OnLine Journal of Biological Sciences 3 (2): 197-203, 2003
ISSN 1608-4217

Evaluation the Ecological Impacts Due to Unique Torrent Phenomenon on Aquatic Ecosystem (River Nile, Cairo, Egypt)

A.H. Abo El-lil
Faculty of Science, Cairo University (Beni-Suif), Egypt

Abstract: From 10-13 Oct. 1994, east bank of River Nile (east desert) at Assiut Governorate, Upper Egypt was subjected to huge amounts of rainfall in few days equal to those fall in one year or more. This unique ecological phenomenon leading to propelling the fine sand, silt and clay from surrounded dunes around the river Nile into its main branch. These particles were carried downward till reach Nile at Cairo and consequently lead to unfavourable changes in water colour from olive green into dark yellow and brownish colour. Water transparence altered negatively and off-course affected other physical parameters like DO_2, redox pot., T.S.S., pH and caused considerable change in anions and cations contents, in addition to dramatic decrease of phytoplankton flora in water. The author be aware to study this unique phenomenon which did not happen for many decades and evaluate the alteration happen due to this phenomenon from physical, chemical and biotic view points, also comparing with features before the torrent period and recovering time needed to remove the impacted features.

Key words: Aquatic ecosystem, ecological impact, River Nile

Introduction

During mid October 1994, the east bank of River Nile at upper Egypt (at Assuit Governorate) received huge amounts of rainfall (torrent) in few days equal or more than those, which fall in one year or more. Zahran and Willis (1992) reported the average of annual rainfall over the whole country is only about 10 mm, the amounts of rainfall in these few days exceed hundreds of millimeters. The excess rainfall takes place to River Nile after causes big damage to surrounded area. The east bank, generally, consists of rocky mountains, sand dunes and finally small strip of black soil (clay and silt) near the River Nile.

Due to high velocity of current resulted from heavy rainfall (torrent), huge amounts of sand, clay and silt dropped in main River Nile branch and then transported with water till reach Cairo 12 Oct. 1994. The peoples of Cairo and Giza impacted due to sharp change in Nile water colour which became dark yellow and brownish after greenish or olivey colour which never change since high-dam constructed at 1970's approximately.

In general, Campbell *et al.* (1988) recognized that sediments form important habitats for aquatic organisms. Clay and suspended particles have direct and indirect effects on plankton communities. They may change primary productivity by altering light penetration intensity and scattering (Kirk, 1985). Also Barko and Smart (1986) reported that, the velocity of water has been hypothesized to be a major factor affect the aquatic ecosystem.

Wetzel and Likens (1991) states, sediments within the basin can be redistributed by water current velocity and wind movements. Some remains of interred organisms preserve at different rate water changing lake conditions; others do not preserve at all. So, the huge amounts of aquatic weeds play an important role in controlling suspended particles in water by trapping, consequently, affect the roughness of water bodies, turbidity and finally affect water quality. Nile silt at normal conditions was known for its nutrients deposited on the soil. Formerly about 110 million tons of silt flowed through the Nile mostly during the flood period (Abo El-lil, 1995).

Turbidity in surface water is due to particulate of organic nature and of mineral nature as silt and clays (Hart, 1986). Fremling (1960) stated river impoundment considerably influenced the types and amounts of suspended matters downstream and thus impact on the composition of communities downstream. Badr (1990) reported the physical factors that influence the type and numbers of phytoplankton in river are flow rate, water land, light, temperature and turbidity.

Solar radiation, which affect by water turbidity, occupy an important role in the control of planktonic life. Abo El-Kheir *et al.* (2001) reported the relation between abiotic factors on phytoplankton structure along Ismailia canal, Egypt.

The aim of present study is to collect data on base line parameters to be used in long term monitoring of ecological impacts on aquatic ecosystem due to torrent phenomenon, contributed to our knowledge of the structure and function of the ecosystem and assessment the roles played by natural fluctuations on physico-chemical parameters as well as biota of the system .

Materials and Methods

Physico-chemical characteristics of water were studied before, during and after torrent period according to methods adopted by Golterman *et al.* (1978) and Anonymous (1985).

Velocity of current flow, transparency of water, electrical conductivity, redox pot., dissolved oxygen were detected in studied sites (River Nile), channels and drains using Hana portable pool test, Janway oxidigimeter and seechi disk. Suspended particles of water were detected by centrifuge and hydrometer. Macro and micro elements were evaluated by using atomic absorption spectrophotometer (Perkin- Elemer).

Isolation, fixation and identification of phytoplankton flora in Nile water at different stages of study were done according to Prescott (1978) and Hustedt (1959).

Results and Discussion

Physical parameters

The data collected from studied sites at River Nile during torrent phenomenon revealed the following remarks, firstly the velocity of water current was doubled twice than the velocity of water before mentioned phenomenon, this may regard to receiving huge amounts of water at River Nile in short time lead to increase the discharge rate. After end of phenomenon velocity reduced again and became around average. Flow rate is one of important physical factors that influence the type and numbers of phytoplankton (Badr, 1990).

Before this phenomenon the transparency of water was ranged between 60-80 cm by using secchi disc, while during the standing of torrent phenomenon complete disappearing of Nile water transparency was observed, so light can not penetrate water to any depth. We also observed that the amounts of clay and silt before torrent period were about 317 mg l^{-1} while at the torrent period increase dramatically to reach more than two thousand mg l^{-1} (2187 mg l^{-1}). After 3 weeks the amounts of clay and silt decreased again to reach 348 mg l^{-1}. Fremling (1960) clear the importance of suspended matter quantities on composition of communities in river.

Sharp decrease in DO_2 of Nile water was recorded at the studied area, whereas DO2 at the same site was average between 5.5-6 ppm (mg l^{-1}) before the phenomenon, it was record 3-3.5 mg l^{-1} during the torrent (Table 1), this may regard to dramatic decrease in photosynthesis process of phytoplankton and hydrophytes as a result of absence light due to dramatic decrease in water transparency. On the other hand after 2 weeks at the end of phenomenon at the same site DO_2 reincreased to reach 5.5 mg l^{-1} again due to increase light intensity in water

Table 1: Showed some physico-chemical characteristics of Nile water, canal and drain before, during and after torrent period

	Before torrent			During torrent (12-15 Oct.)			After torrent period		
Time	River Nile	Canal	Drain	River Nile	Canal	Drain	River Nile	Canal	Drain
Transparency (cm)	60-80	52	35	0.0	5	25	50	40	30
Water current velocity	Slow	Mod.	Slow	Very high	High	Mod.	Mod.	Mod.	Slow
pH	8.2	8.3	8.3	9.0	8.8	8.1	8.5	8.3	8.4
DO_2 (mg l^{-1})	6.0	4.1	3.9	3.5	3.3	4.1	5.5	4.2	4.1
T.S.S. (mg l^{-1})	280.0	338.0	718.0	407.0	412.0	801.0	350.0	342.0	752.0
Suspended particles (mg l^{-1}l)	317.0	307.0	281.0	2187.0	1412.0	329.0	348.0	405.0	318.0
HCO3 (meq l^{-1})	2.8	3.1	3.9	3.4	3.8	3.9	3.0	3.2	3.
Cl (meq l^{-1})	0.755	0.91	0.98	1.13	0.92	0.98	0.82	0.90	0.97
K (mg l^{-1})	4.23	-	-	5.8	-	-	5.6	-	-
Na (mg l^{-1})	35.6	-	-	42.8	-	-	32.6	-	-
Ca (mg l^{-1})	28.2	-	-	37.2	-	-	24.55	-	-

(transparency reach 50 cm again). Chapman and Chapman (1981) reported, the degree of aeration and chemistry of water in addition to water temperature are significant in controlling biota of water.

A decreasing trend was observed in the redox pot. from 178 mv before phenomenon to 95 mv at starting phenomenon and this may regarding to disturbance in biotic equilibrium as a result to absence the light penetrates water which affect negatively the activities of algae and water plants to the side of bacteria and fungi (non-photosynthetic organisms). It was repeatedly reported that any alterations in the physico-chemical characteristics of water lead subsequently to quantitative and qualitative changes of biota inhabiting these water bodies (Hynes and Roberts, 1962; Madson and Adams, 1989).

On the other hand slight increase of pH was recorded at the starting of phenomenon comparing with water pH before and after, water pH increased from 8.2 to 9.0 at studied sites and after 2 weeks recorded 8.5 again. Badr (1990) found pH of River Nile in alkaline side.

Chemical parameters

T.S.S. was ranged between 280 mg l^{-1} before phenomenon while at Oct.14, 1994 reached to about 405 mg l^{-1}. This increasing may resulted from huge amounts of sands and soils dropped and propelling to River Nile due to heavy rainfall at the east banks of river and these soils contain great amounts of salts which dissolved in water and raised the level of T.S.S. One week later of phenomenon T.S.S. decreased to reach 350 mg l^{-1} (Table 1).

Cations and anions analysis of Nile water before and during the phenomenon revealed marked increase, which came parallel to above-mentioned increase in T.S.S.

The increasing concentrated mainly at bicarbonate and chlorides which recorded 3.4 and 1.13 meql respectively during phenomenon while at the same site before phenomenon were recorded 2.8 and 0.755 meql for bicarbonate and chlorides. Archibold (1995) stated carbon dioxide is much more soluble than oxygen and it normally reacts with water to form weak carbonic acid (H_2CO_3), which may then dissociate into bicarbonate (HCO_3) depending on pH.

On the other hand sulphates and K content recorded slight increase while Ca and Na record valuable increase especially in water contents of Ca. Also, Archibold (1995) clear that, calcium is the most reactive cations present in water, the decrease in calcium is directly associated with the utilization of CO_2 in photosynthesis process. Here the photosynthesis process was almost dropped due to high turbidity of water as mentioned before. Also sulphate levels are variable because they are affected by the amounts of dissolved oxygen that is in water. Fe, Mn and Cu from micro elements showed no marked change before and during the phenomenon.

Regarding to algal flora (phytoplankton) in Nile water before phenomenon, Nile water contained varieties of green algae (chlorophycean) like ***Pediastrum***, ***Scendesmus***, ***Mougeatia*** and ***Cladophora*** contributed about 21% of algal flora isolated from studied sites while blue-green algae

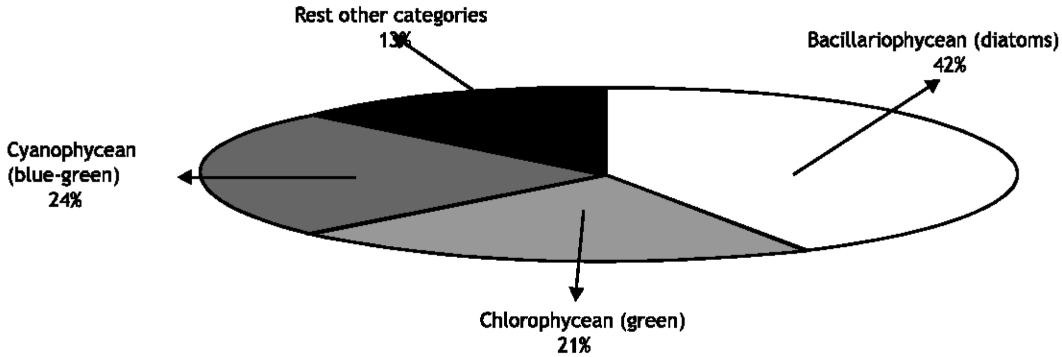

Fig. 1: Distribution of algal flara (phytoplankton) before torrent period at River Nile

(cyanophycean) which contributed about 24% of Nile algal flora, includes mainly ***Microcystis, Oscillatoria, Lyngbya, Anabaena*** and ***Merismopedia***. In addition to Bacillariophyta for example ***Cyclotella, Melosira, Gomphonema, Synedra, Coconies, Navicula*** and ***Nitzchia*** represents about 42% of Nile algal flora and the rest were in dominant species, Fig. 1.

During the period of torrent we failed completely to isolate any chlorophycean species from Nile water and these may regarded to complete absence of penetrating light inside water column, consequently affect negatively photosynthesis process of green algae and lead to such disturbance. Some diatoms and rare species of blue green algae were difficulty isolated during this period. Maddson and Adams (1989) reported that, any alterations in the physico-chemical characteristics of water lead to changes of biota inhabiting these water bodies. Such changes in quantity and diversity of biota may be argued from various angles as total counts, percentage composition, predominance etc. (Hynes and Roberts, 1962).

On the other hand, complete recovery from this disturbance were achieved after 3 weeks from finished this phenomenon and partially after one week approximately when water transparency became clear and allows the light to penetrate the water column, also when chemical constituents in Nile water started return again to normal or near normal status. Kirk (1985) reported that, clays and suspended particles can have direct and indirect effects on plankton communities. They may change primary productivity by alternating light penetration and scattering.

The above mentioned data came in harmony with Badr (1990) reported the flow rate, light and turbidity influence the type and numbers of phytoplankton in River Nile. Also Fremling (1960) showed the types and amounts of suspended matter impact on the composition of communities at downstream. The phytoplankton community composition of River Nile showed the highest diversity was detected for green algae followed by diatoms and the lowest was for a blue-green algae (Badr, 1990).

South and Whittick (1987) regarding the observed alteration in diversity and abundant of phytoplankton may due to the brackish nature of water during torrent period.

Hydrophytes during the period of impact still persists but moved from place to another, its completely covered with soil particles especially submerged ones like ***Ceratophyllum demersum***, ***Myriophyllum spicatum*** and ***Potamogeton*** species and after the problem disappears. These hydrophytes remain covered because its play as trapper for suspended particles.

Such phenomenon affect negatively on abilities of these hydrophytes to made photosynthesis process for long time as a result of covering plants with fine and sandy particles.

On the other hand, floating hydrophytes like ***Eichhornia crassipes*** not affect greatly like submerged ones but its transported with high currents to north way, its fixed valuable amounts of sediments through its root system.

Petticrew and Kalff (1992) and Adams and Prentiki (1982) and Dawson (1980) were emphasized on stands of submerged macrohydrophtes are considered to be traps for particulate matter, while Prentik ***et al.*** (1979) said that rooted species that form canopies are poor at trapping cool flowing water following summer storms.

On the other hand, the irrigated channels branched from main River Nile branch like Al-Zomer, Al-Mansouria affected negatively by torrent period but with grades less than happened in River Nile branch, for example suspended particles in canal water increased from 307 to 1412 mg l comparing with 2187 mg l^{-1} at River Nile, pH raised to 8.8 after 8.3, T.S.S beaing 412 mg l^{-1} while before this phenomenon was 342 mg l^{-1}. Also DO_2 decreased to reach 3.3 mg l^{-1} after (4-5) mg l^{-1} before torrent period. Abou El-Kheir ***et al.*** (2001) showed the effects of abiotic factors (physico-chemmical parameters on the phytoplankton structure at 3 locations on Ismailia canal, which receive some pollutants.

The data also revealed that drains which received remains of irrigated water after irrigation process from agricultural lands not affected greatly by this phenomenon, no marked change in physico-chemical characteristics of water of drains. This may regard to that, drainage water probably born already big amounts of suspended particles (silts and clays) run off from agricultural land (Khattab and El-Gharably, 1990). So, we can conclude that, the torrent phenomenon lead to dramatic change in physico-chemical parameters of Nile water as well as biotic flora found in aquatic ecosystem. Sharp decrease of phytoplankton flora was observed.

References

Abo El-lil, A. H., 1995. Evaluation of the efficiency of some hydrophytes for trapping suspended matters from different aquatic ecosystem. J. Fac. Edu. Ain Shams Univ., 20: 325-343.

Abou El-Kheir, W., A. El-Shimy, H. Touliabah and N. Abdel-Salam, 2001. Seasonal variation in phytoplankton structure in relation to abiotic factors in some polluted area along Ismailia canal, Egypt. ***Biodiversity and Conservation of natural heritage***, 1st Int. Conf. of the Egyptian-British Biological Soc., 1: 18.

Adams, M. S. and R.T. Prentki, 1982. Biology, metabolism and function of littoral submersed weed beds of lake Wingra. ***Arch. Hydrobio***., 62: 333-409.

Anonymous, 1985. Standard methods. American publication health association, pp: 1500.

Archibold, O.W., 1995. Ecology of world vegetation. Chapman and Hall, London.

Barko, J.W. and R.M. Smart, 1986. Sediment-related mechanisms of growth limitation in submersed macrophytes. Ecology, 67: 1328-1340.

Badr, S.A., 1990. Changes in Nile water quality and their relation to phytoplanktonic distribution. Egypt. J. Bot., 33: 77-92.

Campbell, P.G., A.G. lewis, P.C. Chapman, A. Crowder and M. Winfery, 1988. Biologically available metals in sediment. NRCC. No. 27694 Ottawa, Canada, pp: 298.

Chapman, V.J. and D.J. Chapman, 1981. The Algae. 2nd ed. (Macmillan Press Ltd.) London, pp: 497.

Dawson, F.H., 1980. The origin, composition and downstream transport of plant material in a small chalk stream. Fresh Water Biol., 10: 419-435.

Fremling, C.R., 1960. Biology and possible control of nuisance on the upper Missiipi river. State Res. Bull., 483-856.

Golterman, H.L., R.S. Clymo and M.A.M. Ohnstad, 1978. Methods for physical and chemical analysis of fresh water. 2nd ed. Blackwell Sci. Publ., pp: 213.

Hart, R.C., 1986. Zooplankton abundance, community, structure and dynamics in relation to inorganic turbidity. Fresh Water Biol., 16: 351-371.

Hustedt, F., 1959. Die kiesfalgen, Teil und 2. Akademische Verlags Gesellchaft.

Hynes, H. and F. Roberts, 1962. The biological effects of detergents in the river Lee. Ann. App. Biol., pp: 50: 77-90.

Khattab, A.F. and Z. El-Gharably, 1990. The effect of water hyacinth on the hydraluic effeciency of irrigation system in Egypt. 14th Congress, ICID, Brazil, 331-341.

Kirk, J.T., 1985. Effects of suspensoides turbidity on penetration of solar radiation in aquatic ecosystems. Hydrobiologia, 125: 195-208.

Madson, J. and M.S. Adams, 1989. The distribution of submerged aquatic macrophyte biomass in eutrophic stream. Hydrobiologia, 171: 111- 119.

Petticrew, E.L. and J. Kalff, 1992. Water flow and clay retention in submerged macrophytes beds. Can. J. Fish and Aquatic Sci., 49: 2483-2489.

Prentki, R.T., M.S. Adams and S.R. Carpenter, 1979. Role of submersed weed beds in internal loading and interception of allochthonusus materials in lakee Wingra. Arch. Hydrobiol., 57: 221-250.

Prescott, G.W., 1978. How to know fresh water algae. 3rd ed. P.K.NS. USA, pp: 293.

South, G.R. and A. Whittick, 1987. Introduction to psychology. Blackwell Sci. Pub., UK, pp: 341.

Talling, J.F. and Rzoska, 1967. The development of plankton in relation to hydrological regime in blue-Nile. J. Ecol., 55: 637.

Wetzel, R.G. and G.E. Likens, 1991. Limnological analysis, 2nd ed. Spring-Velarg, New York, pp: 391.

Zahran, M.A. and A.J. Willis, 1992. The vegetation of Egypt. Chapman and Hall, London.