OPEN ACCESS
Freely Available Online

JOURNAL OF AGRONOMY RESEARCH
ISSN NO: 2639-3166

Research Article

DOI : 10.14302/issn.2639-3166.jar-18-2457

Assessment of Water Quality of Blue Nile River in Sudan

Rasha Babiker Gurashi Abu Sabah[1], Abubaker Haroun Mohamed Adam[2,*], Dawoud Mohamed Ali[3]

[1]Al Zaeem Al Azhari University, Sudan.

[2]Department of Crop Science, College of Agriculture, University of Bahri, Sudan.

[3]Al Nelain University- Khartoum, Sudan.

Abstract

The objectives of this study were to quantify the fresh water quality of Blue Nile River before processing, identify the pollutants, and to determine the most polluted areas, and their impacts on living organisms as well as the surrounding environment. Thus, random water samples were collected and analyzed at the laboratory of the Ministry of Irrigation and Water Resources, Ground water and Wadis Directorates - Khartoum. The outcomes were compared with the World Health Organization standardization. The results revealed variations in the concentration of the studied elements taken from the different locations. But, the results indicated that the water quality is good, and it is within the permissible water use. However, further study is recommended to include seasonal variation as well as the biological analysis.

Corresponding author: Abubaker Haroun Mohamed Adam, Department of Crop Science, College of Agriculture, University of Bahri - Sudan, E mail: abubakerharoun@gmail.com

Citation: Rasha Babiker Gurashi Abu Sabah, Abubaker Haroun Mohamed Adam, Dawoud Mohamed Ali (2018) Assessment of Water Quality of Blue Nile River in Sudan. Journal of Agronomy Research - 1(3):1-14. https://doi.org/10.14302/issn.2639-3166.jar-18-2457

Key words: Processing, pollution, standardization, Zones

Received: Nov 02, 2018 **Accepted:** Nov 28, 2018 **Published:** Dec 07, 2018

Editor: Khalid Hussain, Department of Agronomy University of Agriculture, Faisalabad, Pakistan.

Introduction

Water is an abundant resource, yet in different regions safe, fresh clean water is critically short supply. The fresh water is considered one of the most vital resources in this planet. If water is polluted; it is not only devastating the environment, but also the human and animal health. Therefore, information on water is vital for monitoring, analyzing, evaluating, maintaining the quality, and sustainable use [1].

Blue Nile River in Sudan is of great concern for socio-economic and environmental aspects. Fortunately, its water is, for many of years, had been; and still of good quality for irrigation, domestic, industrial, fishing, bathing uses, and electric power production, therefore, it should be kept clean [2]. The important water attributes is the water quality, which refers to the chemical, physical, and microbiological characteristics which show wide variability worldwide.

The physical properties are the color, turbidity, taste, temperature, and odor of water which can be determined by touch, taste, senses and smell. While chemical characteristics. The chemical is determined by the source such as refers to rocks, soil, industrial, etc. Any transformation in the chemical properties affects the water quality causing pollution. The major pollutant are in inorganic minerals, the cations, like calcium [(Ca^{++}), magnesium (Mg^{+}+), sodium (Na^{+}) and potassium (K^{+}), ($CaCO_3$) etc.., and anions such like (Cl^{-}), (HCO_3^{-})(NO_3^{-}) (SO_4^{--}), pH (Alkalinity, and Acidity). While the organic includes parameters includes hardness, total dissolved solids (TDS), electrical conductivity (EC).

Water is said to be polluted; if it is impaired by contaminants so that it does not support a human use (drinking water), or undergoes a marked shift in its ability to support its constituent of biotic communities. Pollution; typically refers to chemicals or other substances in concentrations greater than would occur under natural conditions. Major water pollutants include organic chemicals, nutrients, microbes, heavy metals, sediments, oil and heat which raise the temperature of the receiving water [3].

Water pollution occurs when a body of water becomes contaminated either by physical such as plastic, water bottles or rubber tires, or by chemical such as the run-off that finds its way into waterways from factories, cars, sewage treatment facilities. However, despite people have already started taking precautions, the water pollution levels are raising rapidly [4]. Nevertheless, today, water pollution is likely to occur because of dramatic world population expansion and increasing human activities like industry, and agriculture which contribute to water pollution significantly.

Several studies on water pollution were carried out in different parts of the world. A researcher, [5] studied the Surface water quality contamination in Nigeria, Other researchers [6] assessed water quality of Ebro River in Spain. The influence of Anthropogenic activities on water quality in Karstic region was also studied [7]. Other studies of water quality included the White River Basin, Indiana, in the United States of America (USA) [8], and Melen River in Turkey [9].

Several factors cause water pollution, among these the human activities which play an important role in river water pollution. In Sudan, the establishment of factories like Tannery, soap, sugarcane industries in addition to chemicals used by farmers find their way to the river contaminate and pollute the water of the Blue Nile. This includes chemicals, pathogens, and physical changes like increased temperature and discoloration.

However, high concentrations of naturally occurring substances like calcium, sodium, iron, and manganese, can have negative impacts on aquatic flora and fauna. Oxygen -depletion has an effect on photosynthesis. Moreover, the anthropogenic activity may cause turbidity (cloudiness) which blocks light, disrupts plant growth, and clogs the gills of some fish species [10]. Furthermore, pathogens can produce waterborne diseases [11].

Several studies revealed that alteration of water physical and chemical properties like change in acidity and electrical conductivity, eutrophication and temperature, has negative effect on aquatic living organisms. Similar effect can be produced by thermal if is released from cooling system by power plants and industrial manufacturers, when water temperatures will increase, consequently, oxygen levels will decrease. This can kill fish, alter food chain, reduce species biodiversity, and foster invasion by new thermophilic species [12].

Generally, several factors causes river water

pollution such as residues, animal waste, garbage toxic materials, including heavy metals such as Lead (pb), Mercury (My), Cadmium (Cd), Arsenic etc., biological: Microbial waste carried by water, organic and inorganic pollutants, including plant and animal wastes.

Several methods are used for testing water quality, among these:

Physical tests; including temperature, solid concentrations e.g., total suspended solids (TSST) and turbidity.

Chemical Method

It is used to measure the concentration of different chemicals in water samples to be measured. If the concentrations are high, the water is said to be polluted. It is used for both organic and inorganic compounds, including metals like copper, zinc, calcium, lead, mercury, oil, grease, and also nutrients like nitrate, nitrite, phosphorous compounds, pH, biochemical oxygen demand (BOD), and hydrocarbons [13].

Biological testing; involves the use of plant, animal or microbial indicators to monitor the health of an aquatic ecosystem. The presence of any biological species reveals what degree of ecosystem or environmental integrity is present e.g., fish, insects and small water crustaceans and other invertebrates that present in water bodies. Such organisms can be monitored for changes (biochemical, physiological, or behavioral) indicating the water quality. The quality is said to be very good; if the water supports the living entities, if not, it is said to be poor [14].)

Studies identified two main sources of water pollution, these are: the point sources (PS), which refers to contaminants that enter a waterway from identifiable source, like ditch or a pipe e.g., discharges from municipal storm sewage systems, industrial storm water, such as from construction sites a sewage treatment plant, a factory, or a city storm drain [15], and non-point sources (NPS); that refers to diffuse contamination that does not originate from a single source. It is a cumulative effect of small amounts of contaminants gathered from a large area e.g., leaching out of nitrogen compounds from fertilized agricultural lands. Nutrient run-off in storm water from an agricultural field [16].

Materials and Methods

Study Area

This study was carried out along the Blue Nile River; which is located between the latitudes 14^0-24 ' N 28^0-33 ' E. and longitudes 15^0-00' N, $2^0$1- 33' E, The study area included Arbagi south Al Hessahisa, Abu Furou, Aldiem, Aljadded in Al Geizera State and Al Bageer, and Alack in Khartoum State.

Materials

The following materials were used: Global Positioning System (GPS), boat, rulers, sterilized glasses and containers, water.

Methods

Sampling Method

In this study, six points were located along the Blue Nile River. The World Health Organization (WHO), water sampling method was adopted. Where, timely; about one liter (1 L) of water sample at the depth of 20 cm was taken by using sterilized bottles from each of the six locations. Water samples were taken from the two beaches (East and West) as well as from the middle of the river. All samples were tightly closed and placed in sterilized containers and immediately sent to the laboratories for Physical, chemical and biological analysis. The samples were analyzed at the laboratory of the Ministry of Irrigation and Water Resources. Ground water and Wadis Directorates-Khartoum and Sudanese Training Centre for Biotechnology- Department of Bacteriology and water analysis- Khartoum.

Data Analysis

The collected data were analyzed by K^2**.** The results of data analysis were presented in tables**.**

Results and Discussion

Locations from where soil samples were taken are presented in the following tables: Tables (1-8)

Results of Biological Analysis

Sudanese Training Centre For Biotechnology

Department Of Bacteriology

Water Analysis

Date: 24/12/2012

Community: Rural area

Table 1. Sample location before Al Hesahesa (Arbagi, 2012)

Sample Date LOCAL: BEFORE EL HESSAHESSA WATER SOURCE SAM DEP (m): LOMT. DISCHARGE (mm^3/day) Discharge (mm^3/day). SAN DATE: 13/12/2012	SERNM: 10723 STATE: GEZIRA **LATIT** WATER LEVEL (m) ANA DATE:…13/12/2012
Physical Properties: COOR (Pi Co)……N TURB (FTU)……..0 E COND (µs/cm) …226 D O (ppm) ……..0	**ODOUR…..N** **pH……..7.9** **TASTE……..N** **S S (ppm)**
Aesthetical Quality in (ppm) TDS……151.2 TH……..113 T ALKAL…….128 EX ALKA……66.82 BICARBONATE ALKA…..123 CARBINATE ALKA…0 CHLORIDE…..8,57	**SULFATE……23** **CALCIUM….34.4** **MAGANESIUM….4.86** **SODIUM….80** **POTASIUM….0** **SILICA…..0** **IRON…..0**
Inorganic Constituents of Health Significance in (ppm) FLUORIDE….0.01 NITRATE……2.83 NITRITE…….0.033 AMMONIA ….0	**MANGANESE……..0** **ARSENIC……0** **COPPER……0** **LEAD……0**

Table 2. Water sample location after Al Hessahessa (2012)

Sample Date: LOCAL: AFTER EL HESSAHESSA WATER SOURCE SAM DEP (m): LOMT. DISCHARGE (mm^3/day) Discharge (mm^3/day). SAN DATE: 13/12/2012	SERNM: 10724 STATE: GEZIRA **LATIT** WATER LEVEL (m) ANA DATE:…13/12/2012
Physical Properties: COOR (Pi Co)……N TURB (FTU)……..0 E COND (µs/cm) …207. D O (ppm) ……..0	**ODOUR…..N** **pH……..8.3** **TASTE……..N** **S S (ppm)**
Aesthetical Quality in (ppm) TDS……144.9 TH……..132 T ALKAL……..115.8 EX ALKA……..46.428 BICARBONATE ALKA…..109.8 CARBINATE ALKA…6 CHLORIDE…..7.81	**SULFATE……..23** **CALCIUM….28.8** **MAGANESIUM….14.58** **SODIUM….80** **POTASIUM….0** **SILICA…..0** **IRON…..0**
Inorganic Constituents of Health Significance in (ppm) FLUORIDE….0.23 NITRATE……0.89 NITRITE…….0.0133 AMMONIA ….0	**MANGANESE……..0** **ARSENIC……..0** **COPPER……..0** **LEAD……..0**

Table 3. Sample location: South El Gunied Sugar Factory (2012)

Sample Date: LOCAL: BEFORE EL GUNIED SUGAR FACTORY WATER SOURCE SAM DEP (m): LOMT. DISCHARGE (mm^3/day) Discharge (mm^3/day). SAN DATE: 13/12/2012	SERNM: 10725 STATE: GEZIRA **LATIT** WATER LEVEL (m) ANA DATE:…13/12/2012
Physical Properties: COOR (Pi Co)……N TURB (FTU)……..0 E COND (µs/cm) …208. D O (ppm) ……..0	**ODOUR…..N** **pH……….8.3** **TASTE……..N** **S S (ppm)**
Aesthetical Quality in (ppm) TDS……145.6 TH……..98 T ALKAL……..152.4 EX ALKA……108.544 BICARBONATE ALKA…..146.4 CARBINATE ALKA…0 CHLORIDE…..6.39	**SULFATE……..20** **CALCIUM….29.6** **MAGANESIUM….3.4** **SODIUM….80** **POTASIUM….0** **SILICA…..0** **IRON…..0**
Inorganic Constituents of Health Significance in (ppm) FLUORIDE….0.01 NITRATE……2.64 NITRITE…….0.033 AMMONIA ….0	**MANGANESE……..0** **ARSENIC……..0** **COPPER……..0** **LEAD……..0**

Table 4. Sample location North ELGunied Sugar Factory (2012)

Sample Date: LOCAL: AFTER EL GUNIED SUGAR FACTORY WATER SOURCE SAM DEP (m): LOMT. DISCHARGE (mm^3/day) Discharge (mm^3/day). SAN DATE: 13/12/2012	SERNM: 10721 STATE: GEZIRA **LATIT** WATER LEVEL (m) ANA DATE:…13/12/2012
Physical Properties: COOR (Pi Co)……N TURB (FTU)……..0 E COND (µs/cm) …209. D O (ppm) ……..0	**ODOUR…..N** **pH……..8.1** **TASTE……..N** **S S (ppm)**
Aesthetical Quality in (ppm) TDS……146.3 TH……..118 T ALKAL……121.8 EX ALKA……4.028 BICARBONATE ALKA…..109.8 CA……..12 RBINATE ALKA…0 CHLORIDE…..15.62	**SULFATE……16** **CALCIUM….28** **MAGANESIUM….1.458** **SODIUM….30** **POTASIUM….0** **SILICA…..0** **IRON…..0**
Inorganic Constituents of Health Significance in (ppm) FLUORIDE…….0.19 NITRATE……..2.2 NITRITE……..0.0133 AMMONIA ……0.0122	**MANGANESE……..0** **ARSENIC……0** **COPPER……0** **LEAD……0**

Table 5. Sample location South Al Bagair (2012)

Sample Date: LOCAL: SOUTH AL BAGAIR WATER SOURCE SAM DEP (m): LOMT. DISCHARGE (mm^3/day) Discharge (mm^3/day). SAN DATE: 13/12/2012	SERNM: 10725 STATE: GEZIRA **LATIT** WATER LEVEL (m) ANA DATE:…13/12/2012
Physical Properties: COOR (Pi Co)……N TURB (FTU)……..0 E COND (µs/cm) …204. D O (ppm) ……..0	**ODOUR…..N** **pH……..8.3** **TASTE……..N** **S S (ppm)**
Aesthetical Quality in (ppm) TDS……142.8 TH……..80 T ALKAL…….115.8 EX ALKA……101.548 BICARBONATE ALKA…..109.8 CA……..12 RBINATE ALKA……6 CHLORIDE……7.81	**SULFATE……18** **CALCIUM……29.6** **MAGANESIUM….1.584** **SODIUM……60** **POTASIUM….0** **SILICA…..0** **IRON…..0**
Inorganic Constituents of Health Significance in (ppm) FLUORIDE….0.17 NITRATE……3.08 NITRITE…….0.0198 AMMONIA ….0	**MANGANESE……..0** **ARSENIC……0** **COPPER……0** **LEAD……0**

Table 6. Sample location after Al bagir (2012)

Sample Date: LOCAL: NORTH AL BAGAIR WATER SOURCE SAM DEP (m): LOMT. DISCHARGE (mm^3/day) Discharge (mm^3/day). SAN DATE: 13/12/2012	SERNM: 10726 STATE: GEZIRA **LATIT** WATER LEVEL (m) ANA DATE:…13/12/2012
Physical Properties: COOR (Pi Co)……N TURB (FTU)……..0 E COND (µs/cm) …223. D O (ppm) ……..0	**ODOUR…..N** **pH…….7.9** **TASTE……N** **S S (ppm)**
Aesthetical Quality in (ppm) TDS……156.1 TH……..106 T ALKAL…….134.2 EX ALKA……138.012 BICARBONATE ALKA…..134.2 CARBINATE ALKA…0 CHLORIDE…..12.07	**SULFATE…….23** **CALCIUM….34.4** **MAGANESIUM….4.86** **SODIUM….80** **POTASIUM….0** **SILICA…..0** **IRON…..0**
Inorganic Constituents of Health Significance in (ppm) FLUORIDE….0.01 NITRATE……2.64 NITRITE…….0.033 AMMONIA ….0	**MANGANESE……..0** **ARSENIC……0** **COPPER……0** **LEAD……0**
Sample Date: LOCAL: NORTH AL BAGAIR WATER SOURCE SAM DEP (m): LOMT. DISCHARGE (mm^3/day) Discharge (mm^3/day). SAN DATE: 13/12/2012	SERNM: 10726 STATE: GEZIRA **LATIT** WATER LEVEL (m) ANA DATE:…13/12/2012
Physical Properties: COOR (Pi Co)……N TURB (FTU)……..0 E COND (µs/cm) …223. D O (ppm) ……..0	**ODOUR…..N** **pH…….7.9** **TASTE……N** **S S (ppm)**

Aesthetical Quality in (ppm) TDS.....156.1 TH.....106 T ALKAL.....134.2 EX ALKA.....138.012 BICARBONATE ALKA.....134.2 CARBINATE ALKA...0 CHLORIDE.....12.07	**SULFATE.....23** **CALCIUM....34.4** **MAGANESIUM....4.86** **SODIUM....80** **POTASIUM....0** **SILICA.....0** **IRON.....0**
Inorganic Constituents of Health Significance in (ppm) FLUORIDE....0.01 NITRATE.....2.64 NITRITE.....0.033 AMMONIA 0	**MANGANESE.....0** **ARSENIC.....0** **COPPER.....0** **LEAD.....0**

Table 7. Result of water analysis (2012)

Sample No.	Parameters			
	Color	Oder	Taste	Turbidity
1	Slight brow	Sandy	Tasty	Turbid
2	Slight brow	Sandy	Tasty	Turbid
3	Slight brow	Sandy	Tasty	Turbid
4	Slight brow	Sandy	Tasty	Turbid
5	Slight brow	Bad	Tasty	Turbid
6	Slight brow	Sandy	Tasty	Turbid

Table 8. Summary of Physical and Chemical analysis of water samples

Sample No.	Area	Solid materi-als	Fluoride (F)	pH	NO_3	NO_2	Talk	HCO_3	CO_3	CL	SO_4	Ca	Mg g/L	Na	NH4
1	Arbagi	145.6	0.01	7.9	2.83	0.0330	128.0	123.0	00	08.57	80	34.4	04.86	80	0.0000
2	Abu Frou	1460.	0.23	8.3	0.89	0.0132	115.8	109.8	06	07.81	23	28.8	11.58	80	0.0000
3	Daeim	151.2	0.01	8.3	2.64	0.0330	152.4	146.4	00	06.39	20	29.6	03.40	80	0.0000
4	Al jaded	144.9	0.19	8.1	2.20	0.0132	121.8	109.8	12	16.62	16	28.0	01.45	30	0.0124
5	Buotary	142.8	0.17	8.3	3.08	0.0198	115.8	109.8	12	07.81	18	29.6	01.58	60	0.0000
6	Alack	156.1	0.01	7.9	2.64	0.0330	134.2	134.2	00	12.07	23	34.4	04.86	80	0.0000
Av.		114.7	0.1803	8.2	2.38	0.028	129.6	122.2	05	09.88	30	30.8	4.55	68.3	0.0020

Sample side: Blue Nile

Place (s): EL Hessahessa, El Gunied, and Al Bagair

Source: Blue Nile

Sampling: Samples were taken in sterile containers

From the above table (8), the analyzed data from the six locations showed no variations regarding the solid substances except the sixth location (156.1). Fluoride showed high concentration in the locations 1, 2, and 4 (0.22, 2.1 and 2.3) respectively. The other parameters, particularly the Nitrate, Nitrite, Talc, Bicarbonate, carbonate, Chloride, Sulphate, calcium. Magnesium, Sodium and Ammonia showed variations in their six respective locations.

However, based on the guidelines of World Health Organization (WHO), the concentrations of all analyzed elements are low and within the permissible water use.

Most analysis of water from different countries showed pollution, while the Blue Nile remains with its quality.

Conclusion and Recommendations

Conclusion

The study revealed spatial variations in the concentration of the analyzed elements. The concentrations are within or below the normal or fresh water, and comply with the guidance of the World Health Organization (WHO). However, the pollution may be caused by turbidly and accelerated water follows during the rainy season and the flood period.

Recommendations

a. Provision of safe, clean drinking water to the rural communities.
b. Campaigns for raising awareness of the rural people about the mishandling of chemicals (fertilizers, pesticides and herbicides).
c. Sanitation issues to be addressed immediately by the local authority.
d. Further studies using air space technology is recommended.

Appendix

Plate (1): Brick industry pollution along the Blue Nile River (2012)

Plate 2. Carrying Sugar cane wastes to Blue Nile River

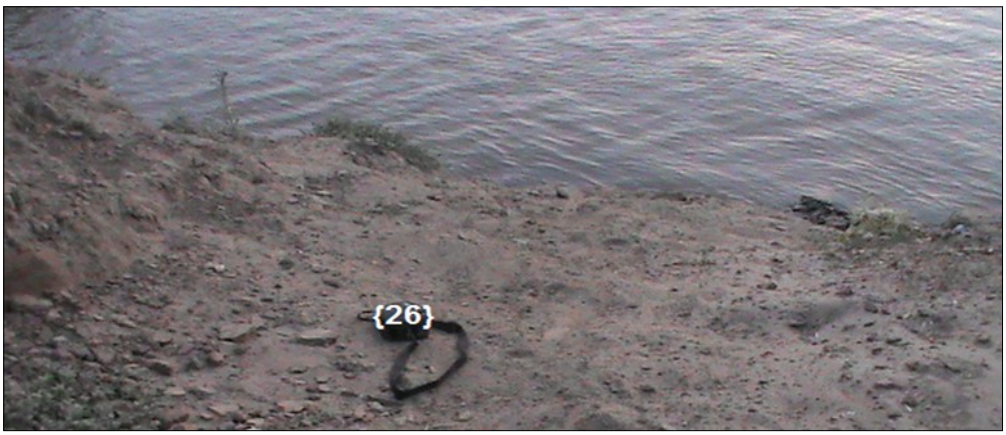

Plate 3. Water turbidity, during the rainy season. Blue Nile River (2012)

References

1. Zhou, F., Huang, G.H., Guo, H.C., Zhang, W. and Hao, Z.J. (2007): Spatio-Temporal Patterns and Source Apportionment of Coastal Water Pollution in Eastern Hongkong. Water Research, 41, 3429-3439.
2. Sudan National Academy of Sciences (2016): SNAS Newsletter, 2016.
3. World Water Development Report 3 'Water in a Changing World'. WWAP, 2009.
4. Luxmy Begum, P. Eng., First Edition, October, 2015; http://www.amazon.com/Water-Pollution-Causes-Treatments Solutions/dp/1514335166).
5. Adamu Mustapha, Ahmad Zaharin Aris, Hafizan Juahir,Mohammed Firuz Ramli (2013): Surface water quality contamination source apportionment and physicochemical characterization at the upper section of the Jakara Basin, Nigeria. Arabian Journal of Geosciences, 2013, Volume 6, Number 12, Page 4903.
6. Bouza-Deano, R., Ternero-Rodrigues, M., & Fernandez-Espinosa, A. J. (2008). Trend study and assessment of surface water quality in the Ebro River (Spain). *Journal of Hydrology, 361*, 227–239.
7. Calijuri ML, Couto EA, Santiago AF, Camargo RA, Silva MD (2011) Evaluation of the influence of natural and anthropogenic processes on water quality in Karstic region. Water Air Soil Pollut. doi:10.1007/s11270-011-1012-5
8. Gamble A, Babbar-Sebens M (2012) On the use of multivariate statistical methods for combining in-stream monitoring data and spatial analysis to characterize water quality conditions in the White River Basin, Indiana, USA. Environ Monit Assess. doi:10.1007/s10661-011-2005-y.
9. Koklu R, Sengorur B, Topal B (2010) Water quality assessment using multivariate statistical methods: a case study of Melen River System (Turkey). Water Res Manag 24:959–978
10. EPA. "Protecting Water Quality from Agricultural Runoff." Fact Sheet No. EPA-841-F-05-001. March 2005.
11. Hogan, C, Michael (2010). Water pollution. Encyclopedia of Earth. Topic ed. Mark McGinley; ed. in chief C. Cleveland. National Council on Science and the Environment, Washington, DC.
12. Goel, P.K. (2006). Water Pollution - Causes, Effects and Control. New Delhi: New Age International. p. 179. ISBN 978-81-224-1839-2.
13. Xia Hong Sheng 92014): Water quality testing 2: water quality indicators detection methods (Rural Water Supply industry professional and technical staff skills Training Series)(Chinese Edition). .
14. Karr, James R. (1981). "Assessment of biotic integrity using fish communities". Fisheries. 6: 21–27. ISSN 1548-8446. doi:10.1577/1548-8446 (1981)006<0021:AOBIUF>2.0.CO;2
15. Moss, Bria (2008): Water Pollution by Agriculture. *Phil. Trans. Royal Society B. 363: 659–666.* doi:10.1098/rstb.2007.2176.
16. EPA. "Protecting Water Quality from Agricultural Runoff." Fact Sheet No. EPA-841-F-05-001. March 2005.