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FIRST RESULTS OF RADON MONITORING PROGRAM IN SLOVENIA ACCORDING TO EU EURATOM DIRECTIVE

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Abstract: In 2018 Slovenia adopted the new ordinance where the requirements of the Council of the European Union 2013/59 Euratom on radon were taken into account (2LIT). As the new ordinance requires systematic survey of radon concentrations in public institutions and dwellings in Slovenia, Ministry of Health announced two tenders for the radon surveys in 2018 and 2019. Zavod za varstvo pri delu (ZVD) successfully competed on both tenders. The tenders required measurements of radon concentrations in public institutions, mainly schools and kindergartens and in private dwellings every year in 24 municipalities which were recognised as radon prone areas. Besides these measurements ZVD as the authorised organisation measured radon concentration in companies all over Slovenia and private dwellings where owners wanted to know how high the radon concentration is and if some actions are required to lower it. The radon concentrations were measured with track etched detectors. The results of the survey are presented in the article as well as the difficulties we encountered during sending track etched detectors to people.

Keywords: Radon, radon concentration, radon prone areas, track etched detectors, dwellings, school.

1. INTRODUCTION

In years 2018 and 2019 ZVD performed radon concentration measurements in Slovenia according to legislation in EU and Slovenia. All together approximately 2400 measurements were done. The radon concentrations were mainly measured in 24 municipalities in Slovenia which were recognised as radon prone areas from previous measurements. The radon concentrations were measured with track etched detectors. The results of the survey in the last two years are presented in the article as well as the difficulties we encountered during sending track etched detectors to people.

2. RADON PRONE AREAS IN SLOVENIA

In the last 20 years many measurements of radon concentrations in Slovenia were done [1,2]. Slovenian Radiation Protection Administration at Ministry of Health financed a study where authors reviewed all the radon concentration measurements in buildings and radon examination measurements in Slovenia in the last 20 years (3LIT). The geological composition with Ra-226 concentration in soil and stone was also taken into the account. In the study authors propose three radon areas in Slovenia: areas where radon concentrations in buildings are expected to be high, the area where radon concentration in buildings are expected to be elevated and areas where radon concentration in buildings are expected to be low. In the ordinance on National Radon Programme Slovenia adopted in 2018 (4LIT) (called also “radon ordinance”) 24 municipalities are recognized as areas with possible high radon concentrations in buildings, 27 municipalities are recognized as areas where radon concentration above 300 Bq/m^3 were measured in buildings (elevated concentration) in the past. The classification of radon areas is debatable, someone would include more areas, even other areas but in the end we have what we have (Figure 1). After 5 years of measurements in these areas the evaluation will be done and the map of radon prone areas in Slovenia might be changed.

In the radon ordinance it is required that living and working environment is systematically surveyed in schools, kindergartens and hospitals as well as in other buildings on radon prone areas. At least 50

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schools, kindergartens or hospitals and at least 100 homes must be measured every year. Measurements are financed by the Ministry of Health.

Besides measurements that are financed by the Ministry of Health employers on radon prone areas must ensure radon concentration measurements if they have buildings on radon prone areas. Measurements must be done in basement and ground floor.

In addition to measurements funded by the Ministry of Health, employers in radon-prone areas must provide radon concentration measurements if they are building in radon-prone areas. Measurements must be made in basements and ground floors.

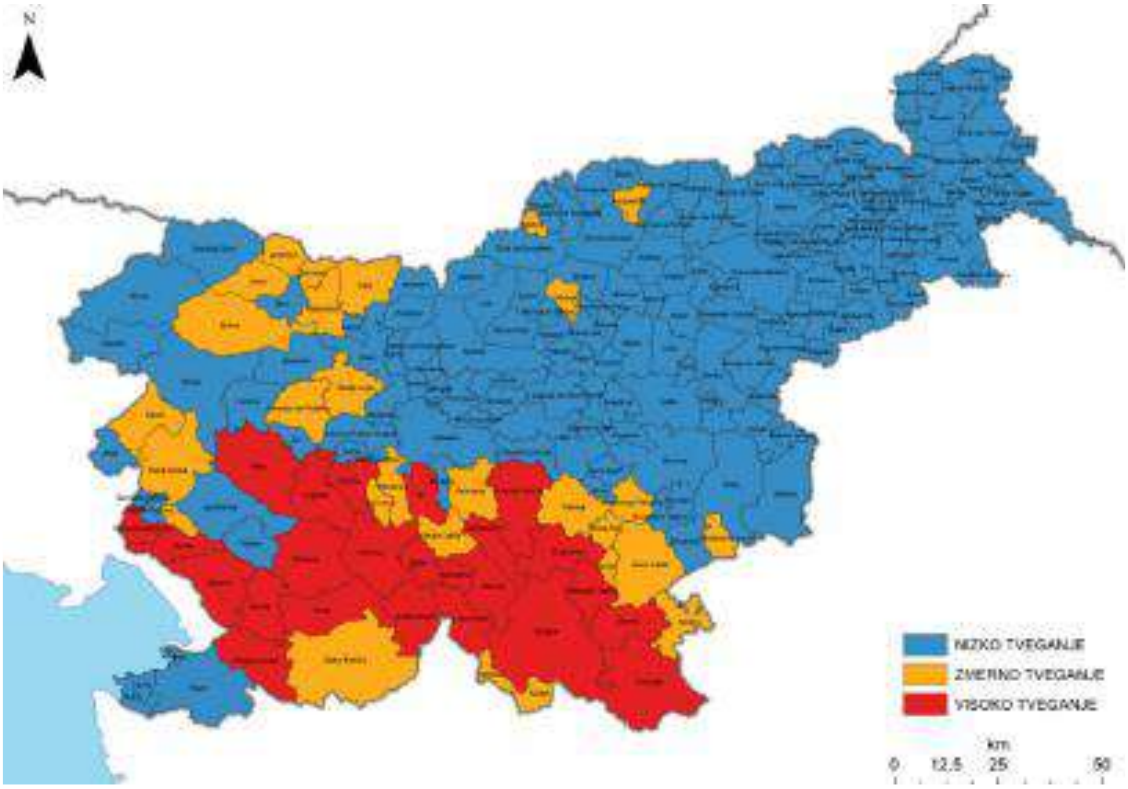

Figure 1. Map of radon prone areas in Slovenia. Red colour: high risk, orange colour: medium risk, blue colour – low risk. Map is taken from [3]

3. MEASURING CAMPAIGN

In 2018 and 2019 ZVD won two tenders issued by Ministry of Health for radon concentration measurement. The Ministry of Health defined all the buildings and rooms where the measurements must be done.

First project was measurements of radon concentration in schools, kindergartens and hospital. It was very easy to call schools or kindergartens since the responsible person was contacted in advance by Ministry of Health. Our main concern was to send track etched detectors on time and check if they are properly put in place.

The second project were measurements of radon concentration in private homes on radon prone areas with track etched detectors.

The intention of both projects in 2018 was to measure radon concentration in 12 municipalities with high radon risk. The 12 municipalities were chosen from the 24 municipalities recognized in the radon ordinance. The first idea was to find 40 private homes in each of 12 municipalities, send track etched detectors to owners and after 2–3 months of exposure owners return detectors which are then analysed. In order to find 40 owners of private homes in each municipality we decided to start with people our workers know from personal relations (relatives), previous measurements (teachers in schools) or workers that are working with ionizing radiation and are involved in personal dosimetry. Soon it became clear that we will not be able to find 40 names in every municipality. Therefore, we decided to advertise free radon measurements in local media, we launched internet page with short and clear explanation of the project, we called mayors of every municipality and offered radon measurements for free. In some municipalities

mayors were clearly against radon measurements since they just foreseen problems in case of measured high concentration. The connected high results with actions they should do to lower the radon concentration. No explanation helped to change their conviction. We spent a lot of time on telephones, we visited municipalities and explained the project and measurements to local people. Despite all the efforts it was clear that in the first year of measuring campaign (2018) we will not be able to find 40 private homes in every municipality. There was also the problem that some municipalities are small compared to others (Table 1) and 40 locations mean more than 10% of all the homes in some municipalities while in the others it is less than 1%. Due to difficulties in getting measurement locations we informed Ministry of Health and it was agreed that we can expand measurement to all 24 municipalities and that it does not matter if we get exactly 40 locations. It was agreed that we should follow the local situations. But we were obliged to accept that the total number of locations should be 480 as requested in the project in 2018. With that solution we were able to continue with the project and found the desired number of locations for measurements (Table 1). We can conclude that out of all the detectors that were sent, at least 10% have been lost due to different reasons. The most common cause of losing the detectors is that people just forgot to return them, some of them did not even put the detectors in place.

Table 1. Radon prone municipalities in Slovenia and numbers of residents in these municipalities. The first 12 locations chosen in 2018 where measurements should have been done are in bold text. The number of measurements done in private dwellings in 2018 and 2019 and the number of measurements with radon concentration above 300 Bq/m^3 are in the last two columns.

Municipality	Number of residents	Number of measuring locations (private houses)	Number of locations with Rn concentration above 300 Bq/m^3
Bloke	1529	10	5
Cerknica	11.502	55	39
Črnomelj	14.293	36	20
Divača	**4.093**	60	16
Dobrepolje	**3.847**	15	9
Dolenjske Toplice	**3.471**	59	29
Hrpelje - Kozina	4.426	22	8
Idrija	11.730	108	49
Ig	7.441	13	9
Ivančna Gorica	16.611	26	11
Kočevje	**15.681**	151	70
Komen	**3.523**	43	15
Logatec	14.048	39	17
Loška dolina	**3.739**	18	6
Loški Potok	**1.830**	36	18
Miren - Kostanjevica	**4.885**	29	5
Pivka	**6.112**	35	13
Postojna	16.120	64	29
Ribnica	9.424	50	34
Semič	**3.766**	48	15
Sežana	**13.287**	127	53
Sodražica	2.187	7	2
Vrhnika	17.071	61	18
Žužemberk	**4.631**	29	10

Since we saw that it is quite difficult to get owners of private dwellings for radon concentration measurements, we started a big advertisement campaign for free radon measurement in 2019. We informed all public media (TVs, newspapers, internet media) in Slovenia about free of charge radon concentration measurement. After the short interview on national TV an interest for the measurements increased rapidly and in next 14 days more than 2000 owners of private dwellings wanted to measure radon concentration for free. We were surprised by the interest. Since Ministry of Heath payed only 480 measurements due to project we decided to do app. 1000 measurements, i.e. more than 500 at our own cost since we had a feeling that we are obliged to do measurements due to media campaign we started. After we reached the quota of 1000 measurements some people decided to pay by themselves the cost for the measurements. Some companies also decided to do measurements. The number of measurements in private dwellings and the number of measurements with radon concentration above 300 Bq/m^3 is also presented in Table 1. It can be seen that in radon prone areas (red area on Figure 1) 1141 measurements in private dwelling were done and in 500 (44%) radon concentration exceeds 300 Bq/m^3. Some preventive or remediation actions should be done in these dwelling in the future. Since these actions are to be paid by the owner in very rare cases some actions are done to lower the radon concentration.

If we take into the account all the measurements we performed in 2018 and 2019 we can see that people in some municipalities are more aware of radon risk and participated in larger number in radon concentration measurements (Figure 2).

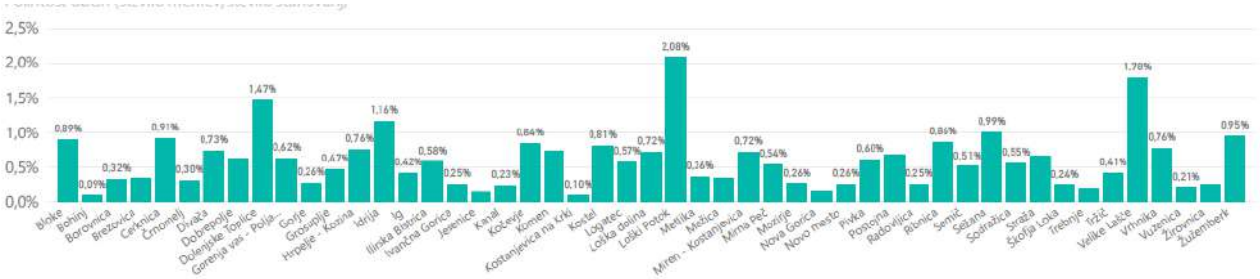

Figure 2. The % of all the dwelling in municipalities where radon concentration measurements were done relative to number of all dwelling in the municipality.

4. RESULTS

All together 2808 measurements in private dwellings, companies, schools, kindergartens and hospitals in 2018 and 2019 with track etched detectors which were exposed usually for two to three months have been realized. The frequency of measurements is shown in Figure 3.

About 1/3 of measurements are below 100 Bq/m^3 what is low for Slovenia. The results of about 30% of measured concentrations were above 300 Bq/m^3. The average measured radon concentration was 440 ± 70 Bq/m^3. This is a quite high value but we must take into consideration that the majority the measurements were taken in radon prone areas. The median value for the measurements is 181 Bq/m^3.

The locations where radon concentration measurements were done are shown on Figure 4.

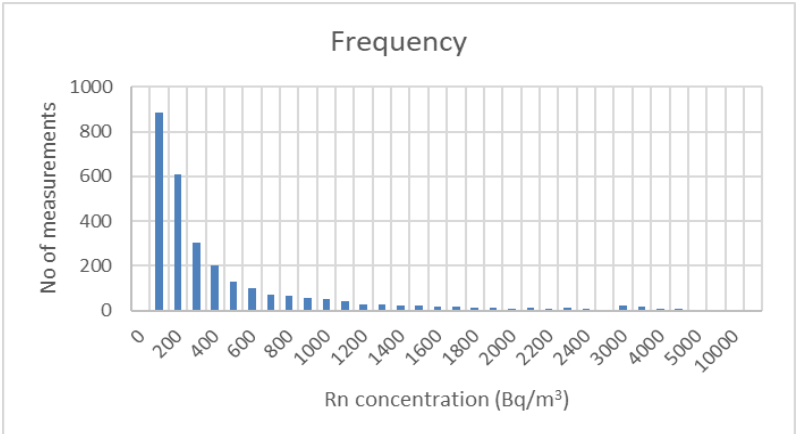

Figure 3. Number of measurements of radon concentrations in concentration intervals

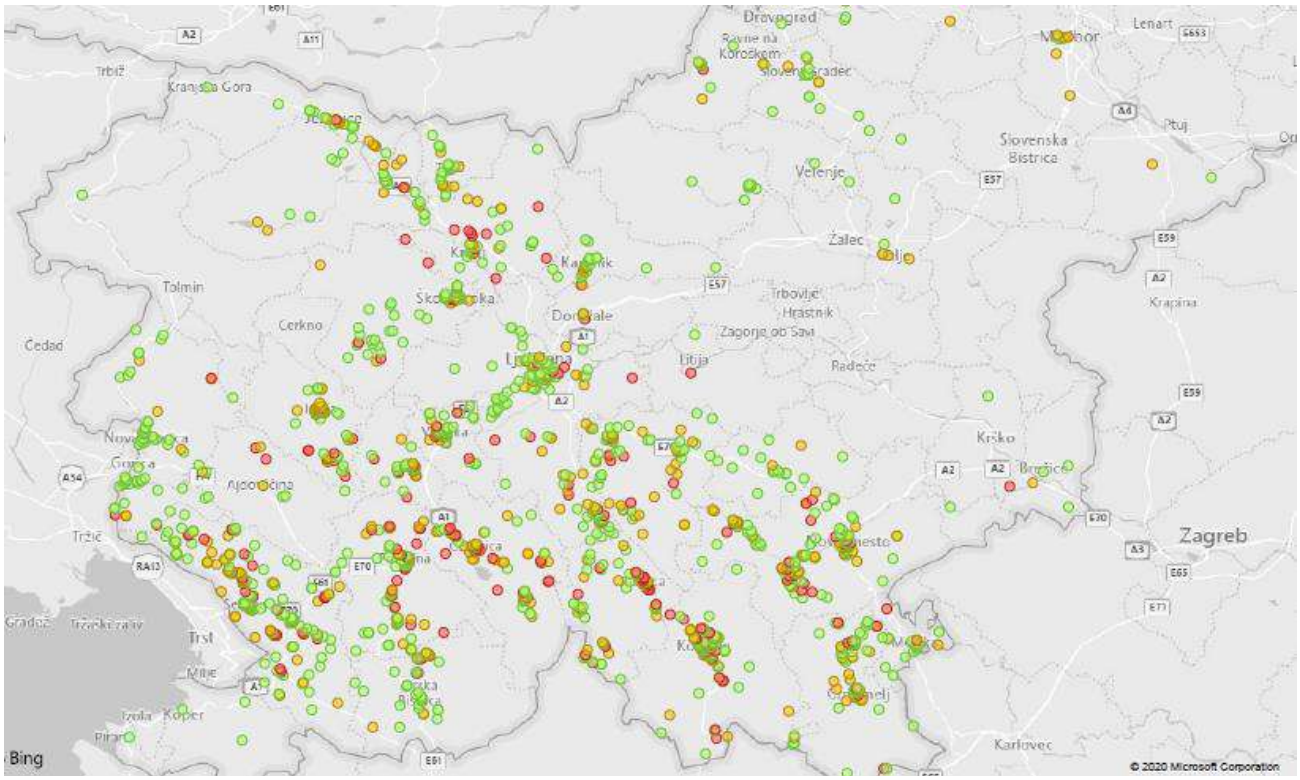

Figure 4. The measurement locations of radon concentrations. Green colour: radon concentration < 300 Bq/m^3, yellow colour: 300 Bq/m^3 < radon concentration < 1000 Bq/m^3, red colour: radon concentration > 1000 Bq/m^3

From the measurement results we can see that some municipalities have higher radon concentrations. Average radon concentrations in municipalities are shown on Figure 6.

Due to results we can also conclude that radon prone areas are not equal, and in some municipalities higher concentrations are expected. Among those municipalities are Idrija, Cerknica, Žužemberk and Ribnica (Figure 6). We would say that inner Slovenia has a higher risk due to radon exposure than coastal Slovenia in general.

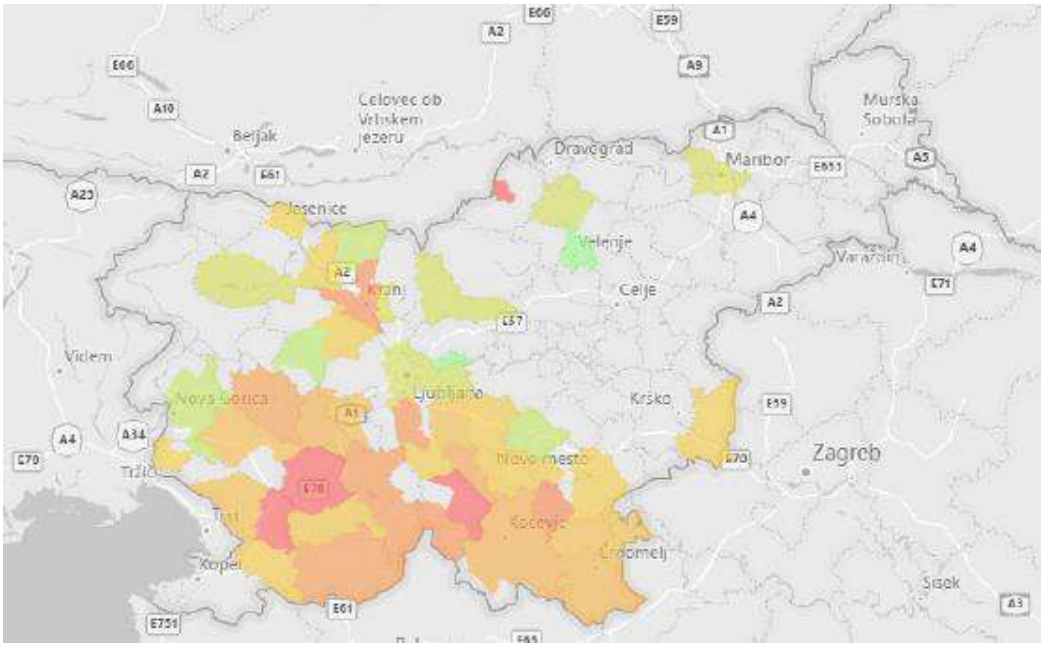

Figure 5. The average radon concentration in Slovenian municipalities: green colour: radon concentration < 300 Bq/m^3, shade of yellow colour: 300 Bq/m^3 < radon concentration < 1000 Bq/m^3, red colour: radon concentration > 1000 Bq/m^3

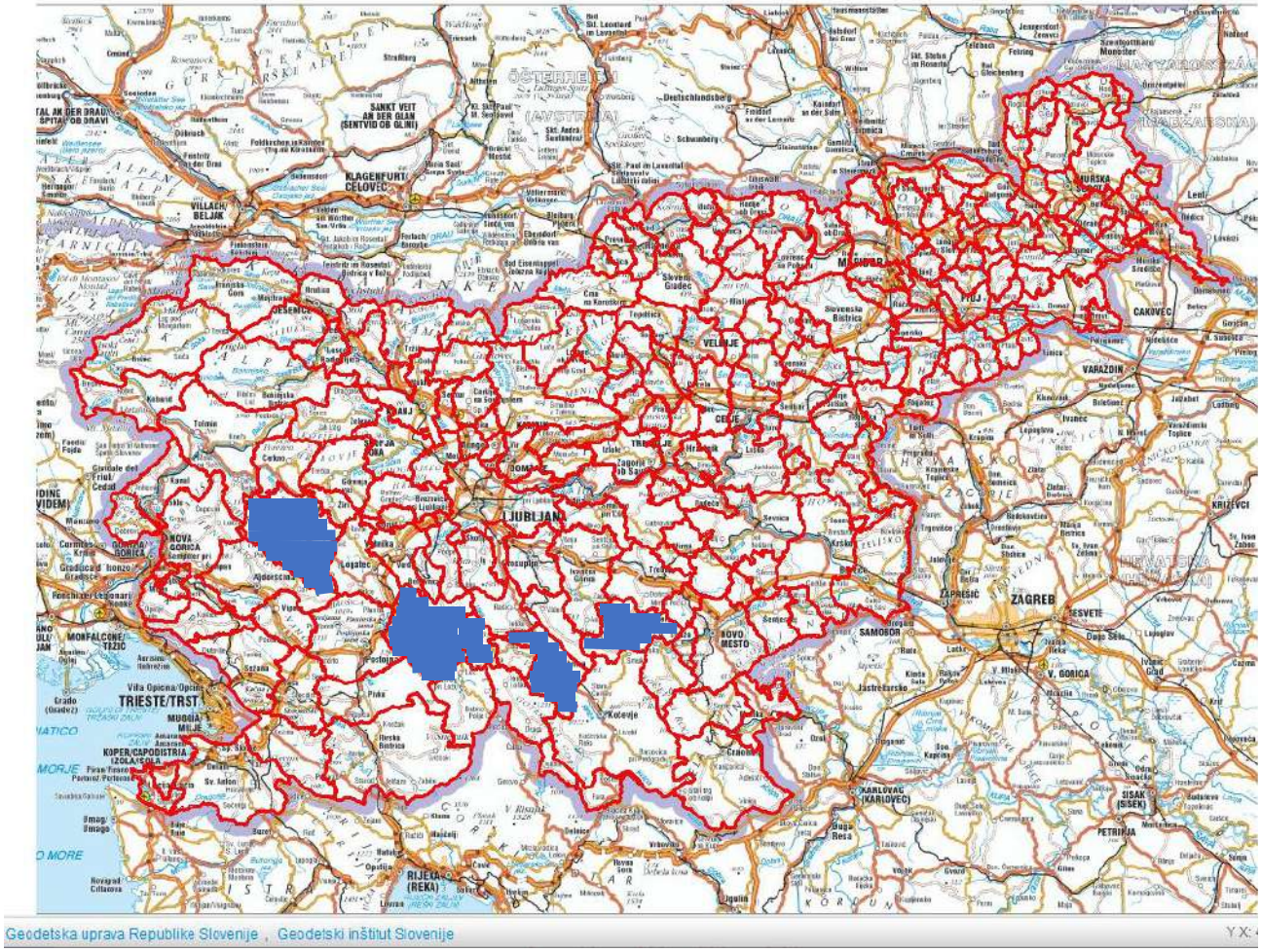

Figure 6. The map of municipalities with highest number of houses with indoor radon concentration well above 300 Bq/m^3. The map of Slovenia is from geopedia.si.

The highest radon concentration 12 300 ± 1 800 Bq/m^3 was measured in Ilirska Bistrica municipality but the result must be taken with care since the detector was located in the cave under the sleeping room.

The next location with a very high radon concentration 5361 ± 383 Bq/m^3 was measured in Idrija a in living room. There was also one location in Kočevje and one in Loški potok with radon concentrations above 5000 Bq/m^3. Due to very high concentrations measured we were interested if people living in these houses are aware of radon risk. They were not aware and are not worried. If we calculate doses to the inhabitants in these houses we would get more than 200 mSv per year. Unfortunately, no further action was taken in these houses up to now. Since we informed people on high radon concentrations they are interested in additional measurements in other rooms.

5. CONCLUSION

In 2018 and 2019 ZVD made approximately 2400 measurements of radon concentrations in private houses in Slovenia. In total app. 2700 track etched detectors were sent to the locations (private homes and companies) and the return rate was 85%. The measurements were done in the frame of new EU Directive and requirements in radon ordinance adopted in 2018 in Slovenia. Measurements were mainly performed in 24 municipalities declared as radon risk areas. In 30% of measurements radon concentrations were found to be above reference level of 300 Bq/m^3, in radon prone areas almost 45% of the results is above 300 Bq/m^3. People living in these houses were informed on high radon risk and basic information were given how to lower radon concentration. To our knowledge people did not undertake any action to lower radon concentration in

their houses. It is obvious that measurements only are not enough to solve problems associated with radon risk for the population

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6. LITERATURE

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ПРВИ РЕЗУЛТАТИ ПРОГРАМА МОНИТОРИНГА РАДОНА У СЛОВЕНИЈИ ПРЕМА ДИРЕКТИВИ ЕУ ЕУРАТОМ

Сажетак: Словенија је 2018. године усвојила нови правилник, гдје су узети у обзир захтјеви Вијећа Европске уније 2013/59 Еуратом о радону. Како нови правилник захтијева системско истраживање концентрација радона у јавним установама и становима у Словенији, Министарство здравља објавило је два тендера за радонска истраживања у 2018. и 2019. години. ЗВД Завод за варство при делу (ЗВД) успјешно се такмичио на оба тендера. На тендерима су била потребна мјерења концентрације радона у јавним институцијама, углавном школама и вртићима и приватним становима, сваке године у 24 општине које су препознате као подручја која су подложна радону. Поред ових мјерења, ЗВД је као овлашћена организација мјерио концентрацију радона у компанијама широм Словеније и приватним становима гдје су власници жељели знати која је концентрација радона и јесу ли потребне неке радње за његово спуштање. Концентрације радона мјерене су детекторима. У чланку су представљени резултати анкете као и потешкоће на које смо наилазили приликом слања детектора људима.

Кључне ријечи: радон, концентрација радона, подручја склона радону, детектори, станови, школа.

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