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Bordering Nuclearity: Very Low-level Radioactive Wastes' Clearance and the Production of Spatial Nuclearities in Germany

Teva Meyer*

Abstract: »*Bordering Nuclearity: Freigabe radioaktiver Reststoffe und ‚Spatial Nuclearities‘ in Deutschland*«. The proliferation of concepts to qualify relations between nuclear energy and space demonstrate the difficulties encountered in characterizing them. In this paper, building on Hecht's work on "nuclearity," we postulate that understanding the geographies of nuclear energy calls for a deconstruction of "spatial nuclearities" rather than "nuclear spaces." Here we hypothesize that the production of nuclearities' limits through controversies determines the borders of spaces considered as nuclear. To test it, this article will look into debates triggered by the clearance of very low-level radioactive waste in Germany. Clearance is the administrative act of denuclearizing radioactive materials, allowing them to be recycled, reused, or disposed of in the conventional sector. Research was conducted through the analysis of local newspapers, parliamentary debates, and semi-structured interviews. Results show three dynamics. Firstly, spatial nuclearity is relational, produced through interaction between the involved actors. Secondly, nuclear power spatialities are processual, emerging from everyday operations. Thirdly, spatial nuclearity is multidimensional, depending on socio-spatial and local contingencies.

Keywords: Nuclearity, clearance, radioactive waste, Germany, dismantling, nuclear power plant.

1. From Defining Nuclear Spaces to Bordering Spatial Nuclearity

1.1 Territories, Spaces, Landscapes, or Communities? The Conceptualization of Nuclear-Space Relations

The development of nuclear technologies for power generation, weapons manufacturing, food conservation, or medical purposes has multiplied the

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places intertwined by this industry. This spatial deployment was described as a planetary unifying force having “irrevocably merged radiation with land and bodies” due to its “capacity to connect disparate geographies through its vibrant and invisible materiality” (Alexis-Martin and Davies 2017). Yet, this development has produced an archipelago of places that are unevenly nuclear. Mobilizing the concepts of “geography of sacrifice” (Cram 2016; Lerner 2012) and “nuclear colonialism” (Edwards 2011; Endres 2009; Jacobs 2013), research has documented how unequally the burden of its environmental and social consequences have been geographically distributed. If names like Hiroshima, Chernobyl, or Fukushima have become “geosymbols” (Bonne-maison 1981) of the nuclear complex, “nuclear technology also inhabits more mundane spaces” (Alexis-Martin and Davies 2017) less seldom associated with it, such as hospitals using nuclear medicines daily or food-packing facilities ionizing fruits and vegetables. All components of the atomic archipelago are not evenly considered as nuclear. Consequently, this paper aims at exploring how spaces come to be “counted as nuclear” (Hecht 2007) and separated from the conventional realm.

Once lacking integration and coherence, nuclear geography experienced a renewal in the 2010s (Alexis-Martin and Davies 2017), leading to growing theorization efforts (Alexis-Martin et al. 2021). This renewal has led to a proliferation of geographical metaphors used to signify places of the nuclear complex, such as “atomic lands” (Osseo-Asare 2016), “nuclear oasis” (Kari 2010), “nuclear community” (Hänninen and Yli-Kauhaluoma 2014), “nuclear territory” (Storm 2020), “nuclear landscapes” (Pitkanen and Farish 2018), “nuclear spaces” (Stanley 2013), and “nuclear zones” (Alexis-Martin and Davies 2017). However, these concepts rarely constitute a coherent corpus and articles do not always clearly define the expression they employ and often switch from one to another without distinction.

Nuclear spaces are distinguished by the presence of *things* related to the nuclear complex. Research either describes them as places undergoing demographic and socioeconomic reconfigurations caused by the industry (Karafantis 2014) or transformed by the presence of radiation and radionuclides (Alexis-Martin and Davies 2017). Nuclear spaces are defined by both the existence of radiation and by the human actions of measuring, controlling, mapping, and delineating (Luedee 2021). Here, *nuclear space* echoes *nuclear landscapes*, used to signify the fluidity of radiation, indicating “that these spaces are ultimately impossible to enclose” (Pitkanen and Farish 2018), blurring “boundary between contaminated and safe” (Davies and Polese 2015). Intangible and uncontainable (Masco 2004), “radiation could be anywhere, yet appears nowhere: it resides in everyday spaces and on ordinary objects” (Pitkanen 2017), thus turning nuclear landscapes into places of uncertainty (Pitkanen 2020). In contrast, *nuclear territories* are defined by the borders limiting them. For Storm (2020), *nuclear territories* are “social and industrial

enclaves,” where “due to the level of secrecy and levels of calculated risks, [infrastructure] were enclosed within well-defined security buffer zones with special restrictions.” These borders are determined through administrative categorization and judicial work to enclose spaces dedicated to nuclear operations (Osseo-Asare 2016). *Nuclear zones*, recurrently employed in accounts of Chernobyl and Fukushima, refers to well-delimited areas produced on purpose to protect society from risks (Alexis-Martin and Davies 2017; Lerner 2012; Overly 2020) and are defined by the peculiar norms, rules, and laws enforced within their limits. In this paper, we suggest bridging these two streams of literature to study the processes through which the fluidity of nuclearity is bordered and to discuss the question of how space comes to be socially counted as “nuclear.”

1.2 Nuclearity and the Process of Bordering

In her seminal book on uranium mining in Africa, Gabrielle Hecht (2012) documents how similar materials, activities, workplaces, and bodies were treated as “nuclear” or non-nuclear depending on the spatial and temporal context. Hecht proposed a conceptual distinction between “radioactive” and “nuclear,” between “being radioactive” and “being nuclear,” between “radioactivity” and what she coined as “nuclearity.” Unlike radioactivity, nuclearity “does not reside in essence [and] is not self-evident” (Hecht 2007). It is not measurable with Geiger counters or dosimeters. Nuclearity is a technopolitical classification and being nuclear implies falling under a special set of norms, both social and administrative, leading to treatments disparate from the conventional domain. Hence, nuclearity cannot be seen as clear-cut but rather as a “spectrum that shifts in time and space” (Hecht 2006), and “emerges in practices [and] rituals” (Hecht 2007). Produced by actors, nuclearity is “a regularly contested technopolitical category” depending on “history and geography, science and technology, bodies and politics, radiation and race, states and capitalism” (Hecht 2006).

Geographers have already engaged with Hecht’s proposal, to assert the fluctuating nature of nuclearity in space (Alexis-Martin and Davies 2017; Luedee 2021; Pitkanen and Farish 2018) and to serve as a basis for discussion on the negotiation of limits encompassing nuclear spaces through performance of measurements and controls (Davies 2015). These approaches call for a better understanding of the geographical processes leading to some space being “counted as nuclear” (Hecht 2006) or not. Here, we offer to bridge Hecht’s “nuclearity” with Van Houtum’s and Van Naerssen’s concept of “bordering” (2002). Bordering refers to the creation of socio-spatial distinctions built upon strategies of ordering and othering space. It is thus fundamentally relational, as it produces categories of distinction between spaces which could not exist on their own. Bordering is processual, as borders are “made through

practices, whether these are aimed at maintaining and strengthening them or at disrupting or subverting them” (Cassidy, Yuval-Davis, and Wemyss 2018). Finally, bordering is multidimensional, as practice of delimitation can take various material or immaterial forms (Bürkner 2019). Accordingly, our hypothesis is that space gets labeled and counted as nuclear through these *borderworks*, i.e., arrangements that produce locally the limits between the *nuclear* and the *conventional*. Using *bordering* as a conceptual framework, we will discuss the production of spatial nuclearity through three elements: relationality, processuality, and multidimensionality.

2. Methods and Case Studies: The Clearance of Very Low-Level Radwastes in Germany

2.1 Clearing Nuclear Wastes in Germany

To investigate the processes of producing spatial nuclearity, this paper focuses on the controversies triggered by the clearance of very low-level radioactive waste (VLLW) in Germany and on the places and spaces these materials pass through. While an extensive literature has been dedicated to the management of spent nuclear fuel and the politics of deep geological repositories (Ocelík et al. 2017; Stefanelli, Seidl, and Siegrist 2017; Kojo, Kari, and Litmanen 2010), the fate of VLLW remains understudied, even though they constitute around 90% of the total volume of nuclear waste produced in Europe (Garcier 2014). Radwaste’s categorization varies from one country to another, and their classification changes according to their origin, half-life, radiation levels, and disposal pathways. VLLW lies at the bottom of this spectrum, flirting with the threshold of natural background radioactivity. They typically come from nuclear infrastructures’ decommissioning, involving large volumes of concrete and metals, but also consisting of items (e.g., textiles, tools, and plastics) used in everyday operations.

Two modes of VLLW management coexist. The first, applied in France, considers that any substance coming from zones categorized as *radioactive* should be treated as radioactive waste and stored in purposely built disposals, regardless of their actual level of radioactivity. The second, called *clearance*, and used in countries such as Germany, Sweden, and the UK, institutionalizes levels of radioactivity below which wastes can be declassified and managed as conventional. While the materials remain unchanged, physically radioactive, it is administratively labeled as non-nuclear. But this administrative act has spatial consequences. Cleared materials are removed from any further nuclear regulatory control enforced by specialized bodies and are instead placed in the conventional sector for reuse, recycling, or disposal.

Clearances are insightful situations for studying the bordering of spatial nuclearity for two reasons. On the one hand, clearance constitutes a processual act of denuclearizing objects and places. But if it dictates what is administratively considered as nuclear, it does not prevent actors from disagreeing with this categorization. As a contested practice, clearance shows us different regimes of nuclearity and how things can remain “nuclear” for some actors even though they are in legal terms defined as conventional. These controversies constitute potentially fruitful case studies that can inform us on the arrangements producing nuclearity. On the other hand, clearance sets these materials in motion by channeling them to the conventional sector. Wastes circulate, passing through places which are usually outside of the obvious nuclear geography, such as sorting centers, municipal landfills, scrap metal smelters, and recycling plants. These flows thus bring into question the spatial nuclearity of these places, which handle legally denuclearized materials originating from nuclear infrastructures. So, when do places affected by cleared materials come to be considered as nuclear or not and by whom?

Here, we will focus on the clearance of radioactive wastes in Germany. The German law on atomic energy (*Atomgesetz*) introduces sets of radioactivity thresholds, specified for each radionuclide, below which materials can be considered as non-nuclear. Conducted since the late 1980s, clearance was organized at the Federal level through the 2001 revision of the radioprotection ordinance (*Strahlenschutzverordnung*). Defined as an administrative act, clearance authorization is not the responsibility of the federal government, but of the *Länder* and more particularly of their nuclear safety regulatory bodies. Legally, *Land* authorities can only reject demands of clearance if it breaches the obligations stipulated in federal legislation. However, the *Länder's* role is not only procedural, as the *Strahlenschutzverordnung* allows room for interpretation and adaptation. Furthermore, clearance regulation is tied to laws regulating the management of conventional wastes, which falls under the responsibility of the *Länder* and municipalities. Consequently, in Germany, clearance must be studied at these different levels. We suggest comparing two *Länder*, Baden-Württemberg and Schleswig-Holstein, the two states with the greatest number of reactors to be dismantled.

2.2 Methods and Data Collection: Assessing Clearance Controversies

In this paper, we identify the controversies triggered by the clearance of VLLW in these two *Länder*. We suggest that these conflicts constitute processes whereby spatial nuclearity is produced. We focus on tracing the circulation of these wastes after their administrative denuclearization to understand the conditions under which some conventional places come to be considered as nuclear after being crossed by these materials.

Data were collected following a three-step approach. Firstly, we gathered a corpus of articles dealing with clearance using two keywords, “*Freigabe*” and “*Freimessen*” (cleaning), on the newspapers’ aggregator of the *Deutsche National Bibliothek*.¹ Articles were then coded between those that presented cases of controversies and those that did not, and the places and actors involved were identified. In total, 141 papers were compiled, of which 93% (n=123) dealt with controversial situations. Secondly, we produced a corpus consisting of the minutes of parliamentary debates. At the federal level, we applied the above-mentioned keywords in our search at the *Bundestag* and *Bundesrat* online databases. At the *Länder* level, we used the same approach on the databases of the Schleswig-Holstein (SH) and Baden-Württemberg (BW) *Land* assemblies. The exploratory analysis of the newspaper corpus led to the identification of places, mainly municipal landfills, which were the subject of clearance controversies. We then focused the research on the databases of the involved district assemblies (*Kreistage*), that is, Ludwigsburg (BW), Karlsruhe (BW), Heilbronn (BW), Neckar-Odenwald (BW), Schleswig-Flensburg (SH), Rendsburg-Eckentörde (SH), and of their municipal assemblies (*Gemeinderäte*): Buchen (BW), Schwieberdingen (BW), Vaihingen/Enz (BW), Kiel (SH), Achterwehr (SH), Flensburg (SH), Handewitt (SH), and Harrislee (SH). We gathered material on 10 debates at the national level, 25 at the regional assemblies, 10 at the district level, and 27 at the municipal level. Thirdly, we conducted 26 semi-structured interviews with NGOs, waste managers, elected representatives, and civil servants, mainly with actors situated at the *Länder* level.

3. Localized Controversies and the Spatial Nuclearity of Cleared Wastes

3.1 Relationality: The Spatial Unevenness of Cleared Wastes’ Nuclearity

Press corpus data trace a clear spatialization trend for the papers dealing with clearance controversies. The breakdown of articles between newspapers and places of publication, summarized in figure 1, shows aggregation in Schleswig-Holstein, Baden-Württemberg, and to a lesser extent Lower Saxony and Hesse. Clearance is not discussed in *Länder* where the nuclear industry is absent, and the presence of closed nuclear power plants coincides with a larger number of articles. The existence of a soon to be, or currently, dismantled reactor does not systematically translate into a greater number of articles on clearance controversies. Similar trends appear in the parliamentary minutes.

¹ This research was conducted up until May 16, 2018.

for deconstruction rubble located within the district's borders. If the district does not possess such facilities, it can either build one or negotiate with a neighboring district to export the cleared wastes. Furthermore, when significant volumes of wastes are to be conditionally cleared following the dismantling of large infrastructure, the *Land* authority can impose a distribution of the materials across several licensed landfills outside of the district so that radioactivity does not overburden one place.

Material flow analysis conducted by nuclear power plant operators prior to dismantling operation estimates that these conditionally cleared gravels represent less than 3% of the total weight of the cleared wastes (Gesellschaft für Anlagen- und Reaktorsicherheit 2017). However, the places crossed by the 97% remaining materials, which are unconditionally cleared (e.g., scrap metals sorting centers, smelters, or gravel recycling plants), seem not to trigger controversies. This also applies to the parliamentary debates, where the conditionally cleared gravels constitute the only subject of debate at all the studied political levels, from the federal to the local. Interviews with national NGOs show a similar trend.

The spatiality of clearance thus traces an uneven geography. Municipal landfills are the only type of facility where the handling of cleared nuclear wastes generates controversies. Spaces where unconditionally released wastes are handled, managed, and treated are not conflictual and are not socially nuclearized. This is confirmed by the geographical repartition of collected articles at the infra-regional level (figure 2 and 3). Papers are predominantly published in the direct vicinities of municipal landfills licensed to receive conditionally cleared wastes. It is also reflected in the district and municipal parliamentary debates, which occur almost only in towns hosting landfills and not in those where dismantled power plants are located.

Figure 2 Distribution of Controversies on Cleared Gravels in Baden-Württemberg

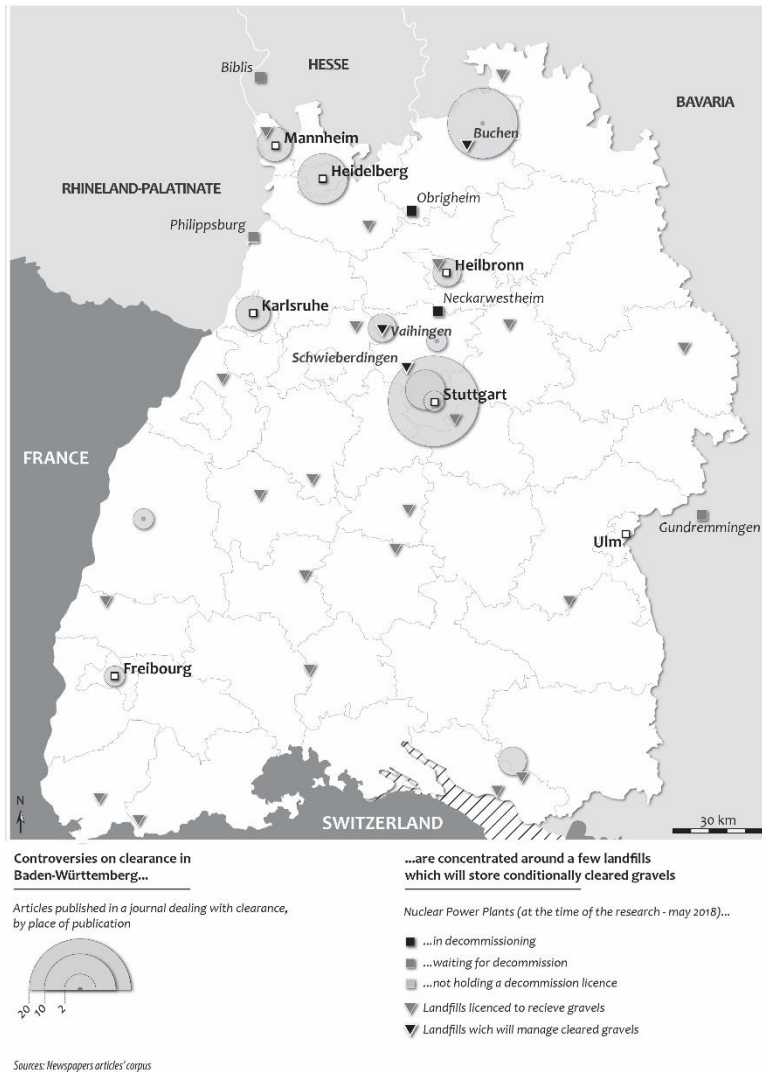
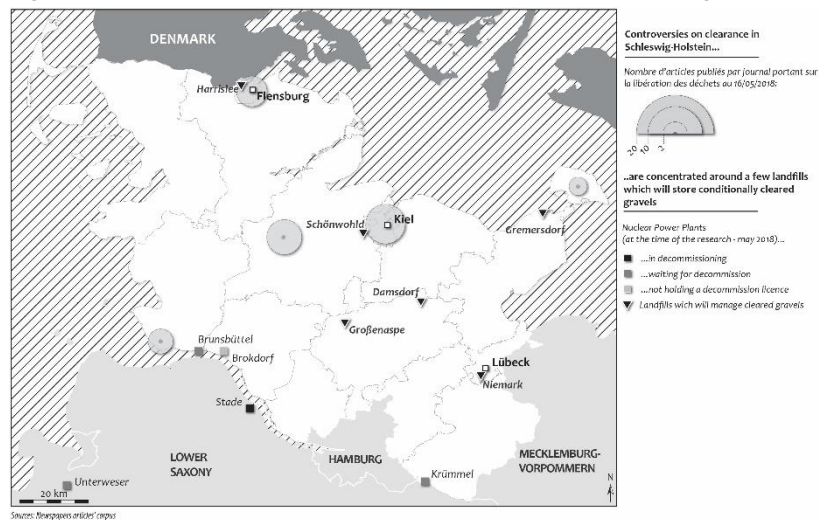


Figure 3 Distribution of Controversies on Cleared Gravels in Schleswig-Holstein



3.2 Processuality: Controversies against Disposal in Municipal Landfills

The intensity of these local controversies reached a point where the *Land* authorities in Schleswig-Holstein and Baden-Württemberg had to enforce a temporary moratorium in 2017 and 2018 on reactor dismantling to sort out the landfill issue. Data show that these conflicts do not equally concern all municipal disposal sites which were to receive cleared gravels. Six landfills were licensed for these materials in Schleswig-Holstein (SH) and twenty-four in Baden-Württemberg (BW). In SH, the article corpus shows that controversies happen predominantly concerning two landfills, Harrislee and Schönwohld, located close to the two largest cities of these *Länder*, Flensburg and Kiel, respectively. In BW, conflicts are centered around two disposals: Schwieberdingen (northwest of Stuttgart) and Buchen in the north, close to the Bavarian border. In both *Länder*, disposal sites are either managed by private companies contracted by the district or directly by municipal utilities. We find a similar pattern in the parliamentary minutes. In both *Länder*, only the districts where the above-mentioned landfills are situated show debates about the clearance of the wastes. This is particularly relevant in Schleswig-Holstein, where the authorities have unilaterally decided to distribute the cleared materials across all of the *Land's* licensed disposal sites, whether they are situated in a *district* hosting a dismantled nuclear power plant or not.

Debates show a variety of political reactions. In Harrislee, the three groups in the town council, the SPD (Social Democratic Party of Germany), the CDU

(Christian Democratic Union of Germany), and the SSW (Federation of Voters of Southern Schleswig), unanimously passed a motion against the disposal of dismantling waste in their municipality. The municipal council of Achterwehr, where the Schönwohld landfill is located, has also taken a stand against disposal. As early as 2013, the municipality of Kiel, which is in charge of this disposal site, had changed its acceptance criteria and operating rules to prevent the arrival of cleared gravels. In, BW, elected representatives of Neckar-Oldenwald district, where Buchen is situated, and of Ludwigsburg, home of the Schwieberdingen landfill, unanimously voted a motion calling the *Land* authority to reconsider alternatives to the disposal of the gravels. In the two municipalities of Schleswig-Holstein, citizens' initiatives (*Bürgerinitiative*) were created to protest against the arrival of cleared gravels: the *Bürgerinitiative Atommüll Einlagerung Stopp* (BAESH) in Harrislee et la *Bürgerinitiative Keine Atommüll* (KAMIS) in Schönwohld. Similar dynamics appeared in Baden-Württemberg where two citizen initiatives, *Interessengemeinschaft Deponien Froschgraben Schwieberdingen und Burghof Horrheim* and the *Bürgerinitiative Gegen Müllgeschäfte*, were founded.

All municipal landfills are thus not equally considered as nuclear and treated as such, even though they receive the same cleared wastes. How can we explain these differences in the ways of “bordering” the spatial nuclearity of disposal? Why do controversies about the nuclear/conventional nature of space emerge in specific places?

3.3 Multidimensionality 1: Between Common Ground against Clearance...

From a material standpoint, all licensed landfills should manage approximately the same amount of waste produced by the decommissioning of nuclear power plants. This is particularly the case in Schleswig-Holstein where the *Land* decided to share the burden equally between all available disposal sites. The situation is slightly different in Baden-Württemberg, where the regional authorities allowed for concentration of wastes in disposal sites in districts where phased-out nuclear reactors are located.

Political differences cannot explain the spatial fluctuation of controversies, either. Overall, the parliamentary debates show a cross-partisan opposition to the clearance of the gravels. At the national level, debates are quasi-inexistent and the only dissenting voices come either from elected representatives of the FDP (Free Democratic Party) and the AfD (Alternative for Germany) particularly in BW, who use clearance as a tool to criticize the nuclear phase-out policy, or from Die Linke (The Left Party). At the district level, the politicization of clearance emerged from all sides: Die Grünen (The Green Party), Die Linke, FDP, AfD, SDP, and local parties. At the municipal level, debates on clearance are systematically introduced by town mayors with the

support of all members of the assembly, regardless of their political background.

Consequently, similar arguments can be found across actors mobilized against the disposal of cleared nuclear gravels within conventional landfills. Firstly, all oppose the very principle of clearance and the administrative act of denuclearizing materials. Their objective is to affirm the nuclear nature of these wastes by constantly recalling their spatial origin and referring to them as either “nuclear waste,” “nuclear demolition waste,” “atomic waste,” or “waste sourced from nuclear power plants”:

These wastes are only nuclear because they are controlled under specific nuclear laws. Consequently [...] these wastes are just magically conventional after their clearance. It’s not alchemy, it’s only law! But they are still radioactive. When we choose to qualify these wastes as nuclear, it’s not provocation but a necessity.²

This contestation is rooted in an opposition to the concept of harmlessness of chronic exposure to very low doses of radiation, which serves as a justification for the clearance of nuclear waste. The control of the radioactivity levels of these materials prior to clearance is also criticized, either by doubting about the technical ability to measure all radionuclides or by rejecting the statistical models used to control the activity of radionuclides which cannot be directly and physically measured:

Chronic exposure to low doses of radioactivity is like asking: after how many glasses of schnaps is a liter of beer no longer dangerous for your health? Or like, is smoking harmless if you inhale exhaust gas at the same time?³

Risks of conflicts of interest during measurement and monitoring frequently arise in these discourses. Opponents complain about the lack of transparency in the external companies hired to carry them out. They consider that, since the plant operator has an interest in releasing most of its wastes to lower management costs, the fact that they select and finance third-party companies to conduct these measurements eventually undermines confidence in the data produced. This issue is central in Baden-Württemberg, where the *Land* is at the same time responsible for issuing clearance permits and a majority shareholder through the company operating the plant.

Secondly, opponents contest clearance, advocating for alternative ways to spatially manage nuclear risk, in such a manner as to avoid the dissemination of radioactive materials. All these alternative propositions are based on the idea to aggregate wastes in already delimited nuclear places by either keeping them within the boundaries of the decommissioned nuclear power plants or by centralizing them at a national disposal facility, mimicking the strategy used for high-level radwaste:

² Interview with BAESH militant, September 2018 (translated by the author).

³ Interview with militant in Büchen, November 2018 (translated by the author).

You'll laugh, but for once, we believe that the French solution is the best concerning nuclear problems! We should copy Paris, stop clearing wastes and gathering all at a central disposal site.⁴

Thirdly, opponents convoke environmental and spatial justice to reject disposal in municipal landfills, considering that municipalities that hosted the nuclear power plants and benefited from taxes and jobs that such plants provide should also bear the burden of their deconstruction wastes:

Why should wastes coming from the dismantling of Neckarwestheim be distributed to disposal sites in Schwieberdingen or Horrheim? It would make much more sense to leave them where they are and where people benefited from the plant.⁵

Fourthly, in all three corpora we gathered, controversies relate to the conventional/nuclear nature of the cleared materials, involving confrontation of views concerning either the thresholds for radioactivity levels to be considered safe or the validity of the radioactivity measurements made prior to their clearance. According to critics, although cleared materials are legally defined as conventional waste, their presence turns a municipal landfill into a nuclear waste disposal site:

You know, it's not because you call it a chicken that a cow starts laying eggs. People know where these gravels come from. We have lived next to these nuclear power plants all our lives; it's not rocket science. [...] Our disposal will become as Gorleben.^{6,7}

Here, what makes spatial nuclearity is the administrative categorization of matter, which constrains not only their trajectories after being cleared, but also and most importantly, the existence of information that allows locating them in space. Unconditionally released wastes join the flow of conventional materials with which they are blended, thus becoming untraceable. By contrast, the law requires that conditionally cleared gravels be managed within well-bounded spaces, by clearly specified actors, which crystallize controversies. So, it appears that spatial nuclearity is not primarily determined by actual discussions on the waste's characteristics but more by the ways in which the legal framing of clearance organizes the spatial information:

Nuclear or not? Is it only a question of perspective? The minister for the environment will tell us that something which is below the clearance threshold is not nuclear anymore. Well, the state does not monitor what is radioactive, it is what the states monitor that magically becomes radioactive!⁸

⁴ Interview with a BAESH activist, September 2018 (translated by the author).

⁵ Intervention by the CDU local group, Schwieberdingen municipal assembly, 2017.

⁶ Gorleben is the municipality in which the German authorities have, for several decades, sought to site the facility for underground disposal of spent nuclear fuel. These attempts have failed, largely due to persistent local opposition.

⁷ Interview with an activist in Schöwohld, September 2018 (translated by the author).

⁸ Interview with BAESH activist, September 2018 (translated by the author).

3.4 Multidimensionality 2: ... and Local Peculiarities

Alongside these shared views, the controversies show differences depending on socioeconomic peculiarities, temporal contexts, and the historicity of local mobilizations. Harislee epitomizes the role of socio-spatial configurations in the nuclearization process. Elected representatives opposed the transfer of gravels, fearing that this would damage the region's nature-centered image that was purposely built to sustain its recent economic diversification towards the tourism industry. The landfill's location at the Danish border also fueled controversy. As Copenhagen put antinuclearism at the center of its national policy and diplomacy since the 1970s, German politicians worried that cleared gravels could endanger the transborder relations. Danish local authorities complained to their German counterparts, accusing Berlin of breaching the European conventions on public consultation and participation relating to infrastructure projects with potential transboundary environmental impact. Disposal of cleared nuclear gravels was described as a fundamental change in the nature of the landfill and would thus give the Danes the right to participate in decision-making. However, this plea was never taken up to any court, whether national or European.

They [the Danes] are not happy with the way we're imposing it, without any discussion. [...] Who can blame them? We would do the same if someone put a reactor at the border. [...] But now, it has become a thing that appears during every discussion with Aabenraa municipality, in any project we want to make together, you can be sure that they'll talk about the landfill.⁹

Furthermore, Harrislee is one of Flensburg agglomeration's wealthiest neighborhoods. Its inhabitants feared that the arrival of cleared nuclear gravels and its potential mediatization would lower the property values in the area.

Nuclearization is also conditioned by the spatio-temporal context. The politicization of the clearance in 2019 in Baden-Württemberg happened in the early days of the campaign for the municipal and the district elections, putting the issue at the center of the debates. Both *Länder* were, at that time, ruled by coalitions where The Green Party held a central position. Candidates of the other parties at the local level used the clearance of gravels to criticize the modalities of the nuclear phase-out policy which they associate with the Greens.

Finally, controversies emerged in places with well-established citizen movements. In Schleswig-Holstein, the mobilization by the neighbors of the landfill had been emulated by the strong network of antinuclear citizen initiatives (*Bürgerinitiativen*) continuously active since the 1970s. Militants linked the clearance issue with past mobilization over chronic exposure to low doses of radiation in the *Land*. During the 1980s, debate arose in Schleswig-Holstein

⁹ Interview with Flensburg elected representative, September 2018 (translated by the author).

following the publication of an epidemiological study that showed abnormally high cases of child leukemia in the vicinity of the Geesthacht nuclear power plants. While the causes of this “*Leukämiecluster Elbmarsch*” were never scientifically demonstrated, voices pointed towards the exposure to routine radioactive release:

It really feels like it is an ever-repeating story. In Elbmarsch, they already told us that cancer was not due to low doses, and now, they want us to live nearby it again and accept it.¹⁰

In Baden-Württemberg, anti-clearance mobilization also benefited from the presence of a well-organized antinuclear movement headquartered near the landfill. In Schwieberdingen, opposition was firstly structured thanks to the work of a neighbor who was also a member of the German chapter of the *International Physicians for the Prevention of Nuclear War* (IPPNW). This NGO fought in 2001 against the reform of the Radioprotection Ordinance, which codified clearance at the federal level and financed the assessments concerning their potential risks and dangerousness. Finally, in Ludwigsburg District, opposition emerged as a follow-up to a previous conflict between the local authorities and the residents over the discovery of industrial wastes containing asbestos in the landfill.

4. Conclusion: Coexisting Regimes of Spatial Nuclearity

When does spatial nuclearity occur? In this paper, by taking an actor-centered approach, we considered that space is nuclear when involved agents treat it as such. Different regimes of spatial nuclearity thus coexist in time and space. Places can be simultaneously nuclear for some agents but conventional for others and their nuclearity can shift in one way or another. Places can be administratively conventional but socially nuclear for certain actors. Investigating the clearance of very low-level radwastes and the different nuclearization of places they crossed through the frame of “bordering,” we identified three main dynamics.

Firstly, consistent with the concept of bordering, spatial nuclearity is relational. The landfill’s nuclearity is revealed during negotiations, tensions, and frictions between actors. Harrislee, Schwieberdingen, and Schönwohld became nuclear as the presence of cleared materials triggered disputes fueled by the narratives of citizen organizations. Space tends to be labeled as nuclear when such narratives become dominant and silence opposing discourses. On the contrary, absence of such dynamics concerning other landfills or places crossed by unconditionally cleared wastes led these places to be treated as non-nuclear. Relationality is likewise spatially inscribed. Opponents to

¹⁰ Interview with KAMIS militant, September 2018 (translated by the author).

clearance argue that for a landfill to remain conventional, places where reactors were localized should remain nuclear and keep the wastes. As bordering, spatial nuclearity resides in the mechanism of othering that distinguishes between ordinary and abnormal spaces.

Secondly, spatial nuclearity is processual. A place's nuclearity is revealed in everyday operations. The landfills became nuclear before the gravels were even set in motion. But is spatial nuclearity unconditionally material? The German case proves that places crossed by legally denuclearized substances are not all evenly considered and treated as socially nuclear even though they are physically and chemically identical. Nuclear materiality is thus not a necessary and sufficient condition of spatial nuclearity. The spatial nuclearity of landfills emerged in the multiple actions or demonstrations organized by militants and surfaced via the controversies on statistics and measurements. It also fundamentally resides in generalization processes. Activists point to the presence of discrediting aspects – here potential contamination through gravels – and extend it to a larger space, fearing that the social nuclearity of the disposal site will stain their neighborhood. Spatial nuclearity exists through the ritualized application of differentiated policies, treating these places as uncommon, distinct from normal spaces.

Thirdly, spatial nuclearity is multidimensional. Factors constituting spatial nuclearity are manifold because they are contingent on actors producing it within a particular spatiotemporal context: local socioeconomic configurations, actor networks, heritage of previous controversies, etc. Besides these specificities, our research highlights that spatial nuclearity is embodied in mundane actions, far from the exceptionalism attached to nuclear issues (Hecht 2010).

Finally, spatial nuclearity cannot be assessed without questioning *agency*. Research on nuclearity, especially on nuclear colonialism (Endres 2009), and territorial stigmatization both regard these categorizations as processes enforced by dominant actors to preserve their authority. However, this approach tends to deprive locals of their capacity of action. I argue that documenting spatial nuclearity calls for a greater integration of the concept of *agency*, defined as the actor's ability to initiate and maintain a program of actions independently of the constraining power of social structure (Campbell 2009). The gravel case illustrates the role of agency. Local actors, militants perceiving political opportunities, are responsible for the continued nuclearization of the landfills, while dominant players – essentially, the federal state – retained a denuclearizing narrative. Spatial nuclearity cannot be only understood as a category imposed from above as it is also coproduced by multiple agents, motivated by strategic agendas.

Why does switching from nuclear spaces to spatial nuclearity matter? Beyond the pun and the scholarly discussion on nuclear geography, there are a growing number of practical issues. The International Atomic Energy Agency

(IAEA) counts 193 nuclear reactors and 47 commercial nuclear power plants permanently closed in the world as of June 2021 (IAEA 2021). Dismantling strategies balance between the “greenfielding” goal, that is, immediately and totally obliterating material traces of the nuclear infrastructure leaving space for unrestricted use, and different shades of “brownfielding,” which would keep the industrial and possibly even the nuclear characteristics of the area. These choices frame the trajectories of places, precluding or opening future options. The material erasure which underlines greenfielding aims at switching concerned space ontologies from the nuclear to the post-nuclear. But this article shows that nuclearity survives beyond its own materiality. Space will be nuclear as long as actors treat it socially and narrate it as such.

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