**A review on perfluoroalkyl acids (PFAAs) studies: environmental behaviors, toxic effects, and ecological and health risks**

**Wenxiu Liu, Jingyi Wu, Wei He, Fuliu Xu\***

*MOE Laboratory for Earth Surface Processes, College of Urban & Environmental Sciences, Peking University, Beijing 100871, China*

*\* Corresponding author. Tel./Fax +86 10 62756122. E-mai:* [*xufl@urban.pku.edu.cn*](mailto:xufl@urban.pku.edu.cn)

The supplementary material with three pages includes the following one table:

Table S1 The occurence of PFAAs in the global environmental media

**Table S1 The occurence of PFAAs in the global environmental media (value: minimum~maxmum (mean) or mean** ± **standard deviation; unit: air: pg/m3; water, ng/L; sediment, ng/g, dry weight; biota: ng/g wet weight)**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Location** | **Media** | **PFOA** | **PFOS** | **PFAAs** | **Reference** |
| Hazelrigg, UK | air particle | 101~552 | <44.5 | 574 | Barber et al., 2007 |
| Manchester, UK | air particle | 15.7~341 | 46 | 414 | Barber et al., 2007 |
| Tromso, Norway | air particle | 4.4 | <47.4 | 5 | Barber et al., 2007 |
| Mace Head, Ireland | air particle | 8.9 | <1.8 | 18 | Barber et al., 2007 |
| Hamburg, Germany | air particle | 0.3 ± 0.4 | 1.3± 2.5 | 2.5 | Dreyer et al., 2009 |
| Washington Park Lake， USA | air particle | 0.76~4.19(2.03) | 0.35~1.16(0.64) | 2.05~6.04(4.03) | Kim et al., 2007 |
| Washington Park Lake， USA | gas phase | 1.89~6.53(3.16) | 0.94~3.0(1.70) | 5.10~11.6(7.29) | Kim et al., 2007 |
| Shenzhen | gas phase | 5.4 ± 3.8 | 3.1 ± 1.2 | 15±8.7 | Liu et al., 2015 |
| Lake Chaohu, China | Gas//particle | 38.23 | 4.44 | 105.12 | Liu et al., 2018 |
| Urban area, Tianjin | deposition | 11.4 | 1.44 | 44.2 | Yao et al., 2016 |
| Rural area, Tianjin | deposition | 5.44 | 5.38 | 26.5 | Yao et al., 2016 |
| Tennessee River, USA | water | <25~598 | 16.8~144 |  | Hansen et al., 2002 |
| Upper Mississippi River, USA | water | 1.14-23.8(5.85) | 1.3-245(43.92) | 4.79-369.36(51.55) | Nakayama et al., 2010 |
| Superior Lake | water | 0.24~1.2(0.65) | 0.1~0.4(0.25) | 1.14~5.25(3.21) | Silva et al., 2011 |
| Huron Lake | water | 0.66~4.72(3.22) | 0.24~5.46(2.25) | 3.26~19.17(12.51) | Silva et al., 2011 |
| Ganges River, India | water | 0.39 | 0.54 | 10.86 | Sharma et al., 2016 |
| Yamuna River, India | water | 0.09 | 1.81 |  | Yeung et al., 2009 |
| River Elbe, Germany | water | 2.6~9.7 | 0.2~3.2 |  | Ahrens et al., 2009 |
| Danube River, EU | water | 20 | 8 | 31 | Loos et al., 2010 |
| River Po, Italy | water | 2~337 | 2~12 | 5~348 | Loos et al., 2008 |
| Svitava Rivers, Czech Republic | water | 8.1~9.1 | 9.5~12 | 28.2 | Kovarova et al., 2012 |
| Svratka Rivers, Czech Republic | water | 1.7~3.1 | 0.6~0.65 | 4.4 | Kovarova et al., 2012 |
| Llobregat River,  Spain 2002-2005 | water | <4.2-130 | 1.1-11,120 |  | Flores et al., 2013 |
| Llobregat River,  Spain 2008-2012 | water | 4.9-44 (15) | 20-348 (104) |  | Flores et al., 2013 |
| Jucar River, Spain | water | (0.07~52.2) 4.36 | (0.01~128) 11.29 | (21.1~1140)91.8 | Campo et al., 2016 |
| València, Spain | water | 0.99~120.2(49.5) | 0.94~58.1(14.2) | 0.99~120(77.7) | Pico et al., 2012 |
| Kamo River, Japan | water | 36 | 4.1 |  | Senthilkumar et al., 2007 |
| Uji River, Japan | water | 100~110 | 8.7~10 |  | Senthilkumar et al., 2007 |
| Chao Phraya River, Thailand | water | 4.7 | 1.9 |  | Kunacheva et al., 2009 |
| Bangpakong River, Thailand | water | 0.7 | 0.7 |  | Kunacheva et al., 2009 |
| Tokyo Bay | water | 61.67±425.47 | 10.86±17.21 | 154.37 | Zushi et al., 2011 |
| Lake Victoria, Kenya | water | <0.4~96.4 | <0.4~13.23 |  | Orata et al., 2009 |
| Orge River, France | water | 9.4 ± 0.6 | 17.4 ± 2.2 | 73 ± 4.6 | Labadie et al., 2011 |
| Pearl River (Guangzhou) | water | 0.85~13 | 0.9~99 | 31±37 | So et al., 2007 |
| Yangtze River (Shanghai) | water | 2.0~260 | <0.01~14 | 120±147 | So et al., 2007 |
| Xiaoqing River (Beijing) | water | 7.85 | 1.75 |  | Zhao et al., 2007 |
| Xiaoqing River (Shandong) | water | 1919.23~4534.41 | 0.73~3.28 | 2140.68~5068.97  (3455.78) | Wang et al., 2014 |
| Yellow River (Shandong) | water | 0.96~4.15 | 0.95~5.37 | 7.75~21.63(13.21) | Wang et al., 2014 |
| Taihu Lake | water | 2.15~73.85(28.19) | <0.5~10.48(3.53) | 10.03~119.81(56.86) | Guo et al., 2015 |
| Tangxun Lake | water | 70.5~1390(372) | 73.4~1650(357) | 4570~11890(9850) | Zhou et al., 2013 |
| Nansi Lake | water | 34.9~84.6 | 0.49~1.79 | 38.4~91.4(67.05) | Cao et al., 2015 |
| Dianchi Lake | water | 3.4–35.44 | 1.71–40.90 | 35.76~135.88 | Zhang et al., 2012 |
| Lake Chaohu | water | 7.55±4.07 | 0.21±0.45 | 16.09±9.78 | Liu et al., 2015 |
| Conasauga River, USA | sediment | 0.06-1.97(0.73) | 1.73-20.18(9.72) | 0.29-39.2(16.22) | Lasier et al., 2011 |
| Savannah River, USA | sediment | ND-0.2 | 0.3–0.8 | 0.5-3.6 | Kumar et al., 2009 |
| Superior Lake | sediment | 0.0~0.3(0.1) | 0.1~0.2(0.1) | 0.0~10.5(1.5) | Coding et al., 2018 |
| Huron Lake | sediment | 0.1~3.0(0.5) | 0.1~2.5(0.9) | 0.0~26.0(3.1) | Coding et al., 2018 |
| Jucar River, Spain | sediment | (0.15~6.69) 1.32 | (0.06~9.83)1.71 | (14.3~75.9) 21.8 | Campo et al., 2016 |
| Ariake Sea, Japan | sediment | 0.09-0.14 | 0.84-1.1 | 1.5 | Nakata et al., 2006 |
| Kamo River | sediment | 1.6 | <1.9 | 2.54 | Senthilkumar et al., 2007 |
| Uji River | sediment | 1.3~3.9 | <1.4 | 4.75 | Senthilkumar et al., 2007 |
| València, Spain | sediment | 0.03~10.9(3.19) | 0.1~4.8(1.79) | 0.25~17.4(6.22) | Pico et al., 2012 |
| Orge River, France | sediment | 0.07 | 4.3 ± 0.3 | 8.4 ± 0.5 | Labadie et al., 2011 |
| River Elbe, Germany | sediment | 0.007~0.43(0.093) | 0.023~5.4(0.5) | 0.056~7.5(1.0) | Zhao et al., 2015 |
| Huangpu River, Shanghai | sediment | 0.20~0.64(0.43) | nd~0.42(0.11) | 0.25-1.10(0.71) | Bao et al., 2010 |
| Pearl River, Guangzhou | sediment | 0.09~0.29(0.21) | nd~3.1(0.58) | 0.09-3.60(0.87) | Bao et al., 2010 |
| Tangxun Lake | sediment | 0.48~6.35(2.35) | 10.9~623(74.4) | 41.8~800(151) | Zhou et al., 2013 |
| Taihu Lake | sediment | nd~0.85(0.13) | 0.13~6.95(0.92) | 1.11~8.21(2.42) | Guo et al., 2015 |
| Nansi Lake | sediment | 0.11~0.44 | 0.17~0.83 | 0.47~1.81(1.09) | Cao et al., 2015 |
| Dianchi Lake | sediment | ND-0.71 | 0.07–0.83 | 0.21~2.45 | Zhang et al., 2012 |
| Lake Chaohu | sediment | 0.10±0.03 | 0.09±0.05 | 10.64±0.23 | Liu et al., 2018 |
| Carp, upper Mississipi River | mussle | <0.2-4 | 4.3~19(9.9) | 5.6~24(12) | Ye et al., 2008 |
| Lake Trout, Lake Ontario | mussle | - | 40.41~67.58(51.95) | 43.13~82.87(58.58) | Gewurtz et al., 2012 |
| European chub, France | mussle | <0.1–0.2(0.1) | 24-75(45) | 37-101(64) | Labadie et al., 2011 |
| Crucian carp, Haihe River | mussle | <0.1-0.19 | 0.58-9.14 | 1.09-17.77 | Pan et al., 2011 |
| Market fish, Guangzhou | mussle | - | 2.93 | 3.28 | Gulkowska et al., 2006 |
| Crucian carp, Pearl River | mussle | <LOD | 5.3±5.6 | 6.33 | pan et al., 2014 |
| Mongolian culter, Taihu Lake | mussle | 4.91 | 94.9 | 165 | fang et al., 2014 |
| Fish and shrimp, Lake Chaohu | mussle | 0.22±0.16 | 4.57±4.57 | 12.71±9.21 | Liu et al., 2018 |