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What is good drinking water? 41 Years of risk perception on water quality in the vicinity of the Nuclear Research Centre Karlsruhe, 1956–1997

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Abstract

This article traces the historical evolution of risk perception around the Nuclear Research Centre Karlsruhe, Germany, from 1956 to 1997. It does so by targeting the evolution of water-related risks. Federal hopes in the postwar era that the Nuclear Research Centre would bring progress and prosperity clashed with local values and local perception of nuclear engineering as dangerous to health and the environment. Various conflicts arose and opponents made use of their past lived-knowledge to foster their arguments against future decision-making, mobilizing stories from the past to shape the future. The conflict culminated in the 1990s, when the municipality decided to lease the Centre's waterworks for future drinking water supply. The main argument of the article is that even though the public discourse shifted over the years from water pollution toward greater risks such as nuclear meltdowns, the local risk perception stayed with the water-related risks. The article shows how the locals perceived and narrated their risk perception against the decision-making of authorities as well as against the reasoning of scientists and experts.

KEYWORDS

drinking water, Rhine river, risk narratives, risk perception, water quality

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INTRODUCTION: THE COMPLEX HISTORY OF WATER CONFLICTS AROUND THE NUCLEAR RESEARCH CENTRE

Drinking water in Germany is usually praised as the best-controlled food that can be enjoyed almost without exception. What constitutes high-quality drinking water is defined by law and, according to the German Institute for Standardisation, drinking water should "inspire enjoyment, in other words, it should be colorless, clear, cool and odorless as well as tasty" (Deutsches Institut für Normung, 2017). Since this food is one of the basic human needs, it receives special social attention. Apart from the central role of water for humans' consumption, water also plays a central role for industry. The Rhine in particular, with its many different functions ranging from navigation and transport to hydropower and electricity generation, waste disposal, drinking water supply, and supply of cooling water for the industry as well as to fishery and irrigation of crops has proven to be a site of conflicting interests (Cioc, 2002).

A significant water conflict developed over the period of 41 years around the Nuclear Research Centre in Karlsruhe. It started in 1956, when the idyllic Rhine valley in the borderlands between Southwest Germany and France was turned into Germany's nuclear capital with the siting of the Nuclear Research Centre in Leopoldshafen north of Karlsruhe. The local community feared a decrease of water quality. This perceived water risk ran like a thread through the history of the Nuclear Research Centre and the local society.

Local concerns over water quality soon led to a conflict between the local population, the Nuclear Research Centre, and the local as well as state authorities. The conflict culminated in the 1990s, when the mayor of Eggenstein-Leopoldshafen decided first to lease the Nuclear Research Centre's waterworks and later to purchase it for the municipality. The takeover became a strategic component in the municipality's long-term water supply strategy (Ingenieurbüro Müller 1993), which aimed at modernizing the local drinking water supply and securing it for the future. During the later phases of the conflict, opponents cited past violations of rules and interpretations of limit values as the basis for their counter-arguments.

In 2012, the historians of technology Rolf-Jürgen Gleitsmann and Günther Oetzel wrote in the foreword to their book *Fortschrittsfeinde im Atomzeitalter* (Enemies of Progress in the Nuclear Age) that little had changed in the public and media perception of the Hardtwald communities' resistance since the 1950s. As before, the citizens were perceived as troublemakers who clung to the past. The public perception was contrary to the self-image of the individual opponents, who did not even necessarily see themselves as opponents to nuclear power; they merely had a more pronounced and critical environmental awareness than some decision-makers. This article shows how and why the opponents and their rhetoric were not taken seriously at any point during the 41 years at focus here. Even though they repeatedly used stories from the past to make their arguments more meaningful, they were not believed or their risk perceptions were perceived as exaggerated.

Conflicts over water resources tend to be political and public involvement in water matters is often dismissed by scientists as well as authorities (Agnew, 2011). Furthermore, water quality remains a marginalized field of research in the social sciences compared to water quantity (Karpouzoglou et al., 2018; Rusca et al., 2017). Even the historical sciences have not given water quality the attention that would correspond to the importance of the topic. Especially in the so-called global North, good water quality has usually been taken for granted and hence has rarely been problematised. Little attention was paid to water quality because it was usually not

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objectionable. In the United Kingdom, for example, responsibility for water lay with administrators, scientists, and lawyers. However, trust in these institutions has begun to crumble in recent years due to the threat of privatization, climate change, and various environmental toxins (Hamlin, 1990).

More attention, on the other hand, has been paid to individual extreme cases of water pollution. These include, among others, oil spills (Johnson, 2019), spills of toxic pesticides (Schiff, 2017) as well as industrial pollution in general, and radioactive contamination (Avenell, 2012). Even though radioactive pollution and radiation protection has received considerable attention in history (Kalmbach, 2017), the deeper entanglement between water and nuclear engineering has been mostly disregarded (Högselius, 2022).

Research on the perception and communication of technological risks dates back to the 1970s, and not much has improved in terms of effectiveness to date. Residents still do not want to have risky technical installations in their neighborhood, which most likely has to do with the fact that politics and industry still do not address the needs of those affected, but only provide information about the potential risks (Fischhoff, 1995; Löfstedt, 2003). Especially the accidents at Chernobyl and in Fukushima have shown that politicians and the nuclear industry still need to work on their communication strategies (Slovic, 2012). This article is intended to contribute to a better understanding of long-term risk perceptions of the local population. This should serve to preventively include communicated risk perception of radioactive radiation in future risk communication strategies.

Research on risk perception was increasingly carried out in the 1970s and 1980s, coinciding with the increased planning of nuclear power plants. In Germany, the protests against the Wyhl nuclear power plant in particular marked a caesura, which stood for increased resistance against the authoritarian energy policy of the Federal Republic. Increased resistance to the Federal Republic's energy and research policy, on the other hand, already existed in the second half of the 1950s. The example of this protest will be used to show that risk perception and the resulting protest movements do not only form in the short term, but establish themselves over a long period of time. Social movements use historical events to give their current arguments more impact. Opposing actors are not always aware of these events. Moreover, social movements act on behalf of a larger community that does not necessarily take action. An already existing social movement therefore offers disgruntled actors the opportunity to engage in a larger goal. These different events are then linked together to strengthen the scope of the opposition (Tilly, 2006).

The next section conceptualizes risk and risk perception as well as risk narratives. The ensuing sections then use this theoretical framework to analyse the case of drinking water supply in the vicinity of the Nuclear Research Centre. The story is told backward, beginning in 1997 with the public hearing on the municipality's decision to lease the waterworks Tiefgestade from the Nuclear Research Centre. In the following, the episodes from the 1950s and 1970s are recounted to understand the argumentation from the 1990s. This antichronological narrative serves to clarify the importance of history for the opposition.

Understanding risk perceptions and risk narratives

Research on risk perception has its origins in decision-making and psychology. Both fields are still dominant in this area of research (Slovic et al., 1982). In most cases, these are time-limited snapshots of risk perception. This contrasts with the historical

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approach, which is the focus of this article. The following paragraphs are intended to introduce the theoretical framework of risk perception research to set the foundation of this article in a clear context.

By exploring water-related risk perceptions and narratives around the Nuclear Research Centre, I attempt to illustrate the complex issue of perceiving risk and uncertainty as well as the long-term evolution of risk narratives. This should then lead to a better understanding of the risk perception of the local population and ultimately to better policies (Slovic, 1987).

In a pluralistic society, there cannot be one approach to risk (Sellke & Renn, 2011). Risks are manifold and so are the perspectives on them. Furthermore, the risk potential is often perceived differently and many risks cannot be assessed concretely, because there is simply a lack of knowledge about them (Sellke & Renn, 2011). What a risk, in general, is, how it is debated and what is (not)considered a risk is decided by human actors (Renn, 2008). In this article, I define risk as referring to the uncertainty that an action or object poses. Uncertainty refers to possible consequences and outcomes that pose a threat to something that people value (Aven & Renn, 2009). The undesired events that risks relate to lie in the future, but their impact is already evident in the present, as it is often only a matter of time before they occur (Beck, 1986; Mairal, 2020).

It is not easy to define or measure how grave the outcome will be and neither is the uncertainty (Riesch, 2012). This pertains in particular to environmental risks as the environment cannot speak for itself. Even if a significant environmental problem exists, it is not necessarily picked up by society. This can for example apply to nonvisible environmental problems such as radioactive contamination (Beck, 1986; Kupper, 2003; Sörlin & Wormbs, 2018). However, subjective perception does not guarantee that an environmental issue is actually perceived as a risk. To be perceived as a risk, a problem needs to be discussed and brought to the attention of a wider audience (Beck, 1986; J. X. Kasperson et al., 2003). The societal conflict here then is that people have different understandings of what can be put at risk and what cannot (Sellke & Renn, 2011). Nevertheless, it is often the case that risks are first and foremost ignored or talked down (Beck, 1986).

Even though risk is dependent on values and needs to be constructed, the damage caused by a risk that actually gives rise to an undesired event is real. How risk is countered also depends on the power to act and the will to tackle a risk (Sellke & Renn, 2011). This dichotomy makes risk communication difficult. As the public usually prefers not to be confronted with the unknown, experts need to decide which part of the uncertainty should be communicated. It is not called for a full disclosure of all uncertainty experts are dealing with. However, it is important to communicate the most important uncertainties of a decision-making process (R. Kasperson, 2014). Apart from that, there is the question of which narratives are dominant and who gets the opportunity to tell stories that are also being heard. Often it turns out that the widely carried narratives do not necessarily correspond to the reality of those affected on the ground, as those in power shape the story and get to interpret the event (Mayer, 2017).

Risks become tangible by being told and therefore emerge through narratives and stories as well as imagination (Mairal, 2020; Mayer, 2017). With narratives and stories, people explain and understand the world around them. Despite the fact that narratives play such a central role in how people understand the world, risk narratives have not been given sufficient importance in scholarship (Heise, 2008; Mayer, 2017). Through stories, impressions and feelings are communicated and shared. Although narrative culture does not necessarily have a defining effect on a community, it does make the community more positive and receptive to stories (Mayer, 2017). Narratives are

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shaped by the environment, but they also help people to understand the world anew by shifting power imbalances or introducing new social practices (De Fina & Georgakopoulou, 2015). Narratives therefore not only communicate risks, but also create them. Because by means of risks and dangers, good and interesting stories are also told (Mayer, 2017). Moreover, narratives function retrospectively as a form of understanding and grasping (Freeman, 2015). Thus, risk narratives connect the three levels of time: the past, the future, and the present.

Historicizing risk is valuable in way of gaining a deeper understanding of local resistance against nuclear sites. Risk perception is not a linear process and relies heavily on communication processes as well as the recognition of different value systems. Often, social science research on resistance against nuclear siting remains in the moment (Boudia & Jas, 2007; Lash & Wynne, 1992), even though historians have shown that there is a deeper history behind the opposition (Mohun, 2016). Additionally, historical research often lacks both a theorization and a conceptualization of the issues portrayed. It is not sufficient to place risk perception in a larger historical context; it must also be interpreted more deeply. The fact that historians deal with risk and risk perception is still a relatively new phenomenon. Mostly, historians use theories from the social sciences (Itzen & Müller, 2016).

This article aims to contribute to this still rather new field of research in history and to analyse historical events in more detail with social science theories on risk perception. The emphasis is nevertheless on history as "the historian's historical temporality is longer than 'the thirty years gone by'" which is used as a historical reference by, for example, Beck and other social scientists (Boudia & Jas, 2007). Furthermore, although many disciplines of the social sciences deal with risk conflicts, decision-making, and the like, the phase before the occurrence of the controversy is often not included in the analysis (Boudia & Jas, 2007). Being able to understand where increased risk perceptions come from, how it came to increased resistance, but also which mistakes could have been avoided, paves the way for understanding cooperation and for finding sustainable solutions.

Methodologically, this article is situated in qualitative historical research and is based on published and unpublished writings. The archival materials come from the General State Archive Karlsruhe and the Main State Archive Stuttgart, which both are part of the State Archives of Baden-Württemberg. In addition, interviews were conducted with actors from the early nuclear opposition as well as from the 1990s in Karlsruhe and surroundings.

The Water Concept 2000

In 1992, Eggenstein-Leopoldshafen started debating the long-term supply of drinking water for the municipality. The majority of its water needs was at that time obtained from three wells of the waterworks Hardtwald in Eggenstein (766,430 m^3 in 1991) and from two wells of the waterworks Viermorgen in Leopoldshafen (153,863 m^3 in 1991) plus external procurement from the Nuclear Research Centre's waterworks Tiefgestade (77,650 m^3 in 1991) (Bürgermeisteramt Eggenstein-Leopoldshafen, 1992). The supply from Tiefgestade covered the peak-period demand of Eggenstein-Leopoldshafen. This arrangement dated back to a decision made in 1977. At that time, it was foreseeable that the municipality of Leopoldshafen would suffer from a water shortage in the summer due to population growth. Thus, the company magazine of the Nuclear Research Centre stated: "By means of a contract between the municipality and the Nuclear Research Centre, the prerequisites have been created for

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establishing the necessary facilities for transferring drinking water from the Rhine water pipeline between the waterworks of the Nuclear Research Centre in Tiefgestade and the Nuclear Research Centre to the waterworks of the municipality of Leopoldshafen"[1] (Kernforschungszentrum Karlsruhe, 1977).

Even though the water supply for the municipality was generally sufficient, they expected to be growing in population from 13,500 people in 1993 to 20,000 people in 2005 (Ingenieurbüro Müller, 1993). With the Water Concept 2000 the municipality wanted to plan ahead. The initial idea was to build a fourth well in the Hardtwald waterworks. However, as the Viermorgen wells were in a housing development zone which would eventually interfere with the planned water protection zone, and the generally low water supply from these wells meant that experts could not guarantee long-term water supply. Furthermore, new wells would have to be built. At the same time, in the previous years the Nuclear Research Centre had been experiencing a decrease in water demand, so it was desirable to lease and maybe later sell their waterworks Tiefgestade. These wells were already fully functionable, the supply lines were also already in place and had been recently overhauled (Bürgermeisteramt Eggenstein-Leopoldshafen, 1992; Gemeinde Eggenstein-Leopoldshafen, 1992). The idea then emerged that leasing the Tiefgestade wells could be of mutual interest to the municipality and the Nuclear Research Centre.

In 1993, Eggenstein-Leopoldshafen submitted a proposition for water catchment for long-term water supply. The municipality would lease the Tiefgestade wells and close down the wells at Viermorgen in Leopoldshafen. The municipality's drinking water then would be a 50:50 mix of Tiefgestade and Hardtwald water (Bürgermeisteramt Eggenstein-Leopoldshafen, 1992; Ingenieurbüro Müller, 1993). The water produced at Tiefgestade consisted partly of groundwater flowing underground into the Rhine and partly of bank-filtered Rhine water. The ratio varied with the water level of the Rhine, the amount of inflowing groundwater, and the rate of withdrawal.

Tiefgestade had originally been planned as a cooling water supply for the Nuclear Research Centre's multipurpose research reactor, which went critical in 1965 (Kernforschungszentrum Karlsruhe, 1977; Sperling, 2006). The Tiefgestade facility was supposed to provide between 450 and 500 m^3 of water per hour for the reactor, but also for drinking and industrial needs. Since the existing waterworks already did not provide enough water, it was envisaged that the Tiefgestade waterworks would initially be designed for 1000 m^3/h and as a final capacity 160 m^3/h of water for the Centre's facilities (Regierungspräsidium Karlsruhe, 1962; Wirtschaftsministerium Baden-Württemberg, 1962).

The water quality of Tiefgestade had been discussed already in 1977. The Nuclear Research Centre stated in their inhouse newspaper that bank filtration, which was determined by the distance of the wells from the bank of the Rhine, their distance from each other, and the quantity of water drawn off, ensured adequate purification (Kernforschungszentrum Karlsruhe, 1977). Two years later, the Nuclear Research Centre was a little more open about the water quality of the bank-filtered Rhine water. In a letter to the working group "water" of an environmental citizen action the Centre stated that Tiefgestade's production capacities were not fully exploited due to the impaired quality of the Rhine bank-filtrate water (Kernforschungszentrum Karlsruhe-Öffentlichkeitsarbeit, 1979).

Even though water from Tiefgestade had been used for various purposes since the 1960s and Tiefgestade even supplied surplus water in times of need, the mayor's 1992 decision to lease the waterworks was met with strong criticism from locals and environmentalists. Opponents specifically criticized the close proximity of the Tiefgestade wells to the Rhine River. In the view of a local citizens' initiative,

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pollutants originated in particular from the Rhine bank filtrate. The Nuclear Research Centre also discharged wastewater into the Rhine lowland canal and these discharges had not been conclusively addressed with regard to their impact. Opponents of the decision used missteps and malpractices from the past in their argumentation to highlight the lack of trust between the Nuclear Research Centre, the state, and the citizens.

The following paragraphs examine the conflict situation in the 1950s and 1970s, to provide context for the conflict during the 1990s. The 41-year long conflict culminated in a hearing of the drinking water case in 1997. Despite the fact that the conflict between the municipality and the mayor as well as the local population seemed to reach its peak in the 1990s, an increased perception of risk regarding the municipality's water supply and the planned Nuclear Research Centre was already evident in the previous decades. The way in which risk perception developed from the late 1950s to the 1970s will be presented here.

Germany's bright nuclear future and the Rhine as its main site

After the Second World War worries arose in Germany that the country might not be able to keep up with the technological progress of other countries. One way for the elites of science, technology, and politics to respond to this problem was to call for the establishment of a nuclear program. Physicists like Werner Heisenberg perceived nuclear energy as a solution to all pressing societal questions after the war and nuclear research centers were seen as a basis of Germany's nuclear future. He predicted that the nuclear industry would make Germany competitive again and nuclear research centers would play a major role in its development. In the time after the Second World War, the greater public associated nuclear energy mostly with nuclear bombs (Laufs, 2018; Mignon Kirchhof & Trischler, 2020). However, the opinion on nuclear power in the scientific community differed greatly during the atomic age. Some scientists were very critical, but other (nuclear) scientists painted a utopian picture of the nuclear future. This was necessary as nuclear technology was enormously expensive and needed to be funded with tax money (van Lente, 2012).

The public perception of nuclear energy worldwide shifted from fear to euphoria after the First International Conference on the Peaceful Uses of Atomic Energy in Geneva (Müller & Paul, 2017). Nuclear energy was not only seen as a source of electricity but as a technology that could propel ships and vehicles, desalinate sea water and improve medicine, biology and agriculture (Rusinek, 1993). The West-German government and especially chancellor Konrad Adenauer saw the peaceful use of nuclear power as an essential part of their politics. This concerned not only economic affairs but also foreign, science, and sovereignty policy. With nuclear power would also come wealth, growth, reconstruction, and social peace to Germany, it was predicted (Gleitsmann, 2011). In addition, it was seen as a uniting entity in Europe (Rusinek, 1993).

West Germany's minister for economic affairs Ludwig Erhard pictured the Upper Rhine area as a potential "second Ruhrgebiet" already in 1954 (Gleitsmann, 1988). Erhard's assessment was instrumental for the following development as the nuclear power planning decisions resided with him (Gleitsmann, 1988). The Upper Rhine, in Erhard's vision, would become an industrial hub with around 100,000 workers and new opportunities for work, income and growth (Gleitsmann, 1988). The Rhine with its many different functions ranging from navigation and transport to hydropower and electricity generation, waste disposal, drinking water supply, and supply of cooling

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water for the industry as well as to fishery and irrigation of crops (Cioc, 2002) proved to be the perfect site for extensive nuclear planning.

Karlsruhe—Germany's nuclear capital

The first step toward the nuclearisation of Germany was taken with the establishment of the Nuclear Research Centre Karlsruhe in the municipality Eggenstein-Leopoldshafen[2] north of Karlsruhe. An ordinary municipality in the administrative district of Karlsruhe in Baden-Württemberg, it is quaintly situated in the Hardtwald, a historic woodland also known as the "green lung" of Karlsruhe. The woodland conservation area established in 1962 consisted of two parts: Hardtwald north of Karlsruhe with around 4730 hectares and Hardtwald south of Karlsruhe with approximately 2177 hectares (Landratsamt Karlsruhe, 1962). Karlsruhe with its different municipalities is situated amid the nature preserve (Regierungspräsidium Karlsruhe, 2020a, 2020b). The Rhine is the Hardtwald's natural western border.

Rudolf Greifeld[3], the manager of the Nuclear Research Centre, described its tasks and organization in a 1958 article in the journal *Atombrief* (Greifeld, 1958). The Centre was planned to be a site for basic research in respect to the peaceful use of atomic power. Additionally, it was seen as a possibility for the industry to participate in research and possibly eventually develop nuclear power plants (Gleitsmann, 1988). The Nuclear Research Centre was a mutual endeavor of the Federal Republic of Germany with 30%, the state of Baden-Württemberg with 20% and the nuclear industry in the form of a finance company with 50% (Greifeld, 1958). The supervisory board of the Nuclear Research Centre consisted of 12 members, five of whom belonged to industry. The companies involved were Badenwerk, Siemens-Schuckertwerke, GHH, Mannesmann, and Hoechst (W. D. Müller, 1990).

The choice of a rural area over a densely populated one was hardly coincidental; rather, it was evidence of a decision to minimize the risk of resistance (Meyer, 2014). The rural choice was heavily criticized by the people of the Hardtwald. In 1961, the population was just under 10,000 (Statistisches Landesamt Baden-Württemberg, 2020), and they were under the impression that the decisionmakers from politics and industry moved the risk from the urban area to the rural surroundings and that they neglected the environmental and health impact of nuclear power (Laufs, 2018). Beck put forward the thesis that redistribution of risks had been taking place in the Federal Republic since the 1970s at the latest (Beck, 1986). However, the case of the federal reactor station and the vehement resistance of the local population shows that the distribution of risk away from the cities to the underdeveloped rural population was heavily contested already from the beginning of the West German nuclear age in the 1950s.

The economic impact of the Nuclear Research Centre on the region

In the 1950s and 1960s, the skeptical local population had to relate to political narratives that painted a bright picture of the region's nuclear future. The Baden-Württemberg Minister of Economics, Hermann Veit, for example, wrote in an article in the 1950s that the foundation for the peaceful use of nuclear energy in Baden-Württemberg had been laid as early as in the 18th century. Uranium was already discovered in the Black Forest in 1793 and this led, in the long term, to the decision to build the Nuclear Research Centre on the Upper Rhine in 1956. According to Veit, the

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uranium deposits, albeit few in number, provided the impulse for the rather early consideration of the peaceful use of nuclear energy in Baden-Württemberg (Veit, 1958). Economic prospects were also used as an incentive for the skeptical neighboring municipalities. The promises of a "second Ruhrgebiet," however, could only be partially kept as industries independent of the centre did not settle as much as was hoped, and some industries even decided to settle somewhere else precisely because of the Nuclear Research Centre's presence.

In the beginning, only one research reactor was planned for the Centre, but later in the 1960s four reactors were already built and a fifth one was in planning. In addition to that, plans for a reprocessing plant became public. Two members of Baden-Württemberg's parliament opposed the plant and saw it as a threat to the further development of the region. The state parliamentarians had the impression that the municipalities had been pressured to agree since Day 1 with promises that could not be kept. Apart from the fact that the surrounding municipalities did not receive any tax revenue, they were faced with additional costs. In particular, oil and gas pipelines crossing the area were seen as problematic, as was a planned storage site for toxic sludge and oil residues. Finally, it was said that "the communities had already made great sacrifices for supra-regional institutions and that further burdens were no longer reasonable" (Badische Neueste Nachrichten, 1966).

Nevertheless, the Nuclear Research Centre turned the formerly rural area into a scientific and technological hub and ranked with 4200 employees in 1983 fourth among the biggest employers in the Middle Upper Rhine region (Kernforschungszentrum Karlsruhe, 1985). According to a publication on the economic factor of the Nuclear Research Centre, more than 20,000 people could secure their livelihood in the wider area of the Centre. Employees lived in the city of Karlsruhe and in the neighboring municipalities Eggenstein-Leopoldshafen and Linkenheim-Hochstetten as well as other boroughs in the region (Kernforschungszentrum Karlsruhe, 1985). In the same publication, the Nuclear Research Centre pointed to Leopoldshafen as an example of successful structural change. In the early 1950s, around 1350 people lived in the municipality. In the 1980s, after the merger with Eggenstein which had around 2600 inhabitants in 1961 (Statistisches Landesamt Baden-Württemberg, 2020), the population grew to 6000 people and was compared with an urban housing area. Apart from growth due to in-migration, around a third of the local population found work opportunities at the Centre (Kernforschungszentrum Karlsruhe, 1985).

Eggenstein-Leopoldshafen was strongly agricultural and, with the help of the Nuclear Research Centre, developed into a population dominated by science, technology, and services. Another area of conflict was identified in this context. The Nuclear Research Centre developed from a rejected institution to an essential one, despite the fact that the economic upswing was not quite as rapid as had been promised. Nuclear energy in itself, in the form of a research centre or a nuclear power plant, created jobs, but did not attract independent industry. However, the state government stood behind the argument that nuclear energy had considerable cost advantages compared to hard coal and thus, in the long run, secured jobs because electricity-consuming companies remained located in the state (Badische Neueste Nachrichten, 1982).

Early water risk perceptions

Werner Heisenberg, the leading physicist who was instrumental in driving and influencing West Germany's planning for the Federal Reactor Station, was aware of

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the potential impact of radioactive effluents on the environment even while the Nuclear Research Centre was being planned. On the one hand, it was important to him that the planned reactor station was located near a lake or river to ensure the supply of cooling water (Heisenberg, 1953). On the other hand, this body of water was to be independent of groundwater, so that the "harmful toxic and radioactive components contained in the waste water produced during nuclear power generation could be separated out and rendered harmless in a nuclear sump so that the treated waste water could be discharged without endangering the environment" (Möhrle, 1953).

The municipal utilities in Karlsruhe as well as the chemists Arnim Henglein and Josef Holluta were also concerned with the question of radioactive contamination of water. Holluta was commissioned by various waterworks on the Lower Rhine to investigate the extent to which the nuclear industry could influence water quality. It was already known in 1953 that radioactive wastewater would have a negative impact on water quality. However, Karlsruhe's municipal utilities relied on science and the progress of research:

> A number of these harmful substances can be rendered harmless or removed by known and relatively simple means, while other pollutants are present that can only be removed with difficulty, i.e. by costly measures or not at all completely with the means known to us. In my opinion, however, it can be expected that in the meantime science has continued to work and will continue to work on the task of further limiting and finally eliminating the harmful effects of nuclear energy production on the environment (Möhrle, 1953).

The issue of water supply and quality had preoccupied nuclear researchers for a long period of time. In 1953, the Maxau area directly on the Rhine north of Karlsruhe was still being considered as an alternative location for the planned Nuclear Research Centre, but in 1956 the authorities of the state of Baden-Württemberg together with the city of Karlsruhe decided to build the Centre in the Hardtwald near Leopoldshafen. Arguments against the location on the Rhine were the danger of flooding and the fact that the terrain was deep and the groundwater relatively high. In addition, due to changes in the reactor plans, direct Rhine water cooling was no longer necessary. The Hardtwald site was chosen because it was safe from flooding and 3 km away from the nearest settlement. Saclay in France, which was just 1.5 km from the nearest settlement, was particularly emphasized here, as were US projects that built research reactors in the middle of cities (Steffens et al., 1958).

In contrast to the self-assured expert opinions, Mayor Gustav Hellriegel of Leopoldshafen had strong apprehensions and wrote a letter to the district administrator of Karlsruhe in September 1956. In this letter, the basic concerns of the community were outlined. In particular, the population was worried about radioactive contamination of the water. He emphasized their fear which they "see in this plant, which will be built about two kilometers away from our village, a very big danger for our water supply, for the water in general as well as health-endangering pollution of the air." He underlined that they owed it to their descendants to weigh the advantages of nuclear energy against the disadvantages. He wrote: "We certainly do not want to close our minds to progress of any kind, we also recognize the necessity of developing new sources of energy, which are necessary for the continued existence of mankind, but we fear very much whether the downfall of mankind may not be accelerated thereby" (Hellriegel, 1956).

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The conflict between the municipalities in the Hardtwald and the advocates of the Nuclear Research Centre worsened to such an extent that in 1957 just 1.98% of those eligible to vote in the municipality of Linkenheim took part in the federal election. In absolute figures, this meant that only 47 out of 2363 voters actually voted. This was interpreted as a protest against the decision to build the research reactor in the Hardtwald (Badische Neueste Nachrichten, 1957).

In 1958, the district administration reached an agreement with the Hardt communities regarding the water situation around the Nuclear Research Centre. Previously, there had been objections to the discharge of wastewater into the Old Rhine. The new agreement stipulated that wastewater should only be discharged into the main Rhine. In addition, there were 120 objections to the withdrawal of water from the surrounding area. In particular, it was feared that the groundwater situation would deteriorate considerably. Foremost among them was Mayor Max Borell of Friedrichstal, who said that the objections would be withdrawn if the Nuclear Research Centre agreed to withdraw only 36 L of water per second for 24 h. Furthermore, the reactor company had to be held liable for all damages and disadvantages, as well as have all measuring devices regularly checked by an independent authority, the Water Management Office (Badische Neueste Nachrichten, 1958).

Later on, with the help of extensive information events in the Hardtwald communities, the proponents managed to convince the community of Leopoldshafen of the benefits of the Nuclear Research Centre, but not the communities of Friedrichstal and Linkenheim (W. D. Müller, 1990). The people of Leopoldshafen felt tempted by the promise of economic growth, prosperity, development of the infrastructure, advancements of crafts and raising revenue of municipal tax. These prospects sounded more than promising for an economically underdeveloped, rural region (Gleitsmann, 2011).

In contrast to other large-scale technologies, the risk of nuclear energy was not as immediate. Scientists involved in the development of nuclear energy spoke publicly about the risks of the technology, but in the same breath spoke of the fact that these risks would be kept under control (Engels, 2006). Until the late 1960s, however, there was hardly any interest in experimental nuclear safety research on the West German side. Scientists referred to risk studies from abroad. It was only toward the end of the 1960s, as the expansion of nuclear energy in West Germany took more concrete shape, that the nuclear industry was pressed to look at the risks (Radkau, 1983). Yet the people living close to the Nuclear Research Centre were branded as being reactionary and troublesome by nuclear promoters. The locals felt that they were not at all taken seriously in their concern and were met with strong criticism from the administrative district office, the operator of the Nuclear Research Centre and the government of Baden-Württemberg as well as the mayor of Karlsruhe, who opposed their worries and described them as nonsense (Gleitsmann, 2011).

West Germany's first nuclear waste scandal

In 1961, the State Food Testing Institute in Karlsruhe had to deal with the question of how to dispose of radioactive sludge from the Nuclear Research Centre. The sludge came from the neutralization and detoxification plant, where all chemically contaminated wastewater with residual radioactivity below the maximum permissible concentration of 10^{-7} curie per cubic meter was processed. On August 20, 1959, the District Office as the lower water authority determined that this sludge had to be stored on an officially approved rubble site. Such a debris site did not exist and

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therefore, in agreement with the Karlsruhe Municipal Civil Engineering Office, it was decreed that the sludge could be delivered to the Karlsruhe central sewage treatment plant. The 1959 agreement was valid until June 30, 1961. During the term of this temporary solution, efforts were made to find a permanent solution.

The State Food Testing Institute took samples of the sludge because the Nuclear Research Centre had approached the mayor's office in Leopoldshafen to obtain permission to deposit it on the local waste site. The testing revealed significantly increased radioactivity. As a result, the Food Testing Institute suggested a longer-term series of tests. The Nuclear Research Centre, on the other hand, sought confirmation from the State Institute for Occupational Safety and Health. The Food Testing Institute concluded from this: "It is obvious that this confirmation is to be used as a declaration of harmlessness for the sludge in radioactive terms, because our institute was to confirm the harmlessness of the sludge only in chemical terms according to the order of the Nuclear Research Centre of June 13, 1961. It literally said: 'The investigations should not refer to the radioactivity determinations'. Thereupon, the Food Research Centre urged a more detailed discussion of the problem with the State Institute for Occupational Safety and Health, especially because it was a precedent.

The State Food Inspection Agency carried out a series of tests. It was found that the sludge from the nuclear reactor wastewater treatment plant effectively exceeded the legal limits. Therefore, the sludge was to be delivered to a collection point to be determined according to state law. Areas in the immediate vicinity of the Nuclear Research Centre were considered as collection points. However, "the storage site would have to be provided with impermeable soil and tight enclosing walls." It went on to say: "It is to be left to the Nuclear Research Centre to carry out a sludge incineration and to store the ashes in the designated waste bunker" (Staatliche Lebensmitteluntersuchungsanstalt Karlsruhe, 1961).

The archival documents do not disclose if the Nuclear Research Centre followed these instructions, but 13 years later, in 1974, nuclear waste was found on a landfill in Leopoldshafen and Germany faced its first nuclear waste scandal. An environmentalist of the Citizens' Initiative for Environmental Protection measured 35 pulses per second with his Geiger counter, which was considerably higher than the natural radioactivity of the soil. He alarmed the Nuclear Research Centre and the State Institute for Occupational Safety and Medicine, Immission and Radiation Protection, which had soil samples taken. Apparently, these samples did not show an unusually high amount of radioactivity and the safety representative of the Nuclear Research Centre stated that the figures were "far below what one can even call radioactive" (Der Spiegel, 1974b). The safety representative suspected that the measured radioactivity was detritus from nuclear fallout and that the level of radioactivity was natural. Friedrich Brünner, Baden-Württemberg's Minister of Environmental Protection, also proclaimed that "all this is quite improbable" (Der Spiegel, 1974a).

The environmentalists remained skeptical as no other landfill in the area showed a comparable amount of radioactivity. So, they initiated their own tests which showed a high contamination with cobalt-60 and cesium-137. The radioactivity level of a two-gram sample was 1212 microcurie per cubic meter waste and another sample had a level of 1880 microcurie, which exceeded the allowed radiation limits of waste by 120 and 190 times. Furthermore, the laboratory that examined the samples from the environmentalists, stated that the statutory minimum values were generally too high (Der Spiegel, 1974b).

Nobody could tell where the waste came from and the safety representative from the Nuclear Research Centre said it was impossible that nuclear waste, that needed to be safely stored, could have ended up in a landfill. Other waste, such as sewage

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sludge, was regularly dumped in the Old Rhine, but this sludge was "absolutely nonhazardous" (Der Spiegel, 1974b). When the counter test results became public, the safety representative distanced himself from his earlier theory of nuclear fallout due to the high amount of cobalt-60, which was usually not found in nuclear fallout (Der Spiegel, 1974b).

The environmentalists stated in their own publication on the documentation of the "atomic waste scandal" that after several German as well as US media reported on the case, the safety representative "had to admit that the Nuclear Research Centre had been depositing radioactive waste at the Leopoldshafen landfill for ten years, between 1963 and 1973" ('Zum Atommüllskandal. Ist Das Die "100% Gewährleistete Sicherheit"?' 1974). Moreover, his assertion that all deposited substances had previously been thoroughly examined under strict safety measures later also turned out to be false. The scandal went so far that the lab technicians that were assigned by the environmentalists, were told not to speak to the press by their deputy director. The deputy director then tried to discount the article in the news magazine *Der Spiegel* by stating that "the measurement results had been improperly extrapolated by laypersons in Karlsruhe, ('Zum Atommüllskandal. Ist Das Die "100% Gewährleistete Sicherheit"?' 1974)."

Nevertheless, the head of the lab group later corrected the statement of the deputy director and said that no measurements had been extrapolated and that the report in *Der Spiegel* was correct. In response to this debate, the Nuclear Research Centre admitted to have had dumped 300 m^3 of radioactive waste at the landfill. This number was discounted by the administrative district office, which calculated with 600 m^3 atomic waste. However, the environmentalists thought that it was around 10,000 m^3 and in the end the Nuclear Research Centre admitted to have had dumped 1700 m^3 ('Zum Atommüllskandal. Ist Das Die "100% Gewährleistete Sicherheit"?' 1974; Landratsamt Karlsruhe, 1997b).

Experts, as well as the citizens' action group, the Nuclear Research Centre as well as politicians, referred to the Radiation Protection Ordinance of 1965. This case of the first nuclear waste scandal in the Federal Republic of Germany showed that not only the Radiation Protection Act had to be formulated more clearly, but also that nuclear researchers needed clearer guidelines regarding the disposal of their radioactive waste. *Der Spiegel* wrote that in the course of the scandal it turned out that it was not the Ministry of Environmental Protection that was responsible, but the Baden-Württemberg Ministry of Social Affairs and Health, since paragraph 42 was "the narrower standard for the protection of health" (Der Spiegel, 1974a).

This first nuclear waste scandal might have been dissolved in the 1970s, but locals and environmentalists did not forget about it. Two decades after the scandal, in the 1990s, the history of the Research Centre's nuclear waste disposal surfaced again and became a fundamental topic of concern, when the mayor of Eggenstein-Leopoldshafen announced his plans to lease the waterworks Tiefgestade from the Research Centre to supply drinking water for the municipality. This new water strategy was named "Water Concept 2000" and aimed to secure the municipality's long-term water supply.

Surface water as drinking water

That the nuclear waste scandal resurfaced during the 1990s shows how suspicion and skepticism in the local community had been historically grounded and therefore shaped the opposition to the Water Concept 2000. Even though the landfill site had

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been closed in 1974, it was still brought forward in the course of the debate around the Water Concept 2000. One reason was that no orderly closure took place and therefore harmful discharges into the subsoil were suspected to be the result. The nuclear waste scandal was a central topic that was discussed at length from different perspectives.

The case had been uncovered by a forester who had already begun to critically examine the Nuclear Research Centre in the 1950s. When I had the privilege of interviewing him in autumn 2019 at the age of 95, I received a firm "no" in response to the question of whether there were also good sides to nuclear energy. When he was advocating for the sole water provision from the Hardtwald waterworks in 1997, he stated that everything around the Centre was now contaminated. He quoted the former district administrator Joseph Groß, who later regretted his decision for the Centre and called the area around it a "victim landscape." According to him, along the Rhine, the neighborhood of Eggenstein-Leopoldshafen was the most radioactively contaminated area (Landratsamt Karlsruhe, 1997b).

For the forester, the decision about the community's drinking water supply was not just about a partial issue, but about the big picture. Although those responsible in the 1950s and 1960s promised to keep the environment clean of radioactivity, the environment and the water were permanently polluted. Therefore, he could not understand why drinking water should be drawn from this area of all places. Especially the risk of flooding of the Rhine was perceived as particularly problematic, as the floodwaters would also reach the landfill and in turn seep through the soil into the groundwater. Here, he not only saw potential radioactivity as a problem, but also other industrial waste that had been deposited at the dump, such as oil drums (Landratsamt Karlsruhe, 1997b).

Bank filtrate water was of inferior quality and just 10 km upstream, in Karlsruhe, they had "the best drinking water far and wide" for 20 years. For the former forester, the best solution would have been to build a fourth well for Eggenstein-Leopoldshafen in addition to the three Karlsruhe drinking water wells in the Hardtwald (Landratsamt Karlsruhe, 1997b). On the part of the authorities, this was not an option, as the municipality's assessed water demand would conflict with the assessed peak water demand of the city of Karlsruhe. The provision of water away from the Hardtwald wells was unavoidable (Landratsamt Karlsruhe, 1997a).

The increased perception of risk and the call for more caution was only shared to a limited extent by experts and those responsible in the municipality. The expert who assessed the water quality confirmed that the suitability of the Tiefgestade water as drinking water had not been investigated. The water had already been used as drinking water in previous years and had been tested in accordance with the Drinking Water Ordinance and its requirements. However, the expert acknowledged the concerns of the opponents of the decision by confirming that pollutants could occur in the Rhine and could also get into the bank filtrate and ultimately into the drinking water. He further pointed out that surface water was also used as drinking water in other cities. The working group of the Rhine waterworks considered the Rhine a suitable extraction point for surface water for drinking water production. The directives of the European Union were fulfilled here. Downstream, ozonation, or activated carbon filtration could be used (Landratsamt Karlsruhe, 1997b).

Yet, an environmental analyst stated during the hearing, that "[t]esting is still extremely difficult because analysis is still in its infancy. So, there are even now no state-wide studies on substances that have recently been investigated in the research field" (Landratsamt Karlsruhe, 1997b). He speculated that this could have been one of the reasons "why the water supply in general has not yet been investigated in such a wide variety. After all, […] we not only have the Rhine, but we also have many rivers

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and surface waters that serve as receiving waters, in which the sewage treatment plant discharges […] So, the question does not only […] arise on the Rhine, but throughout the country in general" (Landratsamt Karlsruhe, 1997b).

Even though the Act on the Precautionary Protection of the Population against Radiation Exposure stipulated that, for the protection of the population, the radioactivity in the environment had to be monitored since December 19, 1986 (Bundesministerium für Umwelt Naturschutz und nukleare Sicherheit, 1986), the actual implementation of monitoring relied on practices and standards in science. The municipality's response regarding the opponents' accusations that the nuclear waste scandal still threatened the water quality and thus also the health of the community was dismissed relatively brusquely. Once again, concerns from opponents were interpreted as unruly obstructionism. A council member stated: "These are things that should please not be held against anyone today. It is known that there was something there. But I would like to remind you again that this issue was given to the Ministry by the State Office for the Environment. And I make a clear statement that twenty years ago sewage sludge was placed that could not be detected, neither in the groundwater nor anywhere else. These are just facts. And we as a municipality have stuck to them" (Landratsamt Karlsruhe, 1997b).

CONCLUSION

The quality of water, and drinking water in particular, is still a highly controversial field from a social point of view. The case of the drinking water supply in Eggenstein-Leopoldshafen discussed here shows that authorities as well as politicians have to think more long-term. Employees of authorities change, politicians are elected for only a few years, but the local population spends decades in the same place. This fact must be taken into account when taking risky decisions.

Historians can contribute to bringing new attention to previously ignored or marginalized environmental problems. They can do so by examining not only power figures and decision-making processes, but also, as emphasized by authors such as Boudia and Jas (2007), those affected or people who did not have the opportunity to make their voices heard. By observing and analysing risk perceptions and decision-making processes over a longer period of time, previously invisible problems can be made visible or put into a longer temporal context. A hypothetical risk today can become an experienced risk tomorrow due to decisions made independently of each other away from the place of action.

What made the long conflict on the quality of drinking water in Eggenstein-Leopoldshafen difficult was that the opponents of the decision expected almost absolute safety, which was also promised to them as early as the 1950s. However, as it soon turned out, this safety could not be guaranteed from the technical side. In the course of 41 years, the decision-makers' arguments were typically vague and imprecise. It was only through demands and pressure from the population that more information was made available. Therefore, not only did history repeat itself in the 1990s when opponents used previous missteps to argue their case. Their desire for safety and an unpolluted environment as well as drinking water was met with the same lack of understanding as in the 1950s from the governmental side. Consulted experts were more understanding, but here as well, an absolute need for safety met with scientific practice that applied safety on the basis of possibility and experience.

Different rationalities further complicated the communication between the different actors. The general public demanded promises for safety that could not be

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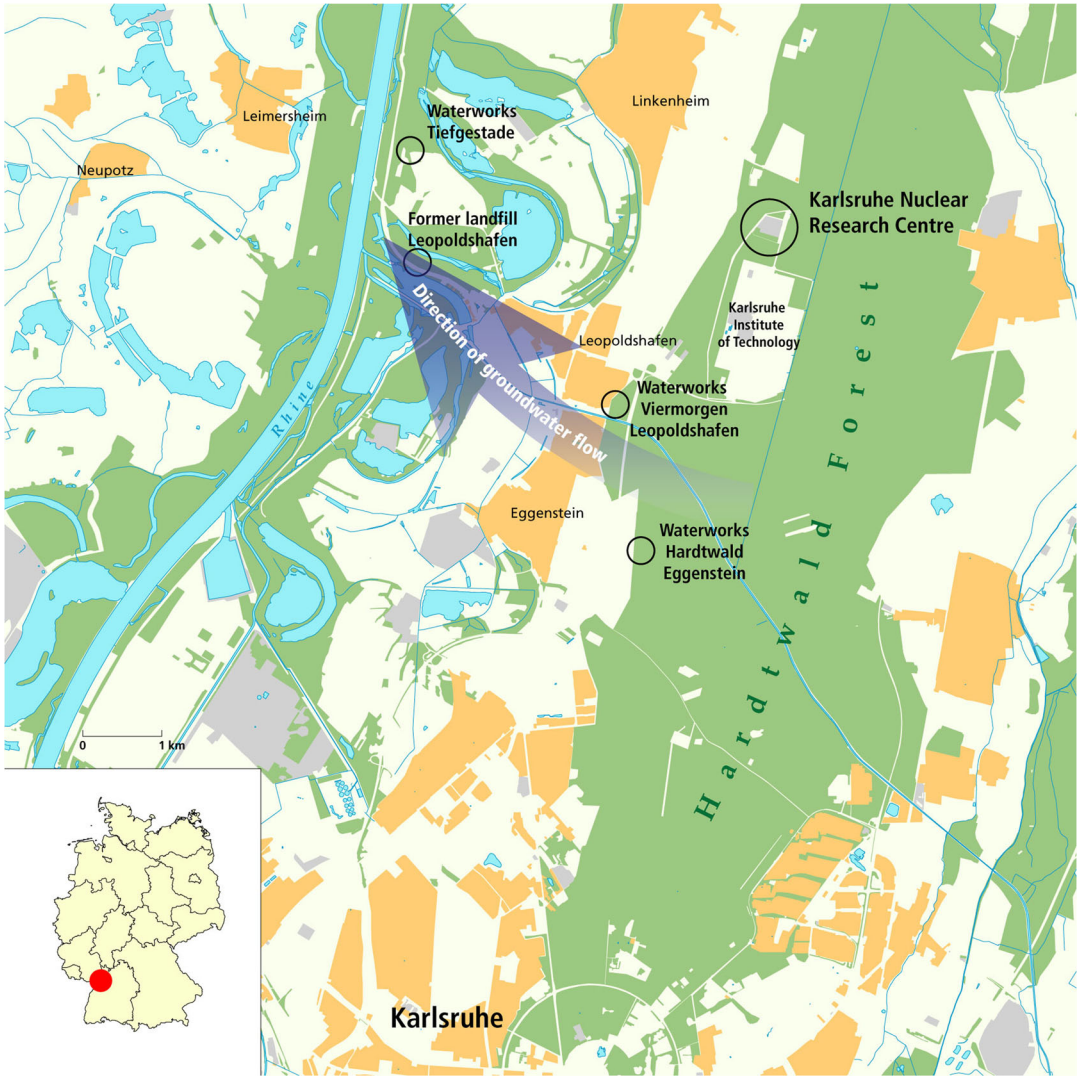
met by experts as these were not part of their field of analysis. Beck (1986) speaks here of the fact that in reactor safety studies, for example, the focus is on "quantifiable risks based on probable accidents." Whereas opponents of nuclear power focus, among other things, on the "long-term nature and irreversibility of large-scale technological decisions." The timeframe once again plays a significant role as practitioners would like to promise absolute safety, but opponents perceive the long-term risks of nuclear power as not only a threat to themselves, but also to future generations.

Communication at different levels leads to actors misunderstanding each other. Uncertainty played a major role in the drinking water debate of Eggenstein-Leopoldshafen. Locals criticized the decision of the mayor to provide drinking water as a mix of surface and groundwater on the basis of lived experience from the previous 30 years. Due to the experiences from the past as well as the miscommunication, the level of social trust was low. A fundamental basis of building



MAP 1 Eggenstein-Leopoldshafen north of Karlsruhe at the Rhine and the three waterworks

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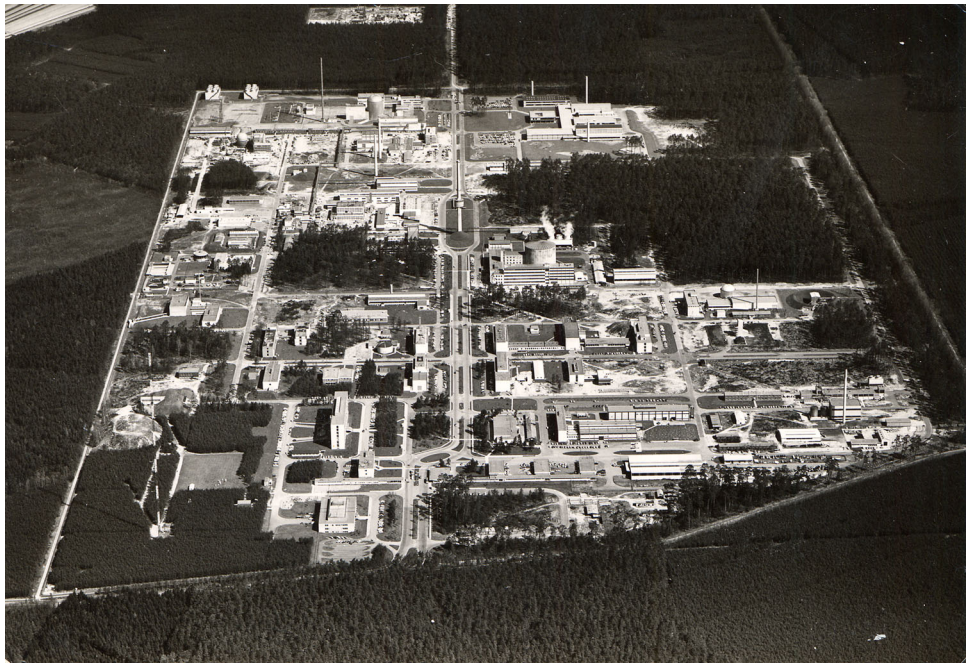
trust is that the public perceives authorities as being trustworthy. In this case, the risk bearer, the Nuclear Research Centre, had a long history of communicating false information and overall being distrustful in their actions. That provided the grounds for the main conflict between decision-makers and opponents. Due to imprecise communication throughout the years as well as false promises, trustworthiness was irretrievably destroyed.

Moreover, progress and technological development at a regional and national level were put before the basic needs of the local population. This prioritization ran like a thread through the history of Eggenstein-Leopoldshafen. This was not due to negligence or ill will, but due to discrepancies stemming from the different perceptions of risk. The authorities as well as the operators of the Centre had applied risk parameters that contrasted those used by the local population. However, the sparse communication as well as the active exclusion of the population from the decision-making processes was problematic.

In Eggenstein-Leopoldshafen the conflict between the population and the municipality was partially settled in the course of the 2000s. The municipality took over the waterworks from the Nuclear Research Centre toward the end of the 1990s, as larger quantities of cooling water were no longer needed. Tiefgestade therefore now only supplies drinking water for the municipality. As the waterworks was already getting on in years, it was decided in 2016 to build new waterworks next to the old Tiefgestade waterworks. Another reason was that the plant was oversized for the needs of the municipality, as the municipality needed about 850,000 m^3 of water a year, but the Nuclear Research Centre needed 12 million m^3 at peak times. The construction work was completed in 2022 (Gemeindeverwaltung Eggenstein-Leopoldshafen, 2021, 2019, 2022).



PHOTOGRAPH 1 The Nuclear Research Centre Karlsruhe in 1965 amid the Hardtwald woodland. *Source*: Stadtarchiv Karlsruhe 8/BA VV 3275.

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PHOTOGRAPH 2 Urban development in the neighborhood of the Nuclear Research Centre in Leopoldshafen, September 3, 1970. *Source*: Stadtarchiv Karlsruhe 8/BA Schlesiger A14a/194/1/7

Regarding the new waterworks, one of the critics from the citizens' initiative said that "the control of the municipal water that goes beyond the drinking water ordinance" is praiseworthy, however, consideration should be given to eliminating pollutants such as medicines or chemicals from the Rhine water by means of a filter system. The local newspaper Badische Neueste Nachrichten asked for the views of a technician and the mayor. From a technical perspective, nano-filtering would not be a problem. The mayor, however, doubted the need (Badische Neueste Nachrichten, 2020). Obviously, a middle way has been found in the meantime to provide more security for the local population without a too cost-intensive solution for the municipality (Map 1 and Photographs 1 and 2).

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dissertation on the nuclear history of the Rhine from the 1950s until today. The dissertation is connected to the research project Nuclearwaters, which aims to radically rethink the history of nuclear energy from the perspective of water, see www.nuclearwaters.eu. The research for this thesis was made possible by generous financial support from the European Research Council (grant no. 771928).

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ENDNOTES

[1] All original sources have been translated by the author.

[2] In the 1970s, during Baden-Württemberg's local government reorganization, smaller villages were reorganized to bigger municipalities. The village Eggenstein and the village Leopoldshafen were turned into one municipality. Before that both villages had their own mayor and administration.

[3] For more information on the controversial persona of Rudolf Greifeld, please see Bernd-A. Rusinek *Der Fall Greifeld*.

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