 column. Two bed volume of the IRA-958 eluent was discarded and the remaining was used for UV and DOC analyses. The chemicals used such as sodium hydroxide and hydrochloric acid for pH adjustment were all AR grade chemicals supplied by Chem-Supply, Australia.

The fractions of DOC were calculated using the calculations below:

$$\mathrm{VHA} = \mathrm{DOC}_{\mathrm{raw}} - \mathrm{DOC}_{\mathrm{DAX\text{-}8\ effluent}}$$
$$\mathrm{SHA} = \mathrm{DOC}_{\mathrm{DAX\text{-}8\ effluent}} - \mathrm{DOC}_{\mathrm{XAD\text{-}4\ effluent}}$$
$$\mathrm{CHA} = \mathrm{DOC}_{\mathrm{XAD\text{-}4\ effluent}} - \mathrm{DOC}_{\mathrm{IRA\text{-}958\ effluent}}$$
$$\mathrm{NEU} = \mathrm{DOC}_{\mathrm{IRA\text{-}958\ effluent}}$$

3. Results and discussions

3.1. DOC fractions of water bodies

The percentage of each DOC fraction presents in the tested water bodies is shown in Fig. 3. It can be seen from this figure that Laidley pond and Narda lagoon are the most hydrophobic water bodies followed by Cooby dam. Kearnys spring and Cressbrook dam have a close percentage of VHA fraction,

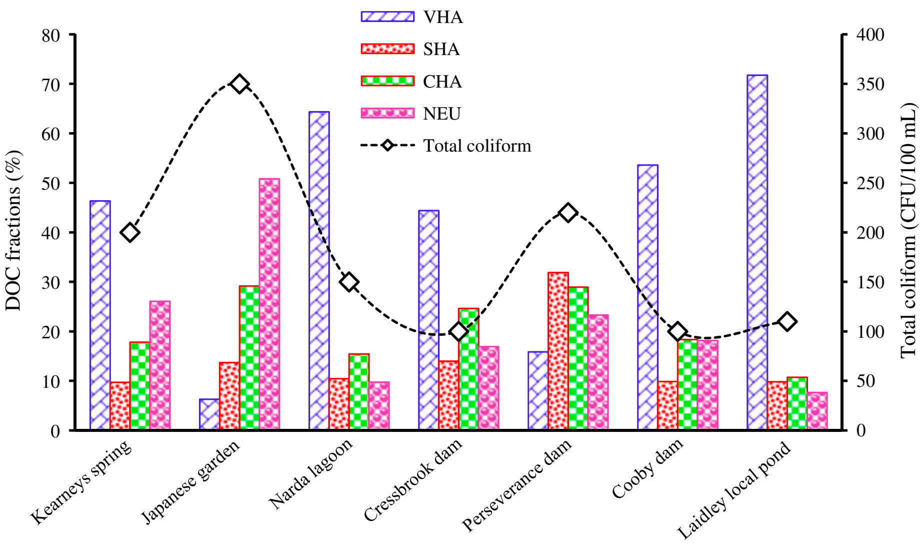

Fig. 3. DOC fractions and total coliform for the seven water bodies.

approximately 46 and 44%, respectively. Perseverance dam and Japanese garden have the lowest VHA fractions of all the water bodies, in fact their VHA fractions are the least among their other DOC fractions. Perseverance dam has the highest SHA fraction of approximately 32% as opposed to the other six water bodies that have the percentage of this fraction in the range of 9–14%.

Laidley pond has the lowest CHA fraction, while the rest of the water bodies are divided into two groups according to their CHA content. The group that contains Japanese garden, Perseverance and Cressbrook dams have a comparable percentage of CHA in the range of 20–30%. The second group that consists of Kearneys spring, Cooby dam and Narda lagoon possesses CHA range of 15–18%. Japanese garden has the highest NEU fraction among all the tested waters. The rest of the water bodies can be divided into three groups according to the percentage of NEU fractions; Keraney springs and Perseverance dam (23–26%), Cooby and Cressbrook dams (16–18%) and Narda lagoon and Laidley pond (7–10%).

From Table 1 and Fig. 3, one can deduce the chemical classes of the organic carbon in the tested watersheds. The high percentage of the hydrophobic fraction in Laidley pond and Narda lagoon indicates abundance of humic acid in these water bodies [4]. The abundance of humic acid implies that the carbon of the water is mostly allochthonous originated mainly from terrestrial runoff and vegetative debris [1,26], and this is consistent with the description of Narda lagoon in [23]. The highest percentage of SHA in Perseverance dam implies that this water source has higher fulvic acid content than the other water sources [4].

The water bodies that have high hydrophilic fraction such as Japanese garden and Perseverance dam are rich in polysaccharides, proteins, carbohydrates and alcohols (Table 1). These chemical classes are associated with microbial activities and the presence of bird's manure [27,28], so the carbon in these waters is predominantly autochthonous. These remarks are confirmed by the total coliform data of the tested water depicted in Fig. 3 as diamond markers and dashed curve. The total coliform data of Cooby, Perseverance and Cressbrook dams were provided by the laboratory services of Mt Kynoch water treatment plant in Toowoomba,Australia, while the total coliform of the rest water bodies was measured in the lab applying membrane filtration standard method (method 9222 B in [29]) using m-ColiBlue24 Broth [30,31].

3.2. Relationships between UV absorbance and DOC fractions

The UV–vis spectra of the seven water bodies and their fractions are shown in Fig. 4. The eluent of virgin resins had a UV reading of approximately zero for the whole tested wavelength range (Fig. 4(h)), which highlights the efficiency of the cleaning procedure and eliminates the possibility of resins contribution to UV absorbance of water samples.

It can be seen from Fig. 4 that the UV spectrum of DAX-8 and XAD-4 eluents for all the tested water bodies drops close to zero at a wavelength ca. 230–240 nm.

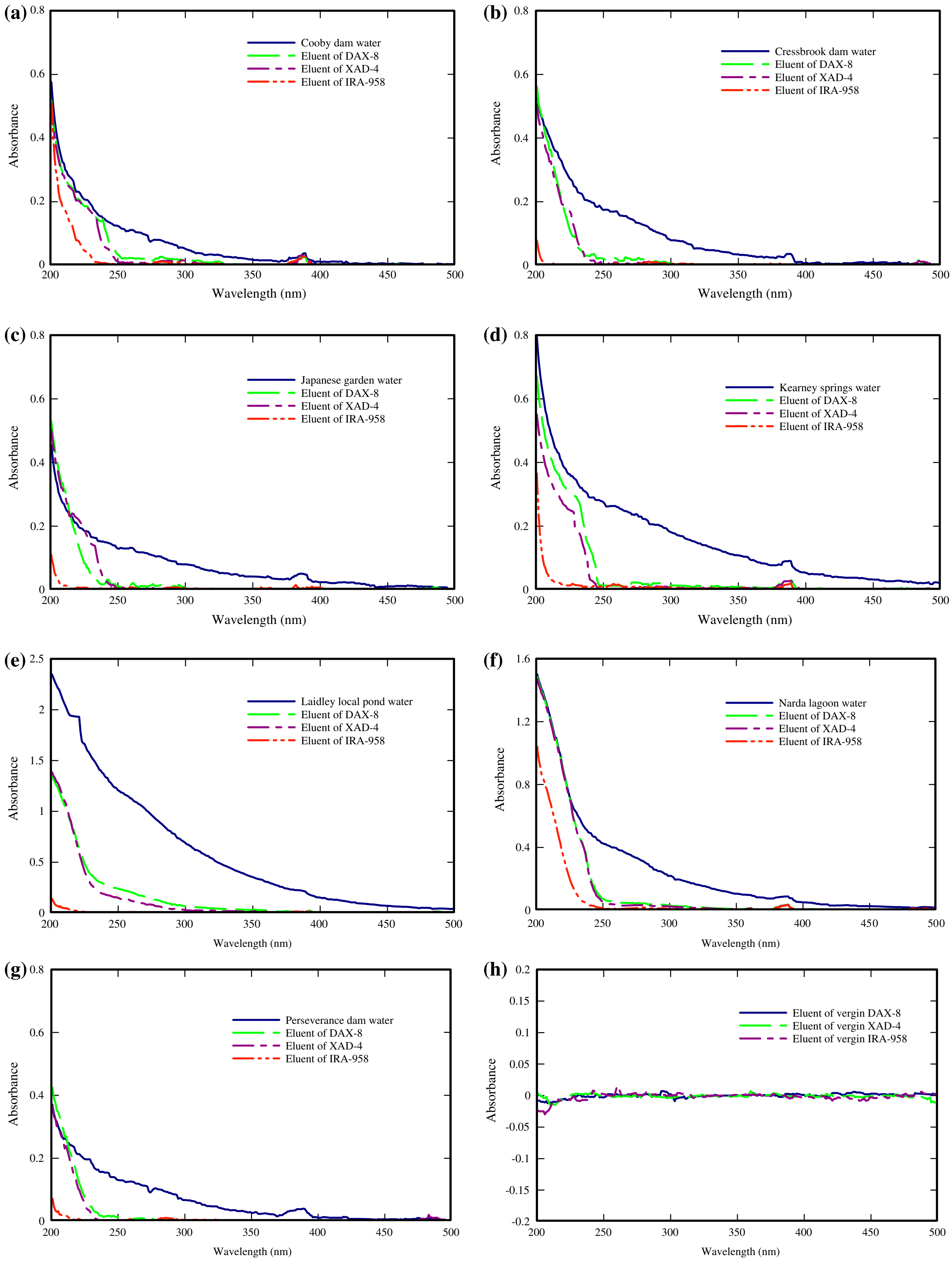

Fig. 4. UV–vis spectrum of (a) Cooby dam, (b) Cressbrook dam, (c) Japanese garden water, (d) Kearneys spring, (e) Laidley local pond, (f) Narda lagoon, (g) Perseverance dam and (h) eluent of virgin resins.

Whilst UV absorbance of IRA-958 eluent is close to zero over most of the measured UV range for all the water bodies except for Cooby dam and Narda lagoon. UV absorbance of IRA-958 eluent for Cooby dam and Narda lagoon dropped to zero at ca. 230 nm. These results are consistent with the trends reported in the literature. Some studies showed a very low UV absorbance of SHA, CHA and NEU fractions at 254 (<0.05) [22,32].

The fall of UV spectra for DAX-8 and XAD-4 eluents close to zero at approximately 240 nm demonstrates that SHA and CHA fractions only have UV absorption at the range of 200–240 nm. Korshin et al. [33] categorized UV absorbance of DOC in the range of 190–400 nm into three regions; local excitation region with absorbance of <~190 nm, beneznoid (Bz) region with absorbance range of 190–240 nm and electron-transfer (ET) region with absorbance of >240 nm. The absorbance of Bz region is centred at 204 nm, whereas the absorbance of ET region is centred at 254 nm. Based on these categories, one can deduce that there is a relationship between DOC fractions and UV absorbance at Bz and ET regions. Korshin et al. [33] found that the ratio of the absrobance at the centre of ET region (254 nm) to that of Bz region (204) of natural water samples gives a good indication to the tendency of DOC to involve in adsorption and complexation reactions. These reactions determine the amenability of DOC to coagulation process and its potential to form DBPs. The relationship between absorbance ratio of ET to Bz regions (A_{254}/A_{204}) and the ratio of hydrophobic/hydrophilic of the seven water bodies was investigated and the outcome is illustrated in Fig. 5.

Hydrophobic/hydrophilic appears to have a strong correlation with A_{254}/A_{204}, $R^2 = 0.9837$. The significance of this correlation was also investigated at a significance level of 0.05 (i.e. p-value = 0.05), and the results showed that the correlation was statistically significant with a p-value of 1.16×10^{-5}. It was reported that the amino groups in NOM absorb higher UV at 210 nm (in the proximity of 204) than at 254 nm [34]. This could explain the strong correlation between A_{254}/A_{204} and hydrophobic/hydrophilic ratio as the amino groups are prevalent in the hydrophilic fraction (Table 1). Based on the structural analysis for DOC fractions in Table 1, non-aromatic structure is dominant in the hydrophilic fraction as opposed to the hydrophobic fraction where the aromatic structure is prevailing. The strong correlation between A_{254}/A_{204} and hydrophobic/hydrophilic ratio indicates that this ratio can also be used as an indicator for distinguishing bulk properties of water samples such as aromaticity and hydrophobicity.

To further explore the relationship between DOC fractions and UV absorbance at Bz and ET regions, the correlation between the component of the ratios was inspected. The correlations between the hydrophobic fraction and A_{254} and the hydrophilic fraction and A_{204} were examined and the results are demonstrated in Figs. 6 and 7. In general, A_{254} showed stronger correlation with the hydrophobic fraction ($R^2 = 0.9682$) as compared to the correlation between the hydrophilic fraction and A_{204} ($R^2 = 0.8465$). However, when testing the significance of the two correlations, they were both found to be statistically significant with p-values of 6.21×10^{-5} and 0.034 for A_{254} vs. hydrophobic fraction and A_{204} vs. hydrophilic fraction, respectively. This confirms the versatile use of A_{254} not only for predicting DOC concentration [29] and humification [5], but also for predicting the bulk hydrophobicity of the water samples.

The relationship between DOC fractions and other common UV measurements, namely A_{280} and the

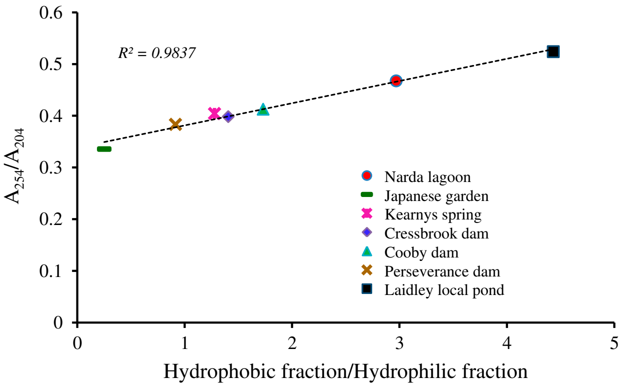

Fig. 5 A_{254}/A_{204} vs. Hydrophobic/hydrophilic for the tested water bodies.

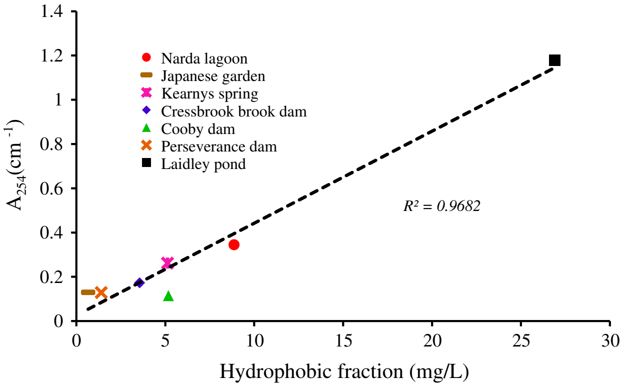

Fig. 6. A_{254} vs. hydrophobic fraction for the tested water bodies.

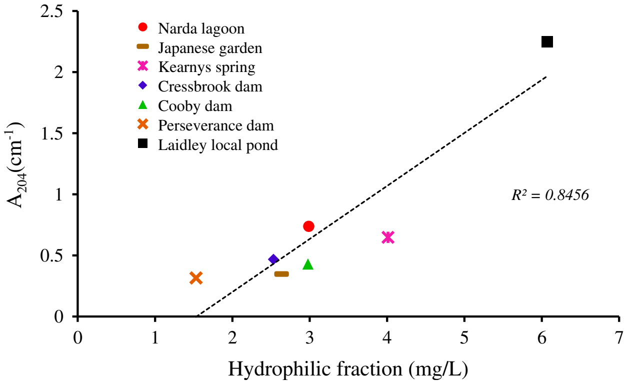

Fig. 7. A_{204} vs. hydrophilic fraction for the tested water bodies.

ratios A_{250}/A_{365}, A_{254}/A_{436} and their components were also investigated. A_{254} and A_{280} have been used extensively in the literature as an indicator for humification and aromaticity [1,12,24,35]. Aromaticity and A_{254} were also reported to be correlated [12,36]. Hence, the correlation between A_{280} and the hydrophobic ratio was studied and the results are depicted in Fig. 8. The results in Fig. 8 demonstrate a good correlation between the hydrophobic fraction of all the water bodies and A_{280}. However, the hydrophobicity correlation with A_{254} is stronger than that with A_{280} ($R^2 = 0.9682$ for A_{254} vs. hydrophobic fraction and $R^2 = 0.9578$ for A_{280} vs. hydrophobic fraction). It should be noted though that the correlation between A_{280} and the hydrophobic fraction was found to be significant with a p-value of 1.26×10^{-4}. Such trend was also indicated in previous studies where the hydrophobic fraction was found to have the highest aromaticity among the other DOC fractions [37]. In fact, Schafer [38] reported that the aromaticity of DOC fractions follows the order of humic acids > fulvic acid > hydrophilic acids, which is consistent with the findings of this study (Fig. 8).

The lower correlation between hydrophobic fraction and A_{280} as opposed to A_{254} could be attributed to the fact that some of the aromatic DOC can be of hydrophilic nature (e.g. aromatic amines) [39].

A_{250}/A_{365} is commonly known as E_2/E_3 ratio, and it is used as an indicative for the proportion of low to high molecular weight organic materials in water [10,35,40,41]. Since hydrophobic fraction is believed to contain high molecular weight molecules and the hydrophilic fraction consists of smaller molecules [22], then hydrophobic/hydrophilic ratio would have inverse correlation with E_2/E_3. This inverse correlation between the hydrophobic/hydrophilic and A_{250}/A_{365} was tested, and found to be relatively a weak correlation as compared to the aforementioned correlations ($R^2 = 0.6873$) as shown in Fig. 9. Nevertheless, when evaluating the significance of this correlation, it was found to be significant with a p-value of 0.021. The weak correlation between hydrophobic/hydrophilic and A_{250}/A_{365} is attributed to the fact that UV absorbance is dependent on the presence of chromophores in the organic molecules rather than the molecular weight of the molecules [42]. In addition, A_{254} which is in the vicinity of the absorbance at 250 nm was found to have a significant correlation with the hydrophobic fraction, which suggests that A_{250} would have an insignificant correlation with the hydrophilic fraction. Such possibility was checked and confirmed that it is true that A_{250} has statistically insignificant correlation with the hydrophilic fraction with a p-value of 0.054. Buchanan et al. [22] found that the VHA fraction has some conjugated low molecular weight moieties highlighting that the hydrophobic fraction does not contain only high molecular weight molecules. It was observed by another study that aquatic humic acid consists mainly of molecules with small to moderate molecular weight [43].

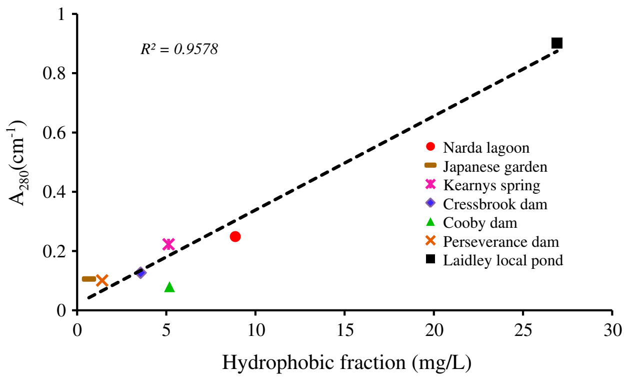

Fig. 8 A_{280} vs. hydrophobic fraction for the tested water bodies.

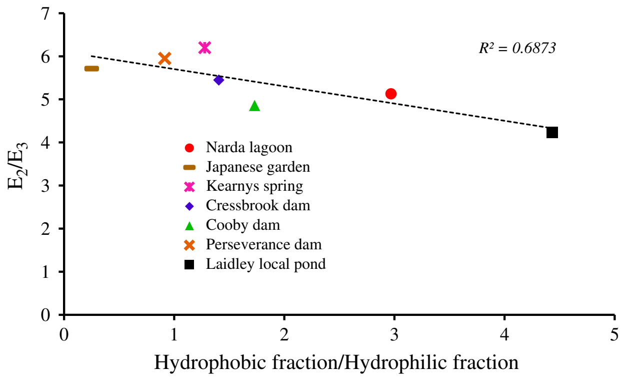

Fig. 9. E_2/E_3 vs. Hydrophobic fraction/hydrophilic fraction for the tested water bodies.

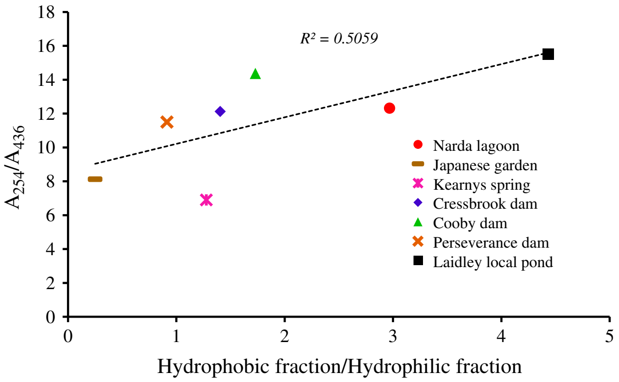

Fig. 10. A_{254}/A_{436} vs. Hydrophobic fraction/hydrophilic fraction for the tested water bodies.

A_{254}/A_{436} has been utilized in the literature to estimate the ratio of the UV absorbing groups of DOC to the colour-forming groups [44]. It was reported in some studies that the UV-absorbing moieties of DOC are of hydrophobic nature, while some of the colour-forming moieties are of hydrophilic nature [45]. To test these claims, the correlation between hydrophobic/hydrophilic and A_{254}/A_{436} was examined, and the results are depicted in Fig. 10. It appears that the correlation between DOC fractions and this absorbance ratio is weak. Even testing the significance of this correlation at p-value of 0.05 revealed that this correlation is insignificant (p-value = 0.073).

The relationships presented in this study ascertain that UV absorbance can be a good surrogate for the chemical fractionation analyses, particularly A_{254}, A_{280} and A_{254}/A_{204}. The fact that the UV absorbance was used in this study rather than specific absorbance (i.e. SUVA) highlights the feasibility of using A_{254}, A_{280} and A_{254}/A_{204} as in situ monitoring techniques for tracking the change in the structure of NOM in natural water resources. However, special attention needs to be given to the pH and the levels of the interfering inorganic species of the water.

4. Conclusion

Chemical fractionation and UV measurements were performed on seven water bodies situated in SEQ, Australia. The correlations between the DOC fractions and selected common UV measurements, namely A_{254}, A_{280}, A_{254}/A_{204}, A_{250}/A_{365} and A_{254}/A_{436} were investigated. A_{254}/A_{204} vs. hydrophobic/hydrophilic ratio showed a strong and significant correlation. The correlations of A_{250}/A_{365} and A_{254}/A_{436} vs. hydrophobic/hydrophilic were both weak, however, the former correlation was found to be statistically significant, while the latter correlation was statistically insignificant. Both A_{254} and A_{280} showed good correlations with the hydrophobic fraction. The observed correlations in this study can effectively be harnessed by environmental or water treatment professionals as cost- and time-effective surrogate measurements for monitoring the structural changes in NOM. However, evaluating the correlation between UV measurements and DOC fractions for natural water undergoing specific treatment steps is a valuable goal for future work.

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