

THE SPATIAL AND URBAN PLANNING CONCERNS RELATED TO NUCLEAR FACILITIES LOCATIONS Case Study of the Vinča Institute Location

by

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The spatial and urban planning is one of the key instruments for the planned formation and development of locations for nuclear facilities, especially in terms of meeting the strict spatial conditionality, as well as in terms of the formation of protection zones in their surroundings. This paper systemizes the international criteria and requirements for the locations of nuclear facilities and analyses the spatial distribution of nuclear facilities in the surrounding countries of the Republic of Serbia. The research was conducted on the example of the location of the Vinča Institute of Nuclear Sciences, within which the fulfilment of spatial requirements, treatment of the location in the existing spatial and urban plans and relationship between other functions in the surrounding area were analysed. The paper proves the starting hypothesis that the general requirements related to both the spatial development of nuclear facilities locations and the protection from radiation have not been met in the Vinča location and its surroundings. It was determined that the spatial and urban plans encompassing the area of Vinča do not contain sufficiently specific planning solutions and that, as such, they do not provide a sufficient planning basis for meeting the necessary requirements and obligations regarding the protection from radiation. The paper also gives recommendations for further spatial development and protection of the Vinča location and its surroundings. The research conducted in this paper indicates the importance and priority of further research so that the necessary planning solutions for further development of the complex in Vinča and for the formation of protection zones could be defined through creating a new planning documentation. In addition, the paper particularly highlights the need for conducting a research to identify a location for permanent disposal of radioactive waste. It also indicates the necessity of considering the aspects of environmental protection and protection from radiation in the national and international context.

Key words: nuclear facility, spatial planning, urban planning, location, planning solution, environment, protection, safety

INTRODUCTION

The process of spatial and urban planning is an activity of general interest. In a narrower sense, it includes the drawing up of several types of spatial and urban plans. The detailed analyses are performed and data on all functions and activities in space are collected for the need of drawing up the plans aimed at harmonizing needs and interests to the greatest possible extent [1]. The theory and practice in planning seek to align different aspects of development, whereby greater accent is put on issues of environmental protection and assessment of effects of the planning solutions on the quality of the environment in future [2]. In

this context, the nuclear facilities are of specific importance in planning, both because of certain conditions necessary for their operation and because of the impact they have or can have on the environment and the surrounding area [3].

Besides considering the general requirements and the state of wider surrounding area, the subject paper also addresses a location of such type in the Republic of Serbia which has not so far been sufficiently investigated the problems of which have been unjustifiably marginalized.

The basic hypothesis and starting point are that the general requirements related to the spatial development of nuclear facilities and protection from radiation in the location of the Vinča Institute of Nuclear Sciences and its surroundings have not been met. At the

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same time, in spite of the obligations prescribed by the Law on Planning and Construction of the Republic of Serbia [4] and other normative documents, the spatial and urban plans encompassing the area of the Institute and its surroundings do not contain specific planning solutions and, as such, they do not provide a sufficient planning basis for meeting the necessary requirements and obligations regarding the protection from radiation.

In this paper, by location or complex, of the Vinča Institute of Nuclear Sciences we mean the entire area of the location of the former Institute, which is today divided into the zone of the Institute and the zone under the jurisdiction of the Public Company "Nuclear Facilities of Serbia".

In accordance with the Law on Ionizing Radiation Protection and Nuclear Safety [5], which defines nuclear facilities and facilities in which nuclear materials either are present or are used, including the facilities for radioactive waste storage, treatment and disposal, the nuclear facilities in this paper primarily include the research reactors RA and RB, as well as a temporary storage facility for a low- and intermediate-level radioactive waste.

The consideration and analysis of locations of nuclear facilities transcend local framework [6], thus it is necessary to consider the issue of further planning in the context of relationship between other functions in space at the regional level, *i. e.*, in the wider surroundings [7]. After all, the main issue of the protection from radiation and prevention in case of accidents is an issue of national and international character because of which any research related to nuclear facilities requires a reference to the spatial distribution and aspects of protection in the surrounding countries of the Republic of Serbia.

Considering the fact that the disposal of radioactive waste implies a set of actions and activities related to a permanent radioactive waste storage [8], the aim of this paper is to also indicate their importance and to initiate research activities to determine the location for a permanent radioactive waste storage.

SPATIAL ASPECT OF DEVELOPMENT AND PROTECTION FROM RADIATION AT NUCLEAR FACILITIES LOCATIONS

An adequate approach to the analysis and planning of locations of nuclear facilities, considerations, functioning and impacts on the surroundings implies knowledge on and implementation of a series of principles and requirements that are broadly defined by the International Atomic Energy Agency (IAEA). This institution defines several levels of the system of standards for the peaceful use of nuclear energy and reduction of radiation risks, such as nuclear safety basis, safety requirements and instructions, which are further developed through national legislative systems.

Based on the comparative analysis of a series of documents, research studies and requirements [9-11], out of which most are defined in general terms and relate to the group of nuclear facilities (to which the plants like reactors RA and RB and the temporary storage facilities for the low- and intermediate-level radioactive waste also belong), the requirements that include the spatial aspect and that are important for urban and spatial planning are the following:

(1) Geological conditions [12]

- the distance of potentially active faults and landslides should not be less than 500 m from the location,
- there should not be the possibility of occurrence of soil settlement caused by cavities formed by the pumping out of water or oil, or by mining activities,
- there should not be the possibility of soil collapsing resulting from the soil dissolution or removal of soluble material (karst erosion or other erosion types), and
- to eliminate relatively seismically active areas (allowable ground movement should not be greater than 0.15 of the earth's gravity acceleration).

(2) Hydrogeological conditions

- the direction of groundwater flow should not be towards more densely populated settlements, *i. e.* towards the larger settlements,
- the groundwater should preferably be 10 m or more beneath the land surface, with flow velocity of several meters per day,
- water for different needs, particularly for drinking and irrigation, should not be used in the vicinity of the location, especially not downstream, and
- there should not be the possibility of torrential flows in the location, nor there should be the possibility of floods caused by river overflow or due to flood embankment failure.

(3) Meteorological conditions

- no frequent temperature inversions should occur in the location. Areas with poor ventilation, such as narrow valleys, should be avoided,
- to eliminate the locations in which winds are most frequently directed towards more densely populated settlements, especially towards the larger settlements, and
- to eliminate the areas where extreme weather events occur.

(4) Requirements associated with population [13,14]

- exclusion zone, the unpopulated area within the radius of at least 150 m. In case of accidents, the evacuation should last not more than two hours,
- low-density zone "should be within the radius of not less than 1.5 km. In case of accidents, the evacuation should last not more than two hours. This zone should not contain hospitals, schools, prisons and other institutions that are difficult to evacuate, and

- “larger settlements” with the population of 25,000 and more should not be closer than 2.5 km
- (5) Conditions related to the dangerous man-made facilities
 - the distance of installations with explosives and the potential discharge of chemicals (particularly emissions of gaseous chemicals) should not be less than 2 km far from the location,
 - the distance of the existing civil and military airports should not be less than 8 km far from the location. The sufficient distance from the air corridors should also be ensured,
 - to eliminate the locations downstream from dams, and
 - the distance of roads with heavy traffic should not be less than 1.5 km from the location.
- (6) Other requirements [15-17]
 - to pay attention to the vicinity of state border and to other factors important from the military and safety aspects,
 - to provide the possibility of supervision, access safety and ensure the implementation of the anti-terrorism measures in the location,
 - to provide safe transportation of radioactive fuel and radioactive materials, and
 - to provide timely information and alarming.

The abovementioned requirements of a general type need to be considered in drawing up the spatial and urban plans, *i. e.* in locating the nuclear facilities, whereby it is necessary to develop them further and to possibly adapt them to the location specificity. The use of these requirements is of local character because they primarily relate to the formation of protection zones immediately around the locations of nuclear facilities, as well as to the prescribing of appropriate protection measures.

However, the aspects of environmental protection and protection from radiation, especially in case of assessing the environmental impacts of possible accidents at nuclear facilities, transcend the local framework and immediate surroundings. In this context, it is important to consider spatial distribution of nuclear facilities in the surrounding countries of the Republic of Serbia.

At the distance of 1500 km from the borders of Serbia, there are 40 operating nuclear power plants with about 90 reactors. In the neighbouring countries of Serbia, there are five nuclear power plants with a greater number of reactors generating a significant amount of electricity, out of which all are situated within the radius of 600 km from Belgrade, namely within the radius of 500 km from the borders of the Republic of Serbia (NPP Krsko in Slovenia, NPP Paks in Hungary with 4 reactors, NPP Kozloduy in Bulgaria with 6 reactors and NPP Belene under construction, NPP Cernavoda in Romania with 2 reactors). In this connection, it should be emphasized that NPP Paks in Hungary is situated 80 km from the Serbian-Hungar-

ian border, as well as that NPP Krsko and NPP Paks are situated very close the large rivers, upstream from the borders of Serbia (the Sava and the Danube).

The location of the Vinča Institute is the only location of nuclear facilities in Serbia, thus it is necessary to analyse it from the aspects of environmental protection and radiation protection and treat it in the spatial plan at the local level. However, the mentioned facts about the importance, number and spatial distribution of nuclear facilities (nuclear power plants) outside the borders of Serbia bring the issue of protection in the regional context given that possible accidents, regardless of their causes, can have adverse effects which go beyond the borders, as evidenced by the negative experiences with some incidents at the global level.

VINČA INSTITUTE OF NUCLEAR SCIENCES-LOCATION, FUNCTIONS AND PROBLEMS

The Vinča Institute of Nuclear Sciences was established in 1948 as a research centre for the realization of the Yugoslav nuclear programme and modelled after the West European scientific research institutes. The Institute complex covers the area of 48 ha.

The work of the Institute is oriented towards the scientific research, improvement and use of nuclear technologies. Today, the Institute is a multidisciplinary centre covering a great number of scientific and technological disciplines and engineering. The Public Company “Nuclear facilities of Serbia” is situated within the Vinča Institute complex. It was formed out of a part of the Institute. According to the provisions of the Law on Ionizing Radiation Protection and Nuclear Safety, the Public Company is authorized for maintaining the necessary level of nuclear safety, as well as for the protection of people and for the environmental protection. At the same time, the Company is responsible for meeting the prescribed requirements for locating, planning, construction, trial operation, putting into operation, use, permanent cessation of operation and decommissioning of nuclear facilities, as well as for managing the radioactive waste, implementation of measures for preventing the radioactive waste to cause environmental contamination, providing the measures for safety of nuclear facilities, radioactive materials and radioactive waste and for the systematic testing of the level of non-ionizing radiation in the environment in the vicinity of nuclear facilities.

The complex of the Institute and Public Company contains nuclear facilities of great importance regarding the impacts on the surrounding area and the implementation of necessary protection measures. They include: (1) reactor RA (10 MW), used for experiments in nuclear physics and for material testing, today out of operation; (2) zero power reactor RB, used for experiments in neutron physics and protection

from radiation, today out of operation; and (3) temporary storage facility for low- and intermediate-level radioactive waste originating from the activities of reactors and the Institute, as well as from medical and military institutions, rolling mills, university laboratories, Institute for Technology of Nuclear and Other Mineral Raw Materials, *etc.* The storage facility consists of two hangars and a solid waste treatment plant. The waste is mainly stored in barrels, but there is also different bulk waste that could not be adequately treated and packed at the time of the waste taking over. The liquid radioactive waste is stored in three reinforced concrete storage pools. The radioactive waste from the entire territory of Yugoslavia (except for the waste from NPP Krsko) is stored in this location.

The previous scientific research activities of the Institute had no significant impacts on the environment. The environmental impacts were primarily caused by the controlled and uncontrolled releases of radioactivity, mostly into the atmosphere of the surrounding area of the abovementioned facilities.

However, over time a problem of lack of permanent nuclear waste storage has become a basic problem related to the performance of the activities of the Institute. The mentioned radioactive storage facilities are only temporary facilities which lifetime has elapsed while their holding capacities have reached maximum. According to the international criteria, the existing location, which was suitable only for building the interim storage facility, is not satisfactory.

Considered in a broader spatial context, namely within the boundaries of the City Municipality of Grocka as a part of the administrative territory of the City of Belgrade, a particular specificity regarding the spatial and urban planning, as well as international impact of the Institute functions and other functions in the area, includes the spatial distribution of certain facilities and activities of regional, national and international importance in the area that is at a relatively small distance from the mentioned nuclear facilities. These facilities include (fig. 1): (1) Municipal Solid Waste Landfill "Vinča", covering the area of 68 ha, of the planned area of 130 ha, with 800.000 tons of disposed solid waste annually (with 80 % of the narrower area of Belgrade), at the distance of 2.2 km; (2) Archaeological site "Belo brdo", one of the most important Neolithic sites in Europe in which the Vinča culture developed dating back to 5000 BC, at the distance of 1.5 km; (3) Kaludjerica, the unplanned settlement with the greatest number of illegally built buildings in the surrounding area of Belgrade with incomplete infrastructure and population of 27,000 inhabitants, at the distance of 2 km from the edge of the settlement and 3.5 km from its centre; and (4) the Pan-European Corridor VII (the Danube River), at the distance of 1.8 km, Pan-European Corridor X (highway Salzburg-Ljubljana-Zagreb-Belgrade-Skopje-Thessaloniki), at the distance of 4.6 km, the planned southern by-pass highway as a part of the Pan-European Corridor X, at the distance of 0.8 km, as well as the Smederevo road

with heavy traffic, at the distance of 1.2 km. From the aspect of environmental protection, there are two categories of major risks of accidents in a wider location of the Institute: the Institute itself with a risk of chemical and nuclear accidents, and the Municipal Solid Waste Landfill "Vinča" with a very great risk of chemical accidents.

THE VINČA INSTITUTE OF NUCLEAR SCIENCES AND ITS SURROUNDINGS IN THE SPATIAL AND URBAN PLANS

The Law on Planning and Construction defines types, hierarchy and content of planning documents, *i. e.* the spatial and urban plans. The types of spatial plans are: The Spatial Plan of the Republic of Serbia, regional spatial plans, local self-government unit spatial plans and special purpose area spatial plans. Urban plans include: general urban plans, general regulation plans and detailed regulation plans. Furthermore, the Law on Ionizing Radiation Protection and Nuclear Safety (Art. 48) prescribes that nuclear facilities can be built only in locations for which the spatial and urban plans are adopted and in accordance with the regulations governing the planning and development of facilities and procedures that guide environmental impact assessment.

The Spatial Plan of the Republic of Serbia from 2010 [18] (with the Environmental Impact Assessment Report) provides basic indications regarding nuclear energy and safety, *i. e.* the trans-border monitoring. It mentions that systematic geological explorations of nuclear minerals (uranium and thorium) were discontinued, primarily because of the moratorium that prohibits the new construction of nuclear power plants until 2015. The reserves are mainly linked to certain



Figure 1. Location of the Vinča Institute of Nuclear Sciences and facilities in its closer surroundings (Source: author of the paper and text, the Google map) 1 – protection zone 1500 m, 2 – 2.2 km from city dump, 3 – 14.0 km from city of Belgrade, 4 – 2.0 km from settlement, 5 – 3.5 km from settlement Kaludjerica, 6 – 4.5 km from highway road, 7 – 1.2 km from regional road, 8 – 1.5 km from significant archeological site and river Danube

granitoid massives (Bukulja, Cer, Janja) and the nearby sediment complexes (Belanovica basin, Arandjelovac basin, Jadari basin), namely to the Permo-Triassic sediments of Stara Planina (Old Mountain) and inner zones of the Carpatho-Balkan area. Furthermore, the Plan emphasizes the importance of a permanent monitoring of potential sources of radiation that can spread to the Republic of Serbia from its immediate surroundings, *i. e.* from the nuclear power plants in Hungary and Bulgaria, so that the cooperation, joint control and permanent notification are recommended. Out of important planning solutions for the Vinča surroundings, the Plan gives the priority to the development of the road and rail corridors, namely to the construction of the Belgrade southern by-pass. Upon the request of the Vinča Institute, the previous Spatial Plan of the Republic of Serbia from 1996 [19] defined the obligation to draw up a spatial plan for the special purpose area of the Institute. At the same time, the Plan also prescribed the obligation to carry out investigations aiming at determining the most suitable location for a permanent storage facility for radioactive waste, as one of the priority activities.

The Regional Spatial Plan for the Administrative Territory of the City of Belgrade [20] (with the Environmental Impact Assessment Report) classifies the Institute complex into category D that contains the entities which can have large-scale impacts on the environment at the regional level and which possess large quantities of dangerous and highly-toxic materials posing a high risk of chemical accidents with the possibility of cross-border impacts on the environment and human health. Due to their ecological weight, such entities should be located at large distances from the residential settlements so that their functions at these distances during the normal operating regime do not threaten the health and safety of the inhabitants and do not cause the unpleasantness to their neighbourhood. New locations for business activities in the territory of Belgrade are not planned, neither is the exten-

sion or increase of capacity of the existing entities belonging to the category D planned, except for the structures of energy system in the municipalities of Obrenovac and Lazarevac. For improving the environmental quality, the existing facilities and production plants should implement all necessary urban, technical and technological remediation and organizational measures of protection in accordance with the requirements of the Law on Environmental Protection and other laws and regulations governing this field, and in accordance with the EU law. The existing entities cannot satisfy the necessary criteria from the aspects of environmental protection, safety and human health and have to be moved to the appropriate safe locations.

Regarding the land use in locations, the Vinča Institute is situated within the coverage of construction area. The urban planning rules and requirements for environmental protection for the ecological category D are based on the minimum planning area of the complex and mandatory protective distance between the source of danger and the residential settlement. For the facilities under category D, there is the predicted possibility of emissions of highly-toxic substances, thus a large-scale risk of accidents. The area of the complex is not limited. The planned area encompasses minimum 300 ha, and a protective distance, *i. e.* the protection zone, is minimum 1500 m. For such type of complexes, it is necessary to conduct an Environmental Impact Assessment for the project (facilities), Chemical Accident Risk Assessment and the Strategic Environmental Assessment for the complex. The same determinants are also given within the Spatial Plan for a Part of the Municipality of Grocka [21].

According to the Master Plan of Belgrade [22], the settlement of Vinča is a part of the spatial sub-entity of this part of Belgrade (fig. 2). It is situated within the boundaries of its cadastral municipalities that are defined by the Danube river bank and Smederevo

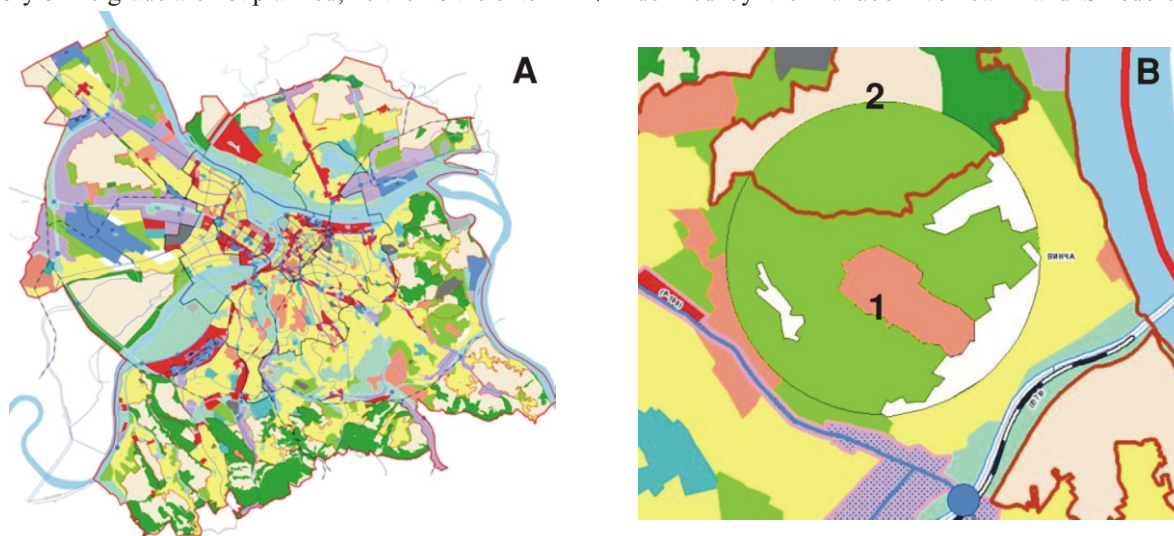


Figure 2.(A, B). Location of the Vinča Institute of Nuclear Sciences on the land use map from the Master Plan of Belgrade: 1 – location, public land, 2 – protection zone, greenery (source: Master Plan of Belgrade)

road. The position of the Vinča settlement is conditioned by the configuration of terrain of the hydrological entity of the Bolec River and the fact that it lies on the river banks. The micro-location of the Vinča Institute has been estimated as promising and of the greatest importance, while the existing complex is retained with the possibility of its transformation, completion and adjustment to the existing situation and new needs without the possibility of extending it or increasing its capacity. The activity of the complex should be adapted to the main purpose, while the disposal of hazardous waste should be regulated in accordance with law. The main protection measure includes the reduction of the number of sources of ionizing radiation, thus it is necessary to undertake the priority protection measures, continue exporting the radioactive waste and remove the old reactors, contaminated equipment and the existing radioactive waste.

Besides in the planning documents, the complex was also treated within the National Strategy for Protection and Rescue in Emergency Situations [23] and within the Assessment of Vulnerability to Natural Disasters and Other Disasters for the City of Belgrade [24], where similar determinates and recommendations for the protection are given.

Based on the abovementioned, we get an impression that the existing plans for the location of the Institute have neither been considered in sufficient detail nor specifically enough, but have treated the location only as a potential source of danger and have only given recommendations for the elimination of the hazards and for retaining the protection zones. The reasons for such insufficient treatment in plans should be further investigated, whereby insufficient knowledge about the relationship of special activity towards its surroundings, a fear based on negative experiences at the global level, other referent laws in the field of protection and treatment of such complexes should be borne in mind, as well as the effects which their operation can have on the environment.

Concerning the purpose of land use, the location of the Vinča Institute is designated for the existing complexes of public services, around which green areas in its northern, western and southern parts are planned. However, the main planning specificity is that the purpose of land use is not determined in the area immediately east of the Institute, in the location of the existing settlement, but will be determined after aligning the existing purposes with the specific regulations and additional investigation. Such undetermined planning solutions are a specific urban planning precedent and the result of a lack of the analysis and studies on the impacts of the special purpose areas on their surroundings, as well as the result of impossibility of solving and harmonizing the relationships between different purposes in the area through plans. Concretely, the impossibility of establishing a protection zone in the part of the Vinča settlement situated at the

location of the Institute is evident. Indeed, the incompatibility of contents requires an urgent realization of strategic solutions related to the remediation of the existing landfill site and dislocation of the temporary storage facility for disposal of nuclear and hazardous waste from the Institute. However, on the other hand, the question arises as to whether and when the illegal construction could have been prevented, *i. e.* what has caused multiple endangerment of the public interest, both in terms of the disturbance of regular functioning and in terms of the failure to consider future needs of the City of Belgrade and the Republic of Serbia, as well as in terms of a negligent endangerment of citizens in case of possible accidents. While studies aiming at conducting the multiple analysis of impacts and assessing the property values in relation to the vicinity of nuclear facilities are made in other countries [25-27], here it is evident that the general carelessness has caused consequences that will be difficult to eliminate.

There are also similar problems in the territory of Belgrade with the protection zones of the Nikola Tesla Airport and the zone of sanitary protection of the Belgrade water source on the left bank of the Sava. If it is at all possible to make a comparison between the problem arising from the importance and contents of the complex and its surroundings, then the analogy with the Nikola Tesla Airport would be the most appropriate. Both purposes are beyond the city content, but they have the status of national importance and are of international character, whereby the specificity lies in the use of international (European and world) standards, norms and Directives for performing the main activity. On the other hand, the illegal construction and extension of residential settlements to the boundaries of the complex impede the observance of technological processes and measures for protection and safety, thus endangering the safety zone, which calls into question the functioning, further development and improvements.

RECOMMENDATIONS FOR THE SPATIAL DEVELOPMENT AND PROTECTION ZONE OF THE VINČA INSTITUTE OF NUCLEAR SCIENCES

The location of the Institute is situated in a small valley of the Mlaka stream where the temperature inversions are frequent, which is unfavourable for places where nuclear facilities are situated. They occur in the late afternoon and early morning hours and more often during winter. As the location of the Institute was determined before the mentioned criterion was established and before adequate measurements were carried out, it is necessary to intensify the existing organizational measures by forming two new measurement points to the south-west and north-east from the fence of the Institute at the distance of about 300 m. It is also

necessary to intensify the control and measurements in periods of poor ventilation of the stream valley and formation of the surface inversion layer inside the Institute complex. The Mlaka stream flows from the northwest to the southeast. Several meters after leaving the Institute complex, it flows into the Bolecica River that flows further to northeast and then into the Danube. As the stream flows towards and through the populated settlement, which is not in accordance with the requirements, it is necessary to continuously collect and analyse water samples at the place where it leaves the Institute complex (fig. 3).

After having carried out groundwater investigations in the Institute complex, it was determined that the groundwater is at the depth ranging from 5 to 6 m and that groundwater flow directions are towards east and northwest. The groundwater velocity was not determined. It has been emphasized that the groundwater for the terrains suitable for the building the nuclear facilities should be at the depth of not less than 10 m and that they should not flow towards the human settlements. For this reason, it is necessary to determine a groundwater use prohibition zone.

From the aspects of seismology and geology, there are no unfavourable factors, *i. e.* the Institute complex is situated outside the zone of active landslides; thus, the location is satisfactory in this regard [28, 29].

The Smederevo road runs northwest-southeast at the distance of 1.2 km from the Institute complex. The function of the road is to link the settlements of Kaludjerica, Vinca, Lestane, Bolec, Grocka, *etc.*, with Belgrade and Smederevo. Until few years ago, it had a character of a regional road of the state importance. However, it has lost this rank due to the impossibility of meeting the basic technical standards, first those related to the necessary width and to the ban of direct access of vehicles from surrounding parcels. In spite of this, the Smederevo road is a busy road, this being supported by the data showing that daily traffic on this road is approximately 15.500 vehicles of all types and in both directions, carrying approximately 30.000 pas-

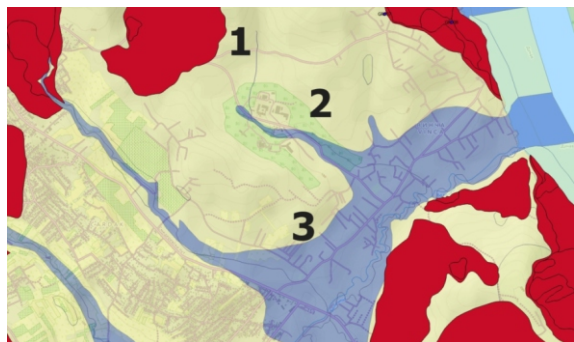


Figure 3. Map of active landslides and basins of surface water courses in the location of the Vinča Institute of Nuclear Sciences and its narrower surroundings; 1 – active landslide, 2 – complex, 3 – river basin. (Source: Urban Planning Institute of Belgrade)

sengers per day [30]. Thus, the requirement that the distance from the busy road should be not less than 1.5 km from the location of nuclear facilities has not been met.

Considering the abovementioned problem and knowledge on the current state of the area, it is not possible to fully meet the requirements related to the distance from busy roads. However, a series of the urban planning and technical measures need to be implemented in the coming period with the aim to reduce possible negative mutual impacts between the nuclear facilities and the function of traffic and transport. This includes: analysing a possibility of building an alternative road in the length of approximately 5 km and at the distance greater than the distance of the existing road from the Institute complex; reconstruction of the existing road with the aim to improve traffic flow (distance between regulation lines, curve radius, *etc.*); consider a possibility of building the frontage roads that would serve to provide access to the individual parcels and ease traffic on the existing road; other technical measures aiming at increasing the traffic flow and safety on the road.

The settlement of Vinca together with surrounding settlements (Kaludjerica, Boleč, Leštane) is in a group of Belgrade suburban settlements. The settlement of Kaludjerica with population of 27.000 (unofficial estimates put the number much higher, up to 40.000 inhabitants) is the largest amongst them. The edge of the construction area is at the distance of approximately 2 km from the Institute complex. However, over the past few years the illegal unplanned construction has been so widespread that today certain buildings are located at the distance of only few meters from the Institute complex and the existing nuclear facilities, where the buildings located in the south-western part are only 300 m far from the location of the temporary radioactive waste storage facility; in the north-eastern part, they are at the distance of only 400 m from the nuclear reactors; and in the eastern and south-eastern parts, they are nearby the fence of the complex, namely approximately 800 m far from the nuclear facilities. The necessary requirement that a settlement with population of over 25.000 cannot be situated at the distance less than 2.5 km from the nuclear facilities has not been met, while the fact that certain buildings are only 300 m far from the temporary radioactive waste storage facility brings to the fore the priority need for establishing the protection zones banning the construction around the Institute complex, as well as the need for a permanent solution to the problem of radioactive waste disposal.

CONCLUSIONS AND RECOMMENDATIONS

The main conclusion of the research on the Vinča location is that it is absolute necessary to prepare a special purpose area spatial plan, which is under jurisdiction of the Government of the Republic of Serbia. The general requirements related to the limitations

in space and formation of protection zones around the nuclear facilities have not been met in the location itself and in its narrower surroundings. The existing situation in the location, primarily the scope of illegal construction and the position of both the existing and the planned roads with heavy traffic is unfavourable and has conditioned such limitations that it is not realistic to expect the possibility of meeting the abovementioned requirements in the coming period. For any planning activity to start and for mitigating the conflicts in space and undertaking adequate protection measures, it is necessary to conduct further research through making a special study, as well as to carry out measurements in a wider area, all with the aim to consider the international impacts of nuclear facilities and purposes in the surroundings, and both in the existing situation and through assessing the impacts of possible accidents in nuclear facilities.

The data on the importance, number and spatial distribution of nuclear facilities outside of the borders of Serbia bring the issue of protection from radiation into the regional context, regardless of whether it comes to a controlled dose of radiation during normal operating regime or to accidents that can have serious consequences for wider surroundings. Given that such nuclear facilities are situated outside of the borders of Serbia, it is formally not possible to undertake appropriate planning measures, but only the measures of organizational nature. In addition to the activities at the international level, they also include the drawing up of action plans dealing with radiation accidents at certain nuclear facilities in surroundings, as well as the providing of necessary equipment. In the domain of spatial and urban planning, it is necessary to draw up plans in border areas and carry out strategic environmental assessment through trans-border and trans-regional cooperation.

The fact that the purpose of land use in the part that is in immediate vicinity of the Institute complex has not been determined, but will be determined after aligning the existing purpose of land use with the special regulations and additional investigations, namely the conclusion that the existing plans have neither considered the location of the Institute in sufficient detail nor specifically enough, but have treated it only as a potential source of danger, and the recommendation for retaining the protection zones, indicate the need to create new planning documents for the Vinča location and its wider surroundings. Because of dislocation of certain facilities and activities of regional, national and international importance from the area at a relatively small distance from the nuclear facilities in the Vinča location (Municipal Solid Waste Landfill "Vinča", archaeological site "Belo brdo", Pan-European Corridors VII and X), as well as because of national importance of the Vinča location, namely because of the need to align important functions in the area, it is necessary to draw up a special purpose area

spatial plan. This type of spatial plan, the adoption of which is under jurisdiction of the Government of the Republic of Serbia, is drawn up for the areas requiring a special regime of organization, development, use and protection and which are of national importance. It is also mandatory to carry out Strategic Environmental Assessment simultaneously with the process of drawing up plans.

The experiences in drawing up the spatial and urban plans for locations of nuclear facilities do not exist in Serbia. The special purpose area spatial plans have been prepared for the locations of protected natural resources, pan-European transport corridors, areas of intense surface exploitation of minerals, *etc.* In the neighbouring countries, such experiences are modest and based on the creation of documents of technical nature (projects) and documents in the field of environmental protection (environmental impact assessment). For this reason, it would be of great importance to develop the methodology for drawing up spatial plans for locations of nuclear facilities and their surroundings. At the same time, a new approach to considering and planning such locations would enable the re-examination of the general criteria and requirements analysed in this paper and would enable their more detailed determination depending on the existing situation and activities in the real surroundings, on the one hand, and the determination of the type and nature of nuclear facilities, on the other hand. The use of examples and experiences with similar facilities and experiences of research centres (according to the time the facility was built and the goal of building it, its purpose and capacity, requirements for its location, termination of certain programmes and functions, the used protection standards, *etc.*), such as, for example, experiences of the Karlsruhe Institute of Technology – KIT or the Belgian Nuclear Research Centre – SCK.CEN, could be very useful in the situation where there are no other referent determinants for the planning decisions. It is necessary to reach a compromise on the abovementioned issues in cooperation with the relevant international institutions and in accordance with the experiences of other countries, this being the condition for further development of criteria and for their use in the national legal system. Based on the experiences gained after accidents, the international community, as well as many other national institutions, consider to increase the radius of protection zones to the nearest human settlement, as well as the radius of evacuation zones, *i. e.* the zones containing disaster shelters and reserves of water and food, while the planning task in such situations would be reduced to finding the solution for satisfying the already endangered minimums.

The research on the example of the Vinča location and the derived conclusions are aimed at initiating the issue of permanent radioactive waste storage in Serbia. The impossibility of taking into account all

necessary spatial conditions in the surroundings of the Vinča location and its position at the distance of only 14 km from the centre of Belgrade, as well as the fact that the existing temporary radioactive waste storage facility in Vinča does not meet the necessary requirements and that its capacity is fully used, more than clearly indicate the priority of solving the future of nuclear facilities in Vinča, as well as the priority of initiating the research activities and developing a study for determining the location for a permanent radioactive waste storage facility. In this context, the spatial and urban plans, without which it is not possible to remove the existing storage facility in a planned way from the Vinča location or to create an adequate planning basis for the selection of new location for building a permanent radioactive waste storage facility in Serbia, are of key importance.

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**ОДНОС ПРОСТОРНОГ И УРБАНИСТИЧКОГ ПЛАНИРАЊА ПРЕМА
ЛОКАЦИЈАМА ЗА НУКЛЕАРНЕ ОБЈЕКТЕ – ПРИМЕР ИНСТИТУТА ВИНЧА**

Просторно и урбанистичко планирање је један од кључних инструмената за планско формирање и развој локација на којима се налазе нуклеарни објекти, посебно у погледу испуњавања строгих просторних условљености и формирања заштитних зона у њиховом окружењу. У овом раду су систематизовани међународни критеријуми и услови за локације нуклеарних објеката и сагледан је просторни распоред нуклеарних објеката у окружењу Републике Србије. Спроведено је истраживање на примеру локације Института за нуклеарне науке „Винча”, при чему је анализирана испуњеност просторних услова, третман локације у постојећим просторним и урбанистичким плановима и однос са другим функцијама у окружењу. У раду је доказана полазна хипотеза да на локацији села Винча и у њеном окружењу нису испоштовани општи услови који се односе на просторни развој локација нуклеарних објеката и заштиту од зрачења. Утврђено је да просторни и урбанистички планови којима је обухваћен простор Винче не садрже довољно конкретна планска решења и као такви не пружају довољан плански основ за испуњавање неопходних услова и обавеза по питању заштите од зрачења. У раду су дате препоруке за даљи просторни развој и заштиту на локацији Винча и њеном окружењу. Истраживање елаборирано у раду указује на значај и приоритет спровођења даљих истраживања, како би се израдом нове планске документације дефинисала неопходна планска решења за даљи развој комплекса у Винчи и формирање заштитних зона. Поред тога, посебно је наглашена потреба спровођења истраживања у циљу изналажења локације за трајно депоновање радиоактивног отпада. Указује се и на неопходност разматрања аспекта заштите животне средине и заштите од зрачења у националном и међународном контексту.

Кључне речи: нуклеарни објекти, просторно планирање, урбанистичко планирање, локација, планско решење, животна средина, заштита, безбедност
