International Journal of Disaster Risk Reduction 12 (2015) 102–111

Contents lists available at ScienceDirect

International Journal of Disaster Risk Reduction

journal homepage: www.elsevier.com/locate/ijdrr

Evacuation in the event of a nuclear disaster: Planned activity or improvisation?

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ARTICLE INFO

Article history:
Received 17 September 2014
Received in revised form
17 December 2014
Accepted 18 December 2014
Available online 20 December 2014

Keywords:
Planning
Evacuation
Nuclear disaster
Nuclear safety
Risk perception

ABSTRACT

Previous research study into evacuation in the case of a nuclear disaster suggests that there is both a high degree of uncertainty about the actual implementation of plans as well as a need for the continuous study of the human aspects of nuclear emergency preparedness. Drawing on the results of a textual analysis of the Regional Plan, a survey of the inhabitants and interviews with representatives of the institutions located within the area of greatest potential threat, our paper seeks to establish the extent to which the population and institutions are prepared for an evacuation in the event of a disaster at Krško Nuclear Power Plant, in Slovenia. Our analysis reveals that, despite planning, communicating and training, almost three quarters of the population living within a three-kilometer radius remain unfamiliar with the locations of the reception centers; and two thirds of them are unfamiliar with the evacuation routes. As far as the institutions are concerned, the level of preparedness is also low due to a fatalistic attitude ('if the disaster occurs there will be no time to evacuate'), poor nuclear disaster planning, the low attendance of personnel at training sessions, poor coordination, and scarce attention and resources devoted to the management of a possible disaster.

1. Introduction

The Fukushima nuclear disaster in March 2011, caused by a tsunami, proves that accidents can happen even in the most developed countries in the world. As a result of this disaster, at least 210,000 people living within a ten-kilometer radius of the reactor and some 180,000 people within a 20-kilometre radius had to evacuate their homes [47].[1] The Fukushima experience has led to calls for all future nuclear power plants to be constructed in such a way that they have a near zero impact outside the plant boundary in the case of a malfunction or disaster [62]. However, despite the fact that there is no reason to assume that a similar nuclear disaster could not occur elsewhere, the current practice remains unchanged. For this reason, we should regularly assess the preparedness of our societies. We would expect that the evacuation lessons of Fukushima would clearly affect the level of evacuation preparedness in all developed countries.

The Krško Nuclear Power Plant (NPP) was built in the early eighties in the former Yugoslavia, and remains jointly owned by Slovenia and Croatia. It is the only nuclear power plant in Slovenia. So far, Krško NPP has met all safety and operational stability standards. Stress tests conducted by the European Union (EU) in the summer of 2011, as part of an assessment of 132 nuclear power plants in 14 EU member states, proved that Krško NPP was a safe installation [50]. The tests encompassed the safety of nuclear power plants in the case of floods, earthquakes, extreme weather conditions, plane crashes, and fires or explosions in the vicinity of the installations.[2]

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[1] The lessons of Fukushima confirm what has long been known: that, as a solution to a nuclear problem, evacuation can also create additional risks for the population and the community [34,6].

[2] It is however necessary to note that Greenpeace and other NGOs were critical of the tests and posed the following questions: why were evacuation plans for villages and cities overlooked? Why were the ages of the reactors not taken into account? Why did authorities not analyze the possibility of malfunctions in more reactors at the same time? And why were plane crashes not taken into account despite the plan that they would be? [18]. However, in the case of the Krško NPP, the potential for a plane crash *was* taken into account.

http://dx.doi.org/10.1016/j.ijdrr.2014.12.005
2212-4209/

If a major nuclear disaster were to occur at the Krško NPP, the threat to life would extend beyond the lives of the Krško NPP employees and the population in the vicinity of the power plant. The entire country of Slovenia and much of Central and South-Eastern Europe could be threatened. Therefore the preparedness of the population for evacuation is one of the crucial preventive and protective measures in the event of a nuclear disaster.[3] IAEA safety standards require that states and other relevant actors maintain an adequate level of preparedness (including planning and preparation) for a nuclear and radiological emergency [22]. However, the lessons of similar evacuation incidents suggests that this is not an easy task [23], and that local and national plans and supporting procedures need further improvement [24].

For this reason, it is vital to explore the various evacuation possibilities and their related feasibility. Girod [16] has emphasized that there have been many events in which people were not evacuated either timely or effectively, in spite of the existence of evacuation plans and even evacuation models. The problem lies partially with the fact that the plans and models have lacked a sufficient theoretical basis. The design and modeling of an evacuation should be based on sound socio-psychological theories and empirical findings concerning mass behavior in such instances [16]. To develop working evacuation policies, it is important to understand how people respond to evacuation alerts, including their choices of when to leave and which routes to take [58]. An individual's decision to evacuate is influenced by several factors which have to be taken into account when planning for an evacuation [7].

The research problem of the article is the evacuation preparedness of population and institutions/companies living and situated, respectively in the close vicinity of Krško NPP. Our main objective is to establish the level of evacuation preparedness and to warn about potential insufficiencies. We also want to offer a few recommendations based upon our research findings.

Notorious cases of nuclear disasters (Three Mile Island, Chernobyl and Fukushima) revealed several insufficiencies in the evacuation process. Concurrently, several empirical studies confirmed that we need to be cautious about the efficiency of evacuation in the event of a nuclear incident. Zeigler and Johnson [66] concluded people have their own ideas about how to behave during a nuclear accident and cannot be counted on to adhere to the advice on protective action issued by public officials. Research by Blando et al. [2] into the emergency preparedness of the general public located around New Jersey's nuclear power plants showed that knowledge of evacuation routes and some aspects of potassium iodide usage was incomplete among the general public. Japanese studies also confirmed the difficulties of implementing a co-operative evacuation plan due to the insufficient familiarity of residents with the plan prior to the disaster [61]. Some debates suggested that, contrary to popular opinion, the major challenge might not be evacuating hundreds of thousands of residents, but rather convincing them to stay put [55].

Despite those facts we formed a hypothesis that inhabitants and institutions/companies living and functioning within a three-kilometer radius around Krško NPP are prepared to adequately respond to the declaration of evacuation as planned by the authorities.

In order to confirm the hypothesis we first define an evacuation and its various forms and describe what we mean by evacuation preparedness. We also briefly explore evacuation planning. Following a theoretical review, we introduce our method and research instruments. We present the key features of the 'Regional Rescue and Protection Plan in the Case of a Nuclear or Radiological Disaster in Posavje' (henceforth: the Regional Plan) in order to identify the official expectations of how people and institutions ought to behave in the event of an evacuation. We then present the results of our survey and interviews. In the discussion, we attempt to determine whether the results of our analysis of the Regional Plan correspond with inhabitants' knowledge and behavior as recorded in the survey and interviews. We conclude by offering some recommendations on how to overcome the current situation and how to improve the quality of evacuation preparedness.

2. Theoretical background: evacuation, preparedness and planning

In order to be prepared for a nuclear disaster, the community living in the vicinity of a nuclear power plant needs to develop adequate plans and structures. Evacuation is an important protective action for mitigating the consequences of a disaster, especially if an evacuation can be carried out in time before the disaster strikes, thereby protecting lives and reducing the number and severity of the injuries. In this sense, the evacuation of vulnerable populations is an effective means of reducing the negative consequences of disasters. Crisis management actors regard an evacuation as a generic protective mechanism because it can be an effective response to several types of disasters, including floods, hurricanes, volcanic eruptions, accidents involving hazardous substances as well as nuclear power plant disasters [36]. An evacuation can be considered as a complex psychological and technical (logistic) process which occurs as a result of warnings and/or actual/perceived necessity. It includes the withdrawal of persons from a threatened zone, their temporary sheltering, and their returning home [3]. In the case of severe disasters, the process of evacuation may conclude with the permanent displacement of evacuees.[4]

Drabek [11] identifies different types of evacuations and provides the following classification which takes into account the stage of the announced evacuation and its duration: preventive (before an accident, short-term); protective (before an accident, long-term); rescue (after an accident, short-term); and recovery (after an accident, long-term). Other classifications are also possible since current approaches recognize the existence of different terms, such as a mandatory evacuation, voluntary evacuation, recommended evacuation, declared or undeclared (self-initiative, shadow) evacuation, formal and informal evacuation, horizontal and vertical evacuation, general (mass) or partial, selective and gradual evacuations (see e.g. [11,36,53,5,65,19]).

[3] The IAEA has established international standardized guidelines for countries on intervention and action levels. The generic intervention level for sheltering is an avertable dose of 10 mSv over a period of no more than two days; for temporary evacuation, the avertable dose is 50 mSv over a period of no more than one week; and for iodine prophylaxis, 100 mGy of an avertable committed absorbed dose to the thyroid due to radioiodine. Authorities may wish to initiate evacuation at lower intervention levels for shorter periods, and also where evacuation can be carried out quickly and easily, for instance for small groups of people. Higher intervention levels may be appropriate in situations where an evacuation would be difficult, such as for large population groups, or if there is inadequate transport [22]. At the national level, countries have mostly adopted these recommended intervention and action levels, but with some variations (see [40]). For a measurement of the different levels of nuclear accidents/disasters, the International Nuclear and Radiological Event Scale (INES) can be used. The INES uses a numerical rating to represent the significance of events associated with sources of ionizing radiation. Events are rated on seven levels: 1–3 are 'incidents' and 4–7 'accidents' [59]. The Fukushima accident was graded as a 'major accident—level 7' according to the INES.

[4] The last notorious example of such an evacuation is the case of the nuclear disaster in Fukushima. The *Japan Times* reported on 10 March 2014 that some 267,000 people remain displaced from their hometowns; the vast majority of them continue to live in small temporary housing units or apartments rented for them [46].

A citizens' decision to evacuate and their behavior in doing so are strongly affected by their perception of the situational risk, namely whether they recognize that a real danger exists [42]. Authors of the psychometric paradigm of risk perception, that every hazard has its unique pattern of qualities which are related to its perceived risk, have found that nuclear risks are considered to be highly threatening [14,51]. This is due especially to their catastrophic potential and people's general lack of knowledge about them. The specificity of nuclear risks is also evident in people's objection to nuclear facilities in their vicinity [44] and in the characteristic 'shadow evacuation'[5] in the case of a nuclear incident [54]. Such reactions to nuclear risks are perhaps also connected to the 'affect heuristic', as a cognitive process in which people also take their feelings into account when evaluating risk [52]. In the process of perceiving and framing the problem, social structures, such as culture, information flows and organizational settings are also important [4].

Nevertheless, due to the nature of the perceived risk of a nuclear disaster (unknown and dread risk), people have tended to show a great willingness to evacuate in the case of a nuclear accident even before any official warning has been issued. According to some authors, this is a common characteristic of hazardous-material accident evacuations [35]. This means that official expectations of public behavior (in terms of whether people would evacuate quickly, willingly and according to plan) may be inaccurate. Lessons learned from previous disasters at nuclear power plants and natural disasters show that the endangered population often does not act in accordance with the official guidelines. On some occasions they have not taken these guidelines into account; while on other occasions they have acted ahead of the official guidance and evacuated on their own initiative (comp. [45]).

Nevertheless the importance of planning for a successful evacuation has been acknowledged by several authors (see [32]). There have been even claims that actors should place less emphasis on prevention and more on preparatory measures [64], planning being one of them. However, we tend to agree with Rosenthal [49], that prevention is the first-order measure whereas planning, equipment, training and intervention are second-order measures, which, if not properly performed, actually contribute to the potential for the disaster to assume 'dramatic proportions'.

The planning literature reinforces the assumption that implementing nuclear emergency evacuation plans will meet with difficulties. Perry and Lindell [43] have stressed that the problem with emergency planning is the excessive emphasis on the written plan which has tended to draw attention away from the process of planning itself and from the original objective of achieving community emergency preparedness. Community emergency preparedness and related planning should not only include all relevant organizations but also the population-at-risk, especially if the population is expected to undertake personal protection in an emergency. Additionally, some authors warning against disaster myths, have stressed that disaster victims will likely make their own decisions about whether and when to evacuate. Following impact, they are more likely to contact informal sources such as friends, relatives and local groups rather than governmental agencies [43]. Likewise, Wilson [63] suggests that in the case of a nuclear evacuation, like the one in Fukushima, the assumption that the risk of alternative human action is small is false. McConnell and Drennan [38] have also stressed the limited value of a written plan and have identified the problem of 'a symbolic readiness', which they describe as the tension between the ideals of planned pre-crisis preparedness and the operational reality. They also stress that local communities need to be a part of the planning, because, firstly, from a human rights perspective, people have a right to be involved in processes which may profoundly affect them; and secondly, the effectiveness of planning will increase. Also the planning literature warns that planning practice is based on achieving targets rather than working in the best interests of the people or the common good.

Swain and Tait [57] have identified four reasons why there has been a general decline in trust in planning and planners: the rise of a risk society (myriad risks have induced a process of individualization and individuals are consequently set free from the ties of certainty); the rise of a pluralistic society (i.e. a fragmented society in terms of goals, loyalties and interests, etc.); the rise of a rights-based society (the rights culture pervades decision-making because the rights of individuals or groups are more important than their obligations or duties, while planning is increasingly about ensuring that these rights are met); and the rise of advanced liberalism (a shift from public services to private management with a reduced role for the state). Subsequently, Swain and Tait [57] recommend a more participatory approach to planning which would better consider the needs of people.

Factors that influence the success of an evacuation function at three levels: the system, the community and the personal level. We should mention crisis-management structures and plans, socio-demographic factors, such as the number of people, type and location of the population,[6] the effectiveness of communication, and the urgency of the action. An individual's decision to evacuate depends strongly on the perception of the threat as real, the level of perceived personal risk, the presence of an adaptive plan, family and kinship relations and community involvement (comp. [11,36,41]). The potential evacuation scenarios are also significantly different depending on the time of an evacuation: weekend and holiday, morning, afternoon or night represent enormous variations in the circumstances that need to be taken into account. The weather is also a relevant factor: snow, rain, fog or sunshine produce extremely different evacuation conditions. Traffic conditions should also be taken into account.

3. Method

Our research approach is based on a combination of methods, which means mixing quantitative and qualitative research and data. Our research design includes a textual analysis, an opinion survey, and semi-structured (semi-directed or open-ended) interviews concerning the preparedness of the population, of institutions and companies to evacuate in the event of a nuclear disaster at the Krško NPP. The field research was carried out from October 5 to November 15, 2012.[7]

In order to develop our research instruments (textual analysis guide, survey questionnaire and interview guide) we explored the theoretical conceptualization of evacuation and evacuation preparedness, and we studied the empirical findings of evacuations in the case of past nuclear disasters (Three-Mile Island, Chernobyl and Fukushima) as well as other disasters.[8] We also analyzed

[5] Unofficial or 'shadow evacuation' takes place when people evacuate without an official declaration by the authorities [30].

[6] The distance of people to the nuclear plant affects their behavior. People living closer to the plant will be more likely to evacuate, more likely to support nuclear energy production, and less psychologically concerned about a potential disaster [15].

[7] The empirical material is plausible and credible therefore the validity of research is achieved. Due to the fact that this is an applied research, the generalization of the findings is limited.

[8] 'Backgrounder on the Three Mile Island Accident [1]', the United States Nuclear Regulatory Commission; 'Documents of Energy and the Environment: Chernobyl [9]': 'Hard lessons for U.S. Nuclear Safety from the Fukushima Meltdown'; 'Inquiry Sees Chaos in Evacuations After Japanese Tsunami [25]'; 'Informationskreis

Slovenia's experience of evacuation planning for a nuclear disaster as well the experiences of some other countries.[9] The variables covered by all three research instruments were: the perception of threats and the assessment of the probability of a nuclear disaster; the measures to be implemented in the event of a nuclear disaster; the evacuation preparedness; the information and communication process; the response to the warning; public behavior during an evacuation; and transportation and temporary housing.

We began the empirical part of our research with a textual analysis of the Regional Plan. We incorporated all the relevant variables (see above) into the instrument in order to carry out our analysis. The Regional Plan was scrutinized in order to check the presence and meaning of those variables.

The survey research comprised a cross-sectional design in relation to which data was collected through structured interviews. The questionnaire consisted of a collection of questions (scaled items) that can be classified into two main parts—a core section (threat perception, probability of accident, awareness of measures, sources of information, evacuation behavior, transportation and temporary housing) and a section with a set of demographic variables (sex, age, level of education, type of settlement, sub-region of residence and employment status).

The survey research was based on a process of simple random sampling, where each subset of elements from the population had the same probability of being selected for the sample. The sampling framework included adult residents within a three-kilometer radius of the NPP (approximately 10,000 people).[10] Where only part of the settlement fell within the three-kilometer radius, we took the entire settlement as the basis for sampling. The statistical characteristics of the realized sample match the characteristics of a simple random sample of $N=1000$ persons, aged eighteen and over. A wider selection was carried out by the Statistical Office of the Republic of Slovenia. The response rate according to the sampling framework was 50 percent. The completion rate calculated on the basis of the ratio between the conducted surveys and the number of contacts amounted to 70 percent. A total of 502 respondents participated in the survey.

Additionally, we also conducted the semi-structured (semi-directed) interviews with leading personnel in twelve major institutions and companies in the Municipality of Krško, namely: the kindergarten, the Jurij Dalmatin Primary School, Leskovec Primary School, the High-school Centre, the medical center, the pharmacy, the nursing home, Hotel City, and the companies VIPAP Videm, KOSTAK, LEVAS and SOP International. We selected companies and institutions to cover a broad spectrum of activities: education, childcare, small, medium and large enterprises, medical care, and public infrastructure services. We took into account the relevant actors in a nuclear disaster response and interviewed the leading personnel responsible for a nuclear disaster response and/or leading community managers: the school principals, the kindergarten principal, CEOs, and assistants to CEOs responsible for safety and disaster response.

(*footnote continued*)
KernEnergie [20]'; Investigation Committee on the Accident at the Fukushima Nuclear Power Stations [26,27,28]; 'Japanese Reaction to the Fukushima Daiichi Nuclear Disaster [33]'; 'Lessons Learned From Chernobyl, Fukushima [29]'; 'Loss of Life after Evacuation: Lessons Learned from the Fukushima Accident [37]'; 'Notification on Evacuation in Pripyat on April 27 at 2 pm [39]'; and Stallings [54].

[9] See for example: Conlow [5]; Donn [10]; 'Emergency: Evacuation [12]'; Evacuation Plans for a Limerick Nuclear Plant Accident [13]; 'Koeberg Nuclear Plant: Evacuation Plan?' [31]'; IAEA [21]; 'Revealed: Secret Evacuation Plan for Tokyo after Fukushima [48]'; Sorensen and Vogt [53]; and Surry Power Station—Emergency Planning [56].

[10] The three-kilometer zone is the official 'area of preventive protection measures'.

4. Results

In this section we present the results of our textual analysis, opinion survey and interviews concerning the preparedness of the population, institutions and companies to evacuate in the event of a nuclear disaster at the Krško NPP.

4.1. The regional evacuation plan

In Slovenia, national, regional and municipal planning for an evacuation in the event of a nuclear disaster is obligatory.[11] It is also important to emphasize that the municipality determines which educational, social, health and similar organizations should plan for emergency measures and prepare for protection, rescue and assistance. Their plans should be coordinated with the plans of the municipalities. We will focus our analysis on the 'Regional Protection and Rescue Plan in the Case of a Nuclear or Radiological Disaster in Posavje' [17]. However, we will not scrutinize this very comprehensive document exhaustively, but rather focus only on the issue of evacuation. In particular, we will pay close attention to the plan's expectations regarding the behavior of people and institutions in the potentially affected area.

The official perception of a threat from the Krško NPP is that there is a very low probability of a nuclear disaster of 'broader proportions' which would impact on the inhabitants and the environment, because the facility has a high level of passive and active inbuilt safety. However in the event of a major disaster, all municipalities in the region of Posavje would be affected. The official view admits that a disaster at Krško NPP could also be triggered by natural and other disasters, such as an earthquake, floods, extremely strong winds, or an airplane accident, or similar.

The plan defines four levels (0–3) of danger that could occur in relation to an extraordinary event at Krško NPP. The evacuation of the nearby population is envisaged upon declaration of danger level 2 (a danger inside the NPP facility), or danger level 3 ('general danger'). A three-kilometer radius around the nuclear power plant is defined as the area of preventive protection measures, and all inhabitants must be evacuated from this area where circumstances permit when a general danger is declared.[12]

One important task for crisis management actors is to communicate with the inhabitants of the threatened area to inform them of the danger and the possible measures to address it.[13]

[11] The ministries of the Slovenian Government are responsible for maintaining preparedness and for the performance of activities within their regular competences. The preparations for natural and other disasters are coordinated by the Ministry of Defence and by the Administration for Civil Protection and Disaster Relief (ACPDR). The basic tasks of the system are prevention, preparedness, protection, rescue and relief, the provision of basic living conditions, and recovery. Operational leadership and the management of civil protection structures is organized and carried out uniformly at the local, regional and national levels. The national and regional civil protection commanders are appointed by the government whereas local commanders are appointed by the mayors. The commanders at all levels are supported by the Civil Protection Staff (CPS) which is comprised of experts from various fields [8].

[12] Sometimes an evacuation can prove to be too dangerous due to the radiation cloud. In such cases, it is better to remain within a closed and protected space.

[13] A uniform communication system is used by almost all rescue services and civil protection units in the country. The system is comprised of the Regional Notification Centres (RNCs; 13 of them) and in the National Notification Centre. The RNCs manage the system, collect and relay data for the rescue units and respond to emergency calls. The information system for natural and other disasters can store, process, transfer and exchange data between the ACPDR, the RNCs, CPSs and other organizations involved in the emergency response. Public alarm signals are used in the case of disaster or threat. When sounding the alarm, the respective RNC must inform the public of the purpose of the warning and a proper response to it via radio and television. According to the law, the latter must without hesitation broadcast appeals, announcements and other urgent messages relating to the danger at the request of the Government, mayor, CP commander or other responsible authority [8].

Inhabitants should be informed of the different types and levels of radiation, its consequences, and of the key protective measures: sheltering; evacuation; the ingestion of potassium iodide tablets; and the reception and care of evacuees. The plan and an accompanying leaflet with a short abstract inform the public about the method by which an evacuation will be announced when the decision to evacuate has been taken. The plan also envisages measures to reduce radiation contamination. This encompass: the use of personal protective equipment; treatment of the injured; control of the affected area; and the decontamination of people and equipment. The planned long-term measures are the temporary or permanent displacement of people and the decontamination of the environment.

In this plan, 'evacuation' refers to the immediate protection measures which are performed in line with defined evacuation routes, in the direction of reception centers, and from there to temporary housing locations. On the basis of this plan, the inhabitants in the potentially affected area received an informative leaflet. They were also informed about the evacuation plan through public announcements in the local media and presentations in schools. Therefore, residents should know in what circumstances an evacuation will be declared and how to respond to it. The leaflet also informs them about the location of their reception center and the route they should take to reach it. They should use their own means of transportation, while special categories of population (children in schools and kindergartens, patients in hospitals, senior citizens in nursing homes, and prisoners) should be provided with transportation by their respective institutions. In the event of an evacuation, the plan envisages the protection of property, the functioning of relevant companies and institutions, a health service, education and adequate treatment for animals. Once the evacuation process has been completed, there is either the possibility that evacuees will return home or will be permanently relocated to other parts of the country.

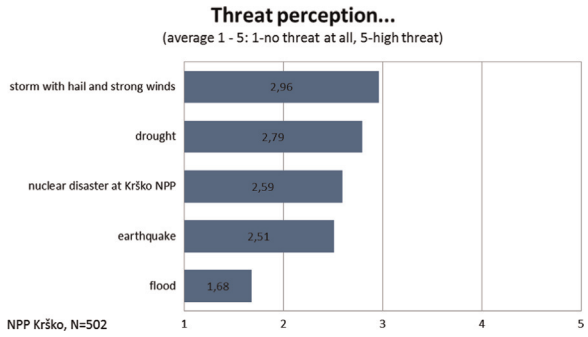
4.2. The preparedness of the population for an evacuation

The respondents were asked to evaluate how strongly they **perceived the threat** of earthquakes, floods, a nuclear emergency, drought, and hail storms with strong winds. Each of the above potential threats was evaluated on a scale from 1 to 4 (not at all threatening to high threat). Respondents were also offered the option to list and evaluate additional threats using the same scale. This question therefore places the perception of the threat of a nuclear disaster at the Krško NPP in the comparative context of the perception of other potential threats to the Posavje region.

The results show that, on average, the respondents perceive a storm with hail and strong winds to be the greatest threat (the average response on the scale from 1 to 4 is 2.96), and a flood as representing the least threat (1.68). The threat of a nuclear disaster at the Krško NPP was attributed an average value of 2.59, which is slightly more than for an earthquake (2.51) and slightly less than for a drought (2.79) (Graph 1). A nuclear disaster is perceived as a major threat by 29 percent of the respondents; while 18 percent perceive it as a secondary threat, 29 percent as a minor threat, and 19 percent as no threat at all. Furthermore, five percent of respondents did not know or did not want to specify on what scale they perceived the threat of a nuclear disaster.

Cross tabulations of the threat perception of a nuclear disaster with the demographic variables reveals that only people who have a family member with disabilities feel more threatened than those without such limitations (Table 1).

Closely related to the threat perception is **the estimation of the probability** that a nuclear disaster might occur, as perceived by the population living in the close vicinity of the nuclear power plant. The respondents were asked to evaluate the likelihood of a



Graph 1

Table 1
Threat perception by dissability.

Threat perception	Dissability		Total (%)
	Yes (%)	No (%)	
Nuclear disaster at the Krško NPP			
Not at all	11.4	20.0	19.2
Low threat	11.4	30.5	28.9
Medium threat	25.0	17.1	17.8
High threat	43.2	27.5	28.9
D.k.	9.1	4.8	5.2

$\chi^2 = 12.88$; $p = 0.1$; Cramer's $V = 0.16$; $n = 502$.

nuclear disaster at the Krško NPP with serious consequences for the environment that would necessitate the evacuation of the nearby population.

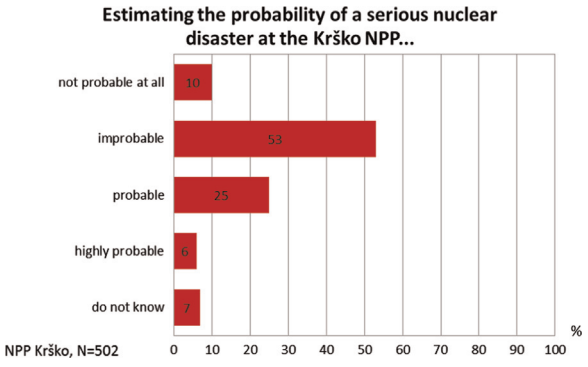
Most respondents (53 percent) expressed their belief that such a disaster is improbable[14]. This may explain the average response to nuclear threat perception. In addition, 10 percent believe that such a disaster is not at all probable. Conversely, some respondents believe that a disaster of this type is probable (25 percent) or even highly probable (six percent) (Graph 2).

Cross tabulations of the probability of a nuclear disaster against demographic variables reveal that the following categories of respondents consider a serious disaster that would require an evacuation more likely to occur: respondents with lower incomes and respondents with physical disabilities (Table 2).

The residents have at their disposal several possible protective measures against a nuclear disaster: sheltering, ingesting potassium iodide tablets, evacuation, and temporary accommodation outside the threatened zone. Human **awareness of these measures** is a necessary—though not a sufficient precondition—for an adequate response in the case of an emergency. In assessing the respondents' knowledge of the protective measures in the event of a nuclear disaster in Krško, the majority of respondents indicated that they were partially familiar with these measures.

The respondents reported a greater knowledge of sheltering and evacuation, while the least amount of knowledge concerned the potassium iodide tablets. A relatively large proportion of individuals (16–30 percent) reported not being familiar with the measures at all, while many (16–22 percent) reported being only slightly familiar with them. 27–42 Percent reported being partially familiar with the measures, while 19–28 percent reported being completely familiar (Graph 3). The real proportion of individuals familiar with the protective measures is likely to be even smaller

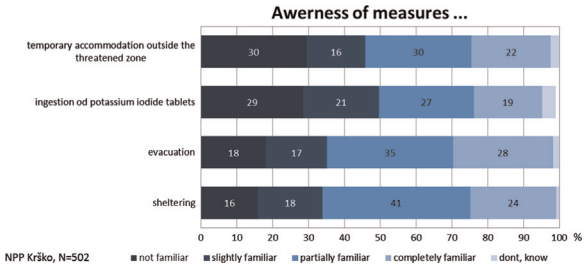
[14] The analyses of the national survey data reveals a paradox that those inhabitants living within the vicinity of Krško NPP express a lower level of threat perception and think it is less probable that a disaster may occur than those inhabiting more distant areas [60].



Graph 2

Table 2
Probability of nuclear disaster by income and dissability.

Probability of nuclear disaster $p=0.01$, $N=502$	Income	Dissability
Pearson χ^2	27,767	12,887
Cramer's V	0.118	0.161



Graph 3

since respondents are often inclined to overestimate their knowledge.

Details of the measures were disseminated through the following **main sources of information**, which our survey respondents were asked to identify (multiple answers were possible): a leaflet on evacuation[15] (identified by 62 percent of respondents); the mass media (identified by 52 percent of respondents); and educational means (identified by 33 percent). Approximately half of respondents (53 percent) had in last five years received information on an evacuation plan and other emergency measures. In all other cases, the information had been received more than five years ago (25 percent), was not received at all (8 percent), or the respondents did not know (14 percent).

The respondents were also asked to identify **the location of their evacuation reception center,** to which 55 percent were unable to identify it. This means that in the event of an evacuation they would evacuate elsewhere, as it is hardly imaginable that they would wait at home. Others (45 percent) selected one of the three planned options we offered in the questionnaire. Those who stated that they were familiar with the location of a place of reception were subjected to further analysis on the basis of their sub-region of residence; our intention being to check the accuracy of their answer. We discovered that an additional 16 percent of respondents incorrectly identified the location of their reception center. This means that a total of 71 percent of respondents do not know the correct location of their evacuation point. At the same time, more than half of respondents are unfamiliar with **the planned evacuation routes** (51 percent). Of those who claimed to know the evacuation route, 65 percent correctly identified the direction of the evacuation routes; however, 26 percent either identified the wrong direction, or their response was too vague or unclear to be considered accurate (nine percent). Overall, this means that about two-thirds of the population is unfamiliar with their evacuation routes.

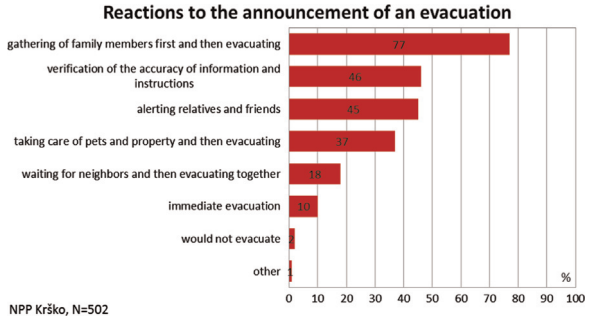
The respondents were asked **how they would react** following an order to evacuate. The majority would take care of their family members first and this fact has to be taken into account in the event of an evacuation. People would not evacuate automatically on command. They would first take care of their family members and, if possible—depending on the situation, they would also gather additional information and alert relatives and friends. Only 10 percent would evacuate immediately (Graph 4), although we could expect that in a real nuclear emergency this percent would be higher.

In the event of an extraordinary incident at the nuclear power plant, and in the absence of any announcement of official protective measures, the inhabitants would respond on their own. Almost half of respondents say that they would as an immediate response initially attempt to find a suitable shelter within their own home. Almost a third of them would evacuate immediately, while only one in seven would wait for official instructions.

Temporary housing is one measure envisaged by the regional contingency plan. However, people would prefer to take shelters either in another dwelling in their possession if they have one, or in the houses of relatives and friends. By contrast, official shelters would be hardly used or used only for short periods.

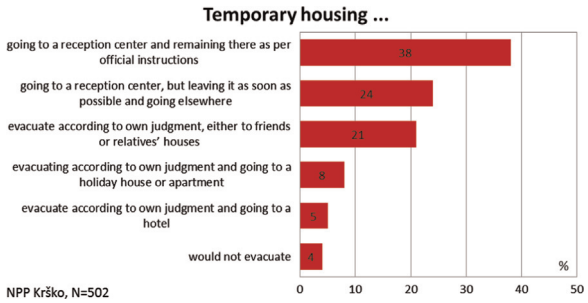
Regarding temporary accommodation, 38 percent of respondents expressed their intention to go to a reception center and remain there as per official instructions. An additional 24 percent would also go to a reception center, but would leave it as soon as possible and go elsewhere. Here, it is important to reiterate that the majority of respondents do not actually know the location of their reception centers. One-third of the respondents would evacuate according to their own judgment, either to their friends or relatives (21 percent), to a holiday house or apartment (eight percent) or a hotel (five percent). The proportion of respondents who would not evacuate is relatively high (four percent) given the high level of danger (Graph 5).

In average approximately two thirds of all respondents expect to be offered support measures relating to their physical health and safety (contamination test, decontamination, food and shelter, and health care), and a relatively high proportion (32 percent) also



Graph 4

[15] In 2008, every household in the vicinity of the Krško NPP received a leaflet containing general information on how to respond in the event of a nuclear disaster. The survey respondents were asked whether they still kept the leaflet at home: 36 percent of respondents said they still have the leaflet; whereas 46 percent stated they do not have it any more; and 18 percent indicated they did not know whether they had it or not. This means that in the event of a nuclear disaster more than half of the population would not have to hand the basic essential information that would be required for an optimal response.



Graph 5

expect to receive psychological assistance. All of these measures are provided for in the official plans. Younger respondents (those aged 30 and younger) are less likely to have such detailed expectations regarding psychological assistance (Table 3).

Three quarters of all respondents claimed they would stay in temporary housing as long as was required, whereas the remainder expressed their intention to leave it after a certain period of time; in some cases, this meant after only a few days.

4.3. The preparedness of local institutions and companies for an evacuation

The representatives of the institutions and companies with whom we conducted interviews have considered the possibility of an evacuation due to a nuclear disaster at the Krško NPP. However the educational institutions (the high school, elementary schools, and kindergartens) have given more serious consideration to this possibility than have the privately owned companies. There is a general belief among our respondents that the probability of an evacuation due to a nuclear disaster is very low. This is because they reason that if a large-scale disaster at the Krško NPP were to occur, an evacuation would not be possible (or even necessary) because they would be located too close to the NPP to avoid the effects in time. On a day-to-day basis, the respondents do not burden themselves with their proximity to the NPP and express a high degree of trust in the individuals employed in the NPP, many of whom they know personally.

The specific plans dealing exclusively with a nuclear disaster have not been developed; nevertheless some institutions and companies do have emergency response plans, but do not have specific plans or documents relating to a nuclear disaster.

The respondents believe that their institutions and companies are generally well prepared and able to evacuate those to whom they have a duty of care (for example, evacuating children from school and kindergarten buildings). The only exception is the nursing home for elderly people, which clearly faces significant obstacles to any rapid and efficient evacuation. Our respondents expressed the view that the most critical aspects of an evacuation are those necessitating the involvement of a large number of actors (for example, organized transport for children from schools and kindergartens). Respondents from educational institutions have not been informed and are unaware of the existence of any arrangements between the municipality and transportation companies in order to provide for a sufficient number of buses for all children from kindergartens and schools. Another important problem identified is the reaction of parents: do they intend to come to the schools/kindergartens to collect their children, even though the emergency plan does not anticipate such behavior?

In most cases, neither the respondents nor their institutions/companies had been included in any exercises relating to a potential nuclear disaster, except for the health service and the pharmacy which participated in a national exercise in 2008; the pharmacy was not included as part of an evacuation, but rather in terms of the stockpiling and supply of iodine prophylaxis. Regular evacuation drills are carried out in all of the educational institutions; nevertheless what these exercises practice is the evacuation of buildings, not the evacuation along the routes provided for in the event of a nuclear disaster.

The problem of protective equipment was also identified. The educational institutions and companies selected for the sample do not possess any special protective equipment for a nuclear disaster, nor do they have any special protective equipment for employees who, due to the nature of their work, would have to stay at the workplace after an evacuation had been announced. The only exception is the pharmacy which is equipped with a sufficient number of protective masks for its employees.

According to the vast majority of respondents, the most critical matter of any evacuation is the organization of transport for children and elderly people and the traffic conditions along the evacuation routes. The respondents expressed a particular concern with the feasibility of evacuating so many people (approximately 10,000) with buses and their own private vehicles, given that on a typical day the city is already susceptible to traffic congestion.

Table 3
Psychological assistance by age.

Support measure		Age				Total
Percent of "yes"	Psychological assistance	−30 Years	31–45 Years	46–60 Years	61+ Years	
		22.9	33.1	38.7	27.6	31.5

$\chi^2 = 38.88$; $p = 0.01$; Cramer's $V = 0.16$; $n = 502$.

5. Discussion

The results of our research confirm several pessimistic theoretical findings and empirical facts about the preparedness for a nuclear evacuation. The existence of a written plan which fulfils the internationally recommended criteria and the dissemination of general information have failed to guarantee an adequate level of evacuation preparedness among the potentially-affected population. The views recorded in our survey and in the institutional interviews, along with certain predictable human behavior, would suggest that in the actual event of a major nuclear incident in the heart of Central Europe evacuation would most likely be predominantly improvised and chaotic. This could potentially precipitate additional and unnecessary risks.

The **perception of risk** is one of the key factors influencing people's attitude towards preparatory activities in potentially threatened surroundings. A comparison of the results of our textual analysis of the Regional Plan, our public opinion survey data and interview findings suggests that, as far as the perception of threat is concerned, the official and popular views are quite similar. The official governmental view is that a nuclear disaster of 'broader proportions' with its impact on the population and environment is unlikely to occur, while the public estimates a nuclear disaster to be less threatening than either a storm with hail and strong winds or a drought. The view that a nuclear disaster is likely or even highly probable is endorsed by less than one third of the population living within the three-kilometer radius of the nuclear power plant. The representatives of institutions and companies have considered the possibility of a nuclear disaster; however they believe the installation to be safe, and that if a disaster were to occur there would in any case be no time to respond.

The authorities have disseminated **information** about the

measures to be taken in the event of a nuclear disaster, especially regarding the evacuation process. Nevertheless the inhabitants remain ill-informed about these measures in general, including the evacuation. Only slightly more than one third of them still retain the leaflet containing the key information, delivered to them only four years prior to the survey. Consequently, more than one fifth of respondents do not know how they would be informed of an evacuation in the event of a disaster. Evidently the information flow was interrupted at a certain point of communication process.

We also checked the self-assessed **knowledge** of our population sample and established that the population tends to overestimate their knowledge of the facts. These figures perhaps give some cause for concern given that the sample we surveyed was taken from within the three-kilometer radius around Krško NPP. The representatives of institutions and companies also lack information, although they were informed of the possible measures and, according to the Krško Municipality Ordinance, they ought to prepare for them. It is important to emphasize that several exercises were previously carried out by the national and regional authorities to test the plan and to play the different roles that it envisages. The local population, institutions and companies should have been involved in this training in order to improve their preparedness but they were either absent or had forgotten the crucial information by the time of our research. Consequently, their preparedness to evacuate can be said to be rather low, regardless of the fact that the measures are planned at national, regional and local levels. However the majority of institutions and companies have no specific plans in place to cope with the event of a nuclear disaster. This is surprising and a violation of the provisions of the Regional Plan. Furthermore, with just a few exceptions, members of these organizations do not attend trainings where the plans are tested and the crisis management actors are trained although this is an excellent opportunity for them to learn their roles prior to the disaster, which is a significant feature of disaster-socialization.

The **preparedness** of the population is also questionable due to the fact that more than 70 percent of those living within the potentially most threatened zone are unfamiliar with the location of the reception centers assigned to them in the event of a disaster, whereas more than 60 percent of them do not know the evacuation route. On the other hand, the representatives of the majority of community institutions and companies claim that they are capable of evacuating their children, patients and employees from their own premises. However, they tend not to know what happens next: where to go, what route to take, and, most importantly, who would provide the transportation? The latter, as seen from the Regional Plan, should be provided by the respective institutions and companies. It is also a fact that the majority of the population and the institutions and companies do not possess any standard protection equipment, not even for those employees who would be expected to remain at their stations due to the nature of their roles.

In the case of Krško NPP, it is evident that **evacuation planning** is performed insufficiently. Even after several poor nuclear disaster experiences, the planning process still appears to be too technocratic, neglecting the social dimension. Objectives are understood as given; however, in order to achieve them, we need to take into account the social process. The 'object' of planning is 'social' (namely, the population and institutions within the vicinity of the NPP) and the envisaged implications are also social. At the same time, the planning process should itself be a social process that takes account of the various interests and convinces the main actors (i.e. the population, the community institutions and community leaders) of the importance of their active participation and their compliance with the planned measures. Participatory planning is an imperative. Clearly, evacuation planning is also a cognitive process; therefore the process of planning should involve the key actors with their perceptions and knowledge of the planned measures. In our case, this proved to be the most problematic issue. A proactive attitude among all the stakeholders involved in the process is a prerequisite of any rational and reliable planning.

In the case of the Krško NPP, the goals seem to be quite clear but the means of achieving them are scarce, especially at the municipal and institutional levels (e.g. the lack of transportation and protection means). However, the goals that are clear are not realistic because they are planner-friendly: the plan rather optimistically sets a three-kilometer evacuation zone, whereas the disasters in Chernobyl and Fukushima required much greater zones to be evacuated; reception centers and temporary housing facilities are too close to the potential disaster site; and the expectation that there will be enough time to evacuate is rather unrealistic. As a matter of fact, a national level 3 (on the scale 0–3) Scenario is not severe at all, meaning that the planning process is not based on the worst-case scenario in terms of the scope of danger and impact, the time available to respond to it, and the zone to be evacuated.

6. Conclusions and recommendations

According to the EU stress tests, Krško NPP is a safe installation. However the very existence of such an object requires local, regional and national authorities to have a planned response to the possibility of a nuclear disaster. Although the measures to mitigate the consequences of such an event are several, our analysis has focused primarily on evacuation. The results suggest that, despite the efforts of the authorities and past lessons, the evacuation of the population from the three-kilometer radius around the NPP Krško would be an improvised and even chaotic activity, rather than an organized and smooth operation. To reiterate only crucial facts: the nuclear power plant related threat perception and the estimation on the probability of disaster are rather low, the knowledge about planned measures is over-estimated, the vast majority of inhabitants are not familiar with the evacuation routes and location of the reception centers, response to an evacuation seems to be time-consuming, many of the leading personnel in institutions and companies take a fatalistic stand, they do not have adequate evacuation plans, transportation means and equipment, and they are not sufficiently trained. This means our hypothesis that "inhabitants and institutions/companies living and functioning within a three-kilometer radius around Krško NPP are prepared to adequately respond to the declaration of evacuation as planned by the authorities" cannot be confirmed.

In order to help overcome this state of affairs, we offer several recommendations. A realistic evacuation plan must be developed that would take into account the experiences of those nuclear installations that have experienced an accident. It is not only the municipality authorities of Krško and the Posavje region that need to plan for an evacuation; the institutions and companies within the region also need to plan; meanwhile the population need to be better informed about the measures and more involved in trainings on a regular basis. Modern ICT media should be used to communicate with inhabitants to enhance their knowledge of the adequate measures, particularly given that three quarters of all households in the area have internet access. For practical information, an informative sticker should be placed in the homes of the local inhabitants. Evacuation plans should be tested and modeled, taking into account the number of evacuees, the transportation means available, the capacity of the transport infrastructure, the planned evacuation time, critical points, and the

envisaged behavior of citizens etc.

We need to acknowledge the fact that many people will not passively follow instructions but will instead actively define the situation and attempt to find their own solutions. Therefore, the evacuation must be a balanced process that will not be too protective thereby limiting the natural resilience of the population in its resources. This means that the evacuation planning needs to be a more participatory process that not only takes into consideration people's rights but also predicts their behavior (based on studies such as ours).

In the case of a disaster, an evacuation should be declared immediately if the circumstances require and permit. The threatened population should be promptly provided with information on what has happened, who is threatened and what the adequate protective measures are. The disaster warning should be simple, comprehensible, clear, consistent, fair, and designed with a sense of empathy. The warning should be repeated several times at the initial stage of the crisis and should also include visual images.

This prompts the question whether it actually matters if more people are aware of the real threat and of the correct evacuation routes and so forth prior to a deadly nuclear and radiological incident. Would not this deficiency in information and preparedness be corrected by the government's response as soon as the emergency erupted? We believe not. We believe that such low levels of awareness and preparedness cannot be excused in light of the abovementioned IAEA requirement that an adequate level of preparedness must be maintained and that the local and national plans and supporting procedures need to be improved. By fulfilling this requirement much valuable time would be saved in the emergency phase. So too would human lives.

Acknowledgments

This article is based on the results of the research project 'Preparedness for Evacuation in the Case of a Nuclear Accident', co-financed by the EU Civil Protection Mechanism and the Krško Municipality. The authors thank to Boštjan Bajec and Živa Broder for their help in the research process.

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