Heavy metals and radon content in spring water of Kosovo

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Table 1A Municipalities and measuring sites: Zvečan: 1. Zvečan, Gvozdićka česma; 2. Rudare, Sokolica; 3. Grabovac; Leposavić: 4. Lokvice; 5. Koporije; 6. Kijevčiće; 7. Popovce; 8. Ravnine; 9. Jevtiće; Novo Brdo: 10. Nova Kolonija; 11. Vlasce; 12. Trnićevce; 13. Vlajkovci; 14. Utmanovci; 15. Reka.

| No of sample | As (μg/L) | Cd (μg/L) | Cr (μg/L) | Cu (μg/L) | Fe (μg/L) | Mn (μg/L) | Ni (μg/L) | Pb (μg/L) | Zn (μg/L) |
|--------------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|-----------|
| **Zvečan**   |           |           |           |           |           |           |           |           |           |
| 1            | 0.4110    | 0.4930    | 11.48     | 2.178     | 7.210     | 0.4869    | 6.605     | 1.999     | 1.684     |
| %RSD         | 187.1     | 2.178     | 1.660     | 20.03     | 8.411     | 0.9185    | 20.84     | 1.065     |
| 2            | 1.451     | 0.4795    | 1.985     | 1.115     | 1.398     | 0.4688    | 0.8491    | 32.82     | 13.76     |
| %RSD         | 110.4     | 8.583     | 9.999     | 7.349     | 7.730     | 11.37     | 61.19     | 2.792     |
| 3            | 1.174     | 0.4372    | 0.0196    | 1.071     | 0.8895    | 0.5562    | 0.7274    | 41.72     | 2.214     |
| %RSD         | 50.96     | 14.04     | 201.70    | 23.88     | 42.12     | 11.32     | 31.94     | 293.1     | 3.468     |
| **Leposavić**|           |           |           |           |           |           |           |           |           |
| 4            | 2.459     | 0.5055    | 0.1954    | 1.305     | 0.5686    | 0.3901    | 38.19     | 1.003     | 6.006     |
| %RSD         | 28.88     | 1.651     | 181.0     | 3.798     | 27.07     | 6.334     | 0.7048    | 40.07     | 1.102     |
| 5            | 1.669     | 0.4815    | 0.7282    | 1.280     | 57.99     | 1.914     | 0.6804    | 0.8275    | 1.397     |
| %RSD         | 14.42     | 2.846     | 30.94     | 24.02     | 2.139     | 1.277     | 14.01     | 31.82     | 1.113     |
| 6            | 33.74     | 0.4987    | 12.47     | 0.9094    | 3.465     | 0.5222    | 1.688     | 1.447     | 0.7431    |
| %RSD         | 2.967     | 8.509     | 2.103     | 29.64     | 99.50     | 13.92     | 1.189     | 32.98     | 1.774     |
| 7            | 1.608     | 0.0848    | 0.5375    | 17.14     | 255.9     | 4.237     | 0.2793    | 0.2906    | 3.581     |
| %RSD         | 52.94     | 18.26     | 48.32     | 2.829     | 0.4389    | 0.9651    | 110.3     | 1.474     | 1.474     |
| 8            | -0.3224   | 0.8984    | 0.6582    | 1.807     | 8.376     | 0.4449    | 0.8568    | 0.9376    | -0.027    |
| %RSD         | 491.1     | 113.2     | 49.37     | 66.25     | 3.906     | 27.03     | 102.6     | 6.726     | 2.914     |
| 9            | -0.9755   | 0.3999    | 4.289     | 0.4440    | 3.714     | 2.255     | 1.344     | 8.781     | -1.286    |
| %RSD         | 90.85     | 85.64     | 8.081     | 97.13     | 9.714     | 1.887     | 28.18     | 18.42     | 20.26     |
| **Novo Brdo**|           |           |           |           |           |           |           |           |           |
| 10           | 8.596     | 0.4879    | 3.384     | 0.5673    | 50.16     | 3.919     | 0.8167    | 0.1330    | 122.3     |
| %RSD         | 13.44     | 2.804     | 75.72     | 38.26     | 3.617     | 9.220     | 27.62     | 403.1     | 0.1866    |
| 11           | 0.1135    | 0.0194    | 0.7529    | 0.8143    | 0.9023    | 1.707     | 0.6636    | -1.610    | 2.190     |
| %RSD         | 806.0     | 245.1     | 297.9     | 7.695     | 135.0     | 65.53     | 21.05     | 28.07     | 3.212     |
| 12           | 1.965     | 0.0219    | 5.559     | 0.4707    | 1.294     | 0.8542    | 0.2599    | -0.7592   | 0.4167    |
| %RSD         | 46.83     | 244.9     | 57.33     | 109.7     | 190.0     | 57.32     | 99.09     | 123.1     | 5.456     |
| 13           | 2.650     | 0.0064    | 6.887     | 0.1333    | 0.7822    | 1.161     | 0.1332    | -0.7318   | 0.5184    |
| %RSD         | 47.04     | 689.4     | 30.10     | 207.2     | 334.6     | 145.8     | 174.9     | 61.98     | 8.618     |
| Measuring sites | As     | Cd     | Cr     | Cu     | Fe     | Mn     | Ni     | Pb     | Zn     |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| **Zvečan**      |        |        |        |        |        |        |        |        |        |
| 1               | 1.09E-05 | 1.3E-05 | 0.000304 | 5.76e-05 | 0.000191 | 1.29E-05 | 0.000175 | 5.28E-05 | 4.45E-05 |
| 2               | 3.84E-05 | 1.27E-05 | 5.25E-05 | 2.95E-05 | 3.7E-05 | 1.24E-05 | 2.24E-05 | 2.48E-05 | 0.000364 |
| 3               | 3.1E-05  | 1.16E-05 | 5.18E-07 | 2.83E-05 | 2.35E-05 | 1.47E-05 | 1.92E-05 | 7.68E-06 | 5.85E-05 |
| **Leposavić**   |        |        |        |        |        |        |        |        |        |
| 4               | 6.5E-05  | 1.34E-05 | 5.17E-06 | 3.45E-05 | 1.5E-05  | 1.03E-05 | 0.00101 | 2.65E-05 | 0.000159 |
| 5               | 4.41E-05 | 1.27E-05 | 1.93E-05 | 3.38E-05 | 0.001333 | 5.06E-05 | 1.8E-05  | 2.19E-05 | 3.69E-05 |
| 6               | 0.000892 | 1.32E-05 | 0.00033  | 2.4E-05  | 9.16E-05 | 1.38E-05 | 4.46E-05 | 3.83E-05 | 1.96E-05 |
| 7               | 4.25E-05 | 2.24E-06 | 1.42E-05 | 0.000453 | 0.006765 | 0.000112 | 7.38E-06 | 0.001103 | 9.47E-05 |
| 8               | 0       | 2.38E-05 | 1.74E-05 | 4.78E-05 | 0.000221 | 0.4449  | 2.27E-05 | 0.000868 | 0       |
| 9               | 0       | 1.06E-05 | 0.000113 | 1.17E-05 | 9.82E-05 | 5.96E-05 | 3.55E-05 | 0.000232 | 0       |
| **Novo Brdo**   |        |        |        |        |        |        |        |        |        |
| 10              | 0.000227 | 1.29E-05 | 8.95E-05 | 1.5E-05  | 0.001326 | 0.000104 | 2.16E-05 | 3.52E-06 | 0.003233 |
| 11              | 3E-06   | 5.13E-07 | 1.99E-05 | 2.15E-05 | 2.39E-05 | 4.51E-05 | 1.75E-05 | 0       | 5.79E-05 |
| 12              | 5.19E-05 | 5.79E-07 | 0.000147 | 1.24E-05 | 3.42E-05 | 2.26E-05 | 6.87E-06 | 0       | 1.1E-05  |
| 13              | 7.01E-05 | 1.69E-07 | 0.000182 | 3.52E-06 | 2.07E-05 | 3.07E-05 | 3.52E-06 | 0       | 1.37E-05 |
| 14              | 0.000124 | 1.86E-06 | 0.000164 | 2.49E-05 | 1.06E-05 | 4.22E-05 | 8.98E-06 | 0.000176 | 8.4E-05  |
| 15              | 5.64E-05 | 8.38E-07 | 0.000168 | 0       | 0.000144 | 3.61E-05 | 7.05E-06 | 0       | 8.2E-08  |

### Table 2A UORAL values for 9 heavy metals in natural spring water from 15 measuring sites (mg/kg/day)

### Table 3A NKORAL values for 9 heavy metals in natural spring water from 15 measuring sites (non-dimensional value)

| Measuring sites | As     | Cd     | Cr     | Cu     | Fe     | Mn     | Ni     | Pb     | Zn     |
|-----------------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| **Zvečan**      |        |        |        |        |        |        |        |        |        |
| 1               | 0.036219 | 0.026067 | 0.101168 | 0.011516 | 0.000272 | 9.19E-05 | 0.008731 | 0.0151  | 0.000148 |
| 2               | 0.127869 | 0.025354 | 0.017493 | 0.005896 | 5.28E-05 | 8.58E-05 | 0.001122 | 0.007082 | 0.001213 |
| 3               | 0.103459 | 0.023117 | 0.001173 | 0.005663 | 3.36E-05 | 0.000105 | 0.000962 | 0.002195 | 0.000195 |
| **Leposavić**   |        |        |        |        |        |        |        |        |        |
| 4               | 0.216699 | 0.026728 | 0.001222 | 0.0069  | 2.15E-05 | 7.37E-05 | 0.050482 | 0.007576 | 0.000529 |
| 5               | 0.147081 | 0.025459 | 0.006471 | 0.006786 | 0.00219  | 0.01361 | 0.000809 | 0.006251 | 0.000123 |
| 6               | 2.973338 | 0.026369 | 0.109892 | 0.004080 | 0.000131 | 9.86E-05 | 0.002231 | 0.01093  | 6.55E-05 |
| 7               | 0.141705 | 0.004484 | 0.004737 | 0.090629 | 0.009665 | 0.000800 | 0.003069 | 0.31535  | 0.000316 |
| 8               | 0       | 0.047603 | 0.0058  | 0.009555 | 0.000316 | 1.18E-05 | 0.001333 | 0.247908 | 0       |
| 9               | 0       | 0.021145 | 0.037797 | 0.002342 | 0.00014 | 0.000426 | 0.001777 | 0.066328 | 0       |
| Measuring sites | As     | Pb     | Cr     | Cd     | Ni     |
|-----------------|--------|--------|--------|--------|--------|
| Zvečan          |        |        |        |        |        |
| 1               | 1.63E-05 | 4.49E-07 | 1.24E-05 | 7.95E-08 | 1.47E-07 |
| 2               | 5.75E-05 | 2.11E-07 | 2.15E-06 | 7.73E-08 | 1.89E-08 |
| 3               | 4.66E-05 | 6.53E-08 | 2.12E-08 | 7.05E-08 | 1.62E-08 |
| Leposavić       |        |        |        |        |        |
| 4               | 9.75E-05 | 2.25E-07 | 2.12E-07 | 8.15E-08 | 8.48E-07 |
| 5               | 6.62E-05 | 1.86E-07 | 7.89E-07 | 7.77E-08 | 1.51E-08 |
| 6               | 0.001338 | 3.25E-07 | 1.35E-05 | 8.04E-08 | 3.75E-08 |
| 7               | 6.38E-05 | 9.38E-06 | 5.83E-07 | 1.37E-08 | 6.2E-09 |
| 8               | 0       | 7.38E-06 | 7.13E-07 | 1.45E-07 | 1.9E-08 |
| 9               | 0       | 1.97E-06 | 4.65E-06 | 6.45E-08 | 2.98E-08 |
| Novo Brdo       |        |        |        |        |        |
| 10              | 0.000341 | 2.99E-08 | 3.67E-06 | 7.87E-08 | 1.81E-08 |
| 11              | 4.5E-06  | 0       | 8.16E-07 | 3.13E-09 | 1.47E-08 |
| 12              | 7.79E-05 | 0       | 6.03E-06 | 3.53E-09 | 5.77E-09 |
| 13              | 0.000105 | 0       | 7.47E-06 | 1.03E-09 | 2.96E-09 |
| 14              | 0.000186 | 1.49E-06 | 6.71E-06 | 1.13E-08 | 7.54E-09 |
| 15              | 8.46E-05 | 0       | 6.89E-06 | 5.11E-09 | 5.92E-09 |
Table 5A: Summed-up radon Rn-222 measurement results in the samples of natural spring waters collected at the investigated measuring sites

| No of sample | T (°C) | $C_{corr}$ (Bq/l) | $E_{	ext{ing}}$ (µSv/y) | $E_{	ext{inh}}$ (µSv/y) |
|--------------|--------|-------------------|--------------------------|--------------------------|
| **Zvečan**   |        |                   |                          |                          |
| 1            | 15     | 33±3              | 240±24                   | 91.8±8                   |
| 2            | 16     | 46±5              | 340±30                   | 129.6±14                 |
| 3            | 14     | 27.6±2.8          | 190±20                   | 77.2±7.8                 |
| **Leposavić**|        |                   |                          |                          |
| 4            | 16     | 22.7±2.3          | 160±16                   | 63.6±6.4                 |
| 5            | 15     | 30±3              | 220±22                   | 83.9±8.4                 |
| 6            | 17     | 13.8±1.4          | 100±10                   | 38.7±3.9                 |
| 7            | 16     | 1.6±0.5           | 10±3                     | 4.4±1.4                  |
| 8            | 15     | 0.34±0.12         | 2.0±0.7                  | 0.9±0.3                  |
| 9            | 16     | 0.91±0.15         | 6.0±1.0                  | 2.5±0.4                  |
| **Novo Brdo**|        |                   |                          |                          |
| 10           | 16     | 5.1±0.5           | 37±3                     | 11.1±1.4                 |
| 11           | 11.5   | 341±35            | 2500±260                 | 954±98                   |
| 12           | 11     | 3.9±0.4           | 28.0±2.9                 | 10.9±1.1                 |
| 13           | 15.5   | 3.4±0.4           | 24.0±2.8                 | 9.4±1.1                  |
| 14           | 12     | 15.1±0.9          | 110±6                    | 42.3±2.5                 |
| 15           | 13.5   | 2.3±0.4           | 16.0±2.8                 | 6.4±1.1                  |
| **Min**      | 11     | 0.34±0.12         | 2.0                      | 0.9                      |
| **Mean**     | 14.6   | 36.44             | 260                      | 101.8                    |
| **Max**      | 17     | 340.7±35          | 2500                     | 954                      |