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ORIGINAL ARTICLE

Qualitative parameters modeling of dissolved oxygen (DO) and nitrate in Karkheh River using WASP6

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ABSTRACT
Water resource is one of the main pillars of sustainable development. In recent years, the field of proper planning in water management, Considerable investment has been made. Aware of the changes and predict future water quality, according to the plans Water and urban planning, agriculture and industry, provides the possibility to predict possible future problems , planning and alternative thinking for them. Use of a particular method of water quality modeling at the macro level can help us in controlling water crisis. The concentration of dissolved oxygen (DO) in water resources is vital because of the dependence of aquatic animals and plants. WASP6 model solve the governing Equations on chemical and biological processes using mathematical tools such as finite element method. In this study, simulation of water quality parameters in the study area (Kharkheh River) in the reach of Paypol - Alhayy was performed by WASP6 model. According to the simulation results can be seen that the applicability of the model between data and model is seen as an almost acceptable. Finally DO and Nitrate values are in suitable limits.
Keywords: *Modeling, Dissolved Oxygen, nitrate, Kharkheh, WASP*

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INTRODUCTION

In the past, most of the water resources for agriculture, drinking, and later also used for transportation. Water quality is important to people. Today, it can be seen that contaminated water causes many diseases are transmitted, the typical transmitted diseases from contaminated water, cholera can be cited. Review of research over the past 100 years reflects the understanding of the biological, physical and chemical processes in rivers and a significant increase in the ability to model the impact of the entry of pollutants into the wastewater is generated. Quality models used by many experts are HEC-5Q, QUAL2E and WASP etc. Water Quality Analysis Simulation Program (WASP6) is an upgraded version of the original WASP. This is a dynamic structural model that used for the evaluation of all pollutants in aquatic ecosystems such as rivers, lakes, etc.

WASP6 model that helps the user to interpret and predict the effects of natural events and hand contamination for various pollutants could reach reasoned decisions on management. Razzagh Manesh[1] WASP model used to simulate water quality Kor River, Iran. Maleki [2] Study on Pasikhan River, to simulate parameters of nitrate, phosphate, ammonium and nitrogen using the Mike 11 and WASP6. Zheng et al. [3] using a three-dimensional physical model and mathematical model WASP5, Satilla River in Georgia spans quality parameters simulated. The study by Artioli et al. [4] cargo capacities, the model used WASP6 on a river PO in Italy. The purpose of this study is to simulate the Karkheh river quality parameters of dissolved oxygen and nitrate using WASP6.

MATERIAL AND METHODS

Karkheh River Basin area (south west Iran) is 42,239 square kilometers in the site of Paypol station. The average annual volume of flow in Paypol is over 5916 million cubic meters and annual long-term average discharge of 188 cubic meters per second is equivalent to this station. More than 64% of the total annual runoff occurs in February to May [5].

Selected reaches including Intervals between hydrometric stations of Paypol, Shahid Najian, Abdolkhan and Alhayy. Quality parameters measured in these stations is done, the data collected can be classified into four groups:

A - Qualitative information about contaminants and input lateral flow into Karkheh river

B - Information on the surveyed sections from the river

C - The daily flow data of hydrometric stations located on the Karkheh River, and

D - Information about the Karkheh river monitoring stations.

WASP modeling process

WASP model structure to form the desired route must first be segmented. For simplicity, the distance between the stations was considered as a unit. The Karkheh River was divided into 4 segments. Calculate the volume of each segment, average velocity and average depth of water, the next step in the calculation. Discharges recorded from each station are current composed function that was introduced as the Flow Function to the system. After completing the input data, simulation work was performed.

Model calibration and verification processes.

The purpose of calibration is adjustment of parameters such that the model results with observations (at an optimum) to match. Definition, it must determine the best match. Observed data from the study area were collected within a period of 12 months. Observed data for calibration and verification of the models were divided into two categories: the first 6 months to calibrate and the second 6 month was used for verification. To evaluate the accuracy of the model, the correlation coefficient, mean absolute error (MAE) and the coefficient of performance (Cp) was calculated according to the model equations. Values in terms of cubic meters of water for each segment must be given to the model. Can be used for mean scale of period and mean cross-section area Calculation of between two consecutive segments, each segment can be calculated water volume [6]. It should be noted that the WASP6 software itself can with the geometry of the river, such as length, average width, and depth, estimates the volume water and calculations to arrive.

Initial condition

The purpose of the initial conditions is introduction of first pollutant concentration at the start of modeling period. Parameter concentrations of nitrate and DO were determined at the start of the simulation in Table 1 are presented.

Table (1) Values used for the initial conditions

station	The start of period simulation	Nitrate	DO
Paypol	May 2012	0.63	8.24
Shahid najian	May 2012	4	7.92
Abdolkhan	May 2012	3.86	6.69
Alhayy	May 2012	4.09	6.14

Constants Kinetic and used rates

In all Model builders, selection of proper coefficients for calibration is a main issue that without it, the results are of no real use. In simulator software of hydraulic characteristics of the river (such as HEC-RAS) using the Manning coefficient, the calibration is done. Re-aeration rate coefficient, temperature correction factor for re-aeration, the decay rate of CBOD, temperature correction factor for the decay of CBOD, the decay rate of NBOD, temperature correction factor for the oxidation of ammonia and nitrite is important [7].

RESULTS

Diagrams of WASP6 model in calibration phase

Model calibration used data from observations of four stations in six months April, May, June, July, August and September of 2012. According to available data and simulated parameters, calibration was done at the end of each period. Coefficients were calculated for each parameter along the river. The result of model calibration is presented in Figures 1 to 8 and statistical analysis is given in Tables 2 to 5.

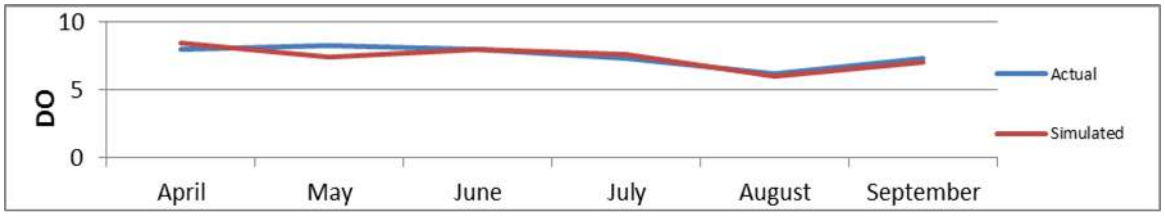

Figure (1) the amount of dissolved oxygen (DO) in the calibration of model for the Paypol station

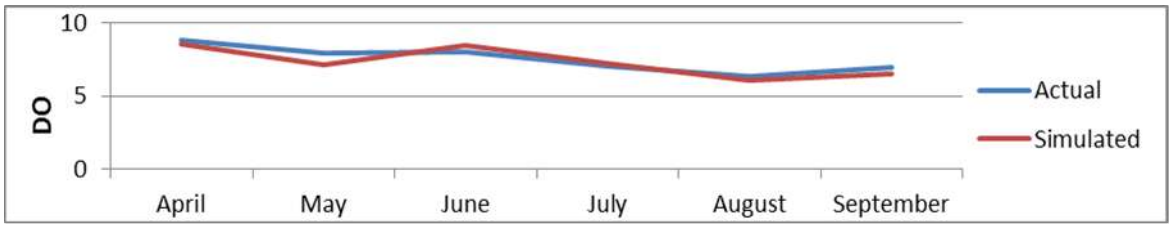

Figure (2) the amount of dissolved oxygen (DO) in the calibration of model for the Shahid najian station

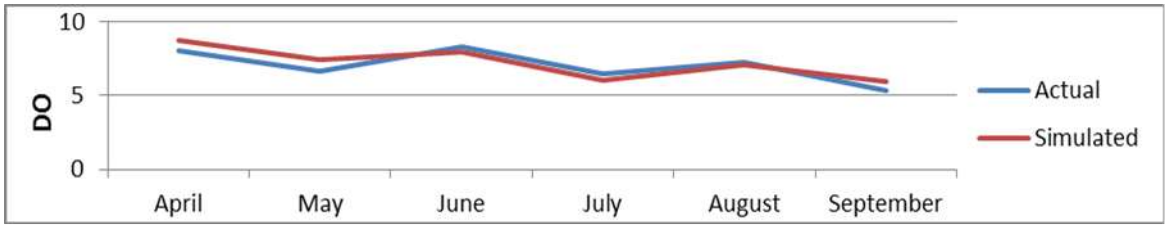

Figure (3) the amount of dissolved oxygen (DO) in the calibration of model for the Abdolkhan station

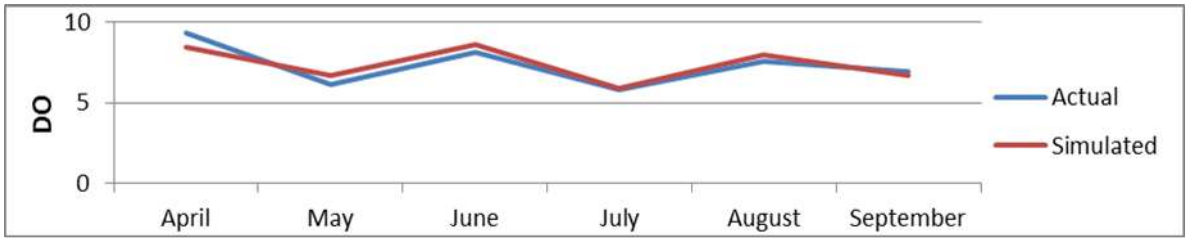

Figure (4) the amount of dissolved oxygen (DO) in the calibration of model for the Alhayy station

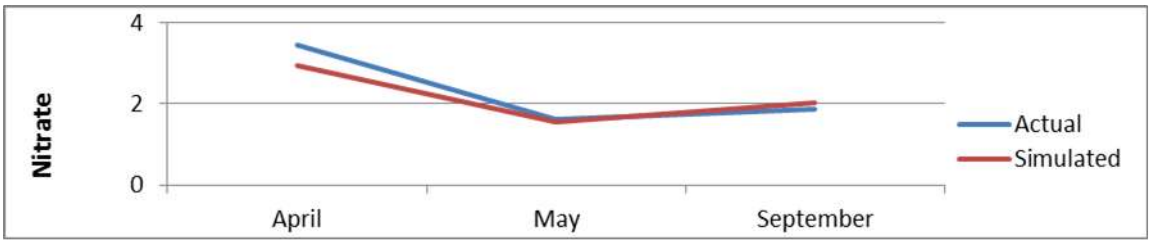

Figure (5) the amount of Nitrate in the calibration of model for the Paypol station

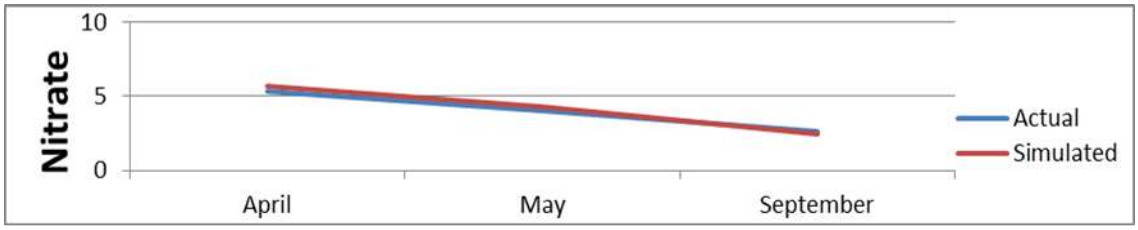

Figure (6) the amount of Nitrate in the calibration of model for the Shahid najian station

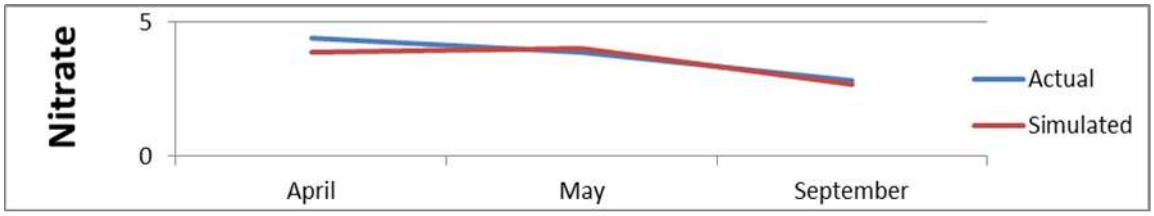

Figure (7) the amount of Nitrate in the calibration of model for the Abdolkhan station

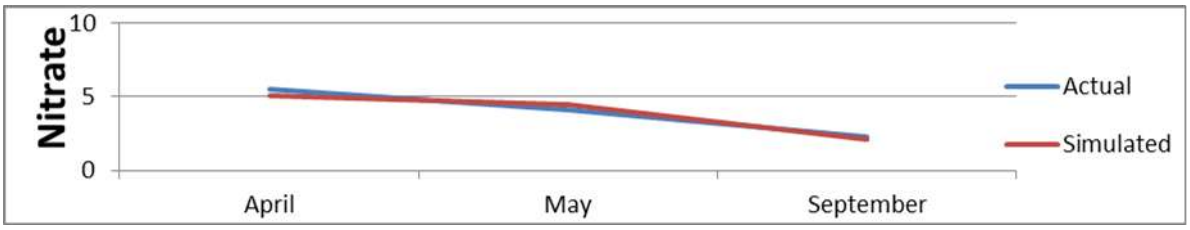

Figure (8) the amount of Nitrate in the calibration of model for the Alhayy station

Table (2) Statistical analysis WASP6 model calibration in Paypol station

Parameter	C_P	MAE(mg/l)	R	MSE(mg/l)
DO	2.244	1.164	0.034	7.562
NO_3	0.261	0.870	0.908	6.894

Table (3) Statistical analysis WASP6 model calibration in Shahid najian station

Parameter	C_P	MAE(mg/l)	R	MSE(mg/l)
DO	3.881	0.93	0.407	7.472
NO_3	0.178	0.713	0.999	6.788

Table (4) Statistical analysis WASP6 model calibration in Abdolkhan station

Parameter	C_P	MAE(mg/l)	R	MSE(mg/l)
DO	0.441	0.58	0.952	6.523
NO_3	0.021	0.103	0.996	6.711

Table (5) Statistical analysis WASP6 model calibration in Alhayy station

Parameter	C_P	MAE(mg/l)	R	MSE(mg/l)
DO	1.648	0.999	0.58	6.428
NO_3	0.173	0.711	0.992	6.884

According to Tables 2 to 5, correlation coefficient and mean absolute error for nitrate is greater than dissolved oxygen across the river. The performance coefficient is closer to zero indicate better function that Nitrate is better than dissolved oxygen.

WASP6 model verification phase diagrams

After calibration model WASP6, verification was performed with 4 station data from months of October, November, December, January, February and March of 2012. The following charts compare the model results with observational data to determine performance quality parameters in the simulation model.

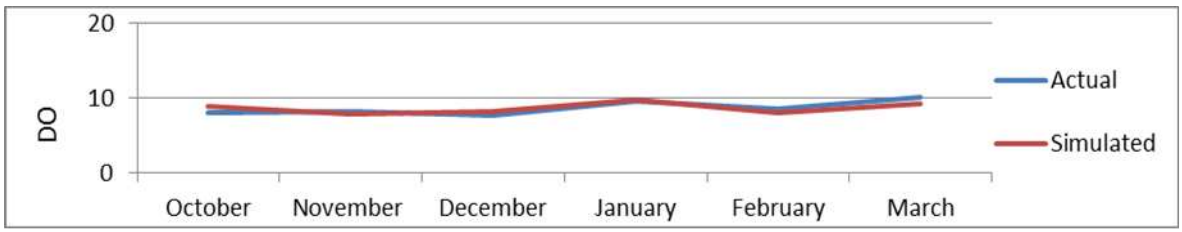

Figure (9) amounts of dissolved oxygen (DO) at the stage of verification for the Paypol station

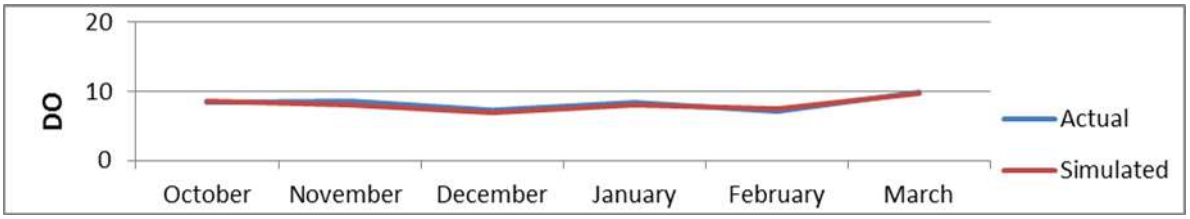

Figure (10) amounts of dissolved oxygen (DO) at the stage of verification for the Shahid najian station

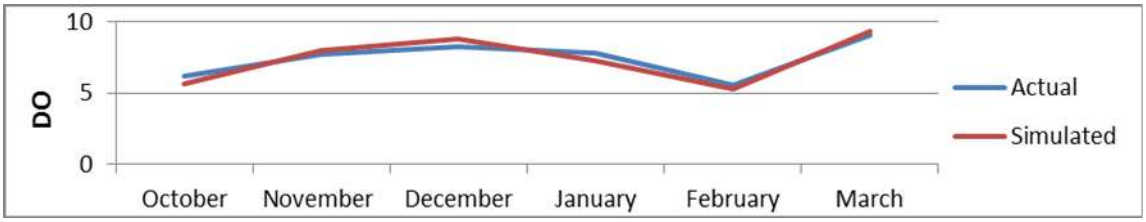

Figure (11) amounts of dissolved oxygen (DO) at the stage of verification for the Abdolkhan station

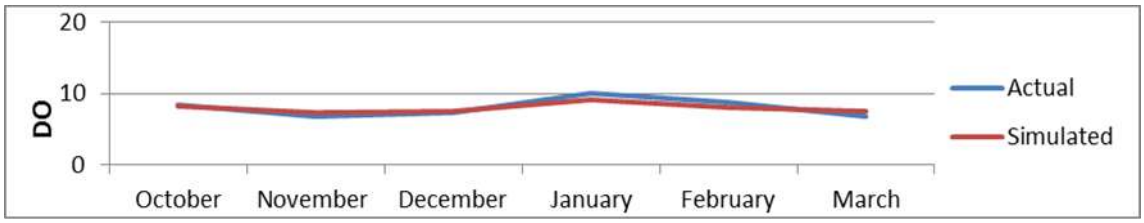

Figure (12) amounts of dissolved oxygen (DO) at the stage of verification for the Alhayy station

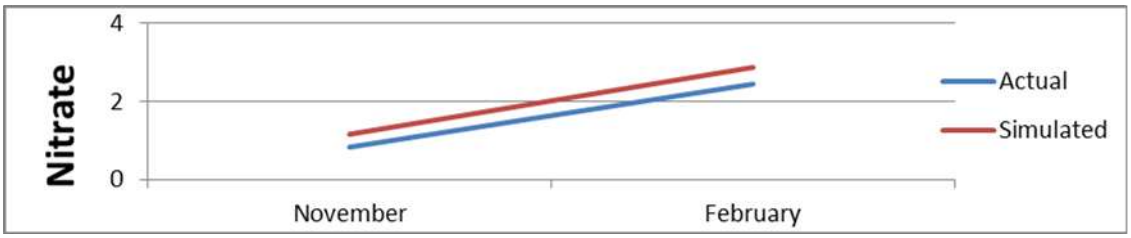

Figure (13) amounts of Nitrate at the stage of verification for the Paypol station

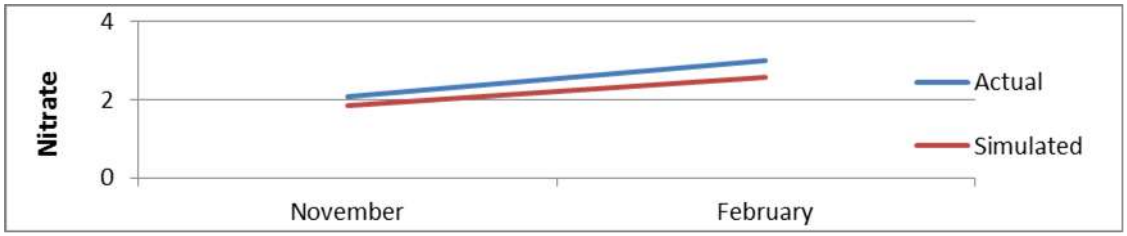

Figure (14) amounts of Nitrate at the stage of verification for the Shahid najian station

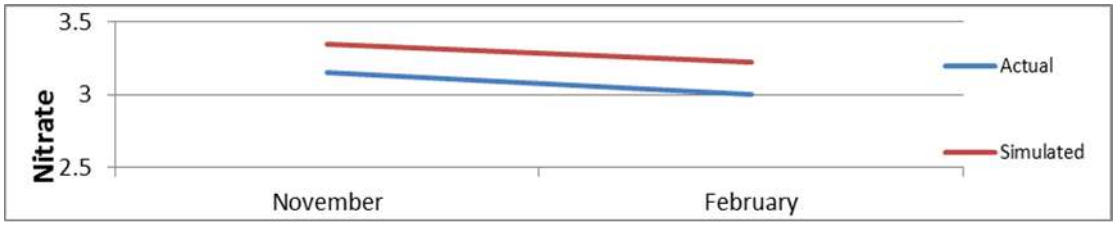

Figure (15) amounts of Nitrate at the stage of verification for the Abdolkhan station

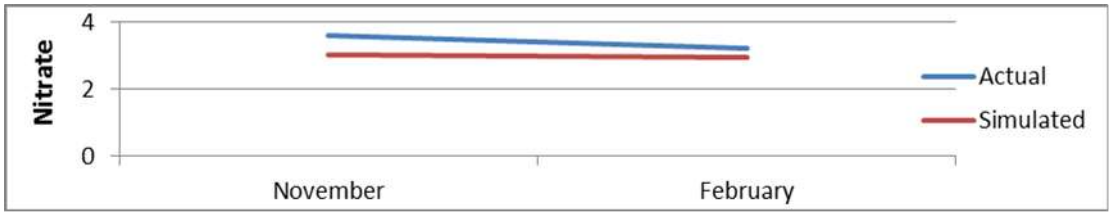

Figure (16) amounts of Nitrate at the stage of verification for the Alhayy station

Table (6) Statistical analysis WASP6 model verification in Paypol station

Parameter	C_P	MAE(mg/l)	R	MSE(mg/l)
DO	1.064	1.316	0.631	7.993
NO_3	0.391	0.541	0.994	5.311

Table (7) Statistical analysis WASP6 model verification in Shahid najian station

Parameter	C_P	MAE(mg/l)	R	MSE(mg/l)
DO	0.439	0.734	0.812	7.994
NO_3	1.953	0.428	0.847	5.366

Table (8) Statistical analysis WASP6 model verification in Abdolkhan station

Parameter	C_P	MAE(mg/l)	R	MSE(mg/l)
DO	0.772	0.671	0.971	7.618
NO_3	0.024	0.101	0.984	6.422

Table (9) Statistical analysis WASP6 model verification in Alhayy station

Parameter	C_P	MAE(mg/l)	R	MSE(mg/l)
DO	0.521	0.511	0.762	7.811
NO_3	1.948	0.733	0.523	5.372

According to the tables 6-9, the correlation coefficient for oxygen is greater than nitrate. The mean absolute error in the simulation for dissolved oxygen and nitrate has the low values. Performance coefficient for simulation of dissolved oxygen is higher than nitrate. Whatever the flow, the more DO is added. Substantially increase of flow and velocity causes the natural treatment of waste materials found in rivers and streams can be of great help in improving the environment [8].

Comparison of the simulated DO ranges can get the lowest DO value 5.38 mg/lit in September of Abdolkhan station and maximum amount of DO 10.2 mg/lit happened in March in Paypol station. Results indicate dissolved oxygen in the Karkheh River in the period of study is in good condition. Nitrate entered into water resources from chemical fertilizers and waste and sources such as animal waste and biodegradation organisms. These resources may or may not be discharged directly into the river or through drainage shallow water [9]. Acceptable nitrate concentration in the water should be less than 2.4 mg/lit. High nitrate levels in April in Alhayy station 5.54 and the lowest in October in Paypol station 0.38 mg/lit.

CONCLUSION

According to studies, it can be seen that the critical time for the oxygen content is in low water season (late spring, summer and early fall) because the low-velocity, high-polluting and the slow re-aeration, but in the full water season the condition is good. According to the simulation results can be seen that the applicability of the model for the one-year period between data and model is seen as an almost acceptable. So we can conclude that despite limited data, WASP6 model is an appropriate model for the simulation of water quality in rivers Karkheh. Among the parameters studied in the Karkheh River dissolved oxygen (DO) is in reasonable condition. With increasing temperature in the hot months of the year and then reducing the flow of the river, dissolved oxygen reduced. The lowest DO value is 5.38 mg/lit in September for Abdolkhan station and maximum DO value is 10.2 mg/lit in March at station of Paypol.

Variation tend indicates that the amount of nitrate in the river was higher than standard, maximum in November Alhayy station to the 3.6 and lowest in April at the Paypol station 1.63. The model WASP6 major cause of differences between actual data and simulation results can be caused by the lack of coefficients of kinetic and use of the default values, the sampling error, the impossibility of sampling all stations sampled and on the other hand Error in analysis of test samples. It is recommended that users should regularly monitor the river and polluted wastewater and planned On Line is possible.

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