Types of Water Pollutants: Conventional and Emerging

Arif Ahamad, Sughosh Madhav, Amit K. Singh, Ashutosh Kumar and Pardeep Singh

Abstract Among all natural resources water is the most valuable resource existing on this planet. In present scenario, around the globe more than 0.78 billion people do not have access to safe and potable water which ultimately deteriorating their health. It is the right of every individual to have contamination free water but due to rampant urbanization, industrialization and uncontrolled population growth the pressure has been increased on existing available water resources (surface/ground water both) which leads to shrinkage of quantity and degradation of its quality. Various types of pollutants (organic and inorganic) released from different sources into the environment are increasing day by day. Conventional water pollutants include F^{-}, NO_3^{-}, and trace heavy metals (Pb, Cd, Cr, Ni, Zn, As, Hg, etc.), while emerging water pollutants include steroids and hormones, endocrine disrupting compounds (EDCs), pharmaceuticals & personal care products, artificial sweetener, surfactants, etc. The existence of these cocktail of pollutants in the water resources is more dangerous, which could lead to undesirable synergistic consequences.

Keywords Water · Pollutants · Trace metals · Nitrate · Pharmaceuticals & personal care products

1 Introduction

Water is the key constituent of all the existing lives. Being an essential component the freshwater comprises 3% of the total water on our earth. Out of which only a little amount (0.01%) of this fresh water is available to us for all purposes [46, 55].

A. Ahamad (✉) · S. Madhav · A. K. Singh
School of Environmental Sciences, Jawaharlal Nehru University, New Delhi 110067, India
e-mail: evsarif786@gmail.com

A. Kumar
Department of Geology, Institute of Science, BHU, Varanasi 221005, India

P. Singh
PGDAV College, University of Delhi, New Delhi 110065, India

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Due to various reasons like rapid growth population, urbanization and unsustainable use of water in agriculture and industries, this small portion of freshwater is now under in serious stress [2]. Non polluted water is a fundamental need of community and public health. On the event of World waterday 2002, a press release of UNO Secretary General highlighted the significance of accessibility of high quality drinking water. According to their report- an estimated 1.1 billion people are unable to get safe water for drinking purpose, 2.5 billion people are not getting proper sanitation, and more than 5 million people lost their lives due to water borne as well as water-related diseases which is equal to ten times the number killed in wars, on average, every year. So far where sufficient or plentiful water supplies are available, they are growingly at risk from contamination and increasing demand. They also reported that two thirds of world's population is expected to live in countries with moderate or severe water crisis by 2025 [5].

Polluted water mainly bears various infectious pathogens (like bacteria, virus and protozoa) as well as carcinogenic organic anions and cations (NO_3, PO_4, SO_4, F, Ca and Mg) and inorganic pollutants (acids, salts and toxic metals). When these substances exceed the permissible limit can become very dangerous and can cause serious diseases in humans and other organisms of the ecosystem [5]. Natural activity like volcanic eruption can contribute a small part of the sources of water pollutants but basically the key sources of water contaminants are anthropogenic like poorly treated or untreated municipal wastes, discharges from individual septic tanks, agricultural wastes like fertilizers, pesticides, industrial chemical wastes, spilled petroleum products, mine drainage, spent solvents, etc. [3]. Pollutants can be added into water bodies (both surface and ground water) through various processes e.g., discharge processes, surface runoff, subsurface infiltration, or atmosphere precipitation etc. Once the mixing of pollutants with water bodies occurs they are immediately carried into the water cycle in a global context. Consumption of polluted water can cause various water borne diseases like gastrointestinal illness by pathogenic microbes and also affect liver, kidney, nervous system and immunity [119]. Such pollutants are familiar to the society since long back termed as conventional pollutants because various researchers have reported their sources and the adverse effects on ecosystem in detail.

In recent years, the study of so-called "emerging contaminants" gains more attention than from conventional pollutants. Harmful effects of these emerging contaminants on human health is so far not known and have been detected at very low concentration (ng L^{-1} to μg L^{-1} levels) [33, 101] in the environment, particular in waters. With rise in population as well as globalization has not only increase the quantity of wastes but has also produced various emerging water pollutants which include pharmaceuticals, personal care products, pesticides, herbicides and endocrine disrupting compounds in last few decades [119]. Everyday emerging contaminants are added to our environment and the main source of formation of these is the byproducts of our modern lifestyle. We use chemical based products every day and these chemicals remain in wastewater due to lack of proper wastewater treatment plants. Likewise the industrial processes having their own treatment plants cannot remove all these chemicals and finally such chemicals end up in lakes and rivers of our environment. Therefore we are worrying about the harmful effects caused by those chemicals that they might be having on organism including human. Yet various pollutants have been detected in drinking water supplies but their negative effects on human body are still unknown. The sources of both natural and anthropogenic emerging contaminants having the levels between ng L^{-1} and μg L^{-1} (also called micropollutants) have been reported by various researchers in their publications including pesticides, industrial compounds, pharmaceuticals and personal care products [12, 57, 85–85].

There are several sources of these micropollutants in natural water. It is reported that industries and municipalities use about 30% of the world available renewable freshwater [19] resulting generation of vast quantity of wastewaters having various chemicals in varying concentrations. Some other remarkable sources of such pollutants are agricultural inputs [10] which use several million tons of pesticides each year; inputs from oil and gasoline spills; and from the human-driven mobilization of naturally occurring geogenic toxic chemicals [27]. Besides these, there are also enormous municipal and especially dangerous discarded industrial and earlier military waste sites from which poisonous compounds may enter into water body, mainly into the groundwater. As more than 100,000 chemicals are recorded and most of are used as daily basis [90], one can easily predict various probable ways of entering these chemicals into our aquatic environment [89]. Most compounds are mainly the resultant of urban waste water and can penetrate into drinking water via water cycle owing to their hydrophilic nature and poor elimination at drinking water and wastewater treatment plants [62, 71, 76, 122]. In several region of the world including rising economies like China, the wastewater having micropollutants are still untreated or undergo improper management which is unable to remove these kinds of pollutants [93]. Therefore, it was highly recommended to monitor the emerging compounds in the environment and basically in water because of their chances of open out via water and other unidentified eco-toxicological character [82, 83].

This book chapter deals with the various kinds of chemical pollutants in water resources including traditional as well as emerging.

2 Conventional Water Pollutants

People are aware about conventional pollutant like Fluoride, Nitrate and trace metals and metalloids because their desirable and permissible standard limit are known and also the causative effects on ecosystem and human health are also well described in the literature.

2.1 Fluoride

There are around 12 million tons of fluoride stores in the ground in India of the estimated 85 million tons present in the world [104]. The fluoride is highly scattered in our environment accounting for 0.3 g/kg of the earth's crust, resulting thirteenth in abundance. When fluorine reacts with other elements and forms ionic compounds like hydrogen fluoride and sodium fluoride in water and after dissociation it results into negatively charged fluoride ion [4]. Fluoride's chief natural source in soil is its parent rock itself [118]. In granitic rocks, fluoride, the only principal mineral of fluorine occurs chiefly as an extra mineral which contain sits concentrations of 20–3600 ppm [107, 112]. Apatite, amphiboles, biotite, hornblende, micas, muscovite, pegmatite, certain types of clays apart from villiaumite also contain fluorine [13, 34, 39]. There are other sources of fluoride into environment such as aluminum smelters, glass, enamel, textile dyeing, brick and tile works, plastics factories, phosphate fertilizer plants, industrial plants manufacturing hydrofluoric acid, along with the thermal power plants which consume high sulphur non-coking coal. At present high-tech industries like those involved in manufacturing semiconductors and integrated circuits generate large quantities of industrial effluents that contain fluoride [23, 25, 69, 73]. Though Fluoride with a very precise amount is an indispensable component for the normal mineralization of bones and development of teeth enamel, but its unnecessary intake could result into fluorosis [7, 59]. Low calcium and high bicarbonate alkalinity has been observed to favor high fluoride content in groundwater [15]. The water with high fluoride is normally soft, having high pH and high quantity of silica. In groundwater the amount of fluoride depends on various factors like aquifer's geological, chemical and physical characteristics, texture of soil and rocks, temperature, the action of other chemicals and the depth of wells [59]. The maximum limits of fluoride in drinking water as per WHO guidelines must not exceed 1.5 mg/L [116].

2.2 Nitrate

Nitrogen in the form of NO_3^-, NO_2^-, NH_3^+ and organic nitrogen could be groundwater's one of most common contaminants [66]. Besides, nitrate is also found naturally in very small concentrations in groundwater [28]. The nitrate exposure could occur from various environmental sources even as the drinking water remains the chief source. Though the ground and surface water normally have low concentrations of nitrates but because of issues like run off and leaching from agricultural lands, it could increase to high values [67]. In environments like oxygen-rich nitrate is generally a stable compound. It is highly water soluble and is easily leached from soils which have negative charges or with moderate to high pH, without being influenced by adsorption and precipitation reactions. For decades, the nitrate compound has the ability to remain in groundwater and get accumulated to higher levels since more and more of nitrogen is consistently used to the land surface on yearly basis. It has been observed that the water with greater than 50 mg/l of nitrate concentration could create health problems in humans and animals [36, 115]. If the nitrate polluted groundwater is discharged to the low nitrate concentration water bodies, it may result in eutrophication [98]. Various researches have observed that the increased nitrate concentration in groundwater can serve as an indirect indicator of the existence of other pollutants that are derived from human activities [28, 77]. The NO_3^-, component of nitrogen cycle in nature, signifies the most oxidized chemical form of nitrogen found in the natural systems and forms an important part of building blocks of living organism, i.e. DNA, RNA, hormones protein, vitamins, and enzymes [75]. Therefore human health consequences for humans because of high nitrate level exposure remain a great concern. The NO_3^- binds itself to the hemoglobin and therefore its increased concentration levels decreases the oxygen-carrying capacity in the blood which causes methemoglobinemia or "blue baby syndrome", a condition that may result in the mortality due to asphyxiation especially in the new born babies [2]. The infants (of <6 months of age) remain at highest risk because their digestive systems have bacteria which speedup the binding process. It is reported that nitrate can be endogenously reduced to nitrate, undergo nitrosation reactions in stomach with amines and then amines to form a variety of *N*-nitroso compounds (NOC) and are mostly carcinogens [106, 100, 113].

2.3 Trace Metals and Metalloids

Natural water dissolves the impurities of trace elements/heavy metals which are already present in water while seeping downward as a part of hydrological cycle [48]. Additionally, several human activities including large scale use of agricultural pesticides, fertilizers, dyes and improper disposal of industrial and municipal wastes introduce these metals to both the surface as well as groundwater [56]. Though for human health many of these metals are considered essential [44], however, their increased concentrations result in water pollution and lead to acute health issues in humans and other organisms. The speciation or the form in which they exist in a given water system determines the fate and toxicity of these metals even as it is a metal's freely dissolved form which is normally the most toxic. The EPA has included metalloids, metals & organics under priority water pollutants [64]. The metals and metalloids include Sb, As, Be, Cd, Cr, Cu, Pb, Hg, Ni, Se, Ag, Zn and Th. Most of them are transition elements, like Cd and Cu, or heavy metals like Pb and Ag and have tendency to form complexes with organic or inorganic ligands. In a solution ligands easily supply a pair of electrons to positively charged metal ions in solution and hence form complex ions with one to six ligands bound to the central metal atom. In fact, metal cations in water are hardly ever present as just the freely dissolved ions. If nothing else, water molecules can serve as ligands and tie to metal ions forming aquo-complexes. The ability of formation of various complex species is the fundamental feature of metals as the concentration of ligands in the water alters. The form of the dissolved metal can vary considerably as in an estuary transition of freshwater to seawater is caused by the metal [91].

Iron, one of the earth's most plentiful metals, occurs in various oxidation states while Fe (II) and Fe (III) are its two common forms in water. Fe $(OH)_3$ (oxidizing environment), Fe^{+2} and $FeHCO_3$ (reducing environment) are the species observed in water at neutral pH [103]. For the normal functioning of living organisms, Iron is an vital element and its deficiency as well as overload could be very harmful for the plants and animals [108]. The WHO has set a standard limit of 0.3 mg/L for iron in the drinking water. So the increased concentration of iron in natural water reservoirs poses a potential risk for human health system as well as the surroundings. Though compared to iron insufficiency, the overload or the overexposure of iron occurs less commonly but poses several serious health issues related to heart and liver [60], diabetes [29], cancer [6, 68], along with neurodegenerative disorders [9].

Manganese (Mn) occurs naturally in surface water and groundwater; however, its addition to water is largely contributed by human activities also [110]. It is an indispensable micro nutrient for all forms of life [30] since it combines to and/or control a number of body enzymes [20]. Manganese, tenth most abundant element in earth's, crust is a redox sensitive and is found in different oxidation states. In the aqueous environment, Mn^{+2} (reducing environment), MnO_2 and Mn_2O_3 (oxidizing environment) are the most prominent species. The exposure to too much doses of Mn results in severe nervous disorders and prominently targets brain [20] and in worst case scenario may permanently lead to a neurological problem which shows similar symptoms like Parkinson's disease [49]. Moreover, it has been observed that the exposure to Mn from food is generally higher than the intake from drinking water [110].

Chromium forms one of the most frequent elements in both earth's crust as well as water. The WHO permits 0.05 mg/L value of chromium in drinking water. In water it is unable to occur as freely as cation and appears as polyatomic anions chromate and dichromate (CrO_4^{2-} and $Cr_2O_7^{2-}$, respectively) [105]. Though this is not poisonous in itself and holds an significant role in the carbohydrate metabolism in our body, however, certain compounds of chromium mainly in its hexavalent state-chromium (VI) (carcinogenic form) cause irritants and diseases related to the digestive, excretory, respiratory and reproductive system, skin diseases ultimately cancers [41].

Nickel is a broadly dispersed component present in air, water and soil, and was dubbed as the "Allergen of the Year 2008" [26]. It can naturally enter the environment through processes such as weathering of minerals and rocks as well as from anthropogenic sources. In the aquatic environment more than 90% of the nickel is linked with particulate matter of sediments [45]. In natural waters, nickel occurs in the +2 valence state. Ni^{+2} form of nickel has been considered to be mainly responsible for evoking a toxic effect in aquatic organisms. The WHOs has put the limit of nickel concentration in water at 0.02 mg/L. Its compounds risk causing number of adverse effects like skin disease in the form of dermatitis, kidney problems, various heart diseases, respiratory tract cancer and lung fibrosis [58, 92].

Lead (Pb) is a normal component of the earth's crust and occurs naturally in very low concentration in soil and water [74]. It exists in two oxidation states of 0 and 2 and the dominant species found in normal water pH are Pb^{+2}, $PbOH^{+}$ and $PbHCO_3^{+}$. Of these Pb^{+2} is more common and reactive form. Lead is less mobile in soil and therefore usually found in minute quantities in deep aquifers in comparison to other heavy metals like Hg, As and Cd. Various sources contribute to the lead contamination in drinking water such as industrial wastes, vehicle exhausts and household paint. The WHO admissible limit for Pb concentration in drinking water is 0.01 mg/L. Lead usefulness in human physiology is unknown [74], but on contrary, its overdose exposure for longer times could affect major body organs and systems like neurological, gastric, haematopoietic, heart, reproductive system and immune system and also affects skeleton and kidneys [80, 111]. Lead has hazardous effects on pregnant women which can cause delay in development, under weight of fetus and cases of miscarriages are also recorded [8].

The naturally occurring compound Mercury (Hg) is considered as "persistent bio accumulative toxin" [114]. The WHO permissible limit for mercury in drinking water is 0.001 mg/L. Inorganic form of Mercury is less toxic than its organic forms owing to the differences in bioavailability [11]. In aquatic environments bacteria can transform mercury to methyl mercury which is highly toxic in nature [32] and can easily accumulated by fish and biomagnification takes place in the food chain. Coal fired power plants, smelting, alkali processing, apart from other industrial activities contribute to the mercury in environment. Historically, mercury was used in number of ways until its adverse effects became known. In the environment, the mercury cycles between air, water, soil, sediment, and biota. This causes difficulties in determination of its proper source. Occurrence of mercury in nature is also recorded in the sediments after the volcanic eruption which causes its mixing in atmosphere. Besides, the fly ash of power plants also contains mercury which directly mixes with atmosphere [91]. Only mercury has the property of biomagnification in the food chain and has serious detrimental effect on human health as well as the environment. Being a potential cellular toxin it has various harmful effects on our nerve cells, production of neurotransmitter even on the rate of production of thyroid and testosterone hormones [32].

Cadmium (Cd) exists in 0 and 2 oxidation states and is found in relatively low concentration in aquatic environment [61]. Its concentration could increase due to different activities like mining, seepage from hazardous waste site, wastewater disposal from industries or continuous use of Cd containing phosphate fertilizers. Cd is widely used in industrial applications including manufacture of batteries (NiCd), pigments, plastics etc. Its dominant form in pure water is Cd^{2+} (in fresh water the aquo-complexes are sticked to humic matters) and at high salinity, it forms a mixture of chloro-complexes, with $CdCl_3^{-}$ overriding in seawater [91].

Therefore the toxicity of same metal varies in different aquatic systems with diverse conditions. There are some metals and metalloids of polyatomic anions like arsenic, which are basically found as either arsenite (contains As (III) or as arsenate (contains As (V) in the water. The metal speciation also depends upon the oxidation-reduction conditions. As (III) species are predominate under reducing conditions, while under oxidizing conditions, the As (V) species are more constant. A good example of wood preservative (generally insecticide) is the lead arsenate—a form of arsenic was widely used for many years. After the decomposition, the wood pieces release arsenic into soil which mixes with surface water and finally makes its way to groundwater. Another chief source of arsenic and lead is smelting operation by which these metals are added into water directly or transported atmospherically. Presently the arsenic poisonings are caused mainly due to the consumption of well water where the ground water is naturally enriched in inorganic arsenic. Its over-exposure may cause reduction in the production of WBC and RBC, damage blood vessels and cause "pins and needles" sensation in hands and feet [1]. Its elongated exposure could result in leuko-melanosis, melanosis, neuropathy, hyperkeratosis, black foot disease, and cancer [17].

Selenium (Se) is often found in association with sulfur containing minerals in the earth's crust. Selenium is a metalloid component, a naturally existing trace element, available in five oxidation states in the nature: −2, −1, 0, +4 and +6, under the forms of elemental selenium, selenide, selenite, selenate and organic selenium [86]. The most familiar forms of selenium in water are selenite (Se (IV), SeO_3^{2-}) and selenate (Se(VI), SeO_4^{2-}). It is a slow process of emergence of selenate from selenite and both forms are found together in solution. Neither can be oxidized or reduced easily [97]. Selenium contamination of aquatic environment could happen due to mine drainage, agricultural drainage water, oil refineries, and sediments produced from fossil fuel thermoelectric power industries and metal ores [63]. The largest utilization of selenium compounds is in electronic and photocopier elements. A key nutrient at the level of low concentration, the permissible limits for selenium in drinking water has been set at 40 μg/L [117]. However, EPA has found that selenium has the potential to cause a number of health issues in case people are unmasked to it beyond MCL levels for relatively short time periods: fatigue and irritability, damage to the peripheral nervous system; hair and fingernail changes. A longer period exposure at levels above MCL have harmful effect on hair and fingernail loss; kidney and liver tissue damage, and the nervous as well as circulatory systems (www.freedrinkingwater.com).

3 Emerging Water Pollutants

Although the risk of health hazardous are not yet understood, all the drinking water supplies around the world is under contamination of chemical pollutants at least at trace level. Such problems lack scientific research and as well as there is scarcity of literature. But this issue is an urgent one and should be considered as emergent issue. There are several ways to define emerging contaminants.

The first one is the chemicals which are newly established into the ecosystem e.g. industrial chemicals which formed recently. The second one is regarding those compounds which have entered in environment in the past but are detected recently in the environment. The third one is same as the second one but they have caused harmful effects on ecosystems or humans [70].

Sources of ECs pollution may be point such as urban and industry or diffuse like agriculture. Point sources directly discharge the ECs into water bodies where their concluding fate is of primary concern as they may transport in the aqueous phase, degrade, adsorb into sediments [37]. However, in the case of diffused source of pollution, various properties of ECs such as their volatility, polarity, adsorption efficiency, persistence as well as interacting compartments determine their transport from source to the sink [31, 38]. Various types of emerging pollutants are displayed in Table 1.

3.1 Pharmaceuticals and Personal Care Products (PPCPs)

Pharmaceuticals and personal care products or PPCPs broadly consolidates the products pertaining to healthcare or medical requirement of humans and/or animals. PPCPs have been lately recognized as emerging contaminant owing to their continual presence in the aquatic environment thereby increasing the interest in their safety PPCPs over past three decades [88]. PPCPs are released in the environment through various sources including domestic wastewater, water treatment plants (WTPs) and hospital discharge [52, 54]. Amongst these, hospital effluents often show high frequency and concentration of pharmaceuticals [51, 65]. It is possible that the contaminants released into the aqueous environment from the source may preserve their initial concentrations and/or change their structure and convert into active or inactive forms throughout their lifespan. Generally, PPCPs are found in surface water, groundwater, drinking water as well as sewage at concentrations ranging from ppt (ng/L) to ppb (μg/L) [22]. It is likely that from the all the pharmaceuticals products sold approximately 65% are never ingested [84]. Additionally, enormous amounts of pharmaceutical products including inflammatory drugs and antibiotics do not even pass the sewage treatment. These are used by veterinarians for treating cattle feedlot and from there directly enter the surface water through run off during rainfall [14, 24].

PPCPs have been classified into multiple categories on the basis of their characteristics and usage. Pharmaceuticals classes include antibiotics, analgesics, steroid hormones, anti-inflammatory drugs, cytostatic drugs blood lipid regulators and β-blockers etc. [79] whereas types of Personal care products (PCPs) include fragrances, bactericides/disinfectants, insect repellents, preservatives and sunscreen ultraviolet (UV) filters [51, 54, 120]. Parabens are basically esters of para-hydroxybenzoic acid and may either contain an alkyl or benzyl group as side chain. These are mostly used in the form of preservatives in various products including food, cosmetics and pharmaceuticals [43, 53]. DEET is widely used

Table 1 Typical class of emerging contaminants and their representative compounds

Distinctive classes	Representative compounds
A. Pharmaceuticals	
A1. Broad-spectrum antibiotics	
1	Fluoroquinolone
2	Sulfonamide
3	Cephalosporin
4	Nitroimidazole
5	Tetracycline
6	Penicillin
7	Macrolide
A2. Hormones	
1	17-β-Estradiol (E2)
2	Estriol (E3)
3	Estrone (E1)
A3. Non-steroidal anti-inflammatory drugs (NSAIDs)	
1	Diclofenac
2	Ibuprofen
3	Naproxen
A4. β-blockers	
1	Metoprolol
2	Propranolol
3	Atenolol
4	Sotalol
A5. Blood lipid regulators	
1	Clofibric acid
2	Gemfibrozil
3	Bezafibrate
B. Personal care products	
B1. Preservatives	
1	Parabens
B2. Bactericides/disinfectants	
1	Methyltriclosan
2	Triclocarban (TCC)
3	Triclosan (TCS)
B3. Insect repellents	
1	N, N-diethyl-m-toluamide (DEET)
B4. Synthetic musks	
b1. Nitromusks	Musk moskene
1	Musk tibetene
2	Musk xylene
3	Musk ketone
4	Musk ambrette

(continued)

Table 1 (continued)

Distinctive classes	Representative compounds
b2. Polycyclic musks	
1	Celestolide (ADBI)
2	Galaxolide (HHCB)
3	Toxalide (AHTN)
4	Phantolide (AHMI)
5	Cashmeran (DPMI)
6	Traseolide (ATII)
B5. Sunscreen UV filters	
1	2-Ethyl-hexyl-4-trimethoxycinnamate (EHMC)
2	4-Methyl-benzylidene-camphor (4-MBC)
3	Octyl-methoxycinnamate (OMC)
4	Octyl-triazone (OC)
C. Endocrine disruptors (EDCS)	
C1. Pesticides	
1	DDT
2	Chlorpyrifos
3	Atrazine
4	2,4-D
5	Glyphosate
C2. Plasticizer	
1	Phthalates
C3. Food contact materials	
1	Bisphenol A (BPA)
C4. Flame retardants	
1	Polychlorinated biphenyls (PCBs)
C5. Textile/clothing	
1	Perfluorochemicals (PFCs)
C6. Antimicrobial	
1	Triclosan
D. Artificial sweetner	
1	Acesulfame
2	Saccharin
3	Cyclamate
4	Sucralose
E. Surfactants	
E1. Anionic	
1	Linear alkylbenzenesulphonic acid (LAS)
2	Sodium dodecyl sulphate (SDS)
3	Sodium lauryl sulphate (SLS)
4	Alkyl sulphate (AS)

(continued)

Table 1 (continued)

Distinctive classes	Representative compounds
E2. Cationic	
1	Quaternary ammonium compound (QAC)
2	Benzalkonium chloride (BAC)
3	Cetylpyridinium bromide (CPB)
E3. Amphoteric	
1	Amine oxide (AO)
E4. Nonionic	
1	Alkylphenolethoxylate (APE)
2	Alcohol ethoxylate (AE)

active constituent in insect repellents and is known to persist in the water bodies for long durations [120].

Synthetic musks have been used as economical substitutes for natural musks since 1930s as fragrances in wide variety of products (domestic and industrial) such as food, perfume, detergent, shampoo, cosmetics and cigarette additives [81]. Synthetic musks have been widely categorised into two groups namely, polycyclic and nitro musks. Amongst them, nitro musks were the most frequently used synthetic musks initially but eventually their usage was reduced by 1950s because of their toxic nature towards humans and environment [102]. Polycyclic musks has replaced the nitromusks, which accounted for around 85% of worldwide production whereas remaining 15% is contributed by nitro musks [18, 102]. UV filters are generally used in sunscreens, cosmetics and lotions for protecting the skin against UV radiation. Their usage has seen a surge owing to increased awareness of people regarding the detrimental health consequences caused by UV radiation. These filters are discharged into water bodies as effluents and through various water based recreational activities [18].

3.2 Endocrine Disruptors (EDCs)

EDCs has been described by the Endocrine Society, (the largest international group of scientists and physicians which work in the area of endocrinology), as: “an exogenous [non-natural] chemical, or mixture of chemicals, that interferes with any aspect of hormone action” [40]. EDCs disrupt the endocrine system by either mirroring the structure of the natural hormone or by obstructing its functional pathway. These have been characterized as artificial chemicals that either mimic or block hormones after entering the body thereby affecting its usual operation. The Environmental Protection Agency (EPA) has described EDCs as foreign factor that may interfere with the development, release, attachment, transport, activity and/or replacement of natural hormones which help in maintaining bodily functions like homeostasis, reproduction, development and behavior [109]). It is now widely accepted that the three main kinds of EDCs are estrogenic in nature and they operate by either mimicking or blocking the pathway of natural estrogens, androgens or thyroids (triggers instant or oblique consequences to the thyroid) [95]. Natural and engineered EDCs are released in the surrounding by human acts, creatures and industries; primarily passing via sewage treatment before finally being discharged into surface water, groundwater, soil and silt. Based on the aforementioned reasons, a lot of research has been carried out just on estrogenic compounds.

These compounds are found in very low concentrations (ng L^{-1} or μg L^{-1}) in wastewater. EDCs are of deep concern since their long period of exposure and effect on humans is unidentified. Today, there are more than 85,000 chemicals that are manufactured out of which thousands may just are EDCs. A list of typical EDCs along with their categories is presented in Table 1. Triclosan which is a antimicrobial compound, is widely used since decades in varieties of PCPs (personal care products) like cosmetics, soaps, shampoos, skin-care lotions and creams, deodorants, toothpastes and mouthwashes [18]. Polychlorinated biphenyl, a flame retardant, is a category of chemical compounds and are utilised in textiles, plastics, and furnishing foams. They have majorly provided towards reducing the risks of fire [72]. Perfluorinated compounds have extraordinary chemical properties such as their ability to repelwater, lipids and oil. These compounds are used in water, grease or dirt repellent platings, in sprays for leather and textiles and in non-stick cookware as PTFE (Teflon) coating [47]. Bisphenol A (2,2-Bis-(4-hydroxyphenyl)propane) is weakly estrogenic and also possesses some anti-androgenic activity [96]. It is a plasticizer manufactured in large quantities and is used in the manufacturing of polycarbonate and epoxy resins, flame retardants and unsaturated polyester-styrene resins as a monomer [99]. Its end product is applied in the platings of cans, dental fillings, and additives in thermal paper, powder paints and antioxidants in plastics [99]. Their discharge in our surrounding occurs throughout the production as well as through leaching from the end products [35]. Being a ubiquitous type of plasticizers Phthalates are widely utilised various products like cosmetic products, playing things, packaging of foods, and medical equipment. Di (2-ethylhexyl) phthalate, one of the most common phthalates, presents a definite public health concern because 100% of population of the US shows significant and detectable levels of this EDC [42].

3.3 Artificial Sweeteners

Being a newest group of emerging contaminants the artificial sweeteners are ate up as substitute of low-calorie sugar in large quantities in a lot of food items and drinks. Examples of these compounds include saccharin, acesulfame, sucralose and cyclamate [78]. Some of these are heat-stable like acesulfame and are used in baking. They are used in soft drinks having long expiry dates owing to their persistency in liquid [47]. Besides, certain class of sweeteners cannot be degraded by human body and become risky since these compounds may end up in large quantities in surface waters after use. This has already been shown in a study of German waste and surface waters by Scheurer et al. [87].

3.4 Surfactants

Another diverse group of chemicals viz. Surfactants (surface-active agents) which is structurally divided into two parts: first, a polar, water-soluble head and second, a nonpolar hydrocarbon tail, insoluble in water. Surfactants have higher solubility and cleaning abilities due to which they has occupied higher rank amongst the detergents and other cleaning substances [50]. A large amount of surfactants are used in various industries as well as household purpose in daily basis resulting in dispersion of them into soil, water, sediment etc. Surfactants have been classified, depending upon the charge on the head group, into cationic, anionic, nonionic and amphoteric.

Here, the most common and oldest type of surfactant is the anionic surfactants which are normally found in detergents or common soaps. Quaternary ammonium compounds (QAC) is the most commonly used cationic surfactants. They are primarily used in hair conditioners, fabric softeners and detergents. The best studied amphoteric surfactants are amine oxides (AOs). At very beginning, these were functioned as alternatives to fatty alkanolamides as foam boosters in dishwashing [16]. AOs are also used in textile industry, in rubber industry, and in deodorant bars as anti-static agents, as foam stabilisers and polymerisation catalysts and antibacterial agents respectively [94]. Nonionic surfactants are mostly used in various biotechnological processes and in facilitating solubilisation as well as increasing the carrier stability of the drug [21].

4 Conclusions

Pollutant in water is a most important topic to discuss since long back years because it is directly linked with health of the ecosystem including human beings. In current situation due to uncontrolled urbanization, industrialization and unmanaged activities, a diverse group of pollutant has been entered in our water resources. People are aware about conventional pollutant like Fluoride, Nitrate and trace metals and metalloids because their desirable and permissible standard limit are known and also the causative effects on ecosystem and human health are also well described in the literature. Since last ten years due to advancement in instrumentations techniques and detection limit researchers have discovered different types of new contaminants (emerging contaminants) in water resources which are unknown to our society. Although these emerging contaminants are measurable in different types of samples, even at present they are not usually monitored, due to the comparatively high charge of analysis and the inadequate number of experts. Scientists are trying to discover another new emerging contaminants and generating a huge number of data but very few knowledge about their fate and transport in water and their effects on organisms making it more complex. Hence regular surveys and monitoring of water resources and waste water resources should be carried out to acquire an understandable picture of these conventional and emerging contaminants. Actually we know that prevention is better than cure hence public awareness program should be initiated to alert the population about these traditional and emerging type of contaminants and their sources so that people will think about it and make some changes in their lifestyle.

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