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Decadal water quality variations at three typical basins of Mekong, Murray and Yukon

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Abstract. Decadal distribution of water quality parameters is essential for surface water management. Decadal distribution analysis was conducted to assess decadal variations in water quality parameters at three typical watersheds of Murray, Mekong and Yukon. Right distribution shifts were observed for phosphorous and nitrogen parameters at the Mekong watershed monitoring sites while left shifts were noted at the Murray and Yukon monitoring sites. Nutrients pollution increases with time at the Mekong watershed while decreases at the Murray and Yukon watershed monitoring stations. The results implied that watershed located in densely populated developing area has higher risk of water quality deterioration in comparison to thinly populated developed area. The present study suggests best management practices at watershed scale to modulate water pollution.

1. Introduction

Probability distribution and trend analysis are widely used in hydrological and climate related studies to capture variability in time series. Literature shows that precipitation probability distribution is widely assessed [1, 2]. In contrast, probability distribution is rarely inspected to capture water quality variability [3-5]. Well-known probability distribution types, normal and lognormal, are not commonly adopted by water quality parameters [6, 7]. Similarly, extensive literature is available on trend analysis in hydrological and climate related studies [8-10]. Variations in climatic drivers i.e. precipitation, temperature, runoff etc. have been conducted at global scale using Nonparametric Mann–Kendall test [11-15]. Decadal distribution analysis has been carried out in climate change studies to detect hot extreme in air temperature [16]. Decadal distribution analysis has not been investigated in water quality studies which motivated the authors for the current study.

2. Study area and methods

Three typical watersheds, Murray, Mekong and Yukon, were selected for the current study based on population, development of the territory and climatic conditions as shown in Figure 1. The Murray and Mekong watersheds both have tropical (Aw) dry and wet climate while the Yukon watershed has subarctic (Dfc and Dsc) climate. The Murray, Mekong and Yukon basins are composed of rangelands, croplands and wildlands respectively as obvious from our previous studies[17, 18]. For Mekong and Yukon watersheds monitoring sites, water quality data were obtained from United Nations

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Environment Programme (UNEP)/ Global Water Quality Data and Statistics (GEMS)/Water (www.gemstat.org). For Murray watershed monitoring sites, water quality record was obtained from South Australian Environmental Protection Agency (EPA) (http://www.epa.sa.gov.au). Turbidity, water temperature, pH, conductivity, dissolved oxygen (DO), dissolved organic carbon (DOC), total nitrogen (TN), ammonia, nitrate, nitrite, nitrate + nitrite, dissolved phosphorus, total phosphorus (TP), dissolved orthophosphate and total orthophosphate were used in the current study. Water quality parameters historical record length varies from 9-24, 6-27 and 36-39 years for Mekong, Yukon and Murray watersheds monitoring sites respectively.

In the current study decade distribution analysis was carried out to compare decadal surface water pollution using normal distribution. First decade was considered as a base line for the remaining decades. Shift to the right of the first decade shows increasing pollution trend while shift to the left of the first decade shows decreasing pollution trend. Shift to the left or right of the reference period will show the decreasing or increasing decadal trend of surface water pollution respectively.

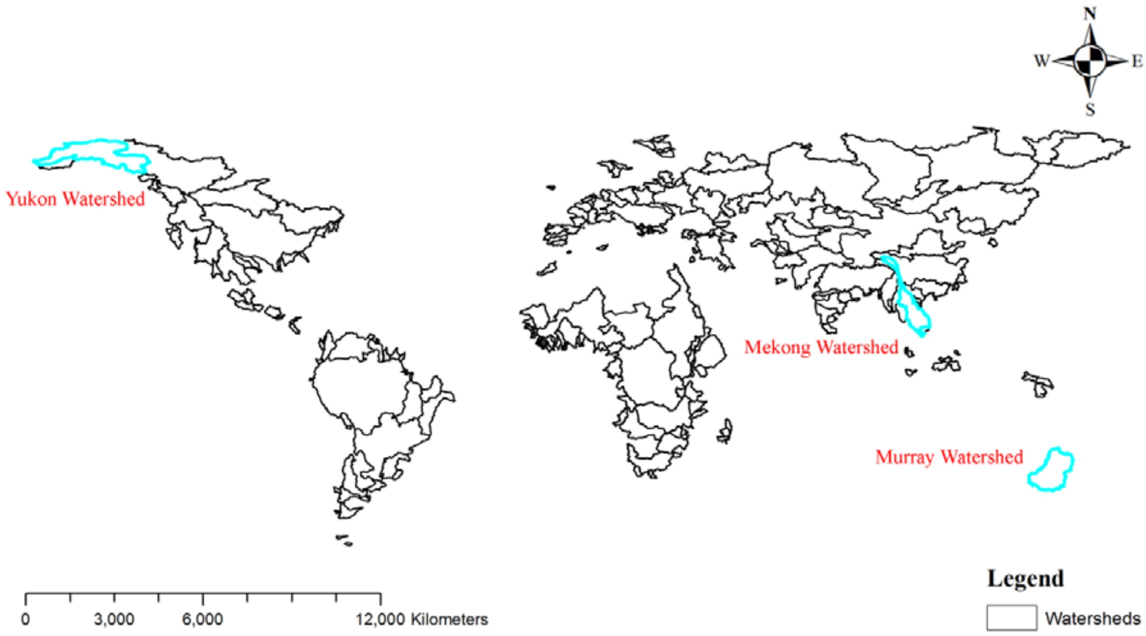

Figure 1. Yukon, Mekong and Murray watersheds.

3. Results and discussion

3.1. Decade water quality variability at Murray watershed

The probability distribution of water quality parameters including total phosphorous, water temperature, DOC, conductivity and dissolved phosphorous shifts to the left in the successive decades for Murray watershed monitoring sites as shown in Figure 2. Phosphorous is concerned with anthropogenic activities while DOC is related with hydrological conditions i.e. high DOC concentration is attributed to high flow volume [19]. Decreasing decade trend in the above stated water quality parameters at Murray watershed may be due to several reasons: implementation of pollution control measures, watershed management, land use management, better treatment facilities, precision farming, restoration practices etc. at catchment level [20, 21].

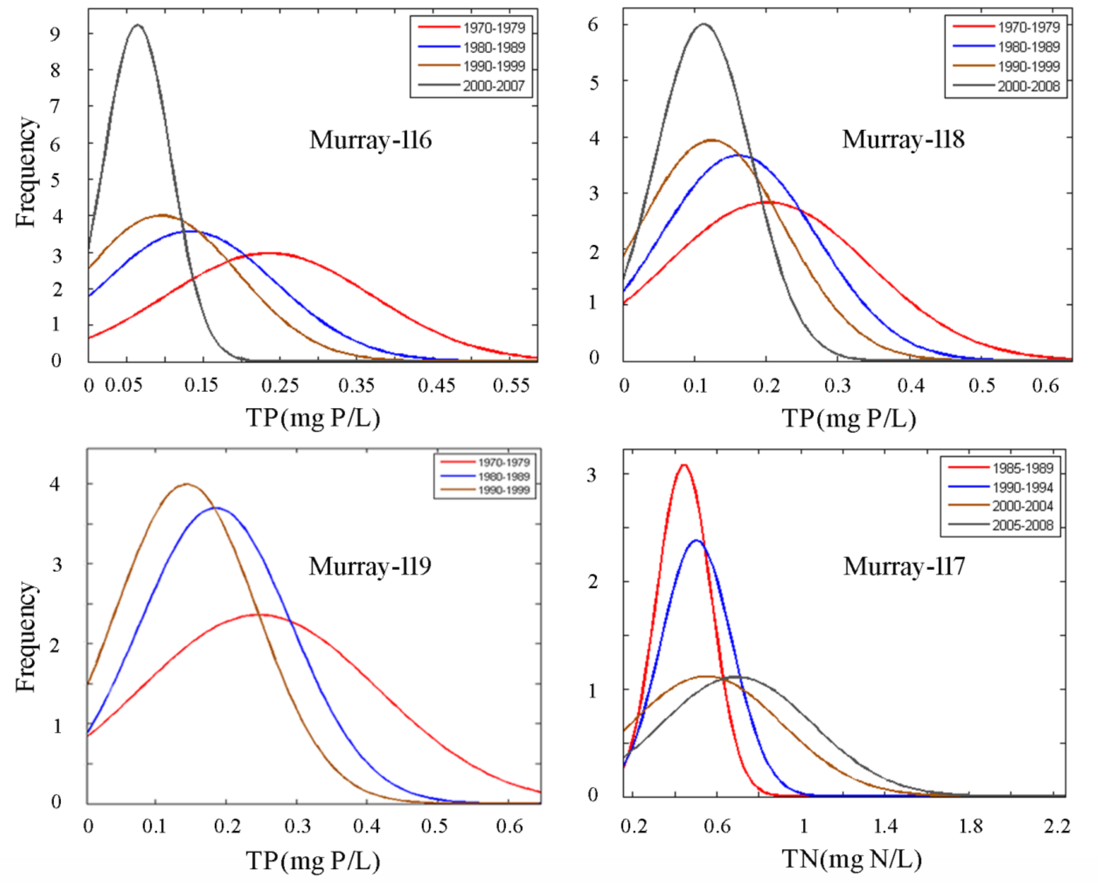

Figure 2. Decreasing decade shifts of water quality parameters at Murray watershed.

3.2. Decade water quality variability at Mekong watershed

At Mekong watershed, right shift was observed for various water quality parameters including ammonia, TP, TN etc. as shown in Figure 3. Excessive application of fertilizers, agricultural crops, animal feeds, mining, etc. causes the accumulation of nitrogen and phosphorus in soil which are drained by irrigation tail water discharge to nearby water bodies [22, 23]. Excessive paved surface in urban areas have low retention capacity which sweeps nutrients from gardens, lawns, and landscaped areas into rivers. Insufficient treatment facilities and rapid urbanization in the region can aggravate surface water quality [24].

Mekong watershed is developing and thickly populated area with high anthropogenic activities. Increase in water contamination may be due to land use change due to urbanization and intense agricultural activities to fulfill the accommodation and food requirement of rapid growing population.

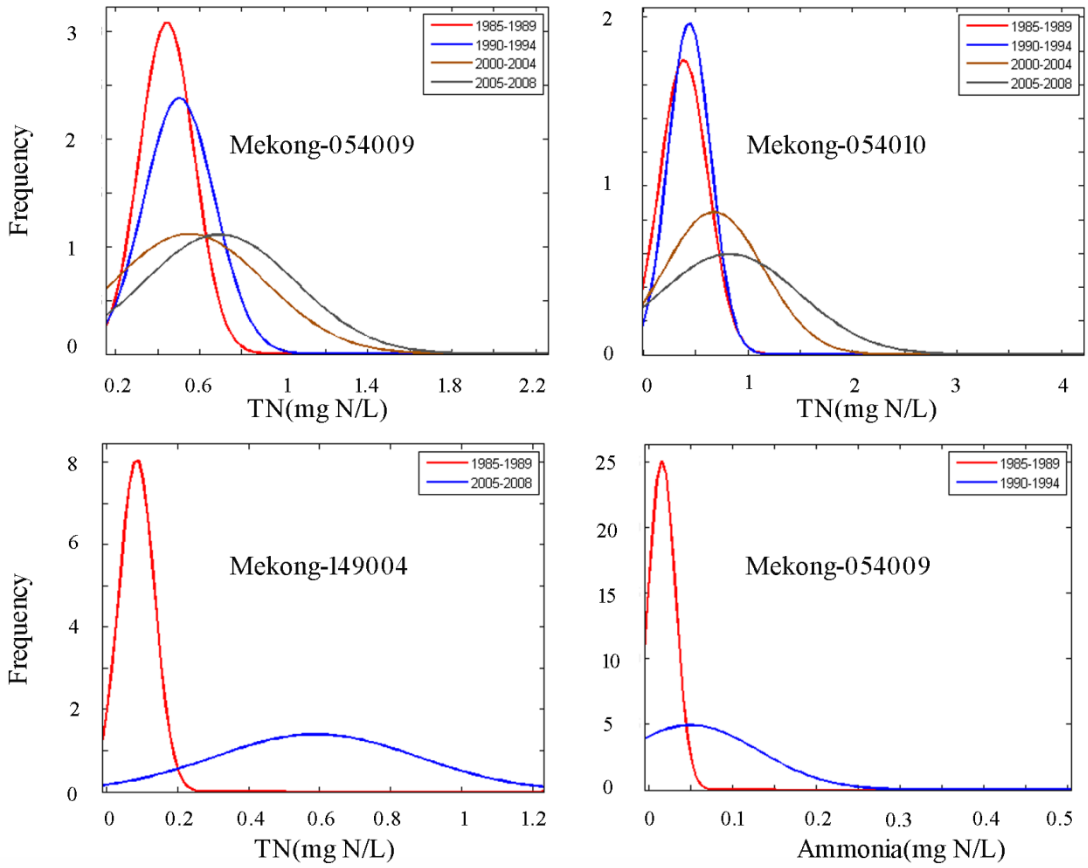

Figure 3. Increasing half decade shifts of water quality parameters at Mekong watershed.

3.3. Decade water quality variability at Yukon watershed

Left shift was observed for various water quality parameters including ammonia, turbidity, pH, phosphorous, nitrite and water temperature at Yukon watershed monitoring sites as shown in Figure 4. Nutrients are related with human activities at watershed level [22, 23]. It may be due to several reasons: cold climate, lower population density, implementation of pollution control measures etc. at catchment level[20, 21].

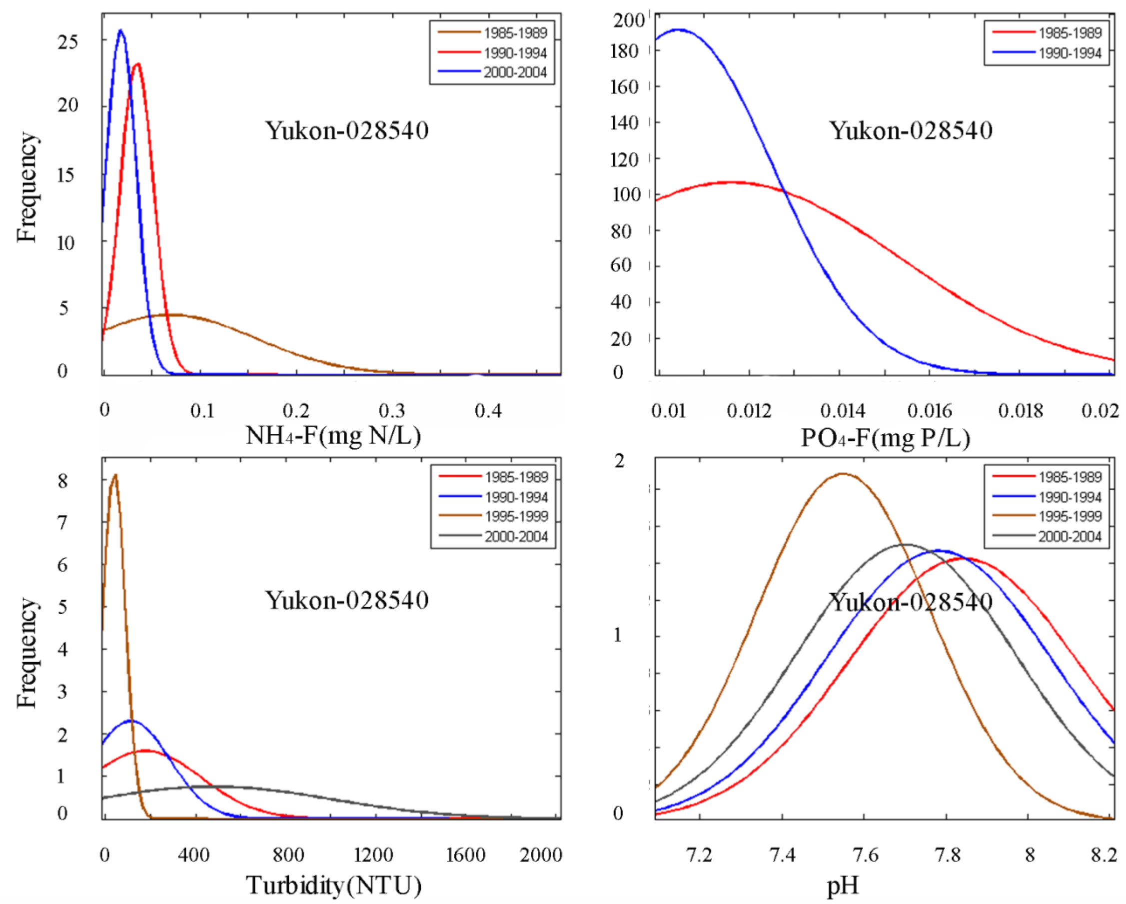

Figure 4. Decreasing half decade shifts of water quality parameters at Yukon watershed.

It is obvious from the above discussions that improvement was observed in water quality variables at the Murray and Yukon watershed while degradation was noted at the Mekong watershed. Murray and Yukon are developed area with less population density while Mekong is developing area having high population density. Moreover, Murray and Yukon basins are composed of rangelands and wildlands while Mekong watershed consists of croplands. Enhancement in water quality at Murray and Yukon basins may be due to implementation of control measures, lower population density, restoration practices, rangelands and wild lands etc. at catchment level. In contrast, degraded water quality at Mekong basin may due to high population density, high proportion of croplands, deforestation, lack of treatment facilities etc. at basin scale[17, 18].

4. Conclusions

In the current study, we evaluated distribution shifts of water quality parameters to the reference decade at three typical watersheds of Murray, Mekong and Yukon monitoring stations. Nitrogen and phosphorous parameters exhibited increasing decade trends at the Mekong watershed monitoring sites while decreasing trends at the Murray and Yukon watershed monitoring sites. Right shifts were observed in water quality distributions at the Mekong watershed monitoring sites while left shifts were noted at the Murray and Yukon monitoring sites. It shows that water pollution increases with time at the Mekong watershed while decreases at the Murray and Yukon watershed monitoring stations.

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