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Measuring current state of radioactivity of air, water and soil in the city of Novi Grad, Republic of Srpska

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Subject of this survey is measuring of background artificial and natural radioactivity of air, water and soil in the city of Novi Grad, Republic of Srpska. This is a first step of environmental monitoring of this area before opening of the nuclear waste material disposal nearby in Trgovinska gora in Croatia. Trgovinska gora is located not more than half kilometre beeline from the city of Novi Grad. Previous underground military ammunition repository is turned into nuclear waste disposal nearby natural border (river Una) between Croatia and Republic of Srpska. In order to be able to measure potential leakage of nuclear waste outside of disposal, content of natural and artificial radionuclides (^{226}Ra, ^{232}Th, ^{40}K, ^{238}U, ^{235}U, ^{137}Cs, ^{210}Pb, ^{90}Sr, ^{3}H) in different matrices (soil, water and sediment) were determined. Also, ^{222}Rn in the soil and air as well as gamma dose rates were measured. Measuring places were chosen upstream and two downstream in the city.

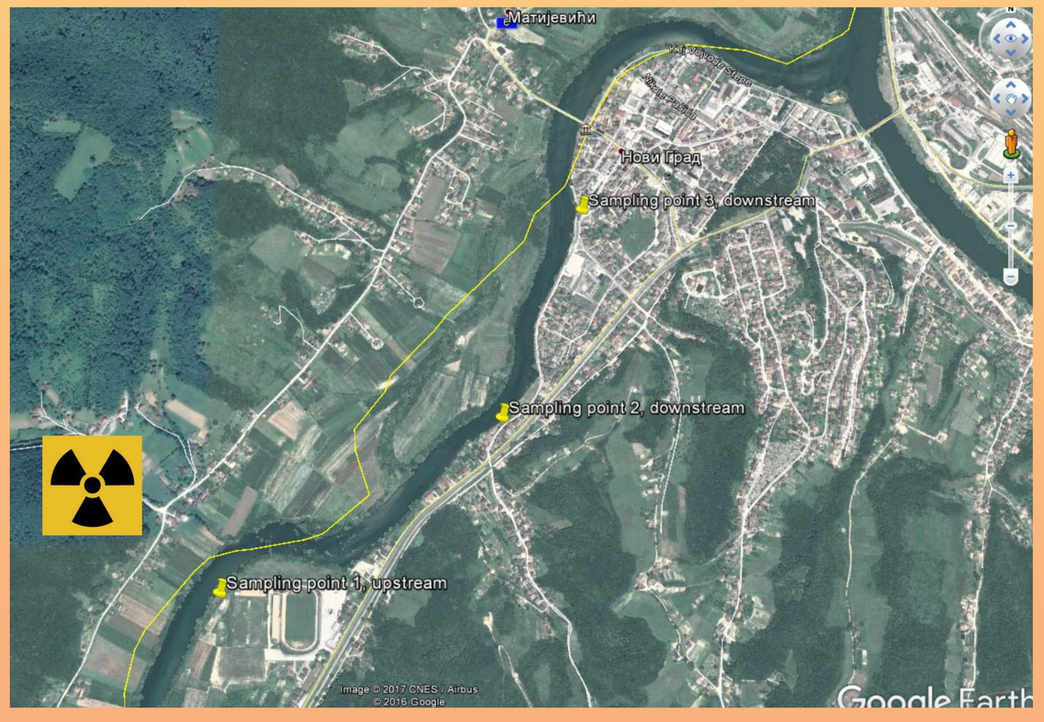

Figure 1. Google Earth map of sampling places.

Radon gas in the soil was measured in a depth of 80 cm at three locations as a the ambient dose equivalent was measured in the same location:

1. A_{Rn}= 27.3 kBq m^{-3}, GPS: 45.0380898 16.3613930;
ambient dose 0.18 μSv h^{-1}.
2. A_{Rn}=1.7 kBq m^{-3}, GPS: 45.0417023 16.3696728;
ambient dose 0.16 μSv h^{-1}.
3. A_{Rn}=54.7 kBq m^{-3}, GPS: 45.0468674 16.3728867;
ambient dose 0.16 μSv h^{-1}.

Preparation of soil and sediment samples for gamma spectrometry analysis included drying at 105 °C, and sieving and for ^{90}Sr determination included mineralization at 500 °C. In all samples radioactive equilibrium was established. Analysis of water samples for gamma spectrometry analysis and determination of ^{90}Sr included evaporation of about 20 l until 200 ml. Determination of ^{3}H in water samples consist of distllation and electrolytic enrichment.

Figure 2. Measuring instrumentation: gamma spectrometer, proportional counter for ^{90}Sr and Quantulus.

Gamma spectrometry analysis were performed on the HPGe detector (Canberra), the relative efficiencies of 18%, 20% and 50%. The resolution of the detector was 1.8 keV at energy of 1332 keV.
For the determination of the contents of ^{90}Sr gas proportional counter Thermo Eberlin FHT 770 T with efficiency of beta radiation 35% and 26% of the alpha radiation, was performed. Measurement time is 3600 s.
Determination of ^{3}H, is carried out on a liquid scintillation spectrometer Quantulus 1220, whose efficiency is 27.5%.
The measurement results of all the analyzes are provided with an expanded measurement uncertainty by a factor of k = 2 (2σ), which for a normal distribution corresponding to the level of confidence of 95%.

The obtained results for radioactivity measurements are the same order of magnitude as concentration of radionuclides in world literature. Nevertheless, this is an important basis for the further radioactivity monitoring of this "potentially exposed area".

References:

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) 2000, Report to the General Assembly, with scientific annexes, Annex C, Exposures to the public from man-made sources of radiation.

Table 1. Measured activity of natural and artificial radionuclides ^{226}Ra, ^{232}Th, ^{40}K, ^{238}U, ^{235}U, ^{137}Cs, ^{210}Pb, ^{90}Sr, ^{3}H.

Sample description	^{226}Ra [Bq kg^{-1}]	^{232}Th [Bq kg^{-1}]	^{40}K [Bq kg^{-1}]	^{238}U [Bq kg^{-1}]	^{235}U [Bq kg^{-1}]	^{137}Cs [Bq kg^{-1}]	^{210}Pb [Bq kg^{-1}]	^{90}Sr [Bq kg^{-1}]
Soil 1, (control sample)	21 ± 2	18 ± 2	190 ± 10	26 ± 2	1.6 ± 0.2	25 ± 2	60 ± 10	
Sediment 1	26 ± 2	17 ± 2	190 ± 10	24 ± 6	1.1 ± 0.1	0.4 ± 0.1	36 ± 9	< 0.57
Soil 2	37 ± 3	30 ± 2	490 ± 30	46 ± 5	2.4 ± 0.2	22 ± 2	68 ± 6	1.63 ± 0.35
Sediment 2	12.1 ± 0.9	10 ± 1	116 ± 8	21 ± 6	0.9 ± 0.1	5.0 ± 0.4	38 ± 9	0.75 ± 0.22
Soil 3	15 ± 1	12 ± 1	121 ± 9	17 ± 3	1.1 ± 0.1	5.3 ± 0,5	55 ± 5	
Sediment 3	31 ± 3	24 ± 2	330 ± 20	35 ± 4	1.9 ± 0.2	31 ± 2	46 ± 5	

Sample description	^{226}Ra [Bq L^{-1}]	^{232}Th [Bq L^{-1}]	^{40}K [Bq L^{-1}]	^{238}U [Bq L^{-1}]	^{235}U [Bq L^{-1}]	^{137}Cs [Bq L^{-1}]	^{210}Pb [Bq L^{-1}]	^{90}Sr [Bq L^{-1}]	^{3}H [Bq L^{-1}]
Water 1, river Una	< 0.02	< 0.01	< 0.05	< 0.09	< 0.004	< 0.004	< 0.1	< 0.007	1.56 ± 0.30
Water 2, well	< 0.02	< 0.01	0.11 ± 0.03	<0.09	< 0.004	<0.004	< 0.1	< 0.005	1.56 ± 0.30
Water 3, water supply	< 0.02	< 0.01	0.15 ± 0.03	< 0.09	< 0.004	< 0.004	< 0.1	< 0.007	1.94 ± 0.40
Water 4, Una beach	< 0.02	< 0.01	< 0.05	< 0.09	< 0.004	< 0.004	< 0.1	< 0.006	1.68 ± 0.40