

 **water2irrigation**

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 **IRAQWQI V.1 manual**



## **Methodology of water2irrigation.net for assessment of irrigation water quality**

Many water quality index have been published various uses and guidelines in the world. Different methodologies and methodologies are often used to derive standards and guidelines, for example some guidelines determine the maximum concentrations of constituents usable, while others attempt to determine the ideal concentration of constituents, often incorporating safety factors. Therefore, depending on the guidelines or criteria used to determine water quality requirements, one can reach answers that are sometimes different from a factor of dozens of other factors.

The purpose of water irrigation was to help understand the water quality index for Iraqi rivers so that the IRAQI Software was made of index and standards agreed experts in water quality. One of the intentions of this approach was to facilitate understanding and use of different standards and guidelines to determine the water quality requirements for private water use by stakeholders of water supply and use in the world in the light of research and experience in water2irrigation.



## **Overview**

The Iraq WQI is developed based on The Iraqi Standards and the World Health Organization specify the quality of water for various uses. The six parameters, viz. total dissolved solids (TDS), dissolved oxygen (DO), chemical oxygen demand (COD), total hardness (TH), chlorides ( $\text{Cl}^-$ ), and total coliform (TC) are considered to significantly affect the surface water quality as the result an expert panel's advice and PCA test. Iraq WQI is very useful for decision-makers, planners and field engineers for maintaining good health of surface water resources, This publication explains the Software's parts and how to use it.

### **Software Requirements:**

- Work on all Windows operating systems.
- Pentium 2 or higher( 512 MB) of RAM.
- (1GB) of storage.
- software size (20) MB.

### **software Input:**

To run assessment operation must the data necessary is:

1. General information (file name, sample location, Source of water, Date,coordinates).
2. Total dissolved solids (TDS)mg/l, chloride ( $\text{Cl}^-$ ). total hardness(TH).
3. Biological parameters (COD), dissolved Oxygen DO, Total coliform (TC).

### **software outputs:**

store Water Quality Index (WQI) assessment data in txt file with Extension (.rep).

# **Part 1**

# **Graphical User Interfaces**

## 1-1-Run Software

After install IraqWQI software on pc or labtop or tablet, the icon for software appear on desktop in the shape figure( 1 ), click on icon to run software.



Figure ( 1 )

## 1-2-the splash interface

After the software runs every time the splash interface appears Figure ( 2 ).



Figure ( 2 )

This interface consists of the following:

1. model name and version number.
2. The website hosting the software.
3. The social network media for the website.
4. start button for access assessment data interface .

**1-2-1-website [www.water2irrigation.net](http://www.water2irrigation.net)**

When you click on [www.water2irrigation.net](http://www.water2irrigation.net) label the software go with you to website for visit and to be useful from it.

**1-2-2- water2irrigation Stuido Interface:**

From the splash interface and when clicking on the icons social meida to opens the interface of water2irrigation Studio Figure ( 3 ).



Figure ( 3 )

water2irrigation studio is platform consists of facebook, twitter, youtube, linkin and google play store which has some useful applications. Figure (4 ).



Figure ( 4 )

### 1-3-before started:

The software create folder called IraqWQI through running at first time. the path folder in c partition and content another folder called Data. all files which will create stored in it Figure (5).

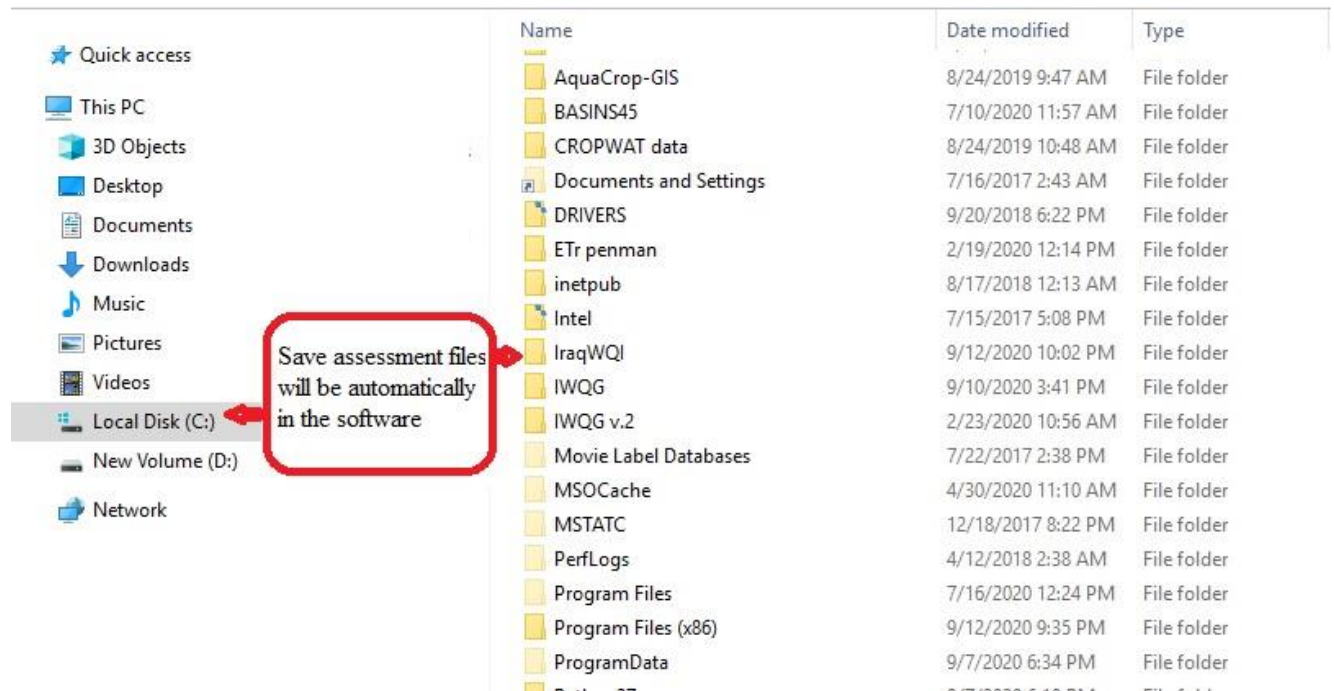


Figure ( 5 )

### 1-4-DATA interface:

1-4 -1-The Menu bar is directly below the Title bar and it displays the menu. The menu begins with the word File and continues with about, View, Help, and Exit. You use the menu to give instructions to the software.

1-4 -2- toolbar is just a collection of icons that provides a shortcut to using the drop-down menu. Toolbars offer quick shortcuts to commonly used commands.

It contains buttons to handle data such as:

1-4 -2-1- New button: by this button you can clean all textbox in Data interface and write new information and parameters value to new assessment.

1-4 -2-2- Open File button:to open file saved in computer and process the data stored in it with text file extension (.wqi).



1-4 -2-3- Save File button: After performing the assessment process, this button saves the sample file separately as text file with extension (rep.).

1-4 -2-4 - Help Button: it is helping user for use software by optimal way.

1-4 -2-5 - About Button:it to know who are developing the Model,References , version of model and copyrights reserved.

1-4 -2-6 - Exit button: to close the program after the end of the assessment process.

1-4 -3 -General information (file name, sample location, water source, coordinates, date).

1-4 -4- parameters use in assessment are : total dissolved solids (TDS), dissolved oxygen (DO), chemical oxygen demand (COD), total hardness (TH), chlorides (Cl-), and total coliform (TC).

1-4 -5 - click on calculate button for data assessment and get WQI score Figure ( 7 ).

The screenshot shows the IraqWQI software interface. It features a menu bar with 'File', 'Print', 'Help', 'About', and 'Exit'. Below the menu is a toolbar with icons for 'New', 'Open', 'Save', 'Print', 'About', 'Help', and 'Exit'. The main window is divided into three sections: 'Information', 'parameters', and 'calculate'. The 'Information' section includes fields for 'File Name', 'Location' (Baghdad,Iraq), 'source of sample water' (River/Chanal), 'Date' (January 2020), and 'Coordinates' (Latitude 33.3152, Longitude 44.3661). The 'parameters' section lists 'TDS (mg/L)', 'TC MPN/100 mL', 'DO (mg/L)', 'TH (mg/L)', 'COD (mg/L)', and 'Cl (mg/L)', each with a text input field set to '0.00'. The 'calculate' section contains a 'calculate' button. Red circles with numbers 1 through 5 highlight the 'Exit' menu item, the 'Exit' toolbar button, the 'Date' field, the 'TDS (mg/L)' input field, and the 'calculate' button, respectively.

Figure ( 7 )

WQI score and assessment description appear directly.

#### 1-5-How open file:

click on open button and select your file from pc .you note that extension file must (.WQI).You can create it by notepad app and put your value vertically with out (TDS , TC ,DO ,TH ,COD ,CL) words and write file name .wqi and select save as type (All Files) and click save button Figure ( 8 )

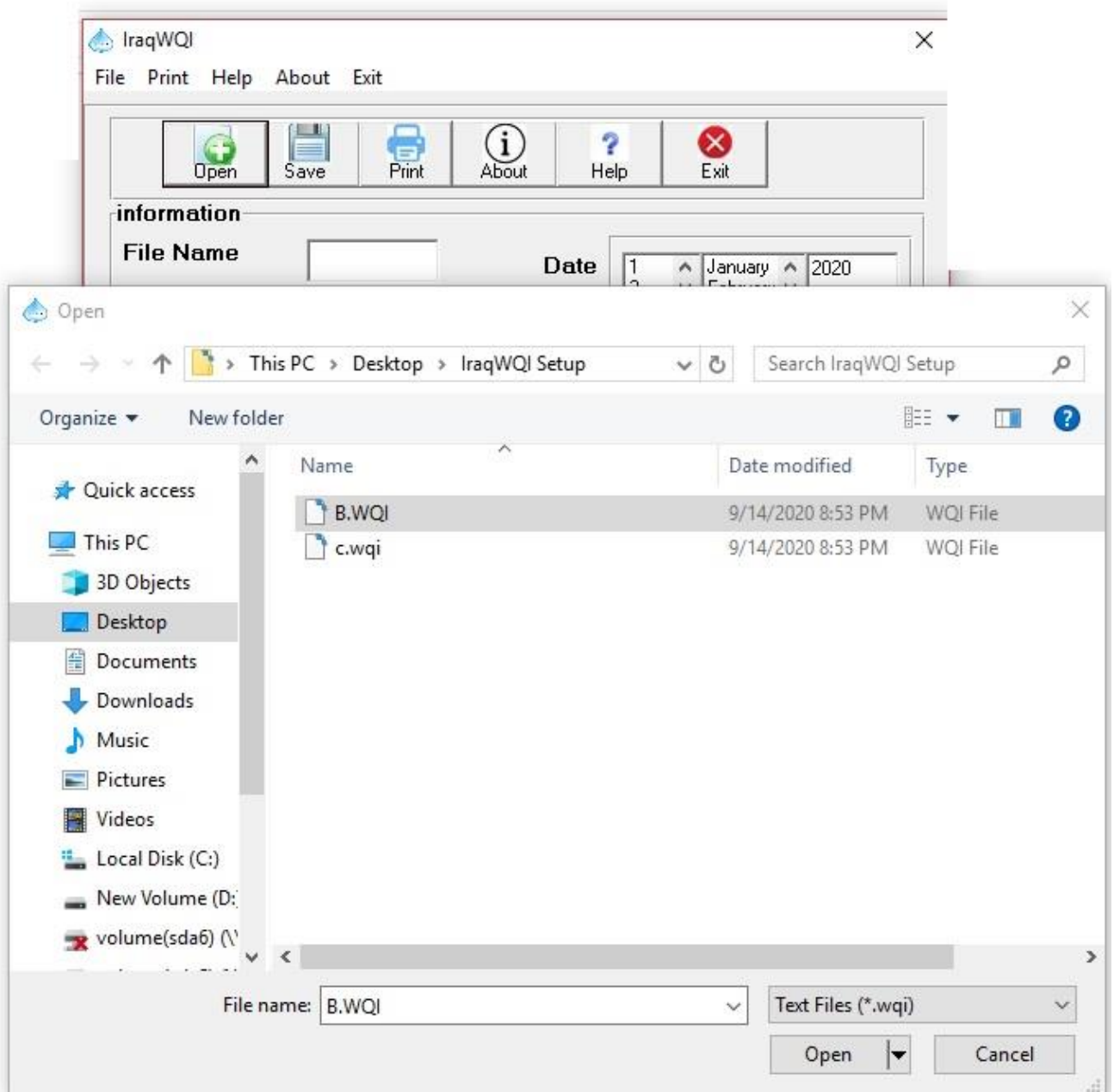


Figure ( 8 )

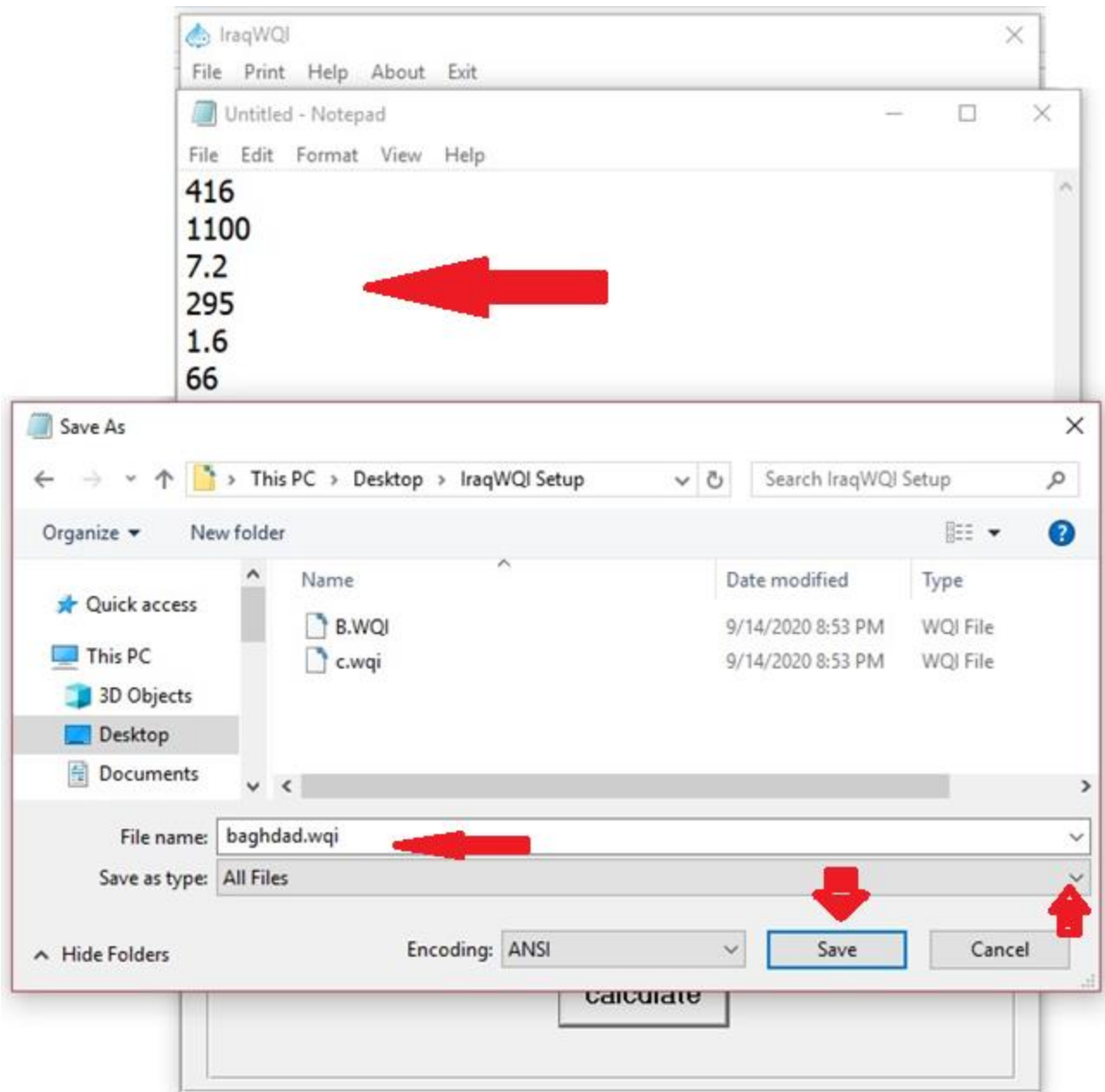


Figure ( 9 )

1-6 - Save file:

After assessment operation finish , click on save button the message appear talk where is file saved Figure ( 10 )

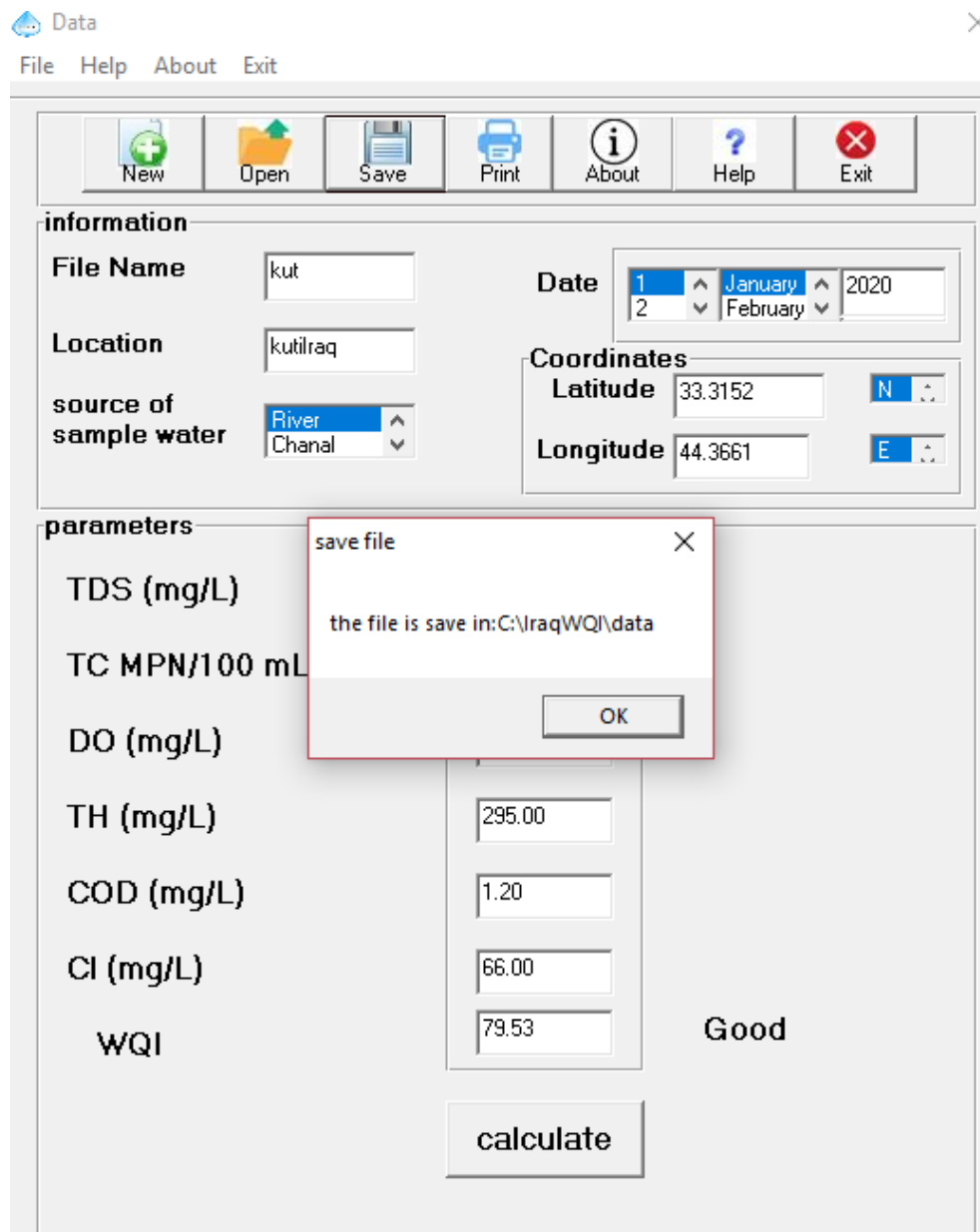


Figure ( 10 )

1-7-Print button :

Click on print button to printing all information and values which you input it directly, you can select any printer from list appear in front of you.click on ok button to start print operation Figure ( 11 )

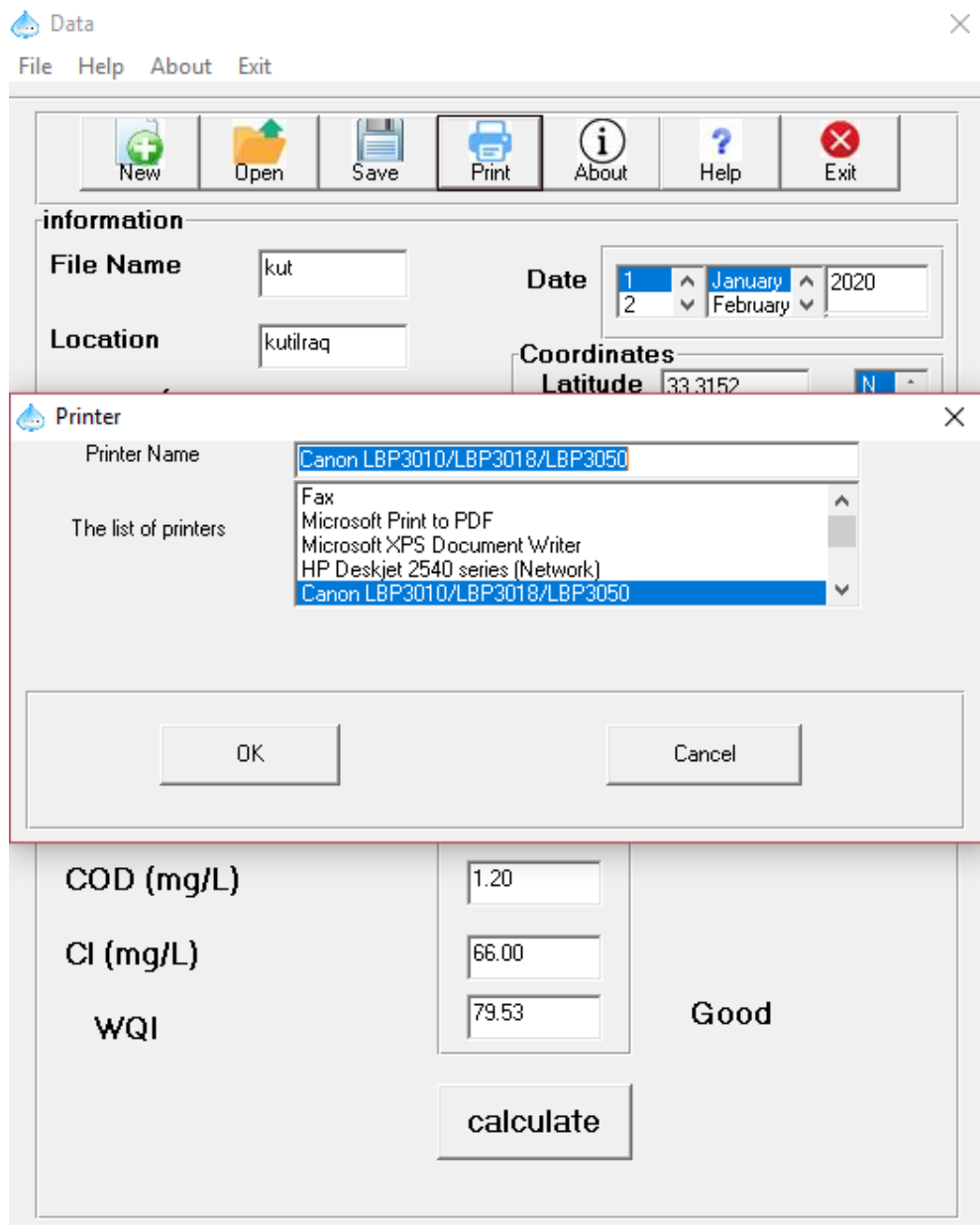


Figure ( 11 )

### 1-8-About interface:

By click on about button in this interface you know model developers , copyright and important references used in the model Figure ( 12 ).



## 1-10-Exit button:

Click on exit button or close button in top interface to leave the software, Figure (14).



Figure ( 14 )

**PART 2**  
**terms and Equations**



Table (1) Chemical Parameters used in the evaluation of water quality

<b>Parameters</b>	<b>Symbol</b>	<b>Unit</b>
Total Dissolved Solids	TDS	(mg/L)
Total Hardness	TH	(mg/L)
Chloride	Cl <sup>-</sup>	(mg/L)
Chemical Oxygen Demand	COD	(mg/L)
Dissolved Oxygen	DO	(mg/L)
Total coliform	TC	(MPN/100 mL)

## 2-1-The Model of Iraq Water Quality Index (IraqWQI)

This model developed by :

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- Dr. Salwan Ali Abed: College of Science, University of Al-Qadisiyah, P.O. Box.1895, Diwaniya 58001, Iraq.
- Dr. Nadhir Al-Ansari: Department of Civil, Environmental and Natural Resources Engineering, Lulea University of Technology, 97187 Lulea°, Sweden.
- Riyadh M. Salih: National Center for Water Resources Management, Ministry of Water Resources, Baghdad, Iraq.

## 2-2- Modified Delphi Method

Delphi survey is a multistage facilitation technique where a group of experts is asked to participate in a series of successive questionnaires to establish an opinion or opinion consensus on a topic's focus areas [34,35].

To know the parameters and their weights are to be included in the index and how the expected output is related to actual measurements of parameters, a panel was selected from 44 engineers and PhD holders with expertise in water quality management. The respondents received one questionnaire that asked them to consider 27 parameters of water quality for possible inclusion in a WQI (the 25 parameters in Table 2 in addition to total coliform and watercolor). The respondents were asked to pick and rate only 10 parameters. Respondents were asked to rate the

parameters that they chose as contributors to the overall water quality according to their significance. This ranking was done on a 1 to 5 scale. Of the 44-member panel, 30 respondents (68% completed the questionnaire and returned it.

The 10 parameters the panel selects were: DO, COD, turbidity, TDS, nitrates, phosphates, pH, total coliform, TH, and Cl<sup>-</sup>.

These 10 parameters and the 16 which result from the PCA can be unified and replaced by these five most important parameters (TDS, TH, Cl<sup>-</sup>, DO, and COD), which include its overall representation and are known to cause the decline in the water quality of the Iraqi rivers whenever we head to the Hydrology 2020, 7, 67 7 of 14 south of the country [37–40]. Therefore, turbidity, nitrates, phosphates, and pH were excluded and total coliform was added according to the panel’s recommendation. Based on the foregoing, the final list of parameters from which the index will be derived is: COD, DO, TC, TDS, TH, and Cl<sup>-</sup>.

### 2-3- Assignment of Weights

Table 3 below shows the weights that are given to the parameters according to the opinion of the experts’ committee, the authors’ experience, and the importance of these parameters in determining the quality of water in Iraqi rivers. Table 3 also includes the proposed categories of values of different water quality classifications of the Iraq WQI based on the Iraqi standard specifications and WHO specifications for drinking water [49,50].

Table 2. Water quality categories proposed for Iraq water quality index (WQI), mathematical equations for function curves, and weights assigned for the six selected parameters

	Very Good 90–100	Good 70–90	Acceptable 50–70	Bad 20–50	Very Bad 0–20	Equation	R <sup>2</sup>	Weight
TDS	50–100	200–300	500–1000	2000–3000	3500–4000	$Y = -0.0191X + 84.587$	0.9455	0.2
TH	50–200	300–400	500–600	650–700	750–800	$Y = -0.1186X + 113.68$	0.9664	0.15
TC	0–1000	2000–2500	3000–5000	6000–8000	12,000–15,000	$Y = -0.0057X + 86.231$	0.9251	0.2
DO	10–9	8–7	6–5	4–3	2–1	$Y = 10X$	1	0.2
COD	0–0.5	1–2	4–6	8–10	12–14	$Y = -5.8862X + 88.846$	0.9685	0.1
Cl <sup>-</sup>	50–150	200–300	400–500	550–650	700–800	$Y = -0.12X + 106.58$	0.9961	0.15

The Iraq WQI is developed to classify the river’s water into five categories, viz. very good, good, acceptable, bad, and very bad.

#### 2-4-. Development of the Sub-Indices

Sub-indices functions are the equations that turn the ranges of concentrations via mathematical equations into index ratings. Then these scores are further translated to a specific scale based on their relative importance for impacting water quality [16]. Such functions of the sub-indices are defined in a specific range based on the standards of water quality and their concentrations to meet in a particular range [12]. To this end, mathematical expressions were fitted for every parameter to get the sub-index equation as given in Table 2. The corresponding difference between the parameter range and index is kept constant in this index to provide a more consistent indices value.

The development of sub-indices function by the weighted sum index method using the proposed categories values of different water quality classifications (Table 2) was plotted as water quality curves.

A set of average curves—one for each parameter representing the variation in the level of water quality produced by the various possible measurements of each respective parameter—is drawn, with levels of (water quality) from 0 to 100 on the vertical axis, while various levels of the parameter were set along the horizontal axis, as shown in Figure 1

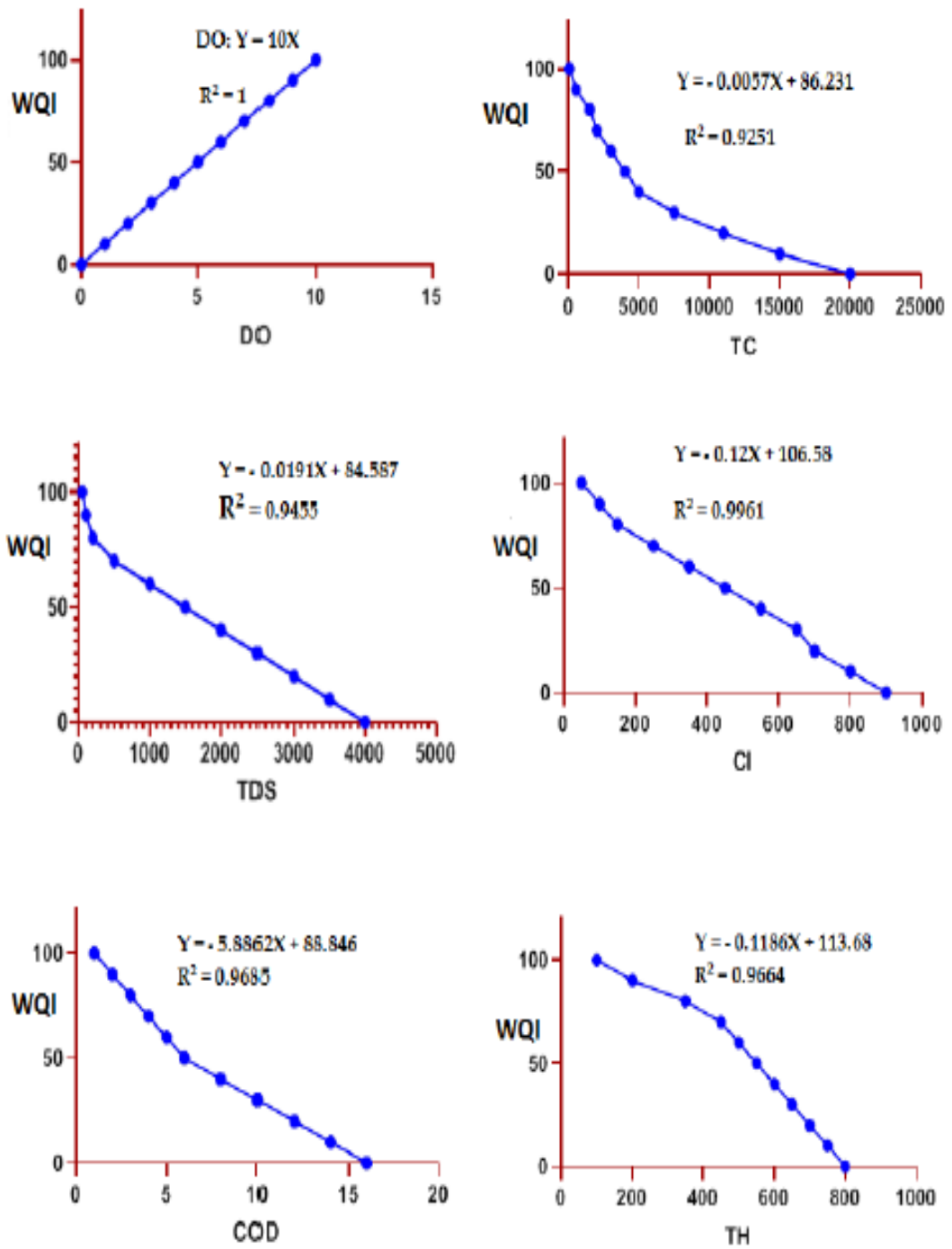


Figure 2 The water quality curves of the sub-indices of the six parameters.

Figure(15 )

## 2-5- Aggregation of Sub-Indices

The score produced by each parameter was averaged-out to measure the effect of each individual parameter on a common single scale. For this reason, the following weighted-average aggregation function is used [15,51].

$$Iraq\ WQI = \sum_{i=1}^n W_i \times Q_i \quad \text{————— (1)}$$

in which

*Iraq WQI* = the Iraqi water quality index, a number between 0 and 100.

*Q<sub>i</sub>* = the quality of the *i*th parameter, a number between 0 and 100.

*W<sub>i</sub>* = the unit weight of the *i*th parameter, a number between 0 and 1, and

$$\sum_{i=1}^n W_i = 1 \quad \text{————— (2)}$$

*n* = number of parameters.

Accordingly, the final formula for the Iraqi Water Quality Index will be as follows:

$$\begin{aligned} Iraq\ WQI = & [(-0.019\ TDS + 84.587) \times 0.2] + [(-0.006\ TC + 86.231) \times 0.2] \\ & + [10\ DO \times 0.2] + [(-0.119\ TH + 113.68) \times 0.15] + [-5.886\ COD \\ & + 99.846) \times 0.1] + [(-0.12\ Cl + 106.58 \times 0.15] \quad \text{————— (3)} \end{aligned}$$

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