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The Effect of Toxic Organic Chemicals on Mogan Lake

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ABSTRACT: In this study, the effect of some toxic organic chemicals on Mogan Lake has been investigated using the AQUATOX Model. The unique property of the Model includes the sub ecotoxicological model when compared to the other water quality models. The ecosystem model AQUATOX, which is one of the few general ecological risk models that represents the combined environmental repercussions and effects of toxic organic chemicals, was selected for this study. The Model also supplies conventional pollutants, such as nutrients and sediments, and considers several trophic levels, including attached and planktonic algae, submerged aquatic vegetation, several types of invertebrates, and several types of fish. All data measured at both lake and creeks have been loaded into the AQUATOX Model as both initial concentration and dynamic loading for the year of 2002. Then, the AQUATOX Model was calibrated and verified for the years of 2004 and 2005. After verification and calibration, the effects of toxic organic substances such as Dieldrin, Simazin, Carbofuran, PCB 180, Malathion, Tefluthrin, PCB 101, Fluridone, Pentachloropenol, DDT, Parathion, EPTC, PCB 110, Chlordane and Alochlor, all of which are found in the AQUATOX Library, on phytoplanktons and zooplanktons in the Mogan Lake, have been observed for one year. The results have indicated that zooplanktons are more sensitive to specific toxic substances than phytoplanktons. It has been seen that phytoplanktons have grown through getting toxic substances at first, and then tended to decrease after a definite time. However, some zooplankton species maintained their growth by taking toxic organic substances.

Key words: Simulation, Dangerous Substances, Toxicity, Modeling, the AQUATOX Model

INTRODUCTION

Since the Industrial Revolution, people have dramatically changed the globe by land clearing, agriculture forestry, animal husbandry and urbanization, and by altering hydrological cycles. In addition, the composition of many natural biological communities has been significantly altered (Smith *et al.,* 1999). Nowadays, water has a vital role for human health and the ecosystem. Besides, it is fundamentally necessary for a country's development. Water quality is deteriorating in most countries. This problem causes very important economic and social problems. It is obvious that the need for water resources is increasing parallel to the growing urbanization and industrialization.

The most affected natural resource by urbanization and industrialization is water resources. The most important water quality deteriorations are caused by toxic substances from point and non-point sources. Toxic substances negatively affect humans and other living beings in the environment with the effect of toxicity, cancer and spoiling of genetic structures. Toxic substances are in the air, soil, water and the bodies of plants and elsewhere after consumption. Toxic substances pollute aquatic environment through arriving at water with washing and transporting from rain water, aerosol and dust, plants and soil. Particularly organic substances tend to dissolve less in water and more in lipids. Therefore, they accumulate in organisms which live in water. The concentration in organisms is much higher than the concentration in water. The concentration depends on: (i) Toxic substances' concentration in water, (ii) The hydrofobite and degradation of half-life of toxic substances, (iii) The life of organisms, which means contact of time or the metabolism of organism.

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The change of toxic substances in water represents a move from sediment to water, degradation of the sediment organic section, absorption and desorption degraded portion of sediment, uptake of algae and macrotyphe, uptake of aquatic organisms and gills, uptake of toxic substances from organisms and turbulence, and diffusion between in hypolimnion and epilimnion. Microorganisms degrade not only organic substances but also derivatives of petroleum, solvents and pesticides to obtain energy.Degraded contamination can be modeled without accumulating in aquatic environment, organic substances or sediment. Substances degrade much more rapidly in sediment surface than water column. Taking toxic substances with gills cause very important effects on the aquatic organisms. The amount of bio-concentration is generally analyzed by the fish experiment. Taking toxic substances with gills is similar to taking oxygen. The aim of this study is to determine the effects of some toxic organic chemicals on aquatic components in the Mogan Lake located near Ankara using the AQUATOX Model. Besides, Mogan Lake is an important wetland; it has beneficial uses such as fishing, water sports and drinking water supply. Furthermore, there are lots of available data in the Mogan Lake. Thus, this lake has been selected as a research area. Monitoring of Mogan and Eymir lakes and Water Sources feeding these lakes has been carried out for pollution purposes for the years of 2001, 2002, 2004, 2005 and 2006 (DGPPEP, 2003). There are intensive arable areas in the Mogan Lake Basin. Farmers have been using pesticides for many years.

Recently, water quality models have been widely employed worldwide for a water environment assessment and prediction in various water bodies including lakes, reservoirs, oceans, rivers and estuaries (McKnight *et al.,* 2010, Morkoc *et al.,* 2009, Park *et al.,* 2007, January, Zhao *et al.,* 2010). According to McKnight (2010), the AQUATOX model indicated that TCE contamination does not have any important effect on the ecosystem. Park et al. (2007) studied PCB concentrations in water and bottom sediment in Galveston Bay; and the predicted concentrations in biota were compared with the observed concentrations. With some exceptions, the mean predicted PCB concentrations fell within the error bounds of the observed data. Rashleigh (2003) applied the AQUATOX model Contentnea Creek and recommended the model as a useful assessment of stream ecosystem response to certain types of stressors. In this study, we observed the effect of the organic substances which come from arable land, on phytoplankton and zooplankton found in Mogan Lake.

MATERIALS & METHODS

Mogan Lake is a small alluvial sediment lake, and one of the most important wetlands of Turkey located between 39° 44' 40"-39° 47' 45 north latitude" and 32° 46' 30" -32° 49' 30" east longitude at 972 m above sea level near the city of Ankara (Fig. 1). It is fed by small creeks most of which are dry in the summer season. The lake has a surface area of 750 hectares with huge reed beds around it. The length and width of Mogan Lake is 6 km and 900 m, respectively. The average depth is 3.5-4 m. The volume is 13-14 million m^3. The precipitation area is 941 km^2. The average precipitation is 403 mm and the average evaporation is 1,485 mm. The total basin area is 971 km^2 for Mogan and Eymir Lake, and the length of the basin is 150 km. The highest altitude is 1,650 m and the lowest altitude is 950 m.

Mogan and Eymir Lakes and their river basins are declared Special Environmental Protection Sites (SPS) by the Cabinet's Decree No. 90/1117 on October 22, 1990. This area covers 245 km^2 of the total precipitation area of the lakes. Mogan Lake is fed by many creeks, which are located in the north and west sides of the lake. They do not flow continuously; some are even dry creeks in general, and flow into Eymir Lake through a concrete channel in the northeast and merge with Ankara Brook with Imrahor Creek. Wetland of 750 hectares in the south of the lake serve as a habitat for a lot of species, especially birds. The mainstream is Çölova which does not flow continuously, gets lost in the middle of the basin, and then appear from wetland which is located to the south of the Mogan Lake. Sukesen, Baþpýnar, Yavrucak and Çölova generally flow except for very dry years.

Mogan Lake is used for hunting, swimming, sporting purposes and recreation for many years. The most highly populated settlement is Gölbaþý district, which is located on the Northern coast of Mogan Lake. Except for Gölbaþý District, there are administrative areas for Çankaya, Bala and Haymana district in the Mogan Lake Basin. There are 31 settlements in the Mogan Lake Basin; and the total population is 62602. Since Gölbaşý County is 20 km far from Ankara; and accessibility is rather easy; population growth and rapid urbanization are main threats. Generally, dry agriculture is carried out in the basin. Production pattern is heavily cereal and in irrigated areas (in the valley of Sukesen creek) vegetable. There are pastures in that portion of the basin. There is very little machinery and few mining industries in the basin, and they are connected to the sewage system. However, they sometimes dump waste into the lake without any control. According to a report which was prepared by the Environmental Protection Agency for Special Areas

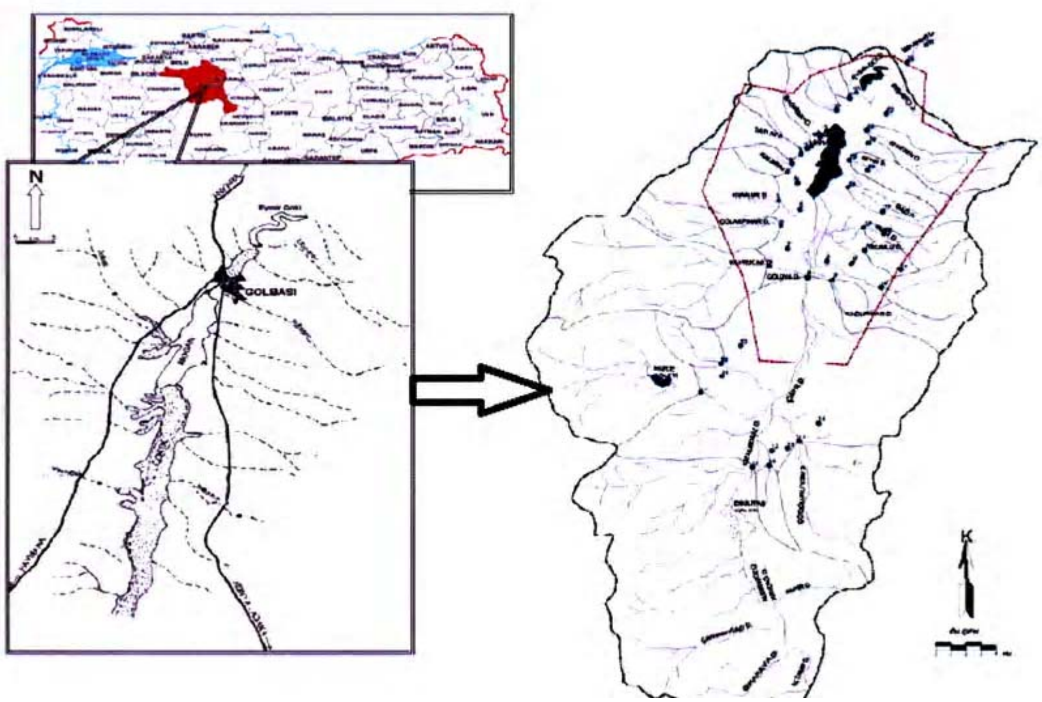

Fig. 1. Mogan Lake location

in 2000, agriculture was carried out in wider areas which are located in the South of Mogan Lake (EPA, 2000).

These areas affect Mogan Lake depending on the used fertilizers and pesticides. Therefore, the reeds have been growing around Çölova creek reaching Mogan Lake. It is anticipated that an extensive use of pesticides in the basin damages aquatic compounds. Substances which flow into Mogan Lake through erosion, snow melting and drainage cause accumulation of sediment and decrease in the depth and volume of the lake as well. The biological activities continue for years; and have been accelerated by accumulating sediment, discharging of wastewater and nutrients which come into the lake through rain water. Therefore, the wetlands in patches, increasing and spreading plants in water and shallow parts have been observed in the Lake. The wetlands and eutrophication have been dominated because of the increasing sediments and nutrients. Another reason for the pollution in the lake is the diffuse pollution from agricultural lands.

When pollution loads into Mogan Lake are evaluated, Gölovasý, Yavrucak, Kumluk, Baþpýnar, Yaðlýpýnar, Kurt, Çolakpýnar, Yayla creeks in the south; Kaldýrým, Tatlým, Göçlük creeks in the west; and Sukesen Creeks in the east carry an important amount of nitrogen, phosphate, and totally dissolved solids and sediments into the lake. Furthermore, instability of the water level of the lake affects the conditions in the lake. Aquatic plants' growth is accelerated because of shallowness (Yerli, 2002). According to Yerli (2002), Mogan Lake is hypertrophic. With coordination of Environmental Protection Agency for Special Areas, Environmental Reference Laboratory conducted analyses in the Lake in the years of 2001, 2002, 2004, and 2006. Similar results have also been obtained in 2003 and 2005. As a result of these analyses, especially in the summer months, Mogan Lake is hypertrophic in terms of total phosphorus and Chlorophyll according to OECD trophic state classification (Yerli, 2002). The AQUATOX is a process-based model for ecological risk assessment that can represent the effects of toxic chemicals and conventional pollutants on the aquatic ecosystem (Park & Clough, 2004a & 2004 b). The model uses a daily timescale to simulate the physical environment (e.g. flow, light, and sediment) and the chemical environment (e.g. nutrients, oxygen and carbon dioxide, and pH). The dynamics of biotic components of detritus, algae, benthic invertebrates and fish can be simulated.

The AQUATOX can simulate organic chemicals, but not metals or organometals. It is a most useful organic chemical with high octanol-water partition coefficients (e.g. $>10^4$) that can be expected to bioaccumulate. For a new chemical, data is required for molecular weight, octanol-water partition coefficient, and Henry Law transformation rates as appropriate. The AQUATOX predicts the partitioning of a toxicant among water, sediment, and biota; and includes processes of microbial degradation, biotransformation, photolysis, hydrolysis, and volatilization (Gonenc *et al.,* 2007).

The AQUATOX Model simulate the parameters: (i) Concentration of nutrients and toxic substances, (ii) Biomass, (iii) Plants, invertebrates and fish, (iv) Chlorophyll a, (v) Phytoplankton, periphyton and algae, (vi) Total Suspended solids and secchi depth, (vii) Dissolved oxygen, (viii) Biological oxygen demand, (ix) Bioaccumulation factor, and (x) Half-lives of toxic organic.

The AQUATOX Model has been applied to water which was chemically and biologically deteriorated. Water manager could learn which factors deteriorate aquatic media by this model. Pollution measures are also determined according to whether they will reach their desired status or not. The AQUATOX model helps to see the required recovery time for the deteriorated aquatic system (Park and Clough, 2004a).The AQUATOX Model is implemented for artificial Lakes, dams, rivers and territorial surface water. Mixing thermal water completely or salty saturated water is modeled easily (Park and Clough, 2004b). The calculation which is based on mass-balance calculation is carried out in the AQUATOX Model. In this framework, all aquatic components are considered. All physical and chemical properties such as toxic organic substances, volatility and 50% of lethal concentration are considered. The differential equation regarding toxic substances and algae is given below.

$$\frac{d\,Toxicant_{Alga}}{dt} = Loading + AlgalUptake - Depuration + -TurbDiff$$
$$-(Excretion + Washout + \sum_{Pred} Predation_{Pred,Alga} + Mortality$$
$$+ Sink + -SinkToHypo) * PPB_{Alga} * 1e^{-6} + -Biotransfom_{Alga}$$

where;

$Toxicant_{Alga}$ = Algae given for water in unit volume related to toxicant mass (g/L),

PPB_{Alga} = Concentration of toxic substances in algae (g/kg),

1 e^{-6} = Unit conversation (kg/mg),

Loading = Loading of out-sourced toxicants (g/L d),

TurbDiff = Average turbulence coefficient between Epilimnion and hipelimnion (g/L d),

Depuration = Elimination rate of toxicants depending on cleaning (g/L d),

Sink = Phytoplankton loss rate of lower sediment (mg/L d),

SinkToHypo = Transfer rate of Phytoplanktons to hypelimniona (mg/L d).

AlgalUptake = Absorption rate of algae (g/L d),

Excretion=Excretion (g/m^2d),

Mortality= Death of living organisms which are not predators (g/m^2d),

Washout= Loss due to drift and flow (g/m^2d),

Predation= Herbivorous animals (g/m^2d),

$Biotransform_{Alga}$ = Biotransformation in algae

Degradation of chemicals and degradation rate has been predicted among water, sediment and biota in the AQUATOX Model. Particularly degradation of toxic organic substances, bio-transformation photolysis, hydrolyzes and volatilization were modeled in the AQUATOX.

Particularly Toxic Organic Substances are modeled under the maximum degradation rate after decreasing sub optimum temperature, pH and dissolved oxygen. At the same time, photolysis, using light portion factor, evaporation, based on aeration oxygen between the air and water transfer rate, were considered.

There are differential equations for toxic substances found in water, sediment, planktons and aquatic living beings in the AQUATOX. For example, exchange of toxic organic substances in water, movement of toxic substances from sediment to water, degradation outcome of sediment organic substances portion, absorption and desorption of degraded and decomposed portion in sediment, uptake of algae and macro phytoplankton, uptake of aquatic organisms with their gills and turbulence and diffusion between the epilimnion and hypolimnion are represented.The AQUATOX Model has a library for the toxic organic substances. This library includes CAS (Chemical Abstract Service), molecular weight for each chemical, Henry Law steady, octanol water division coefficient and aerobic and anaerobic microbial degradation coefficients etc. While the AQUATOX is modeling the effects of each chemical on aquatic environment, all features are considered. The reasons for using the AQUATOX Model in Mogan Lake are listed below:

(i) Since Mogan Lake is eutrophic, it can be modeled in the AQUATOX for both nutrients which is the source of the eutrophication and toxic organic chemicals at the same time.

(ii) The AQUATOX model, together with toxic chemicals, models the biological quality elements and shows the effect of toxic chemicals on them.

(iii) The AQUATOX Model is more sensitive than other water quality model. That means it can work with fewer data.
(iv)Moreover, the AQUATOX Model simulates the organic substances as eight fractions. So, it gives more proper results.
(v) The AQUATOX model can supply input to the model for some parameters which are difficult to measure via calculating with empirical equations.
(vi)The AQUATOX model is perhaps the most comprehensive model available, as can be seen by comparison with other representative dynamic models being used for risk assessment (De Leander *et al.,* 2008, Park *et al.,* 2008). All the models, with the exception of QSim and CASM, are public domain. The closest to the AQUATOX in terms of scope is the family of CATS models developed by Traas and others (Traas and Aldenberg, 1992). These ecotoxicology models have simple representations of growth, and are not as suitable as the AQUATOX for detailed analyses of eutrophication effects. CASM is similar to CATS, with simplified growth terms, but it lacks a toxicant fate component. QUAL2K and WASP are water quality models that share many functions with AQUATOX, including benthic algae WASP, also models the fate of toxicants. The hydraulic and water quality models EFDC and HEM3D are often combined; EFDC has also been used to provide the flow field for linked segments in the AQUATOX, resulting in a similar representation. The AQUATOX, QUAL2K, WASP, and EFDC include the sediment diagenesis model for remineralization (Park *et al.,* 2008).

Certain toxic organic chemicals, namely Dieldrin, Simazin, Carbofuran, PCB 180, Malathion, Tefluthrin, PCB 101, Fluridone, Pentachloropenol, DDT, Parathion, EPTC, PCB 110, Chlordane and Alochlor are selected for analysis. According to the data from Provincial Directorate of Ministry of Food, Agriculture and Livestock, pesticides such as Dieldrin, Simazin and DDT have been used for a long time. Some of them, such as Simazin, Carbofuran and Fluridone were prohibited. Some of them, such as malathion were used (MFAL, 2012). After carrying out the calibration and verification of the AQUATOX Model, toxic organic substances have been modeled. For this reason, some toxic organic substances found in the AQUATOX Library have been added to the interface constituting Mogan Lake in the AQUATOX Model.Among the total of 17 selected sampling points, 10 sampling points are from creeks feeding Mogan Lake, 3 sampling points are from Eymir Lake, 4 sampling points are in Mogan Lake and 2 sampling points are from outlets of those lakes. The coordinates of sampling points are given in Table 1, and sampling Points are presented in Fig. 2. Whilst sampling points for creeks are selected on the mouth of the river just before discharging into the lake to be able to see the pollution from each creek, points in the lake are determined both to observe pollution from creeks and pollution from the bottom sediment. All chemical parameters are in the unit of mg/L. Chemical parameters are loaded to the AQUATOX Model as mg/L. Biological parameters have been analyzed as species or individual/m^3. Therefore, it is necessary for biological parameters to be converted into g/m^3 (g/m^2). In this study, the formulation developed by Mullin et al. (1966) has been used for converting phytoplankton to g/m^3 as follows: Phytoplankton (mg/L) = (individual)/mL)) *2E$^{-4.}$

Phytoplankton has been converted to mg/l with the help of this equation in Mogan Lake. For developing Zooplankton and Daphnia to mg/L, the formulation developed by the AQUATOX has been used, which is: Daphnia or zooplankton (mg/L) = 0.0006*(individual)/5

After all those conversions, all existing data have been loaded into the AQUATOX Model. All data measured at both lake and creeks have been loaded as both initial concentration and dynamic loading. Since the average concentration of some parameters in creeks were bigger than in the Lake, average concentrations of some parameters such as total nitrogen, nitrate, total soluble phosphorus and total suspended solids have been taken as initial values. The total concentration of organic substances in creeks has been taken as initial loading. The values of temperature, Dissolved Oxygen, pH, and Biological parameters measured in Mogan Lake have been loaded as both initial concentration and dynamic loading. The values of the hydrological parameters measured in the creeks have been taken as both initial concentration and dynamic loading. All data were measured in 2002. At the beginning of this study, before calibration and verification, degradation coefficients and ratios determined for Clear Lake (U.S.A.), eutrophically similar to Mogan Lake, have been used in the AQUATOX Model. Clear Lake is the largest, natural freshwater lake in California with 68 square miles of surface area. The AQUATOX Model was simulated in terms of eutrophication and toxicity in Clear Lake.

After establishing input values to the AQUATOX Model, calibration and verification stage has started. While calibration and verification were carried out, the simulation results of the AQUTAOX model were compared with the 2004 measured data. Those comparisons are shown in Fig. 3.

As seen from Fig. 3, there is no need for calibration of temperature, pH and suspended solids parameters in the AQUATOX Model since simulation results and measured results are very close. The calibration and

Table 1. Name and Coordinates of Sampling Points

Sample No	Station No	Coordinates
1	Gölcük Dere	N39°46,303' E32°46,407'
3	Tatlım Dere	N39°46,058' E32°46,163'
6	Çolakpınar Dere	N39°44,288' E32°45,196'
7	Yavrucak Dere	N39°41,687' E32°44,520'
8	Çölova Dere	N39°41,151' E32°46,469'
11	İkizce Gölet	N39°36,572' E32°40,814'
12	Dikilitaş Gölet	N39°34,034' E32°44,118'
15	Başpınar Dere	N39°40,943' E32°49,040'
16	Kumlu Dere	N39°42,388' E32°48,959'
19	Kepir Dere	N39°46,102' E32°48,283'
20	Sukesen Dere	N39°47,445' E32°48,190'
21	Mogan Çıkış	N39°47,671' E32°48,013'
25	Kışlak Dere	N39°49,670' E32°50,820'
MG1	Dere Giriş Mansap	N39°47,414' E32°47,855'
MG2	Mansap	N39°47,219' E32°47,919'
MG3	Orta	N39°46,411' E32°47,683'
MG5	Menba	N39°45,476' E32°47,032'

Fig. 2. Mogan Lake Sampling Points

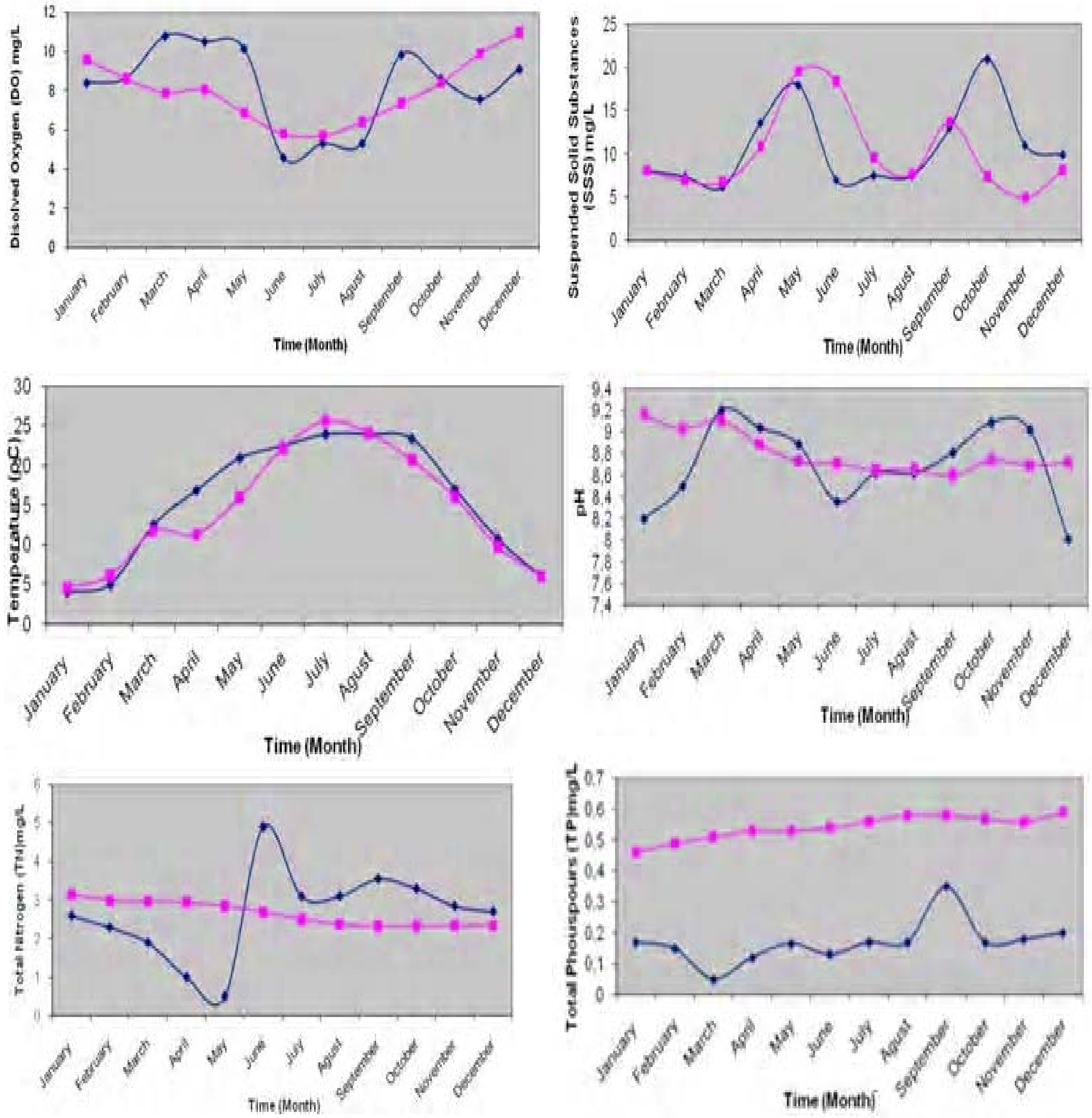

Fig. 3. Comparison of the Dissolved Oxygen, Suspended Solid Substances, Temperature, pH, Total Nitrogen and Total Phosphorus Measured values and the Model Outputs for 2004

verification have been carried out for Dissolved Oxygen, Total Nitrogen and Total Phosphorus. Whether trials determined for suitable intervals or not, relative error has been used.

RESULTS & DISCUSSION

Some toxic organic substances, namely Dieldrin, Simazin, Carbofuran, PCB180, Pentachlorophenol, Malathion, Tefluthrin, PCB101, Fluridone, Alachlor, DDT, Parathion, EPTC, PCB110 and Chlordane have been simulated and their effects on species such as Rotifer, Kerat, Rotifer, Brach, Copepod, Peri, Navicula, Peri, Fragilar, Peri, High-Nut, Phyto, Green, Phyt, Blue-Green found in Mogan Lake have been investigated by using theAQUATOX Model. Some of those substances which affect species found in Mogan Lake have been given in the figures below. As shown in Fig. 4, Copepod, Rotifer, Brach and Rotifer, Kerat gave continual reaction against 4 µg/L DDT. In the first month of the simulation, decreases are 95% for Rotifer, Kerat, 60% for Rotifer, Brach and 6%.

for Copepod. Afterwards, it showed great improvement with spring precipitation. However, declines increased with decreasing rain; and the reaction went on for years.

As shown in Fig. 5, when one year simulation was carried out with 0.5 µg/L Malathion, Zooplanton decreased and Phytoplankton partly increased. The most sensitive species was Rotifer, Kerat to the Malathion in the Mogan Lake.

As shown in Fig. 6, Rotifer, Kerat decreased almost 100% by carrying out the simulation of PCB 180. Afterwards, the decline did not last long. Rotifer, Brach increased at first, and decreased very seriously in the summer time. The species of the zooplankton Copepod increased continuously. The other phytoplankton species increased. The most sensitive species was Rotifer, Brach to PCB 180 in the Mogan Lake.

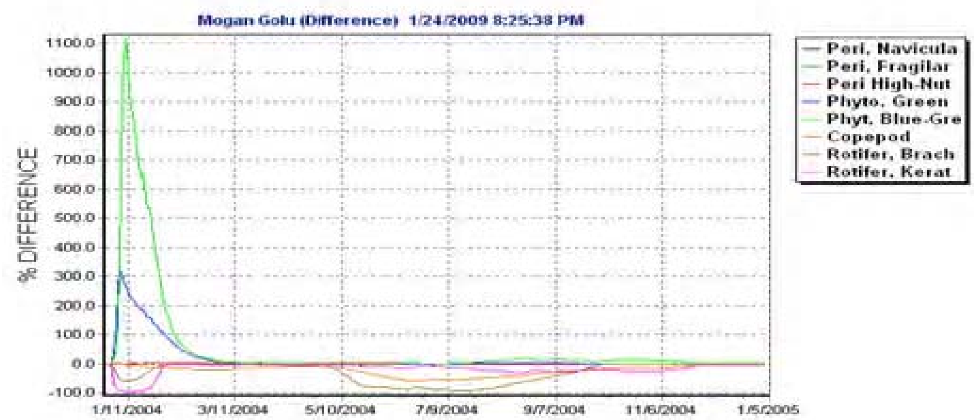

Fig. 4. The effect of 4 µg/L DDT to Mogan Lake Components

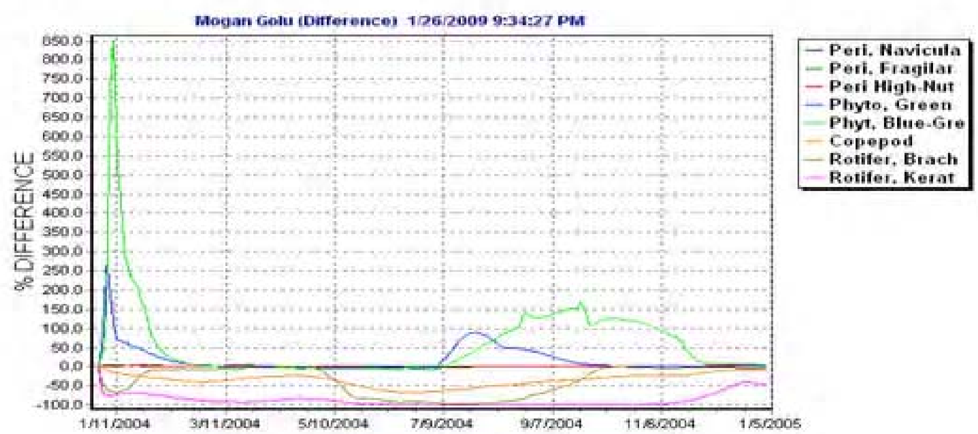

Fig. 5. The effect of 0.5 µg/L Malathion to Mogan Lake Components

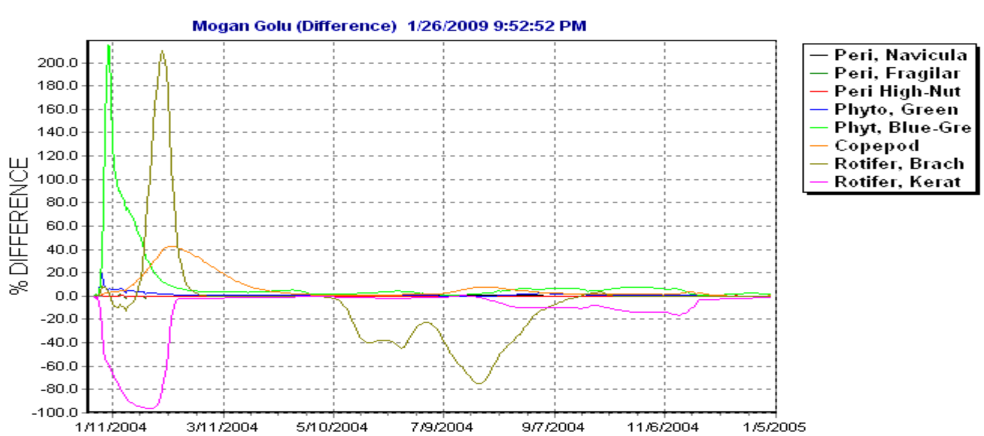

Fig. 6. The effect of 5 µg/L PCB 180 to Mogan Lake Components

As shown in Fig. 7, Rotifer, Brach and Rotifer, Kerat decreased 90% compared to the 0.5 µg/L Parathion. The decline continued during 2004. Copepod reacted by growing extremely. Particularly blue and green algae increased. The most sensitive species were Rotifer, Brach and Rotifer, Kerat to the parathion. The most sensitive species to toxic substances in Mogan Lake are presented in Table 2.

Water quality models predict likely future situations. The results obtained would show whether there should be measures taken to improve the water quality in the aquatic environment. So, it is decided whether the aquatic environment is improved or not. It is determined which measures are to be taken to improve the water quality in the aquatic environment. The AQUATOX Model predicts macro parameters (Dissolved Oxygen, Suspended Solids and pH, Total Nitrogen, Total Phosphorus, Temperature etc.) for probable future situations. Besides, it also predicts micro parameters (Dieldrin, Simazin, Carbofuran, PCB180, Pentachlorophenol, Malathion, Tefluthrin, PCB101, Fluridone, Alachlor, DDT, Parathion, etc) to see the effect on aquatic environment components.

On the other hand, when the AQUATOX Model is compared with other water quality models (Pamolare, Delft 3D, Mohid etc.), since it includes eco-toxicology sub models, the AQUATOX Model covers the effect of the toxic organic substances on aquatic environment components. For this reason, the maximum input concentration which affects aquatic environment components could be found; and the maximum permissible concentration for each parameter, which is the quality values for aquatic environment, could be calculated.

In this study, maximum input concentration for Dieldrin, Simazin, Carbofuran, PCB 180, Malathion, Tefluthrin were found as 15, 6,500, 30, 5, 0.5, 0.5, 5 µg/L, respectively in Mogan Lake.

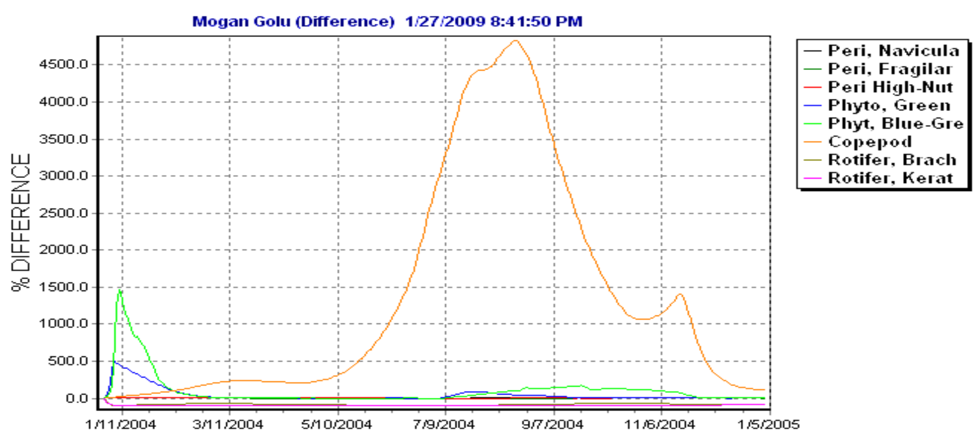

Fig. 7. The effect of 0.5 µg/L Parathion to Mogan Lake Components

Table 2. The Most Sensitive Species to toxic substances in Mogan Lake

Species	Toxic Substance
Rotifer, Brach	Dieldrine
Rotifer, Brach	PCB 180
Rotifer, Brach	DDT
Rotifer, Brach	Pentachlorophenol
Rotifer, Kerat	Simazin
Rotifer, Kerat and Copepod	Simazin
Rotifer, Kerat and Copepod	Tefluthrin
Rotifer, Kerat and Rotifer, Brach	PCB 101
Rotifer, Kerat and Rotifer, Brach	Parathion
Rotifer, Brach and Copepod	Fluridone
Rotifer, Brach and Copepod	Chlordane
Rotifer, Brach and Copepod	Alachlor

CONCLUSION

The effects of Dieldrin, Simazin, Carbofuran, PCB 180, Malathion, Tefluthrin, PCB 101, Fluridone, Pentachlorophenol, DDT, Parathion, EPTC, PCB 110, Chlordane and Alachlor on phytoplankton and zooplankton in Mogan Lake have been predicted for the whole year in this study. The most sensitive species to toxic substances are found as Rotifer, Brach, Rotifer Kerat and Copecod. Simazine is toxic to both Rotifer, Kerat and Copecod. According to all these results, zooplanktons were more sensitive than Phytoplanktons tothe toxic organic substances. During simulation, phytoplanktons grew by taking toxic organic substances at the beginning, but then they tended to decrease. On the other hand, some zooplankton species maintained their growth by taking toxic organic substances. It should be noted that the models' utility must be determined further by model applications in other study areas. Since studies on the effect of these substances on aquatic species are rather difficult, expensive and time consuming, ecotoxicological models can be used for this purpose. With a model study, all pressures affecting the water body in the basin and water body-sediment interactions are considered. Thus, by taking into account all the systems, using the model provides a solution to the problems in a more effective way, and within a short period of time whenever any deterioration in the system occurred. Finally, using the above results, quality criteria for receiving water body can be determined by using the AQUATOX Model or similar models. Moreover, the effects of the discharges arising from industries on receiving water bodies can be assigned.

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