



GLOBAL JOURNAL OF SCIENCE FRONTIER RESEARCH
CHEMISTRY
Volume 12 Issue 6 Version 1.0 Year 2012
Type : Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4626 & Print ISSN: 0975-5896

River Krishna Flood Effects on Soil Properties of Cultivated Areas in Bagalkot District, Karnataka State

By Dr. B.M.Kalshetty, Dr. T.P.Giraddi, R.C.Sheth & M.B.Kalashetti
Karnatak University Dharwad

Abstract - During 2009 Rabi season flood of river Krishna, the cultivated area of 128 Km² was flooded in the northern part of Karnataka catchment. The flood entirely killed the vegetations stands on the fields. After wards, the effects of the flood on the ecological properties of the soils and the conditions of agricultural production had been evaluated. A study was conducted to estimate the flood effects on heavy metals concentrations and on the nutrient status of the soils. The sediment layer left from the flood had a thickness of several mm. Boron, Molybdenum within this layer were in between proscribed values and the metal ions concentrations of Iron, Zinc , Copper, were found slightly above the prescribed limits. Thus no restriction had to be announced for food production purposes. Regarding the Major and Secondary nutrients status of the flooded soils, only the mineral Nitrogen content was substantially reduced when compared to not flooded soils. This effect could most probably be related to denitrification processes as a result of anaerobic conditions during the flood. Available Potash (K₂O) and Phosphorus (P₂O₅) found more than the prescribed limits.

Keywords : Flood effects, heavy metal concentration, soil fertility, and denitification.

GJSFR-B Classification: FOR Code: 050302



Strictly as per the compliance and regulations of :



© 2012. Dr. B.M.Kalshetty, Dr. T.P.Giraddi, R.C.Sheth & M.B.Kalashetti. This is a research/review paper, distributed under the terms of the Creative Commons Attribution-Noncommercial 3.0 Unported License (<http://creativecommons.org/licenses/by-nc/3.0/>), permitting all non commercial use, distribution, and reproduction in any medium, provided the original work is properly cited.

River Krishna Flood Effects on Soil Properties of Cultivated Areas in Bagalkot District, Karnataka State

Dr. B.M.Kalshetty^α, Dr. T.P.Giraddi^σ, R.C.Sheth^ρ & M.B.Kalashetti^ω

Abstract - During 2009 Rabi season flood of river Krishna, the cultivated area of 128 Km² was flooded in the northern part of Karnataka catchment. The flood entirely killed the vegetations stands on the fields. After wards, the effects of the flood on the ecological properties of the soils and the conditions of agricultural production had been evaluated. A study was conducted to estimate the flood effects on heavy metals concentrations and on the nutrient status of the soils.

The sediment layer left from the flood had a thickness of several mm. Boron, Molybdenum within this layer were in between proscribed values and the metal ions concentrations of Iron, Zinc, Copper, were found slightly above the proscribed limits. Thus no restriction had to be announced for food production purposes. Regarding the Major and Secondary nutrients status of the flooded soils, only the mineral Nitrogen content was substantially reduced when compared to not flooded soils. This effect could most probably be related to denitrification processes as a result of anaerobic conditions during the flood. Available Potash (K₂O) and Phosphorus (P₂O₅) found more than the proscribed limits.

The effects of the flood on agricultural management conditions were minor. However, hydrological and land use management concepts have to be developed that help to reduce the probability of such flood events in future.

Keywords : Flood effects, heavy metal concentration, soil fertility, and denitification.

I. INTRODUCTION

Soil is a specific component of the biosphere, it is not only a geochemical sink for contaminants, but also acts as a natural buffer controlling the transport of chemical elements and substances to the atmosphere, hydrosphere. September- 2009, flood of River Krishna was the highest flood ever observed along the river. The maximum rain fall during 6 days covering the on and upper part of the catchment area. The entire catchment led to runoff responses that flooded at most of 10% of the Bagalkot District. This area was famous for cultivation purposes during the flood in these cultivated areas with a water table of 11.5 meters maximum height. Due to water logging, the vegetation stands on the cultivated fields were completely killed.

Author α σ ρ : Comm., BHS Arts and TGP Science College, Jamkhandi, Bagalkot District, Karnataka State. E-mail : drkalshetty@gmail.com

Author ω : P.G. Department of Studies in Chemistry, Karnatak University Dharwad, (Karnataka), India.

The consequences of the flood for the farmers consisted of harvest losses and the restructuration of agricultural infrastructure. Additionally, long term effects on the cultivation conditions of the soil were expected that could result from soil pollution due to sedimentation of pollutant enriched material and from changes of the nutrient status of the soil.

The main objective of our present investigation was therefore to determine the impact of the flood on the fertility and ecological properties of the flooded soils in order to provide a quick estimate of flood effects on the conditions for agricultural production in the flooded area.

After the flood we focused on two governing effects:

1. The possible enrichment of the soils with heavy metals following the sedimentation of polluted material.
2. The change of the nutrient status of the soils due to leaching effects on the hand and sorption or anaerobic conditions on the other hand.

II. MATERIALS AND METHODS

Site characteristics: After Godavari, Krishna is the main River in the southern part of India, It is originated at Mahabaleshwar of Maharashtra State, it flows from west to east of Maharashtra, Karnataka, Andrapradesh, lastly it merges at Bangalkoli .

The longitude of River Krishna in Karnataka State is 480 Kms. The sub Rivers join to this Krishna River are Bhīma, Koyna, Yerla, Panchaganga, Dudaganga, Tungabhadra, HiranneKeshi, Ghataprabha and Malaprabha. The hydrological basin is that of the Koyna Dam. The River Krishna widely enters in the northern part of Karnataka state. Where as Belagavi and Bagalkot Districts of the state receive the Krishna River fist. The altitude reaches its maximum at Bagalkot District.

- Area: Jamkhandi, Mudhol, Bilagi and Bagalkot talukas of the District.
- Main stream length: 480 Kms. In Karnataka State and 128 Kms. in the Bagalkot District.
- Maximum altitude: 519.60 mtrs.
- Mean altitude: 515.8 mtrs.

- Minimum altitude : 521.0 mtrs.
- Average depth of basin : 514.63 mtrs

Floods were more frequent in September and October. There are three surface reservoirs or barrages at Hippargi & Padasalgi barrage near Jamkhandi, Galgali barrage near Bilagi and Almatti Dam at Kudalasangum of height 519.60 mtrs. The capacity of water basin is of 123.08 TMC water, catchment area of Dam 509.02 mtrs. to 514.63 mtrs.

The Almatti Reservoir situated in Bagalkot District of Karnataka State, and latitude 16°19'48" N. the irrigation potential of 87490 hectares and hydropower generation having an installed capacity of 290 MW¹. The water spread area is 487.87 sq. Kms. with a fetch of 124 Kms. The storage capacity at the Dam site has been 3486 m cum (123.08 TMC). The maximum flood discharge of 31,007 chums (10, 95,000 cusecs / min.) had been designed to be discharge through the 26 vents of the spill ways, having radial crest gate of size 15m X 15.25 m with crest level at RL 50.016mtrs out of 519.60 mtrs. Total catchment area of Almatti reservoir is 359.25 sq.Kms.(138.71 sq. miles).Rain fall 635 cms. In Bagalkot District and it is recorded 50 cms. In Dam site during September- 2009¹.

The Krishna River flow gradually began to rise in June, pickup in July and over flow in August and September; the flood lift reached maximum height and gradually falling through October to January and by February found to be almost dry or lean flow.

III. SAMPLING DESIGN AND MEASUREMENT METHODS

Soil is vital eco-compartment acting as a sink for natural for anthropogenic pollutants. Partitioned between 2 micros clay fraction.A comparison in metal accumulation rates between pristine soil and anthropogenic metal contaminated soil will provide an unbiased basis for time bound accumulation of pollutants especially trace elements and others.

Impact on the fertility of lands due to the accumulation of trace elements and other pollutants from Industrial waste discharge into the River stream along with the flood.The variation of fertility of lands due to the flood in the northern part of Karnataka State, especially effect on the area of the Bagalkot District.

The samples were collected and stored in polythene bags separately. These samples were ground sieved with 200 mesh sieve. Accurately 1 gram sample weighed and digested using mixture of conc. HNO₃ and HClO₄ and extracted by 1 N HCl. Filtered the extract and diluted to required volume using DDW. Such prepared soil extract were analyzed for trace elements with the help of Atomic Absorption Spectrometer and also different Physico-Chemical parameters, nutrients in the soil were analyzed by standard methods².

The major effects of the flood on the soil properties were expected:

- An increase in the heavy metal content as a result of the sedimentation of heavy metal enriched material, and
- A change in the nutrients status of the soils as a result of sorption and adsorption on the one hand, and the biological transformation, i.e.; denitrification due to anaerobic conditions on the other hand.

The nutrient status of the soils was determined by taking samples in 30 cms depth. For these samples physical parameters such as Bulk density, water holding capacity and texture were measured. The chemical parameters like pH, EC, Sodium, Potassium and Calcium carbonate were determined using standard methods^{2, 9}. The major nutrients present in the selected samples of different areas were determined, the major nutrients such as Organic Carbon, available P (P₂O₅) and available Potash (K₂O). Finally the heavy metal concentrations, knows as micro nutrients such as Iron, Mn, Zn, Cu, Boron and Molybdenum were estimated using well known standard methods^{10,11}.

A problem evolved due to the fact that for estimating the flood related changes of the soil properties, reference measurements before and after the flood conditions were recorded and it is required. Naturally, no samples were taken immediately prior to the flood, because of water spread over the fields. We solved the problem or estimated the sample properties before flood from the same locations not flooded but having soil properties comparable to these that were not flooded (the areas are frequently effecting by flood once in couple years). Hence, by comparing the measurement with results derived from sampling the soil at the same locations few months earlier (during summer season). The methods used for comparing the measurements are also recorded in the table 1 before and after the flood effect from the same locations of the district.

IV. RESULTS AND DISCUSSION

According to the field survey, the sediment layer derived from the flood in the area had a maximum depth of 3/4 mm. The concentration of some heavy metals and other elemental analysis data of four flooded sediment samples and two soil samples as references, one sample from the flooded lands one year earlier to the flood and one sample from a land outside the flooded area.The element concentrations of all samples as well as the legal limits for metal concentrations, i.e., major, secondary and micro nutrients valid in WHO are also listed in the table 1.

Results of sediment analysis showed that the available Potash (K₂O) was found more than legal limits in all most all 4 sample selected for investigation, the

concentrations of elements (Micro nutrients) Manganese (Mn), Boron (B) were below the limit values, where as concentrations of Iron (Fe), Zinc (Zn), Copper (Cu), exceeded the legal limits, because of the sludge disposal legacy for cultivated soils.

The results of micro nutrients analysis in the fertile land which is not effected by the flood, varies with those derived from flooded area in the district. Hence, comparably slight change in heavy metal concentrations of the sediment samples lead to the conclusion that in terms of heavy metal pollution no risk must be expected for agricultural productions in the flood area. However, the limited number of samples analyzed implies a factor

of uncertainty and requires more investigation.

The micro nutrients such as Zinc (Zn), Copper (Cu) and Boron (B) concentrations of a soil sample taken from not flooded area, i.e., from the spot S5 sample of the same flooded area one year earlier of flood and from a fertile land spot S6 as reference samples (table 1) found in much higher concentrations than those measured within the flooded sediment soil samples. The same trends as found high concentration of such heavy metal in the sediment of European Rivers have often measured and are a subject of environmental concern^{3, 12}.

Table 1 : Nutrient status of sediment soils of flooded lands and reference spots.

Sl.No.	Parameter	UNIT	Spot S1	Spot S2	Spot S3	Spot S4	SpotS5 Before flood	SpotS6 reference spot	Legal limit
I	Physical-Parameters								
	Bulk Density	g/cc	1.10	1.10	1.10	1.10	1.35	1.50	
	Water Holding Capacity	%	57.01	57.00	57.08	57.06	57.10	57.10	
	Texture		Clay loam	Clay loam	Clay loam	Clay loam	Clay loam	Clay loam	
II	Chemical Parameters								
	pH		8.15	8.20	8.18	8.14	8.60	8.62	6.5-7.5
	EC	ds/m	1.14	1.14	1.15	1.16	0.68	0.64	<1
	Sodium	%	0.32	0.38	0.35	0.37	0.18	0.17	<0.1
	Calcium Carbonate		MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	MEDIUM	
III	Major Nutrients								
	Organic Carbon	%	0.74	0.71	0.76	0.78	0.65	0.61	>0.75
	Available P	Kg/h	22.00	21.00	22.01	22.03	16.00	16.24	20-60
	Available K	Kg/h	368.00	370.00	365.02	367.67	350.00	348.00	250-300
IV	Secondary Nutrients								
	Ca	%	1.10	1.08	1.12	1.11	0.98	0.92	<1
	Mg	%	0.37	0.36	0.36	0.35	0.56	0.58	<0.5
	SO4	Ppm	21.5	22.00	21.9	21.7	16.00	16.04	10-20
V	Micro Nutrients								
	Iron	Ppm	5.10	5.06	5.08	5.09	3.92	3.68	Min.4.50
	Manganese	Ppm	1.12	1.10	1.14	1.18	0.92	0.91	Min.2.00
	Zinc (Zn)	Ppm	1.48	1.50	1.54	1.56	2.10	2.18	Min.0.75
	Copper (Cu)	Ppm	1.26	1.24	1.28	1.29	1.68	1.54	Min.0.60
	Boron	Ppm	0.23	0.22	0.24	0.26	0.40	0.48	Min.0.50
	Molybdenum	ppm	0.07	0.06	0.06	0.06	0.04	0.05	0.05-0.2

Soil analysis report in terms of the plant available potassium, Phosphorus, Magnesium content and other nutrients value including pH- values for 4 samples from the flooded fields could be compared with the measurements conducted on the same fields, one year earlier (Spot 5) and the analysis of soil sample from the reference (Spot S6), which is not effected by the flood. To isolate the effect of the soil properties of all the

spots of flooded lands, spot S5 soil of land one year earlier and the Spot S6 from the fertile land which is not effected by the flood.

Results revealed that in case of physical parameters such as bulk density, water holding capacity and texture found to be the same in all most all spots. The pH value of the samples from flooded field were found to be less when compared to the conditions of the

soil before flood spot S5 and soil from fertile land. This is because; of normal washing by the flooded water. The variation in pH value was not pronounced, may be caused by the fertilizer application and plant uptake. The Electrical conductivity found to be more than the prescribed limit in case of all the four spots of flooded lands, this may be due to the deposition of more total dissolved solids (TDS). The values of sodium and Calcium carbonate had increased and found more than the legal limits in all four samples (S1 to S4) of flooded sediment soils.

The amount of major nutrients available Potassium (Potash K₂O) was increased after the flood in most of the spots S1 to S4. The increase in the Potassium content might be possible due to the saturations of the soil might have resulted in the widening of smectitic clay minerals and thus release of previously fixed Potassium and also due to large fertilizer storage have been resulting in the dissolution of the stored fertilizers within the flood water. The later might also be the reason for the increase in the available

Phosphorus and the secondary nutrient Magnesium content on the sediment soils of flooded lands. However, the measured changes in the Potassium content were also within the range variation yearly due to the fertilization.

The Calcium and sulphur content of the sediment soils of flooded fields were found to be more when compared to the conditions from spots S5 and S6. The table 2 contains the micronutrients levels (Cation exchange capacity CEC). The CEC measured for 4 flooded sediment soils and one of the fertile field S6 and another one from the field of one year earlier of flood S5. The CEC of the flooded soil samples was higher in average than that of the not flooded samples as shown in figure 1. However, due to the pronounced variation of the clay content in the different soil samples, the CEC values were within a wide range varying in between 08 to 26 mval/100g. The relative contribution of the different cations to the CEC might therefore be a better basis for comparing the situation of the flooded and not flooded soils (Spots S1 to S6).

Table 2: Cation Exchange Capacity and Relative Contribution to the elements to the CEC (%)

Sl.No.	Spots	CEC mval/100gr.	K ⁺	Na ⁺	Ca ⁺⁺	Mg ⁺⁺	EC	pH
1.	S1	10	368	0.32	1.10	0.37	1.14	8.15
2.	S2	08	370	0.38	1.68	0.36	1.14	8.20
3.	S3	11	365	0.35	1.12	0.36	1.15	8.18
4.	S4	12	367	0.37	1.11	0.35	1.16	8.14
5.	S5	23	350	0.18	0.98	0.56	0.68	8.60
6.	S6	26	348	0.17	0.92	0.58	0.64	8.62

The monovalent and divalent cations contributed to a higher degree and the contribution of protons was lower in the flooded soils when compared to the not flooded soils respectively. The displacement of protons in to the solution was in agreement with the results from pH measurements which is also showed the lower pH –values on the flooded soils. One reason for the decreased pH – values in the flooded soils might have been anaerobic fermentation process that took part during water storage conditions. The increase of the relative contribution of cations to the CEC might be the displacement of protons by cations that were released from clay minerals due to widening during saturated conditions and increased cation availability as a consequence of the flooding of the fertilizer storage.

Table 3: N P K measurements of soil samples of flooded and reference soils at Different Depths.

Fields	N	N	N	P	P	P	K	K	K
	(Kg/ha)	(Kg/ha)	(Kg/ha)	(Kg/ha)	(Kg/ha)	(Kg/ha)	(Kg/ha)	(Kg/ha)	(Kg/ha)
	0-20cm	20-40cm	40-60cm	0-20cm	20-40cm	40-60cm	0-20cm	20-40cm	40-60cm
S1	134	135	128	11.8	11.4	11.6	377	380	371
S2	151	142	150	12.3	12.2	12.8	377	370	369
S3	160	154	141	13.2	12.8	13.0	358	364	363
S4	138	146	135	12.0	9.8	10.8	362	392	388
S5	222	210	206	21.8	22.0	21.6	348	350	354
S6	251	246	231	36.3	35.2	34.8	346	352	349

V. MINERAL NITROGEN CONTENT, AVAILABLE NUTRIENTS (N.P.K) AND ORGANIC CARBON IN THE SOIL SAMPLES

The mineral nitrogen content measured for 4 samples from flooded sediments and 2 reference samples one sample spot S5 from field of one year earlier from the effect of flood and another sample S6 from the fertile land. The Nitrogen, phosphorus and Available Potash contents derived for the three different soil depths as listed in table 3.

The nitrate content expressed in Kg/ha was calculated from the measured values assuming a soil density of 1.5 g/cm. The ammonium content as below the value of 0.05 mg/100g dry soil for all samples.

In most of the samples derived from the flooded fields, the nitrogen content was appreciably lower than that in the reference spot S5 and S6. This might be loss in nitrate concentration due to the flood event, the dissolution of nitrate in the flood water and removal with the flood stream and denitrification of nitrate due to anaerobic conditions during the flood. The major amount of nitrogen removed by water runoff⁴, and the

high vegetation stands on the fields being killed due to water logging provided a source of easily decomposable carbon. This together with the anaerobic conditions during the flood might have triggered the denitrification process⁵. Similar effects have frequently been observed for other areas as a result of flood events or water saturation due to high intensity irrigation^{6, 7, 8}.

All the values were compared the standard limits shown in table 4, guidelines for soil evaluation and soil gradation in order of production potential based on specific value/range.

Table 4 : Guidelines for soil evaluation

Gradation in order of production potential based on specific values.

Soil quality parameter	Soil with high production potential Grade A (Fertile Soil)	Soil with average production potential Grade B (Normal Soil)	Soil with poor production potential Grade C (Unfertile Soil)
pH(Saturation extract)	6.5-8.3	5.5-6.5 or 8.4-9.0	<5.5 or >9.0
Electrical conductivity m mhos/cm(Saturation extract)	0.2-0.5	0.5-4.0	4.0 & <0.2
Cation exchange capacity meg/100 grams	>30	10.0-30.0	<10
Exchangeable Sodium percent	<5	5-15	>15
Available P kg/ha 17cm plough layers	40-60	20-40	<20
Available N kg/ha in 17 cm plough layer,	>200	100-200	<110
Organic matter % on dry wet. Basis (organic Carbon)	>4	2-4	<2
Available K kg/ha in 17 cm plough layer	>280	110-280	<110
Organic Carbon %	>0.75	0.5-0.75	<0.5

VI. SUMMARY AND CONCLUSION

The objective of our present investigation was to determine the impact of the flood on chemical properties and nutrients status of flooded soils of cultivated areas in order to provide a quick estimate of flood effects on the conditions for agricultural production in flooded area. The possible effects were observed to be heavy metal ions (micronutrients) enrichment in the sediment, and the change of the nutrient status of the soils. The concentration of heavy metals in the sediment layer left from the flood was more or less below legal limits except Iron, Zinc and Copper.

The nutrient status of the soils, the reduced in available Phosphorus and the percentage of Magnesium (Mg) and increase in Potassium contents were measured in the soils of flooded area. The pH-values recorded in almost all spots of flooded area were more than the legal limits. The relative contribution of

protons to the CEC was also reduced. The mineral nitrogen content was appreciably decreased in the area of flooded sediment soils. This effect could most probably be related to denitrification processes as result of anaerobic conditions during the flood.

The conclusion is drawn that the effects of the September-2009 flood on the conditions for agricultural production in the 128 Km² area. The total soil evaluation be recorded as the fertile land sample spot S6 showed, the soil with high production potential (Grade A). The spot S5 sample soil from land one year earlier of flood showed the soil with normal/ average production potential (Grade B), this may be due to the fertilizer use. The spots S1 to S4 soil sample analysis showed the soil with poor production potential (unfertile) Grade C. Major Effects on the flood were the direct crops losses and the destruction of agricultural infrastructure. However, given the major damage to leaving beings and social casts the flood caused in the entire catchment, precautions

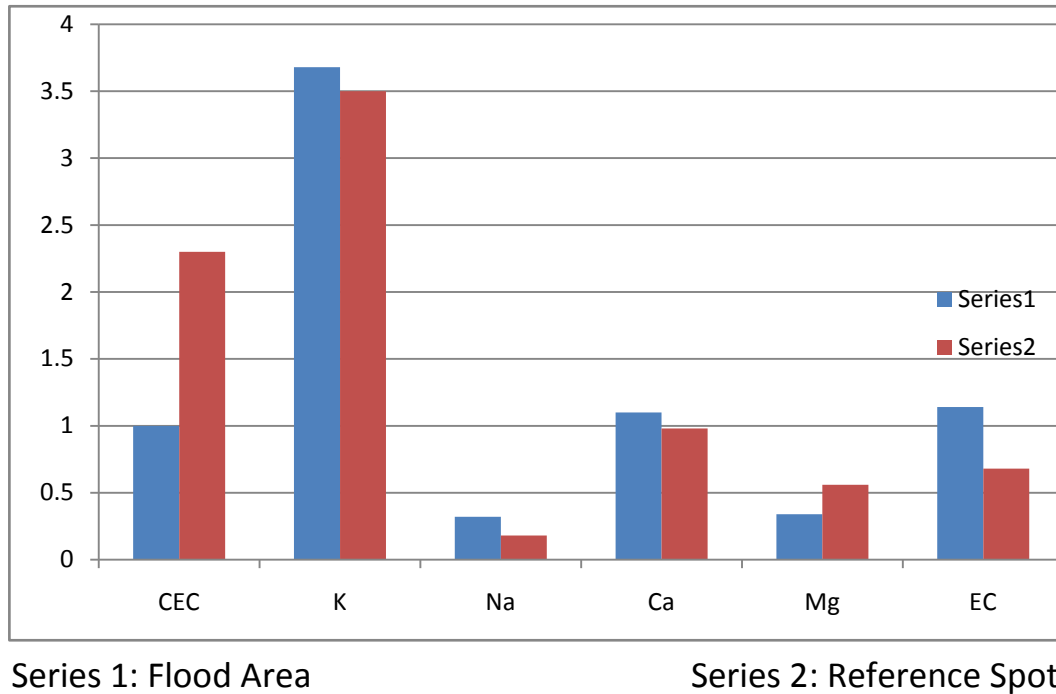
are urgently needed that help to reduce the probability of such flood events in future. Aiming not only reducing the effect of the flood, but reduce the probability of flood events requires a better understanding of the physical nature of rainfall – runoff

Relationships as well as the effects of land use

systems on the hydrological response of the catchment as a whole and in its parts.

The political support to farmers for land use, co-operation and financial supports. The multinational co-operation and mutual research activities are of high importance for success in this research field.

Figure 1 : Cation Exchange Capacity and Relative Contribution to the elements to the CEC (%).



REFERENCES RÉFÉRENCES REFERENCIAS

- Capacity evaluation of Almatti and Hippargi Reservoirs-water resource Department, Govt. of Karnataka State, 2009-10.
- APHA, AWWA, WPCE. 15th Ed., (1980): Standards Methods for the Examination of water and waste water 15th Edition, American Public Health Association Inc., Washington D.C. U.S.A.
- Abfklarv - Klarschlammverornung. Bundesgese tzblatt, Jahrgang 1992, Teli I.S. 912-934, 1992.
- Lawrance R.; Nitrogen out puts from a field-size agricultural water shed. J. Environ.Qual. 21: 602-607, 1992.
- Frede H.G., Gebhardi H., Meyer B.; Ursachen and Bedingungen Von Boden und Dunger-N-Verlusten durch Denitrification aus dem AP- Horizont einer Acker- parabraunerde aus LoB. Gottinger Bodenkundliche Berichte, 34, 69-213, 1975.
- Engler R.M., Patrick W.H.: Nitrate removal from flood water overlying flooded soils and sediments. J. Environ. Qual., 3:409-413, 1974.
- Humphreys E., Melhuis F.M., Xi Z.B. White R.J.G., Muirhead W.A., Flood irrigation of wheat on a transitional red- brown earth.II. Effect of duration of ponding on availability of soil and fertilizer nitrogen. Austr. J. Agric. Res., 42: 1037-1051, 1991.
- Schnabel R.R., Stout W.L.; Denitrification loss from Pennsylvania flood plain soils. J. Environ. Qual. 23: 344-348, 1994.
- B.K. Sharma and H.Kaur, "Environmental Chemistry", Goel Publishing house, Merrut (2004).
- A.K.De, "Environmental Chemistry", Wiley Eastern limited (2003).
- S.S.Dara, "A Text book of Environmental Chemistry and pollution Control", C.Chand. And Company ltd. (2002).
- F. eulenstein,L.Muller, K.Helming Center for agricultural landscape and land use Research (ZALF), Eberswalde str. 84, D-15374 Munch berg, Germany Int. Agro physics, 1998, 12, 241-247.