EFFECTS OF WATER POLLUTION ON HEALTH

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Abstract

Water pollution is responsible for several health hazards and diseases in man and other living organisms. Water pollution occurs due to plastics, aquaculture and agriculture wastage , industrial effluents , nuclear explosions or accidents, coal ash, coal mine spoil, crude oil spills and natural disasters like floods , tsunami, and phytoplankton blooms . Pharmaceuticals and personal care products (PCPs) are emerging water pollutants and their impact on human health are yet to be assessed.

Key words : Water pollution   Plastics   Nuclear explosions

Natural disasters   Industrial effluents   Personal care products

Introduction

Sustenance and good health of humans and other life forms depends on the purity of substances consumed like water and food. Presence of any undesirable substances or elements in water and food threatens survival of species (WHO,2017). Further pure water is required by plants for production of good quality foods which are harmless . Drinking water quality standards for physical and biological characteristics are given in Table.1

Table 1. Drinking water quality standards for physical and biological characteristics

Characteristic	Standard value
Odor	Unobjectionable
Taste	Agreeable
Color (T C Units)	10
Turbidity (N T Units)	10
P ^{H}	6.5 – 8.5
Dissolved oxygen (D O) Mg/L	> 5
Biological oxygen demand (B O D) Mg/L	2.0
E . Coli C F U / 100ml	0
Total coliforms C F U/100ml	0

Total hardness Mg/L	300
Total dissolved solids (T D S) Mg/l	500

So as long as water is clean health of humans and other living organisms are safe. Any activity by man should not disturb purity of water. Hence longevity of man on earth depends on how clean (safe) man keeps water where he lives. However the continuous exploitation of natural resources by man over a century to meet ever increasing energy demand , changes in life styles and rapid industrialization are responsible for pollution of water (Mc Michael,2017). Drinking water quality standards for inorganic constituents are presented in Table.2.

Table 2. Drinking water quality standards for inorganic constituents

Constituent	Standard value	Constituent	Standard value
Sodium (mg/l)	200	Nickel (mg/l)	0.07
Calcium (mg/l)	75	Cadmium (mg/l)	0.01
Magnesium (mg/l)	30	Arsenic (mg/l)	0.05
Zinc (mg/l)	5	Mercury(mg/l)	0.001
Potassium (mg/l)	1-2	Lead (mg/l)	0.10
Fluoride (mg/l)	0.6-1.2	Cyanide (mg/l)	0.05
Iron (mg/l)	0.3	Chloride (mg/l)	250
Manganese (mg/l)	0.1	Sulfate (mg/l)	150
Copper (mg/l)	0.05	Silica (mg/l)	100
Chromium (mg/l)	0.05	Nitrate (mg/l)	45
Aluminum (mg/l)	0.20	Nitrite (mg/l)	3
Barium (mg/l)	1.3	Ammonia (mg/l)	1.5
Boron (mg/l)	2.4	Hydrogen sulfide (mg/l)	0.05

The word pollution refers to presence of pollutant in water .Pollutant may be substance or element which is usually absent in water. Some diseases in tropical countries are due to pollution of water. Spreading of these diseases is rapid in locations where water pollution is more. Most of the surface water in our country is unfit directly for consumption. Consumption of such water adversely affects health of children particularly and adults in general(Benjamin *et al*, 2019, Philip *et al*,2018). Due to over contamination of even treated water supplied by local administration require further measures to make surface water potable. Hence majority of health conscious individuals all over the World use only mineral water. In Table. 3 drinking water quality standards for organic and radiological characteristics are given.

Table 3. Drinking water quality standards for organic and radiological characteristics

Characteristic	Standard value	Characteristic	Standard value
Chloroform (mg/l)	0.30	Vinyl chloride (mg/l)	0.0003
Lindane (mg/l)	0.002	Styrene (mg/l)	0.02
2,4 – D (mg/l)	0.03	DDT (mg/l)	0.001
Benzene (mg/l)	0.01	Endrin (mg/l)	0.0006
Monochlorobenzene (mg/l)	3	Pendimethalin (mg/l)	0.02
Dichlorobenzene (mg/l)	1	Anionic detergents (mg/l)	0.20
Chlorophenols (mg/l)	0.10	Radiation Gross α- activity Bq/L Gross β-activity Bq/L	 0.1 0.03
Benza (o)pyrenes (mg/l)	0.0007	Uranium (mg/l)	0.03

Water pollution by plastics

Plastics that cause pollution   are various sizes of plastic objects and materials. Use of plastics increasing day by day. World wide about 30 million tones of plastic is produced per day. About half of it used for single use plastics like packaging for food , water and beverages. Remaining is used in house hold articles , ladies fancy articles, cloths, footwear, automobile parts , electronic parts , toys etc (Andrady and Neal ,2009). Single use plastics are mostly discarded into nearby surroundings. Some enter into water bodies like canals , rivers and lakes etc. Further plastic manufacturing industries discharge chemicals and waste containing pollutants into water bodies. Since plastics are not biodegradable most of single use plastic about 10-20 million tons of plastic reaches oceans through the rivers of world. Plastics make up 60 -90 % of marine debris. In oceans large volume plastic accumulate   in five garbage patches present in Pacific, Indian and Atlantic oceans. Plastics in sea may form canopy over plankton obstructing sunrays and carbon dioxide utilization by phytoplankton . This may contributes to again global warming (Lebraton *et al* ,2018).

Plastics effects on Health : Several toxic materials are produced from plastics. Toxic chemicals of plastics leach into water, soil and enter food chain. Plastics are produced from toxic petrochemicals**.** So they may be released by the action of gastric juices on ingestion by aquatic life forms. Further toxic chemicals may leach into water as they degrade contaminating water. They may enter aquatic life as they ingest water during feeding. They accumulate in

body tissues like other poly chlorinated biphenyls and stored in body fat and other organs. These pollutants may enter into predators that feed on them and this lead to their further accumulation in higher organisms of food chain. Ultimately they enter humans because marine species form large part of our food around the world (Wright and Kelley ,2017).

Toxic effects of plastics are mainly due to Bisphenol A (BPA) and phthalates. Several studies indicates Bisphenol A is associated with several health problems in men and women. Levels of BPA in human blood and tissues ranges from 0.1 to 10 ug /L. BPA increases risk of breast cancer in women and prostate cancer in men. Further it effects immune system , endocrines, fertility, cardiovascular system . Some studies also show that BPA act as hormone because it mimics estrogen hormone (Rezg *et al* ,2014)

Water pollution due to discharge of aquaculture and agriculture waste

When harvesting is completed excess water is let out into nearby water bodies like canals and lakes along with agriculture waste. Aqua farming also carried out in india surrounding traditional crops. In aqua farming aquatic organisms like fish , shrimp , mollusks, crabs etc. are grown under controlled conditions. Due to growing food demand by world population many Asian countries are mainly engaged in this field. India is second leading country earning valuable foreign exchange. Waste water from these ponds is also released into nearby water bodies. Currently fertilizer and pesticide use is increased extensively due to decreased soil fertility and resistant pests. Hence water discharge is filled with residues of agrochemicals , pesticides, fertilizers and aqua chemicals , feeds and excreta of aquatic organisms. Ultimately they enter human food chain affects normal health of humans and other life forms. Both surface water and ground water are contaminated with chemical as well as biological residues originating from these wastes. In several villages drinking water sources become unfit for human use (Martinez – Porchas and Martinez – Cordova , 2012 , Nagendran, 2011).

Water pollution due to heavy metals

Industries disposing off the untreated effluents into local streams are responsible for the pollution of surface water and well water. Some times deeper bore wells are more contaminated than dug wells . .Heavy metals are mostly responsible for the pollution . Accumulation of heavy metals in marine ecosystem is globally important . Fish assimilate these heavy metals through ingestion and adsorption of dissolved metals on tissues and membrane surface . In other aquatic animals like crabs also accumulation of heavy metals occurs. Irreversible accumulation of heavy metals leads to metal related diseases there by harming aquatic organisms and other organisms like humans on consumption (Meili, 1997).

Mercury pollution: India is one of the mercury pollution hot spot in the world. Mercury is one of the heavy metal pollutent present in the environment. Use of raw materials containing mercury by industries, increased fossil fuel burning and mining activities are some of the factors contributing mercury to environment . In India about 0.1- 0.5 tonnes of mercury is released into environment every year. A part of released mercury is oxidized and transformed into organo mercurials by methylation or other processes .Methyl mercury is accumulated in fish and other marine organisms. It enters human body via food chain leading to serious health problems (Bhan and Sarkar, 2005).

Mercury poisoning: First case of mercury poisoning in humans was reported in 1950 from Japan . By 1988, 730 human deaths were reported due to disease and about 2200 cases of confirmed mercury poisoning were reported .It is due to consumption of sea fish contaminated with mercury. Dumping of industrial waste containing mercury into Minimata bay led this tragedy. Hence it is also known as Minimata disease. Initially mercury was absorbed by the algae present in bay which is later concentrated in fish. Consumption of sea fish contaminated with mercury caused mercury poisoning .Initial symptoms of mercury poisoning are numbness of extremities, unable to use hands for

holding things and writing etc; abnormal gait, weakness and sensory disturbances. These symptoms progress to paralysis, difficulty in swallowing and death can occur (Ekino *et al* ,2007).

Arsenic poisoning: Arsenic poisoning occurs in humans when they are exposed to high arsenic levels in the environment. Arsenic contamination of drinking water is global problem. However it is more severe in West Bengal, India and Bangladesh. Here over twelve million people reside where ground water arsenic concentration is 2 to 40 times higher than recommended permissible level. It is not only an environmental pollutant but also potential human carcinogen. It is associated with skin, liver and lung cancers. Arsenic poisoning causes skin lesions dermatoses, melanosis, keratosis, rhagades (skin cleft on palm and feet), liver damage, mucous membranes and digestive, respiratory, circulatory and nervous system damages. Lesion of skin progress to cancer. Exposure to high arsenic levels also leads to development of diabetes mellitus (Breslin ,2000, Beck *et al* , 2017).

Nitrate pollution

Drinking water is contaminated with nitrate in several parts of our country. It is mainly due to leaching of nitrates formed in environment from atmospheric nitrogen into ground water. Leaching of nitrates from agricultural land and from other sources to ground water is global pollution .Several disorders are reported in humans due to nitrate in drinking water . Methemoglobinemia is present in all age groups in areas with high nitrate concentration in drinking water. Alzheimer's disease , hyper trophy of thyroid , nitrate based drug tolerance , recurrent stomatitis, multiple sclerosis , colon and rectal cancer , changes in apoptosis , differentiation and maturation of intestinal cells , neural tube defects and reduced casein digestion are diseases in humans associated with nitrate pollution in drinking water (L'hirondel and L'hirondel ,2001, Schullehner *et al* ,2018 , Yang *et al* ,2009).

Sulfate pollution

Due to increased industrial activity ground water in Gajuwaka, an upcoming industrial area in Visakapatnam district of Andhra Pradesh is polluted with sulfate. High levels of sulfate in drinking water above safe levels causes health problems related to respiratory system .The concentration of sulfate in drinking water in this area was several times higher (770 mg/l) than the safe limit of 150 mg/l . Surrounding areas like Anakapalli ground water also contains more sulfate than permissible levels (Satyanarayana *et al* ,2013)

Nuclear explosions or accidents pollution

   Nuclear detonations or test places of nuclear weapons like Pokharan of Rajasthan in India , Bikini atolls , Nevada and Marshal islands in U.S.A and nuclear accidents are mainly responsible for radiation in water. Liquid effluents discharged from nuclear reactors and fall outs of nuclear explosions and accidents causes radiation exposure to aquatic organisms, plants and other animals including humans. In humans risk of cancer increases with radiation exposure mainly due to DNA damage. DNA damage leads to mutations in genes. Mutagenic effects of radiation is main concern for public health. Other radiation effects are decreased red cell count, skin reddening and blistering , hair loss and sterility (Simon *et al* , 2006,Yamada *et al,* 2009,Kamiya *et al* ,2015). Living organisms are exposed to radiation when living things ingest water contaminated with radioactive elements . Part of the activity thus entering the body gets deposited in different organs depending on the nature of chemical substance .

Nuclear accidents : In 1986 nuclear accident at Chernobyl in USSR caused uncontrolled release of radioactivity into environment . It severely contaminated several areas of USSR like Belarus and Ukraine states in Russia . All countries in northern hemisphere are also contaminated slightly . Some plant personnel died in the accident . About 1000 people may die due to radiation exposure related cancers .

   Other nuclear accidents reported are Three mile island and Brown Ferry in USA , Saint Laurent in France , Fukushima Daiichi nuclear disaster in Japan, Vandellose in Spain and Soviet nuclear submarine k reactor accidents (Mamun ,2013).

Strontium-90(^{90}Sr) Caesium – 137 (^{137}Cs) and iodine-131 (^{131}I): Nuclear explosions, nuclear accidents and radiation from nuclear power reactors produce radionuclides ^{90}Sr , ^{137}Cs and ^{131}I in the atomosphere. These radionuclides gradually enter human body through natural food chain. ^{131}I get concentrated in thyroid gland and may cause thyroid cancer. ^{90}Sr get concentrated in bone and teeth. Radiation from ^{90}Sr stored in bone may damage adjacent bone marrow. In addition ^{90}Sr is also get concentrated in milk. Consumption of such milk by infants and children may pose threat to their normal health (Mamun,2013).

Coal of thermal power plants

Thermal power plants using coal releases radio nuclides into environment. Coal ash produced by these industries is also potential source of radiation. Coal contains trace quantities of radio nuclide like ^{238}U , ^{232}Th, ^{226}Ra and ^{40}K . Thermal power plants based on coal release these nuclides into surrounding environment on combustion of coal . Further coal ash that is dumped with other waste is also potential health risk due to radio nuclides in coal ash (Ahmed *et al*, 2020,Bem *et al* ,2002).

Coal mine spoil

Coal mining activity produces large quantities of waste known as coal mine spoil . It causes contamination of near by aquatic bodies like lakes , rivers , canals and agricultural lands with toxic substances that leached out from it through rain water . Hence ecology and environment around coal mines are disturbed (Misra and Das ,2017).

Water pollution due to crude oil transport

Transport of crude oil by bulk carriers across the seas is part of international oil trade. But due to several reasons crude oil spills are occurring frequently thus polluting sea water and some times intruding into beaches. Several aquatic life forms are affected by this type of water pollution. Crude oil spill kill marine mammals , migratory birds ,fish, breeding grounds of wild animals (Kingston , 2002)

Water pollution related to floods

East coast and upper West coast areas of our country are prone to floods. Unprecedented heavy rain falls due to cyclonic storms are responsible for floods. Most of the major cities and rural areas of these coasts are affected by floods. Due to mixing of flood water with drinking water system and sewage system leads to pollution. Several ways human health is affected by this type of pollution including adult and children fatalities (Saulnier *et al* ,2018). Recently metros like Mumbai, Chennai , Hyderabad and Bangalore are flooded frequently with rain water due to excessive concretization , high rise structures , encroachments of canals, lakes and drains. These are mostly due to lack of proper rain water outlets , failure of existing sewage system to handle excess rain water ,decreased ground absorption of rain water. They are termed as ' Urban Floods'. They are characteristically 21 st century man made disasters . In recent years severity and frequency of urban floods increased throughout world. A downpour of more than 20 cm in 24 hours in metros invariably leads to flooding in low lying localities first then spreading to other areas. These urban floods make life miserable apart from paralyzing economy (Zuniga *et al* 2020, Pour *et al* ,2020)

Tsunami related water pollution

The most powerful earth quake that occurred on early hours of 26th December 2004 in Sumatra caused a devastating and powerful tsunami ever recorded in south eastern region of India .Srilanka and Indonesia are also affected by this tsunami . Tidal waves of about 3m and above were reported .It caused heavy loss to property and human life. Due to inundation of sea water the surface water got polluted considerably thereby decreasing availability of water for human consumption and agriculture . Due to intrusion of saline or sea water into surface water heavy metal pollution occurred in well water also (Ramanamurthy *et al* ,2005) .

Water pollution due to phytoplankton blooms

Some marine phytoplankton blooms causes pollution of water. They affect water quality and produce toxins. They pose threat to human health and aqautic organisms. Fish kills and human diseases were reported from through out the world due to phyto plankton blooms(Lin *et al* ,2016, Thronson and Quigg, 2008). Ocean surface discoloration by blooming phytoplankton is common in several coastal belts. Some times these blooms are associated with red tides and were responsible for fish kills and paralytic shell fish poisoning. A recent study indicates association of non alcoholic liver disease with phytoplankton blooms in U.S.A (Zhang Flee *et al* ,2015).

Pharmaceuticals and Personal care Products (PCPs)

Until recently the impact of human and veterinary pharmaceuticals, their derivatives and personal health care products on environment are ignored. They enter environment from effluents of bulk drug industries, hospital and domestic waste. World wide several pharmaceuticals and PCPs are identified in aquatic environment where they pose threat to aquatic life. Pain killers , anti inflammatories, antibiotics, anti epileptics and anti lipidemics and their derivatives are most detected pharmaceuticals in aquatic bodies (Jjemba ,2018). Personal care products like shampoos, deodorants, talcum powders, shaving creams, sunscreens, moisturizers, tooth pastes, perfumes , lotions, nail polishes, soaps, eye liners, lipsticks etc., contributes several organic contaminants to aquatic bodies. Ultimately they enter human body through food chain. In humans they cause allergy, fertility and hormonal disturbances and in aquatic animals neurological , immunological and systematic disorders (Pereira *et al* ,2020, Fabbri and Franzellitti, 2016).

Some pharmaceuticals are lethal to non target species. Since each species has role in maintenance of ecosystem balance elimination or reduction in population of particular species leads to ecological disturbances. Recent dramatic decrease in vulture population in some South East Asian countries India and Pakistan is result of poisoning by residue of diclofenac sodium a therapeutic substance. Diclofenac is widely used antipyretic as well as analgesic. Diclofenac poisoning causes renal complications, gout and consequent mortality. Since vultures are efficient scavengers decline in their population leads to environmental degradation (Galligan *et al* ,2019). Other pharmaceuticals acetaminophen kills indonasian snakes, warfarin kills rodents (Mathies and Mauldin ,2020). Therefore pharmaceuticals and personal care products must be evaluated for their environmental hazards prior to their approval.

Conclusion

Continuation of life on this planet needs availability of pure water. Natural disasters and human activities to meet ever increasing energy and life style demands are responsible for pollution of water which affects health of humans and pose threat to survival of other life forms.

References

Ahmed U A Q , Wagner, N J, Joubert J A .(2020). Quantification of U , Th and specific radionuclides in coal from selected coal fired power plants in south Africa. PLoS ONE, 15 (5)**,** e0229452 . https :// doi ;10.1371/journal.pone.0229452

Andrady A L and Neal M A .(2009). Applications and societal benefits of plastics. Philos. Trans.R.Soc.Lond.B.Biol..Sci.364(1526) : 1977-84, . https : //doi.org/10.1098/rstb.2008.0304

Beck R , Styblo M and Sethupathy P. (2017).Arsenic exposure and type 2 diabetes mellitus :micro RNA s as mechanistic links. Curr. Diabetes Reports. 17 (3)**,** 18 , http: //doi.org/10.1007/s11892-017-0845-8

Bejamin A , Gabriele D and Fanny J. (2019). Effects of changes in living environment on physical health : a prospective German cohort study of non movers. The European Journal of Public Health. 29 (6) **:** 1147-1154, http:// doi.org/10.1093/eurpub/ckz044

Bem , H, Wieczorkowski P and Budzanowski , M. (2002).*E*valuation of technologically enhanced natural radiation near the coal fired power plants in the Lodz region of Poland . J.Environ.Radioactivity . ,61 : 191-201,.https ; //doi.org/10.1016/S0265-931 X (01)00126-6.

Bhan A and Sarkar N N (2005).Mercury in the environment: effect on health and   reproduction. Rev. Environ Health. 20 (1) **:** 39 – 56.

Breslin, K. (2000).   Arsenic in Asia : Water at its worst. Environ. Health Perspect. 108 : 393-397, . http ://ehp.niehs.nih.gov

 Ekino S , Susa M, Ninomiya T, Imamura K and Kitumura T. (2007).Minamata disease revisited : an update on the acute and chronic manifestations of methyl mercury poisoning..J. Neuro. Sci. 262 (1-2)**:** 131-144, .http : //doi.org/10.1016/j.jns.2007.06.036

Fabbri E and Franzellitti S. (2016).Human pharmaceuticals in the marine environment :Focus on exposure and biological effects in animal species. Environ.Toxicol. Chem. 35, (4) : 799-812, , http; //DOI : 10.1002/etc.3131

Galligan T H ,Bhusal K P , Paudel K, Chapagain D, Joshi A B , Chaudhary I P, Chaudhary A, Baral H S, Cuthbert R J and Green R E. (2019).Partial recovery of critically endangered Gyps vulture populations in Nepal. Bird Conservation Int. 1-16, , http :/doi : 10.1017/S 0959270919000169.

Jjemba P.A. (2018). Pharma –Ecology : The occurrence and fate of pharmaceuticals and personal care products in the environment. 2nd edition, Wiley

Kamiya K, Ozasa , K , Akiba S,Niwa O, Kodama K,Takamura N, Zaharieva K E,,Kimura Y and Wakeford R. (2015).Long term effects of radiation exposure on health. The Lancet, 386, 469-478, ,https ://doi.org./10.1016/S0140-6736 (15)61167-9

Kingston P F. (2002).Long term environmental impact of oil spills. Spill Sci. and Tech. Bulletin. 7(1-2) **:** 53-61, http : //doi.org/10.1016/s1353-2561 (02)00051-8

Lebraton L ,Slat, B ,Ferrari F , […] Reisser J.(2018). Evidence that great pacific garbage patch is rapidly accumulating plastic. Sci Rep. 8 : 4666, , https ;// doi.org/10.1038/s41598-018-22939-w

L'hirondel J and L' hirondel J-L. (2001) .Nitrate and Man : Toxic, Harmless or Beneficial ? Wallingford, UK : CABI

Lin C J, Wade T J ,, Sams EA , Dufour A P , Chapman A D and Hillborn AD .(2016).A Prospective study of Marine Phytoplankton and reported illness among recreational beachgoers in Puerto Rico .Environ.Health Perspect. 124 (4) **:** 477-483,, https://doi.org/10.1289/ehp.1409558

Mamun M M A. (2013). Recent Fukushima nuclear detonation , Chernobyl nuclear fallout, three mile island nuclear accident and atomic bomb explosion – rethinking the effects of nuclear radiations over human health. Int. J. Radiation Res. 11: 63-80, .

Martinez – Porchas M and Martinez – Cordova L R . (2012).World Aquaculture : Environmental impacts and trouble shooting alternatives . The Sci. World J.2012, 389623, ,http: //doi.org/10.1100/2012/389623

Mathies T and Mauldin R E.(2020). Lethal methemoglobinemia in the invasive brown tree snakes after acetaminophen ingestion, Scientific Reports, 10(1): 1-9, . http: // doi.org/10.1038/s41598-019-56216-1

Mc Michael, A J. (2017) .Climate change and health of Nations : Famines , Fevers and the fate of populations. London : Oxford University Press .

Meili, M (1997). In Metal ions in biological systems. Mercury and its affects on environment and biology (eds. Sigel , A and Sigel ,H) ,Marcel Dekker ,USA ,Vol.34, pp .21-51

Misra N , Dass N.(2017).Coal mining and environment : A study in Talcher coalfield of india. Air , soil and water research, 10 : 1-12, ,http://doi.org/10.1177/1178622117728913

Nagendran R (2011) . Agriculture waste and pollution, In Waste, pp341-355, Elsevier .B. V

Pereira A, Silva L , Laranjeiro C ,Lino C and Pena A. (2020).Selected pharmaceuticals in different aquatic compartments : Part I- Source, fate and occurrence, Molecules, 25: 1026, , http :   //doi :10. 3390/molecules25051026

Philip J L , Richard F, Howard H, Jack C , Maurun L C, David H , Karti S , Thomas C C, Pushpum K, Willium S S.(2018).Pollution and Global health – An Agenda for prevention. Environmental Health Perspectives. 126 (8)**:** 084501, .http :// doi.org/10.1289/EHP3141

Pour S H, Wahab AKA, Shahid S, Asaduzzaman, Dewan A.(2020). Low impact development techniques to mitigate the impacts of climate – change – induced Urban Floods : Current trends , issues and challenges, Sustainable Cities and Society , https ://doi.org/10.1016/j.scs.2020.102373

Ramanmurthy , M V , Sundaramoorthy S ,Pari Y,Rangarao V , Mishra P ,Bhat M , Usha T , Venkatesan R and Subramanian B R..(2005). Inundation of sea water in Andaman and nicobar islands and parts of Tamil Nadu coast during 2004 Sumatra tsunami. Curr.Sci. ,88: 1736-1740,

Rezg R ,El-Fazaa S ,Gharbi, N and Moranagul B. (2014). Bisphenol A and human chronic disease : Current evidences , possible mechanism ,and future perspectives. Environ. Int,64: 83-90, , https ;//doi.org/10.1016/j.envint.2013.12.007

Satyanarayana P , Appalaraju N , Harikrishna K and Viswanath K. (2013). Urban ground water quality assessment : A case study of Greater Visakhapatnam Muncipal Corporation Area (GVMC), Andhra Pradesh, India. Int.J .Eng.Sci.Invent.2 (5): 20-31,, www:ijesi.org

Saulnier D D, Hanson C ,Ir P, Alvesson H M and Schreeb J V.(2018).The effects of seasonal floods on health: Analysis of six year national health data and flood maps. Int. J. Environ.Res. and Public Health.15 (4): 665, https://doi.org/10.3390/ijerph15040665

Schullehner J , Hansen B , Thygesen M, Pedersen C B , Sigsgaard T.(2018). Nitrates in drinking water and Colorectal cancer risk :A nationwide population based cohurt study. Int .J .Cancer ,143 (1): 73-79, http: //doi.org/10.1002/ijc.31306

Simon S L,Bouville A and Land C E.(2006).Fallout from nuclear weapons test and cancer risks. American Scientist ,94: 48 – 57, ,https://www.jstor.org/stable/27858707

World Health Organization , Guidelines for drinking water quality, WHO, Geneva ,2017,Fourth edition.

1. Wright S L and Kelly F J . Plastic and Human Health.: A micro issue ?. Env. Sci. Tech.**51 (12)**, 6634-6647, 2017,https ://doi.org/10.1021/acs.est.7b00423
2. Yang,C.Y. Tsai S-S and Chiu H –F. Nitrate in drinking water and risk of death from pancreatic cancer in Taiwan, J.Toxicol. Environ.Health A,**72(6),**397-401,2009. http : // doi.org /10.1080/15287390802647229
3. ,Yamada ,M. ,Kasagi, F ,Mimori Y , Miyachi T, Oshita T and Sasaki H.. Incidence of dementia among atomic bomb survivors: Radiation effects Research Foundation Adult Health Study, J. Neurol .Sci. , **281 (1-2)**, 11-4,2009,https : //doi.org/10.1016/j.jns.2009.03.03
4. Zuniga E, Magana V and Pina V. Effect of urban development in risk of floods in Veracruz, Mexico. Geosciences, 10, 402, 1-14, 2020 , https://doi.org/10.3390/geosciences10100402
5. .Thronson A and Quigg A. Fifty five years of fish kills in coastal Texas. Estuaries and coasts, **17**, 561-574, 2008, https://doi.org/10.1007/s12237-008-9056-5
6. Zhang Flee J Liang S and Shum C K. Cyanobacterial blooms and non alcoholic liver disease : evidence from a county level ecological study in the United States. Environmental Health. **14** ; 41 ,2015 , https ://doi.org/10.1186/s12940-015-0026-7