OCCURRENCE OF ANTIBIOTICS IN RIVER WATER - A CASE STUDY OF THE VRISHABHAVATHI RIVER NEAR BANGALORE, INDIA

Iyanee FS[1], Shimamura K[2,3], Prabhasankar VP[1], Taniyasu S[2], Tsuruta M[2,3], Balakrishna K[1], Yamashita N[2], Guruge KS[4], Akiba M[4], Joshua DI[1], Kannan K[5]

[1] Dept. of Civil Engineering, Manipal Institute of Technology, Manipal University, Manipal-576104, India; [2] National Institute of Advanced Industrial Science and Technology (AIST), 16-1 Onogawa, Tsukuba, Ibaraki 305-859, Japan; [3] Department of Chemical Science and Technology, Faculty of Bioscience and Applied Chemistry, Hosei University, Japan; [4] National Institute of Animal Health, Kannondai 3-1-5, Tsukuba, Ibaraki 305-0856, Japan; [5] Wadsworth Center, New York State Department of Health and Department of Environmental Health Sciences, State University of New York at Albany, New York, USA

Introduction

Pharmaceutical and Personal Care Products (PPCPs) are raising environmental concern because of their widespread usage, ubiquitous presence and potential for adverse health effects. Some PPCPs remain bioactive in the environment and cause toxicological impacts on non-target organisms [1, 2]. The major sources of PPCPs in the environment are from human and veterinary applications, waste water treatment plants, and residential and commercial areas [3-6]. The concern is that antibiotics can cause many potential risks such as genotoxicity, endocrine disruption, development of drug resistance, and alterations in aquatic ecology[7]. Various studies in the USA, China and the continental Europe have been carried out on the presence and fate of pharmaceuticals in the aquatic environment but there are little or no studies carried out in the Indian sub-continent on the same. Therefore, the aim of this study is to detect the presence of antibiotics in the Vrishabhavathi River in Southern India (Figure-1). In this study, four antibiotics- Sulfamethaxozole [SMX], Trimethoprim [TMP], Erythromycin [ERY] and Chloramphenicol [CAP] were selected for the analysis. The selection was based on a small survey conducted in and around the study area and also the capabilities of the laboratory to analyse the selected antibiotics**.**

Study area

The Vrishabhavathi River, a tertiary tributary of River Kaveri was chosen as the study area as it is one of the most polluted rivers of Karnataka (Figure-1). It is encompassed between 12^0 45^l to 13^0 03^l North latitudes and $77^0 23^l$ to $77^0 35^l$ East longitudes. It drains a major part of the metropolis, Bangalore, and carries effluents generated from the industrial belts and thickly populated residential areas of Bangalore and Ramanagaram districts in Southern India.

Material and methods

Water samples were collected in August (monsoon) and November (post-monsoon) 2012, from five sampling points along the stretch of Vrishabhavathi River, two sampling points at the downstream of Kaveri River and one sampling point after Vrishabhavathi River's confluence with Kaveri River (referred as mixing point)in order to know the variation in the concentration of antibiotics. The sampling points are shown in Figure-1. Grab samples were collected in 250ml clean polypropylene bottles. The collected samples were refrigerated at 4^0C and then transported to the laboratory within 36 hours. In the present study, totally 16 samples were analysed (including both monsoon and post-monsoon). Water samples were extracted using Oasis® HLB cartridges following the methods published[8,9] with a slight modification that is the concentrated sample extracts (0.5ml) were reconstituted (to 1ml) with 25% of methanol instead of water. The target analytes were separated by Agilent HP1100 liquid chromatograph which was interfaced with a triple quadrupole tandem mass spectrometer equipped with a Turbo IonSpray source operated in both positive and negative modes. A Betasil C18 column with 2mM ammonium acetate and methanol as mobile phase were used for the quantification of the target analytes. The limits of quantification for each compound ranged between 0.02-0.5 ng/l. The procedural recoveries ranged from 70 to 100% for SMX, TMP and CAP and 60% for ERY.

Results and discussion

This study is the first study in India which is aimed at detecting the presence of selected antibiotics in the River water. The selected antibiotics-SMX, TMP, ERY and CAP were found in all the 16 water samples collected in both monsoon and post-monsoon seasons. It was observed that the concentration of antibiotics increased from upstream to the downstream side for both River Vrishabhavathi and River Kaveri in the monsoon and post-monsoon seasons. Among the selected antibiotics, SMX was found to be the most predominant. The maximum concentration of SMX reached 900ng/l in monsoon and 155ng/l in post-monsoon season respectively.

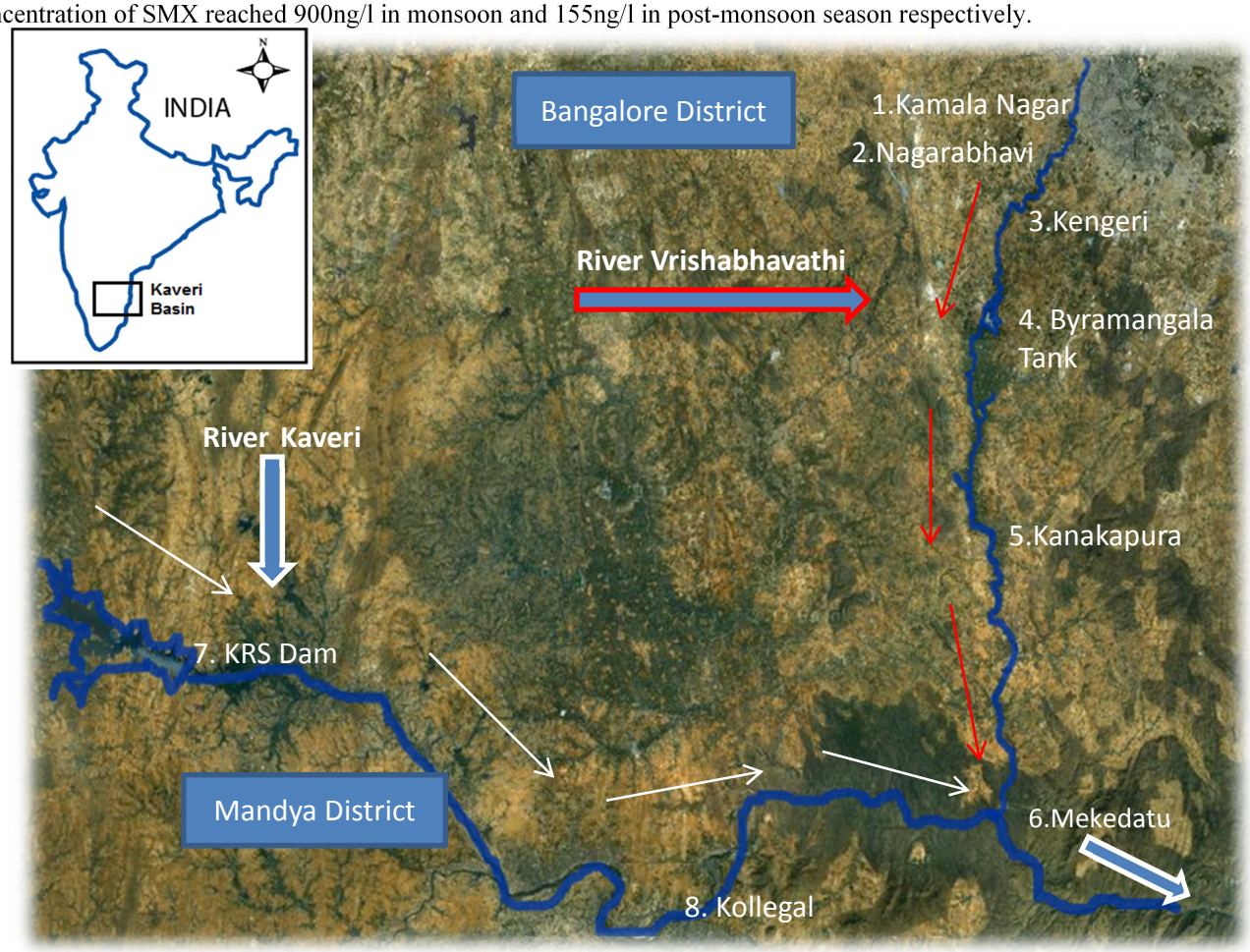

Figure-1 : Sampling locations (Source : Google)

.

Byramangala tank had the maximum concentration of SMX and ERY in both the seasons. This reservoir is located in rural area surrounded by huge agricultural fields and also has lot of livestock rearing. SMX is widely used in human and veterinary applications[10], which could be the reason for its high concentration.

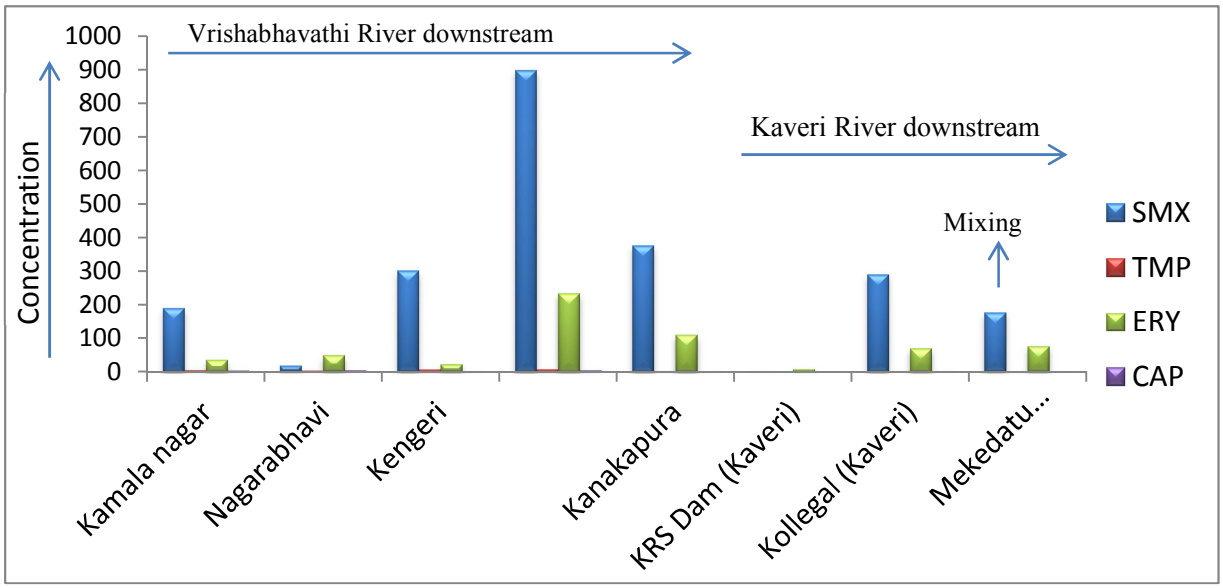

Figure-2: Concentration of selected antibiotics in River Vrishabhavathi and River Kaveri in monsoon season.

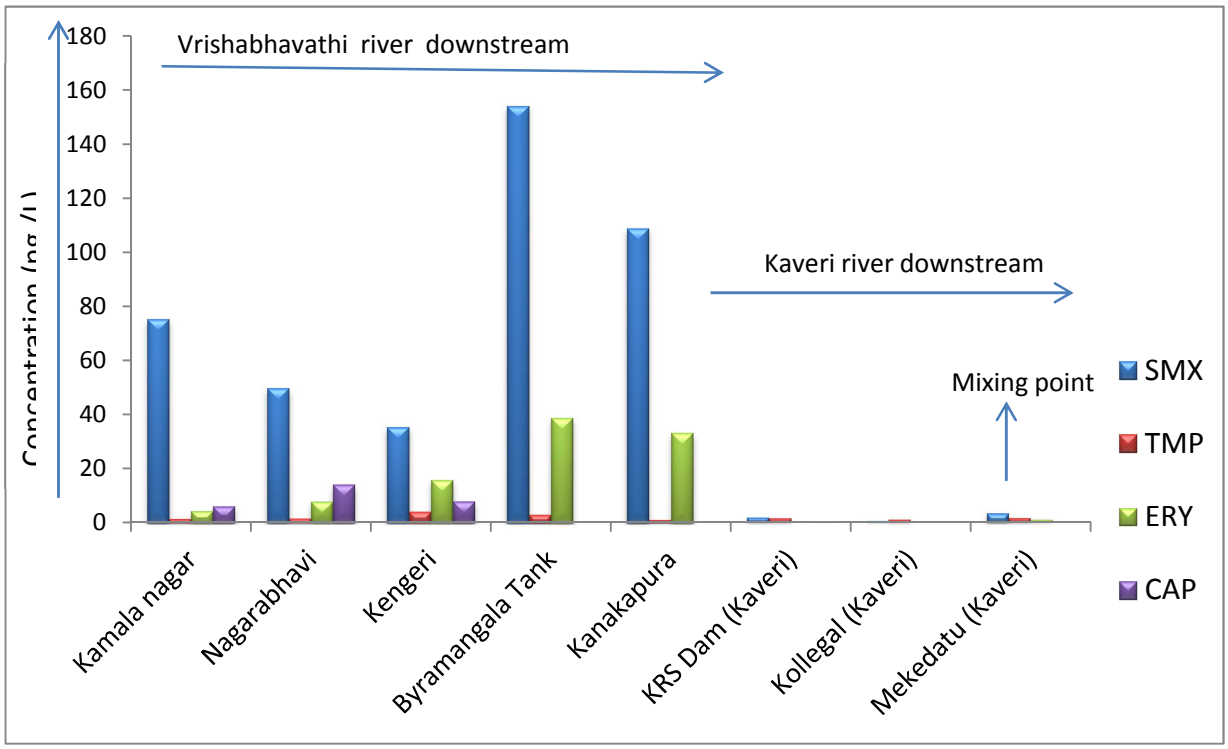

Figure-3: Concentration of selected antibiotics in River Vrishabhavathi and River Kaveri in post-monsoon season.

ERY was found at high concentrations compared to TMP and CAP in both the seasons and reached maximum concentrations of 210ng/l and 40ng/l in Byramangala tank. ERY has been found upto 0.7µg/l in German and US surface waters[11,12] and 1µg/l in UK rivers[13].

The downstream of River Kaveri is polluted mainly due to the agricultural run-off and the entry of treated/untreated domestic and industrial effluents at Kollegal. The concentration of antibiotics is more at the mixing point in the monsoon season SMX- 160ng/l and ERY-50ng/l and less than 5ng/l in the post-monsoon season for the downstream of River Kaveri and the mixing point.

The concentration of antibiotics was high in monsoon season compared to post-monsoon season. One of the reasons could be the increase of large amount of agricultural run-offs from the surrounding areas into the rivers in the monsoon.

The concentrations of selected antibiotics were high in Vrishabhavathi River compared River Kaveri. The concentration of SMX is higher compared to studies done in other countries. This might be due to the excessive usage of SMX in the study area. Frequent sampling should be done in order to know the trend of antibiotic pollution in this study area. This data set can be used as a base-line data for further studies to be carried out
Regarding the treatment of PPCP polluted waters, literature suggests that photolysis may be more effective than hydrolysis, sorption to sediments and biodegradation in the elimination of antibiotics in the natural aquatic environments[14-16].Hydrolysis and sorption to sediments is of minor importance for the elimination of SMX[17]. In addition to this the high levels of suspended sediments and the synthetic substances released in the aquatic environment may also influence the photolysis of antibiotics.

Acknowledgments

This study was partly supported by KAKENHI (project no.240629 and 24256004) of the Japan Society for the Promotion of Science (JSPS). Analytical facilties were provided at the Department of Civil Engineering, Manipal Institute of Technology, Manipal, National Institute of Advanced Industrial Science and Technology (AIST), Tsukuba, Japan and National Institute of Animal Health (NIAH), Tsukuba, Japan. We thank to Prof. Murano (Hosei University) for his kind support.

References

1. Bendz David , Pax´eus Nicklas A, Ginn Timothy R , Loge Frank J.. (2005); *J Hazard Mater.* 122, 195–204
2. Boxall ABA, Blackwell P, Cavallo R, Kay P, Tolls J. (2002); *Toxicol Lett.*131:19–28
3. Guardabassi L, Petersen A, Olsen JE, Dalsgaar A.(1998); *Appl. Environ Microbiol*. 64(9):499–502.
4. Guiliani F, Koller T, Wurgler FE, Widmer RM.(1996); *Mutat Res*. 368: 49–57
5.Hartmann A, Alder A, Koller T, Widmer R.(1998); *Environ Toxicol Chem*.17(3): 77–82
6. Brown Kathryn D, Kulis Jerzy, Thomson Bruce, Chapman Timothy H, Mawhinney Douglas B. (2006); *Sci Total Environ.* 366(2): 772–783
7.Daughton CG, Ternes TA. (1999); *Environ Health Perspect* 107: 907–938
8.Gulkowska A, He Y, So MK, Yeung LWY, Leung HW, Giesy JP, Lam PKS, Martin M, Richardson BJ. (2007); *Mar. Pollut. Bull.*,54(8): 1287–1293
9.Gulkowska A, Leung HW, So MK, Taniyasu S, Yamashita N, Yeung LWY,
Richardson Bruce J, Lei AP, Giesy JP, Lam PKS.(2008); *Water Research*.42:395–403
10.Mookherjee S, Shoen C, Cynamon M.(2012); *Antimicrob. Agents Chemother*. 56(2):1133-1134
11. Hirsch R, Ternes T, Haberer K., Kratz K.L. (1999); *Sci Total Environ.* 225:109–18
12.Kolpin DW, Furlong ET, Meyer MT, Thurman EM, Zaugg SD, Barber LB et al.(2002); *Environ Sci Technol* .36: 1202– 11
13.Richardson ML, Bowron JM.(1985); *J Pharm Pharmacol*.37:1–12
14. Boreen A L, Arnold W A, McNeill K. (2003); *Aquat. sci*. 65(4): 320-341
15. Trovó A G, Nogueira R F P, Agüera, A, Sirtori C, Fernández-Alba A R.(2009);*Chemosphere*.77(10):1292-1298
16. Homem V, Santos L.(2011); *J. Environ. Manage*. 92(10): 2304-2347
17. Radke M, Lauwigi C, Heinkele G, Murdter T E, Letzel M.(2009); *Environ. Sci. Technol.* 43(9): 3135-3141