

Power Relations in Groundwater Extraction Conflicts in Germany – Insights from the Lueneburg Heath

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This paper analyses the interests and power relations that manifest in groundwater conflicts in formerly water-rich regions from a political ecology perspective. Utilising a historical-materialist policy analysis and qualitative expert interviews, this study systematically examines the explicit and implicit interests and micro-struggles in the case of the Lueneburg Heath, Germany. The findings indicate that the conflict is predominantly characterised by a dynamic interplay between nature, public water supply, and economy. Yet, the conflict encompasses various micro-struggles on data collection, democratisation of decision-making processes as well as the regulation of water demands, too. Thereby, this paper sheds a light on the capitalist ruling system that shaped the water management in Germany.

1 Introduction

The redistribution of water from urban and rural areas is a long-standing global practice. Unlike other materials that can easily circulate in a globalised economy, water is distinctive, as it is volatile, finite and vital (Savenije 2002). Groundwater, often of superior quality yet historically invisible in public debate, is gaining prominence as climate change intensifies droughts and heightens cross-sectoral demand. This tendency is becoming increasingly evident not only in regions traditionally characterised by water scarcity, but also in countries perceived to be water-rich, such as Germany. Here, a conflict between Hamburg's public water supply utility and local actors of the Lueneburg Heath developed over the past decades. Hamburg started groundwater abstraction from Northern areas of the Lueneburg Heath (North Heath) in 1982. In 2024, these withdrawals accounted for approximately 12% of the city's tap water consumption. Hamburg's public water supplier seeks to increase its permanent abstraction permit to secure urban supply. Local actors (environmental groups, landowners, public bodies) oppose higher - and in some cases current - abstraction levels, referring to groundwater levels, ecosystems, agriculture and local supply security being at risk. The conflict is mainly carried out in administrative and legal disputes.

A substantial corpus of social science literature addresses (social-ecological) water conflicts associated with risks in quantity and quality. Several case studies focus on infrastructure projects (Gottgens, et al. 2001; Molle 2007; Sneddon 2012), water pollution (Bebbington/Williams 2008; Meijaard et al. 2020; Omofonmwan/Odia 2009; Özkaynak et al. 2012; Pastén-Zapata et al. 2014) or conflicts over corporate extractions (e.g. for bottled water) (Gauriat 2023; Jaffee/Newman 2013; Rosemann 2015). While these contributions usually focus on traditionally arid and semi-arid regions, little attention has been paid to conflicts in water abundant regions. Despite growing relevance due to shifting climatic and socio-economic conditions, research on groundwater conflicts over public water supply in water-rich regions is largely absent. As ecological conflicts can be conceptualised as social phenomena that are intrinsically linked to material transformations and power relations (Dietz/ Engels 2020; Peluso/Watts 2001), a power-critical examination of emerging conflicts over groundwater is needed. The present case study aims to address this gap by analysing a water conflict over water abstractions for public supply purposes in conditions that appear to be characterised by abundant water resources.

Building on a “modern” understanding of groundwater as a resource (Linton 2010), it is highly regulated, yet contested. This paper analyses the ecological distribution conflict in the Lueneburg Heath and the underlying societal nature relations. As an ecological distribution conflict, the struggle for groundwater is assumed a social phenomenon with close ties to material transformations and power relations (Dietz/Engels 2020; Peluso/Watts 2001). Water harbours a special significance within society’s metabolism. Due to its special characteristics of finiteness, vitality and fugacity (Savenije 2002), it can be considered one of society’s most essential substances. Its embeddedness in societal nature relations demands a thorough look at the political, economic, and social power structures producing it. Therefore, it needs to be asked what actors control, act and hold power to assert their interests within contested policy formulations (Karpouzoglou et al. 2023; Winterfeld 2022).

This paper aims to address this gap with the following research question: Which interests manifest in the groundwater conflict in the Lueneburg Heath? It is guided by three sub-questions: (1) Which actor groups are involved? (2) What interests and strategies do they pursue? (3) How do power relations shape proposed solutions?

Theoretically, the study draws on political ecology concepts to holistically examine how water and social relations co-constitute each other and employs a historical materialist policy analysis to situate the conflict within state-mediated power struggles. This paper contributes to current research by uncovering explicit and implicit interests and narratives, and in analysing how power and rule are reproduced through groundwater governance in a “water-rich” context under climate stress. The following sections will briefly introduce the political ecology concepts (2), describe the methodology (3), the historical background of the case (4) and present results of the context (5.1) and actor analysis (5.2). The results are discussed (6) and conclusions drawn in the final section (7).

2 The Political Ecology of Water

According to political ecology literature, water conflicts can be understood as ecological distribution conflicts (Martinez-Alier/O’Connor 1996) that negotiate the distribution of material nature, environmental costs and benefits as well as epistemologies and ontologies on nature (Dietz/Engels 2014; Escobar 2006; Peluso/Watts 2001). Consequently, conflicts are subject to questions of power and affect society’s relations with nature (Brand/Görg 2022). The concept of societal nature relations refers to the concept of social metabolism (Marx 1890). Societal nature relations understand society and nature as

two separated units of a dynamic relation (Jahn/Wehling 1998) that affect each other. Nature affects society as it constitutes the foundation for any societal activity (ibid.); it provides and represents the material basis of societies, for example through biomass and minerals. Vice versa, nature is affected by human activities and societal developments (ibid.). Societal nature relations extend the concept of social metabolisms by analysing the underlying mechanisms and structures that regulate these metabolic societal processes. These societal nature relations manifest along three dimensions, each of them being related to questions of power and rule (Brand/Görg 2022). The material-substantial dimension addresses the supply of human societies, which is accompanied by fundamental modifications of nature. Here, natural relations refer to the biophysical conditions of society (e.g. the installation of water pipelines to provide a city with water). The cultural-symbolic dimension refers to different understandings and epistemologies that are constructed around nature, reaching from romantic to instrumental-exploitative ideas of nature (e.g. water as an economic resource vs. water as a human right). Finally, the regulative dimension (Görg 2003) addresses the changeability of natural conditions over time and space (e.g. the designation of water protection areas).

The relationship between society and water can be further conceptualised as a hydrosocial cycle, which challenges the traditional dichotomy between water and society (Linton/Budds 2014; Swyngedouw 1997; 1999; 2004; 2007). Instead, water and social relations represent hybrids (Latour 1994) that mutually reconstitute each other as inherent parts of a closely intertwined cycle that constantly recreates itself. These co-constituted hydrosocial relations reflect social (power) relations and influence them in material, epistemological, ontological, cultural, political and social ways. Therefore, “[w]ater is what we make of it” (Linton 2010: 3). Consequently, this study aims to address the societal nature relations behind highly contested groundwater policies in supposedly water rich Lueneburg Heath.

The power relations at stake manifest in disadvantages for certain social groups and unequal appropriation of water. Thereby, power as well as active and passive hegemonies reflect larger ruling structures (Weber, 1976 [1921]) that are historically embedded. Furthermore, the prevailing understanding of water has a significant influence on how conflicts about water are understood and discussed. Given numerous existing epistemologies and ontologies of water, analyses must always reveal what understandings of water are at work, since it is the only way to visualise the “relationality of societal natural relations” (Schmitt 2022: 295, own translation). As ecological distributions conflicts involve more than control and access, they usually involve various micro-struggles - the subtle differences in which actors may differ (Brand et al. 2021). Such struggles can range from epistemological over cultural to political

framings of nature and beyond. Consequently, the present study seeks to analyse the explicit and implicit (micro) power struggles inherent in the groundwater conflict in the Lüneburg Heath, and to explore how these struggles are reflected in the formulation of proposed solutions.

3 Methodology

This study uses a case study design, combining a historical-materialist policy analysis (HMPA), qualitative expert interviews and document analysis to examine power relations. The HMPA (Brand 2013; Brand et al. 2021; Buckel et al. 2014), is an approach to analyse state policies and their interactions with hegemonial power relations. As a methodological framework it assumes that policies crystallise amid competing social forces, interests, power resources and hegemonic projects within a relational, contradictory state. As a materialistic approach, HMPA focuses on societal-material structures and interests (e.g. around water) that are embedded in various contradictory and conflictual social relations such as class, nature, and the North-South divide. Such social relations are historically grown and affect the implementation of policies. The study focuses on policy formulation processes and their contribution to the reproduction of existing social structures, as well as their effects on broader societal contradictions and crisis tendencies (Brand et al. 2021). The approach goes along with three major societal considerations (ibid.). Contextualities, such as political, socio-economic and cultural conditions shape the environment, in which policies arise (1). Capitalist conditions are considered conflictual, internally contradictory and crisis-prone. As policies emerge within capitalist systems, they shift a crisis to another policy area and function as symptomatic treatment (2). Finally, it draws from relational state theory (Jessop 1990; Poulantzas 2002[1978]), considering the state as a strategic, asymmetric field, where political actors and social forces contest and advance interests through policy formation, implementation, and obstruction. As a heterogeneous, contradictory entity, the state materialises and reproduces social power relations and inequalities. These societal struggles are most visibly articulated in and through policy processes (3).

Although Buckel et al. (2014) have proposed a division of the HMPA into three analyses, this study conducts a context and actor analysis and abstains from a process analysis, as the legal processes were ongoing during the data collection. Utilising grey literature, the study maps discursive and legal shifts in water and environmental governance. The actor analysis identifies key actors, their positions, motivations and interests, the alliances they form, their strategies, the power resources they mobilise and micro-struggles. Six qualitative expert interviews (Meuser/Nagel 2020) were conducted in

January and February 2024, with actors from the public water supply (Interview (I) 3), environmental NGOs (I1, I4), administrations (I5, I6), and independent experts (I2). The guideline-based, open interviews (ibid.) were tailored to respondents' roles, conducted in German via Zoom and lasted 45 to 60 minutes. Transcripts were generated using Microsoft Word's transcription tool and manually verified. An interpretative interview analysis (ibid.; 1991) was employed to surface explicit and implicit, institutionally situated knowledge. The procedure comprised paraphrasing, combined deductive–inductive coding, thematic comparison, conceptualisation and theoretical generalisation, supported by MAXQDA 22.0.

4 Case Study

Hamburg's historic transition from Elbe surface water to groundwater in the late 20th century externalised abstractions to the North Heath as urban demand grew and river water quality deteriorated (WorldTimes-Online, n.d.). In 1974, an initial authorisation by Lower Saxony authorities of up to 25 million m³ of water per year for abstractions by Hamburg prompted ecological research and local civic mobilisation (Adam 1989; HW 2013). Hamburg started its actual withdrawals in 1982 with voluntary self-restrictions of 15 million m³ (HW 2023c). After interim special permits from 2004 (15.7 million m³), Hamburg's utility applied in 2015 for 18.4 million m³ annually, including a 2.3 million m³ dry-weather buffer not intended for regular use; the core volume was 16.1 million m³ (HW 2015; Senat Hamburg 2016). In 2019, the Administrative District of Harburg, who is responsible for the water right procedure, granted a revocable superior permit for the demanded amounts (BUND Elbe-Heath, n.d.). This resulted in legal proceedings initiated by Hamburg to secure a higher and more secure entitlement as well as counterclaims by local actors citing ecological risks and participation deficits (HW 2023b). The Administrative Court of Lüneburg dismissed all suits in 2021, upholding existing protections without increasing allocations, after which Hamburg appealed (ibid., Administrative Court Lüneburg 2021). As of 2023, roughly 12 per cent of Hamburg's water derives from the North Heath via 38 wells, many in or near FFH sites, with further activations proposed and dense monitoring in place (HW 2023c).

5 Results

5.1 Context Analysis

The context analysis shows that the Lüneburg Heath groundwater conflict is embedded within evolving governance frameworks, shifting material conditions

and intensifying competition over a common resource. Since 2000, the EU Water Framework Directive (WFD) and the Flora-Fauna-Habitat (FFH) Directive have reoriented German water policy towards integrated, sustainability-led management and biodiversity protection, a shift consolidated in the Water Management Act (“Wasserhaushaltsgesetz”, WHG), whose 2009 revision articulated for the first time the law’s purpose of safeguarding water bodies as part of the natural balance and as the basis of human life through sustainable water management (WHG §1; UBA/BMU 2017). While the WHG gives the public water supply formal precedence as a service of general interest (WHG §50), federal states retain wide discretion in implementation, generating heterogeneous fee regimes, benefiting certain economic sectors as well as limited earmarking (NWG 2024; Römer 2019; VKU 2022). These discretionary regimes, together with revocable and short term authorisations, create administrative and legal uncertainty and can weaken the WFD’s polluter pays principle (Directive 2000/60/EC, art. 9). Groundwater is considered common property, thus necessitating the acquisition of licences for its utilisation. Despite formal sustainability goals (WHG §§6, 12), the long-term allocation process gives rise to administrative discretion and engenders both legal and planning uncertainties; thus, potentially undermining protection and supply. Material-environmental dynamics have markedly sharpened these tensions. The exceptional droughts and heat of 2018–2020 exposed vulnerabilities in groundwater-dependent ecosystems and public supply, elevated scarcity on the political agenda and catalysed strategic planning, including Germany’s National Water Strategy adopted in 2023 (Hari et al. 2020; Zdrzalek 2023; BMUKN 2023). At the same time, projected population growth is expected to raise Hamburg’s medium-term demand, while short-term drought peaks strain system capacity, prompting water-saving campaigns and calls for a state-level strategy aligned with national objectives (Statistik Nord 2021a; b; Bürgerschaft der Freien und Hansestadt Hamburg 2023). Agriculture’s expanding reliance on irrigation, especially in Lower Saxony, intensifies competition for groundwater even as nitrate contamination leaves many aquifers in poor chemical status, tightening the ecological and regulatory constraints on abstraction (EEA 2017; MU 2014; Directive 2000/60/EC).

In sum, EU-driven frameworks strengthened ecosystem protection of the North Heath and steered Germany towards a more holistic water management. At the same time, years of droughts and growing sectoral pressures have raised scarcity and politicised allocation. Despite the WHG’s formal prioritisation of supply security, reliance on revocable permits, heterogeneous pricing and exemptions that often benefit agriculture or other industries, and persistent quality problems have eroded planning certainty and exposed contradictions between statutory objectives and practice.

5.2 Actor Analysis

This actor analysis maps the positions, interests, strategies, resources and micro-struggles shaping the Lueneburg Heath groundwater conflict, based on qualitative expert interviews and grey literature.

In Hamburg water issues are subject to the Ministry for the Environment, Climate, Energy and Agriculture, that acts both administratively and politically. Given its maritime location and the Elbe River, Hamburg comes with a lot of water. Since the 1970s, the city successfully reduced their total groundwater abstractions, which is attributed to the implementation of abstraction fees and water meters that both incentivises private water savings (I6 2024). Despite comparatively high self-supply, Hamburg relies on the surroundings for external water production (I1; I3 2024). The city is in increasing need of water, as water demands started rising in the early 2010s given population growth and increased per capita demand, the latter being attributed to weaker saving behaviour and the use of water-intensive luxury tools (e.g. wellness showers, private pools) (I6 2024). Prognoses of increasing water demands until 2030 are accompanied by the salinisation of groundwater bodies with renders some of them unusable (ibid.). Another issue is extremely contested ground and surfaces in Hamburg: Given urban space competition, public water authorities face difficulties to enforce their interests against renewable energy (geothermic), mobility or construction projects as well as public spaces such as parks or playgrounds; most of them bearing groundwater risks such as altered water temperature, leaking toxins or soil sealing that reduces groundwater recharge (ibid.). However, the ministerial staff are confronted with intra-institutional conflicts in which arguments regarding supply security and priority of public supply appear to lose their significance; decisions are made on a political level (ibid.). The primary objective to safeguard the water supply (I3 2024), may also be connected to economic interests, as the city collects funds through the surplus of Hamburg’s water utility, its monopoly fee and groundwater abstraction fees (I1 2024). While wastewater charges flow into infrastructure renovation, the money raised by the supply side flows into the city’s budget (I4 2024). According to one interview, annual earnings could be between 70 to 80 million euros (I1 2024). Scepticism towards alternative water sources such as bank filtration might be historically grown, however this option has not yet been discussed realistically. Hamburg’s responsible authority points to the need of mandatory implementation of nature-based infiltration in construction projects (I6 2024). Further pathways could be the continued promotion of storage and utilisation of rainwater (Rain Infra-Structure Adaptation (RISA)), grey water or sponge city concepts. However, the strong resistance demonstrated by investors, who feared economic disadvantages, illustrated the difficulties to enforce sustainable water management practices. Finally, campaigns promoting water savings in private households,

who make the largest share of the public water supply in Hamburg are considered important steps, as minimal reductions in the per capita consumption of households could compensate for additional water needs due to climate change (ibid.).

Hamburg's water utility uses arguments of supply security and legal predictability under the WHG. It seeks a long-term, predictable, and thus more secure entitlement that accommodates seasonal peaks up to 18.4 million m³, with an intended average of roughly 16–17 million m³, justified by sunk infrastructure, proximity and the high raw-water quality of the North Heath. (HW 2013; 2015; 2023b; Senat Hamburg 2016; I3; I6 2024). High raw water quality in protected areas is also addressed by arguments of profitability and cost efficiency as it reduces treatment costs. However, it reinforces lock ins and prevents discussions about alternative sources (I3; I6, 2024): Alternatives such as bank filtration are rejected as they are perceived as too cost-intensive and risky. Instead, they emphasise cooperations with Hamburg's federal authorities on monitoring, demand-side saving campaigns. Additionally, it litigates to upgrade its revocable superior permit (HW 2023b; I3 2024). Furthermore, it presents itself as a representative of the population's needs, refers to water as a common good and cities' structural dependence on surrounding water resources. The latter is legitimised through reciprocal benefits of urban–rural interdependence such as employment and economic growth (HW 2015; I3 2024). The problem is defined as rising demand, especially peak day loads. Proposed solutions include constraints on agricultural abstractions, improved sectoral withdrawal data, and nature based measures to enhance recharge (I3; I6 2024).

Opposing actor groups are environmental protection NGOs. Self-described as advocates for nature, their most prominent goal is to prevent environmental damages, especially in protected and vulnerable ecosystems due to declining surface water that leads to declining groundwater levels. As the NGOs perceive a growing imbalance between rising water demand and declining water recharge, they demand sustainable usage of water. Water management would not adequately consider nature's interests (I1 2024). To achieve their objectives, these actors are suing (ibid.) or take a stand at court and cooperate with US research institutions, with whom they jointly concluded that statements made in court by the Hamburg water supplier had been incorrect (I4 2024). To avoid biodiversity loss, they claim a complete stop of water abstractions, yet, they are open to compromise solutions, as they are aware of Hamburg's essential need for water (I1; I4 2024). Consequently, they propose solutions such as the installation of well sites in places with lower environmental impact or the use of bank filtration. Hamburg's refusal to adopt alternatives is considered proof of their profit maximisation aims. Hence, water supply should be cooperatively organised (I1 2024). Other related

struggles include the use of outdated and non-transparent evaluation methods, structural disadvantages due to unequal resources, lacking institutional capacities (time, personnel) as well as the transition from reactive water management to proactive, integrated water management with long-term strategies in line with precautionary principles (I1; I4 2024). However, the NGOs acknowledge, that water stress is a multicausal phenomenon and cannot be attributed to Hamburg's withdrawals alone. Instead, it is caused by climatic changes which alter water demands, especially by afforestation, agriculture and private households. Therefore, they call for greater restrictions on agricultural irrigation during drought periods (ibid.) and water tariffs being organised according to the polluter-pays principle (I4 2024). Additionally, they demand educational programs for water usage and (national) holistic strategies for climate mitigation (ibid.). Finally, they criticise urban–rural relations and feel disadvantaged and exploited by Hamburg's activities, through e.g. water extractions and infrastructure projects.

The public authority of the North Heath grants water authorisations. It aims to mediate water demands in a densely populated area, with high water demands by local private and industrial consumers, external water suppliers, the agricultural sector and the environment (I1; I4 2024; Zamponi 2021). Thereby, it strives for preserved room for manoeuvre (I3, 2024), preferring flexible, short term authorisations to react to climate and legal changes (Administrative Court Lueneburg 2021). The authority ordered additional evaluations as a reaction to NGOs concerns about poor measurement quality (I4 2024). Beside the lawsuit, the administration imparts between farmers and Hamburg's utility, on the assessment of crop failures and the agreement of compensations (I1 2024).

Lower Saxony's federal state authority for water management and nature conservation has a consulting function in water right proceedings. The authority approved the current permit but is restrained to Hamburg's latest demands. Self-described as an advocate for nature, who has the least chances to pursue its interests, the authority approves water withdrawals if lying within elastic boundaries that enable ecosystems to adopt to new balances (I5 2024). However, their water yield report, published in 2023, came to alarming results (Johannes et al. 2023). The main issue of declining water recharges is caused by agriculture's rising demand, with prospected rising societal peak-demands during summer worsening the issue (I5 2024). Artificial changes in ecosystems, such as the fostering of pine forests, river straightening and ditch systems contribute to rising pressure on water bodies. Their primary interest is the sustainable groundwater management to ensure availability for humans and nature with a special protection of vulnerable ecosystems. Referred to as groundwater as a resource, it calls for ecosystem-centred, adaptive governance: withdrawals should cease in sensitive areas; authorities should deploy

short, flexible, tightly monitored rights with predefined thresholds and immediate sanctions; abstractions during droughts should be refused and shifted to more robust sites; and recharge should be bolstered by ending agricultural drainage and restricting irrigation, all guided by better data and locally tailored measures. Democratisation and transparency are necessary to rebuild public trust, shared responsibility for water-savings, cross-sectoral cooperation, and a realistic recalibration of expectations given persistent pollution (ibid.).

Many forest owners worry about declining groundwater levels (I1 2024). A public forestry actor sued against increased abstractions, as they fear negative impacts for the agricultural, fishery and forestry use on their territory (Administrative Court Lueneburg 2021). Due to reduced infiltration, trees' loss of groundwater connection and secondary damages (e.g. bark beetle) forests are at risk (I1 2024). With forestry being a long-run business, owners rely on predictability and sustainable management (ibid.). Private forestry owners are under represented in the lawsuit and in water management decisions more generally (ibid.). While interests of private forestry are claimed to be insufficiently considered in decision-making processes, public forestry businesses, structurally closer to administrative and decision-making bodies, enforce their interests more easily (ibid.). Claims for compensation payments are difficult to justify, given long time horizons and verification hurdles. A precautionary principle-oriented water management could help avoiding forestry's disadvantages against the fast-moving agricultural sector (ibid.).

The agricultural sector takes an ambivalent role within this conflict. Local farmers accuse Hamburg's water abstractions responsible for dehydration and crop failures and already received first compensation payments from Hamburg's utility, despite complex causalities complicating the calculation of compensation responsibilities. At the same time, former wetlands bring new potentials for commodification through its dehydration (I1 2024). However, agricultural practices contribute to water stress, as their demands for artificial irrigation and thus for groundwater are rising (I2 2024). This is reflected in local agricultural actors who started their own lawsuit to double annual water abstractions (from 6 to 12 million m³) (I1; I4 2024; Marquardt 2022; Zamponi 2021). Furthermore, agriculture massively contributes to groundwater pollution, through increased application of fertilisers that causes nitrate pollution – with externalised costs for the water sector (treatment costs, decommissioning of wells) (I4 2024) and future generations. Thereby, the agricultural sector disadvantages public water suppliers, as treatment costs increase and some wells become inoperable (ibid.). External actors thus demand controls of fertiliser usage (I2 2024), data collection and controls of often obscure water (I1 2024), the use of alternative sources (e.g. flowing waters, rainwater, water reusage)

(I2; I5 2024), as well as the promotion of landscape water storages and smart irrigation technologies (I2 2024). The implementation of changes to unsustainable water management practices, including those associated with drainage systems and ditch structures, is recommended (I2 – I5 2024). Additionally, fields should be irrigated during the cooler parts of the day cooler periods of the day to minimise evaporation (ibid.). However, the sector had an important cultural and economic role and strong political influence through various agricultural associations (I1; I2 2024) with traditionally close ties to the German Christian Democratic Party (CDU/ CSU) (I1 2024; Tosun 2017). As the CDU/ CSU is frequently part of governing coalitions and holds agricultural ministerial posts (Pappi et al. 2008), the agricultural sector has a strong political influence and the ability to advance its interests (I2; I4 2024).

The industrial sector is a major extractor nationally but is less central in this conflict. In Hamburg, the amount of water provided by the utility for industrial purposes is rather small with 4.6 million m³ (114.7 million m³ for private households and small business enterprises) (HW 2023a). Likewise, the share of self-extracted water by companies themselves is small and controlled by Hamburg's administrations (ibid.). Similar patterns occur in the district of Harburg. Many companies switched to closed water cycles and surface water for cooling processes to reduce their overall water consumption and hence their costs (I2 2024). However, aggregated data and data gaps obscure actual withdrawals (ibid.). Claims for higher water restrictions in industry are often countered with its role in securing prosperity (I3 2024).

6 Discussion

The Luneburg Heath conflict exemplifies how water quality and governance shape contested hydrosocial relations. Findings indicate an omnipresent valorisation and commodification of groundwater, based on a "modern" understanding of water as a manageable resource for societal metabolism, detached from nature, hierarchised (along water quality) and geared to suppressing and controlling nature (Linton 2010). Even actors oriented towards nature conservation tend to invoke nature's needs instrumentally. This hegemonial understanding was imprinted by prolonged governmentality processes (Foucault 2007 [1982]). Since the 1970s, regulation has tightened under the WFD, FFH and WHG. However, implementation remains fragmented. Short term and revocable licences are intended to promote caution but also create legal ambiguity. The implementation of abstraction fees, metering, and EU-driven norms lowered demand and constrained exploitation. Nevertheless, persistent gaps in monitoring and heterogeneous pricing weaken the polluter-pays principle.

Beneath allocation debates lie micro-struggles over power, recognition and environmental justice. Public supply security, ecological protection and economic uses collide with unequal capacities to participate in decision making processes. NGOs, private forestries and individuals encounter informational and financial asymmetries in legal proceedings that advantage large businesses and agricultural alliances; rural communities perceive themselves to be exploited in urban-rural exchanges; and nature remains a largely powerless stakeholder despite formal designations. Historically, public supply held a privileged claim under the WHG. However, Hamburg's water utility lost room for manoeuvre as ecological constraints and legal standards stiffened in recent years. In contrast, the agricultural sector and select industrial domains have been beneficiaries of comparatively reduced abstraction fees, less stringent regulatory oversight and consolidated reporting mechanisms. This is occurring despite the escalating demand for irrigation in the agricultural sector and the resulting constraints on available resources due to nitrate pollution. The long ecological time horizons and evidentiary burdens inherent to forestry impede the process of compensation, thus heightening its vulnerability. Overall, the data asymmetry translates into unequal accountability. The result is a distributive and procedural justice problem (Fraser 2008): the costs of scarcity and pollution (e.g. treatment, lost ecosystem functions) are externalised spatially and temporally, while sectors enjoying lighter charges or oversight benefit.

Material pressures caused by droughts occurred since 2018 have exposed the fragility of ecosystems and the limits to their capacity. Social expectations further entrench pressure by perpetuating the hegemonic norm of ubiquitous, low-priced drinking water for all uses. This sustains high per capita consumption and favours technological fixes over absolute reductions. Classed consumption patterns (e.g., private pools, opulent gardens) inflate peak demand and complicate the design of equitable tariffs. Price rises carry the potential for regressive effects, unless they are coupled with targeted protections and curbs on discretionary uses. Furthermore, urban–rural metabolism flows blur boundaries: Hamburg depends on external sources while offering employment and investment opportunities. Yet, the mutual benefit is perceived unevenly, feeding NIMBY contestation and claims of metropolitan overreach.

These patterns align with political-ecology critiques of capitalist societal nature relations, as water is commodified, governed for efficiency and growth, and enrolled in technocratic control. Solutions, including advanced treatment, closed industrial cycles and monitoring upgrades, have been proposed to mitigate symptoms, yet risk entrenching energy- and capital-intensive pathways without reducing overall flows. Conversely, calls for adaptive, ecosystem-centred

governance - short, tightly monitored rights; predefined ecological thresholds; shifting abstractions away from sensitive zones; and recharge-enhancing land use change - aim to realign use with ecological limits. Implementing polluter pays, constraining irrigation during droughts, improving fertiliser controls and closing data gaps would re weight incentives toward conservation.

A just transition requires the consideration of demand and supply. Diversifying sources (e.g., bank filtration, rainwater use, greywater, sponge city measures) is technically feasible but politically sensitive due to cost and risk perceptions. Demand-side measures, such as seasonal tariffs with social safeguards, restrictions on non-essential uses during droughts, and sustained public communication, offer a high degree of leverage. However, they also present significant challenges to entrenched lifestyles. Structural changes to agri-food regimes (input intensity, crop choices suited to future climates) and urban development (soil sealing, geothermal trade-offs) are essential to prevent peaks from outpacing recharge. Democratising water governance is central to legitimacy and effectiveness. Greater transparency, accessible data across all sectors, strengthened participation (e.g., deliberative water fora), and fairer legal support for civil society and small landholders could rebalance procedural power. Aligning fiscal instruments with environmental objectives could correct current incoherences, e.g. harmonised abstraction fees reflecting scarcity and pollution, and revenues earmarked for restoration and monitoring.

The case stands at a crossroads. Ecosystem protection and societal adaptation are at stake in future court decisions and evolving policies, or risk from short-term exploitation. Durable solutions will be needed to deal with increasing hydroclimatic variability. These solutions must prioritise ecological thresholds, reduce absolute throughputs in social metabolism and ensure fair cost sharing across sectors and classes.

7 Conclusion

This study examines the Lüneburg Heath groundwater conflict through a political ecology lens analysing actors, interests and power relations in a region once deemed water rich. The results indicate tensions between safeguarding public supply, protecting sensitive ecosystems and accommodating rising uneven demands under changing hydroclimatic conditions. The growing competition and stricter environmental legislations redistributed power, weakening the public water supply, forestry and nature, while benefitting economic sectors, especially agriculture. As the state allocates groundwater, it holds an appropriating and regulating position; future relations depend on its actions, yet fundamental changes are difficult given its

embeddedness in wider ruling structures. The conflict comprises micro-struggles over the recognition of nature's water demands vs. economic exploitation; knowledge production vs. undone science strategies (Frickel et al. 2009; Hess 2007); democratisation; and urban-rural relations given expansive social metabolisms. The conflict can be understood as an environmental justice (Agyeman et al. 2003) struggle, challenging territorial ownership of common groundwater and externalised costs. In sum, this paper argues that neoliberal capitalist rule strongly shapes society's relations with groundwater that are reproduced by a state, embedded in this very system.

This study has several limitations. It relies heavily on secondary sources for forestry, agriculture and industrial actors, potentially under-representing these perspectives. The analysis is limited to national and EU frameworks and does not fully capture transnational influences (Brand et al. 2007). Furthermore, the qualitative single-case design limits external validity, while incomplete and contested data underscore the need for further research. Future studies could focus on process analysis (Buckel et al.

2014) and the effects of proposed solutions on power relations. Climate change and environmental awareness may enable greater recognition of nature, but its position remains fragile. While conflicts hold transformative potential (Temper et al. 2018; Turner 1975), it is unclear if collective learning and re-organisation will succeed, given contemporary political shifts. Future water management should move beyond capitalism's symptomatic treatments of short-term tech- and growth-oriented fixes. Instead, sustainable long-term solutions with reduced total water uses and improved quality are needed, implying radical sectoral changes (e.g. agricultural production systems). Governance should follow principles of social fairness, accessibility and sustainability; polluter-pays principles could serve as a blueprint for a transition supporting common goods. Opening a discourse on altering water demands and democratise decision-making processes are necessary first steps to renegotiate societal nature relations. Acknowledging our interconnectedness with water within the hydrosocial cycle, it is time to make water a just, sustainably treated part of humans and the world.

References

- Adam, B. (1989): Der Konflikt um die Grundwasserentnahme Hamburgs aus der Nordheide: Bericht über den Stand der Untersuchung eines Entscheidungsprozesses in der Wasserversorgung bei räumlicher Trennung von Verbraucher- und Lieferregion. *Raumforschung und Raumordnung | Spatial Research and Planning* 47(5/6): Article 5/6.
- Administrative Court Lueneburg (2021, 11.10.): Verwaltungsgericht weist Klagen zu „Hamburg Wasser“ ab. URL: <https://verwaltungsgericht-lueneburg.niedersachsen.de/startseite/aktuelles/pressemitteilungen/beteiligte-einigen-sich-uber-erlauternden-begleit-text-fur-denkmal-der-110-infanterie-division-in-luneburg-204943.html>
- Agyeman, Julian/Bullard, Robert/Evans, Bob (2003): *Just Sustainabilities: Development in an Unequal World*. London: Routledge.
- Bebbington, Anthony/Williams, Mark (2008): Water and Mining Conflicts in Peru. *Mountain Research and Development* 28(3): 190–195.
- BMUKN - Bundesministerium für Umwelt, Klimaschutz, Naturschutz und nukleare Sicherheit (2023): Nationale Wasserstrategie – Download. URL: <https://www.bmu.de/DL3047>
- Brand, Ulrich (2013): State, context and correspondence: Contours of a historical-materialist policy analysis. *Österreichische Zeitschrift für Politikwissenschaft* 42(4): 425–442.
- Brand, Ulrich/Görg, Christoph (2022): Gesellschaftliche Naturverhältnisse. In: Gottschlich, D./Hackfort, S./Schmitt, T./Winterfeld, U. V. (Hrsg.), *Handbuch Politische Ökologie*. Bielefeld: transcript Verlag, 37–50.
- Brand, Ulrich/Krams, M./Lenikus, V./Schneider, E. (2021): Contours of historical-materialist policy analysis. *Critical Policy Studies* 16(3): 279–296.
- Brand, Ulrich/Wissen, Markus/Görg, Christoph (2007): Verdichtungen zweiter Ordnung. Die Internationalisierung des Staates aus einer neo-poulantzianischen Perspektive. *PROKLA. Zeitschrift für Kritische Sozialwissenschaft* 147(37/2): 217–234.
- Buckel, Sonja/Georgi, Fabian/Kannankulam, John/Wissel, Jens (2014): Historisch-materialistische Politikanalyse. Die Operationalisierung materialistischer Staatstheorie für die empirische Forschung. In: Forschungsgruppe »Staatsprojekt Europa« (Hrsg.), *Kämpfe um Migrationspolitik: Theorie, Methode und Analysen kritischer Europaforschung*. 1. Aufl. Bielefeld: transcript Verlag, 43–60.
- BUND Elbe-Heath (n. d.): Grundwasserförderung durch „Hamburg Wasser“. BUND – BUND für Naturschutz und Umwelt in Deutschland. URL: <https://www.bund-elbe-heide.de/landkreis-harburg/grundwasser/> (07.11.2023).
- Bürgerschaft der Freien und Hansestadt Hamburg (2023): Eine zukunftssichere Trinkwasser-Agenda zu einer Hamburger Wasserstrategie weiterentwickeln (Antrag Drucksache 22/13469). Bürgerschaft der Freien und Hansestadt Hamburg. URL: https://buergerschaft-hh.de/parldok/dokument/85474/eine_zukunftssichere_trinkwasser_agenda_zu_einer_hamburger_wasserstrategie_weiterentwickeln.pdf

- Dietz, Kristina/Engels, Bettina (2014): Immer (mehr) Ärger wegen der Natur? – Für eine gesellschafts- und konflikttheoretische Analyse von Konflikten um Natur. Österreichische Zeitschrift für Politikwissenschaft 43(1): 73–89.
- Dietz, Kristina/Engels, Bettina (2020): Analysing land conflicts in times of global crises. *Geoforum* 111: 208–217.
- Directive 2000/60/EC (2000): Establishing a framework for Community action in the field of water policy (Water Framework Directive). *Official Journal L* 327, 22.12.2000: 1–73. URL: <https://eur-lex.europa.eu/eli/dir/2000/60/oj>
- EEA - European Environment Agency (2017): Pricing and non-pricing measures for managing water demand in Europe (3415/B2015/EEA.56130). European Environment Agency. URL: <https://forum.eionet.europa.eu/nrc-eionet-freshwater/library/other-reports-and-assessments/water-management-europe-price-and-non-price-approaches-water-conservation/water-management-europe-price-and-non-price-approaches-water-conservation-1>
- Escobar, Arturo (2006): Difference and Conflict in the Struggle Over Natural Resources: A political ecology framework. *Development* 49(3): 6–13.
- Foucault, Michel (2007): Technologien des Selbst. In: Defert, D./Ewald, F. (Hrsg.), *Ästhetik der Existenz: Schriften zur Lebenskunst*. Frankfurt am Main: Suhrkamp, 287–317.
- Fraser, Nancy (2008): *Scales of Justice. Reimagining Political Space in a Globalizing World*. Cambridge: Polity.
- Frickel, S./Gibbon, S./Howard, J./Kempner, J./Ottinger, G./Hess, D. J. (2009): Undone Science: Charting Social Movement and Civil Society Challenges to Research Agenda Setting. *Science, Technology, & Human Values* 35(4): 444–473.
- Gauriat, V. (2023, 16.06.): Locals blame Danone group for drying up water tables in Volvic, France. *Euronews*. URL: <https://www.euronews.com/2023/06/15/french-region-on-the-brink-of-desertification-says-hydrobiologist>
- Görg, Christof (2003): *Regulation der Naturverhältnisse: Zu einer kritischen Theorie der ökologischen Krise*. 1. Aufl. Münster: Westfälisches Dampfboot.
- Gottgens, J. F./Perry, J. E./Fortney, R. H./Meyer, J. E./Benedict, M./Rood, B. E. (2001): The Paraguay-Paraná Hidrovía: Protecting the Pantanal with Lessons from the Past. *BioScience* 51(4): 301–308.
- Hari, V./Rakovec, O./Markonis, Y./Hanel, M./Kumar, R. (2020): Increased future occurrences of the exceptional 2018–2019 Central European drought under global warming. *Scientific Reports* 10(1).
- Hess, David J. (2007): *Alternative Pathways in Science and Industry: Activism, Innovation, and the Environment in an Era of Globalization*. Cambridge: MIT Press.
- HW – Hamburg Wasser (2013): *Wasserwerk Nordheide – Unverzichtbarer Bestandteil einer sicheren Trinkwasserversorgung der Metropolregion Hamburg*. [PowerPoint-Präsentation]. URL: https://epub.sub.uni-hamburg.de/epub/volltexte/2014/33865/pdf/Nordheide_Praesentation_2013_07.pdf
- HW – Hamburg Wasser (2015): *Bewilligungsantrag der Hamburger Wasserwerke GmbH für das Wasserwerk Nordheide*. Hier: Änderungsantrag auf Erteilung einer wasserrechtlichen Bewilligung über die Entnahme von bis zu 18,4 Mio. m³ Grundwasser aus den Brunnen der Fassungen Nordheide Ost, West und Schierhorn. CONSULATQUA.
- HW – Hamburg Wasser (2023a): *Nachhaltigkeitsbericht 2022*. Hamburg Wasser.
- HW – Hamburg Wasser (2023b, 31.05.): *Hintergründe zum Wasserrechtsstreit*. Hamburg Wasser. URL: <https://www.hamburgwasser.de/magazin/nordheide/monitoring-und-wasserrechtsverfahren>
- HW – Hamburg Wasser (2023c, 01.06.): *Wasserförderung in der Nordheide*. Hamburg Wasser. URL: <https://www.hamburgwasser.de/magazin/wasserfoerderung-in-der-nordheide>
- I1 - Interview 1 (2024).
- I2 - Interview 2 (2024).
- I3 - Interview 3 (2024).
- I4 - Interview 4 (2024).
- I5 - Interview 5 (2024).
- I6 - Interview 6 (2024).
- Jaffee, D./Newman, S. (2013): A Bottle Half Empty: Bottled Water, Commodification, and Contestation. *Organization & Environment* 26(3): 318–335.
- Jahn, Thomas/Wehling, Peter (1998): *Gesellschaftliche Naturverhältnisse – Konturen eines theoretischen Konzepts*. In: Brand, K.-W. (Hrsg.), *Soziologie und Natur: Theoretische Perspektiven*. Wiesbaden: VS Verlag für Sozialwissenschaften, 75–93.
- Jessop, Bob (1990): *State Theory. Putting the Capitalist State in its Place*. Cambridge: Polity.
- Karpouzoglou, T./Vij, S./Blomkvist, P./Juma, B./Narain, V./Nilsson, D./Sitoki, L. (2023): Analysing water provision in the critical interface of formal and informal urban water regimes. *Water International* 48(2): 202–216.
- Latour, Bruno (1994): *We have never been modern*. 3. Aufl. Cambridge: Harvard University Press.
- Linton, Jamie (2010): *What is Water?: The History of a Modern Abstraction*. Vancouver: UBC Press.

- Linton, J./Budds, J. (2014): The Hydrosocial Cycle: Defining and Mobilizing a Relational-Dialectical Approach to Water. *Geoforum* 57: 170–180.
- Marquardt, B. (2022, 04.02.): Grundwasserförderung im Landkreis Harburg: Hamburg saugt die Heide leer. *Kreiszeitung*. URL: https://www.kreiszeitung-wochenblatt.de/tostedt/c-panorama/hamburg-saugt-die-heide-leer_a228609
- Martinez-Alier, J./O'Connor, M. (1996): Ecological and Economic Distribution Conflicts. In: Costanza, R./Segura, O./Martinez-Alier, J. (Hrsg.), *Getting Down to Earth: Practical Applications of Ecological Economics*. Washington, D.C.: Island Press, ISE.
- Marx, Karl (1890): *Das Kapital. Kritik der politischen Ökonomie*. Erster Band. Berlin: Dietz.
- Meijaard, E./Brooks, T. M./Carlson, K. M./Slade, E. M./Garcia-Ulloa, J./Gaveau, D. L. A./Lee, J. S. H./Santika, T./Juffe-Bignoli, D./Struebig, M. J./Wich, S. A./Ancorenaz, M./Koh, L. P./Zamira, N./Abrams, J. F./Prins, H. H. T./Sendashonga, C. N./Murdiyarso, D./Furumo, P. R./.../Sheil, D. (2020): The environmental impacts of palm oil in context. *Nature Plants* 6(12).
- Meuser, Michael/Nagel, Ulrich (1991): Expertinneninterviews – vielfach erprobt, wenig bedacht. Ein Beitrag zur qualitativen Methodendiskussion. In: Garz, D./Kaiser, K. (Hrsg.), *Qualitativ-empirische Sozialforschung: Konzepte, Methoden, Analysen*. Opladen: Westdt. Verlag, 441–471.
- Meuser, Michael/Nagel, Ulrich (2020): Experteninterviews. In: Dick, M./Marotzki, W./Mieg, H. (Hrsg.), *Handbuch Professionsentwicklung*. Bad Heilbrunn: Verlag Julius Klinkhardt, 342–352.
- Molle, François (2007): Scales and power in river basin management: The Chao Phraya River in Thailand. *The Geographical Journal* 173(4): 358–373.
- MU - Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz (2014): Gütebewertung nach EG-WRRL. Niedersächsisches Ministerium für Umwelt, Energie und Klimaschutz. URL: https://www.umwelt.niedersachsen.de/startseite/themen/wasser/grundwasser/grundwasserbericht_niedersachsen/grundwasserbeschaffenheit/gutebewertung_nach_eg_wrrl_2014/bewertung2014-137731.html
- NWG (Niedersächsisches Wassergesetz), 28200 § 22 Abs. 1 (2024).
- Omofonmwan, S. I./Odia, L. O. (2009): Oil Exploitation and Conflict in the Niger-Delta Region of Nigeria. *Journal of Human Ecology* 26(1): 25–30.
- Özkaynak, B./Rodriguez-Labajos, B./Arsel, M./Avci, D./Carbonell, M. H./Chareyron, B./Chicaiza, G./Conde, M./Demaria, F./Finamore, R./Kohrs, B./Krishna, V./Mahongnao, M./Raeva, D./Singh, A./Slavov, T./Tkalec, T./Yáñez, I. (2012): Mining conflicts around the world: Common grounds from an Environmental Justice perspective. *EJOLT Reports* 7.
- Pastén-Zapata, E./Ledesma-Ruiz, R./Harter, T./Ramírez, A. I./Mahlknecht, J. (2014): Assessment of sources and fate of nitrate in shallow groundwater of an agricultural area by using a multi-tracer approach. *Science of The Total Environment* 470–471: 855–864.
- Peluso, Nancy L./Watts, Michael (2001): *Violent Environments*. Ithaca, NY: Cornell University Press.
- Poulantzas, Nicos (2002): *Staatstheorie. Politischer Überbau, Ideologie, Autoritärer Etatismus*. Hamburg: VSA.
- Römer, J. (2019): Die Wasserentnahmeentgelte der Länder – Kurzgutachten des BUND. BUND. URL: <https://www.bund.net/>
- Rosemann, N. (2015): Drinking water crisis in Pakistan and the issue of bottled water: The case of Nestlé. *ActionAid Pakistan*, 4(37): iv, 37 p.
- Savenije, H. H. G. (2002): Why water is not an ordinary economic good, or why the girl is special. *Physics and Chemistry of the Earth, Parts A/B/C* 27(11–22): 741–744.
- Schmitt, T. (2022): Umkämpfte(s) Wasser. In: Gottschlich, D./Hackfort, S./von Winterfeld, U./Schmitt, T. (Hrsg.), *Handbuch Politische Ökologie*. Bielefeld: transcript Verlag, 287–297.
- Senat Hamburg (2016): Statusbericht zur Trinkwasserversorgung in Hamburg. Mitteilung des Senats an die Bürgerschaft, Drucksache 21/5404.
- Sneddon, C. (2012): Inland Capture Fisheries and Large River Systems: A Political Economy of Mekong Fisheries. *Journal of Agrarian Change* 12(2–3): 279–299.
- Statistik Nord - Statistisches Amt für Hamburg und Schleswig-Holstein (2021a): Bevölkerung in Hamburg 2020 (94/2021). Statistisches Amt für Hamburg und Schleswig-Holstein – Anstalt des öffentlichen Rechts (Statistikamt Nord). URL: https://www.statistik-nord.de/fileadmin/Dokumente/Presseinformationen/SI21_094.pdf
- Statistik Nord - Statistisches Amt für Hamburg und Schleswig-Holstein (2021b): Bevölkerungsprognose für die Hamburger Stadtteile (98/2021 Korrektur). Statistisches Amt für Hamburg und Schleswig-Holstein – Anstalt des öffentlichen Rechts (Statistikamt Nord).
- Swyngedouw, Erik (1997): Power, Nature, and the City: The Conquest of Water and the Political Ecology of Urbanization in Guayaquil, Ecuador: 1880–1990. *Environment and Planning A* 29(2): 311–332.
- Swyngedouw, Erik (1999): Modernity and Hybridity: Nature, Regeneration, and the Production of the Spanish Waterscape, 1890–1930. *Annals of the Association of American Geographers* 89(3): 443–465.
- Swyngedouw, Erik (2004): *Social Power and the Urbanization of Water: Flows of Power*. Oxford: Oxford University Press.

- Swyngedouw, Erik (2007): Dispossessing H₂O. In: Heynen, N./McCarthy, J./Prudham, S./Robbins, P. (Hrsg.), *Neoliberal environments: False promises and unnatural consequences*. London: Routledge, 51–62.
- Temper, L./Walter, M./Rodriguez, I./Kothari, A./Turhan, E. (2018): A perspective on radical transformations to sustainability: Resistances, movements and alternatives. *Sustainability Science* 13(3): 747–764.
- Tosun, Jale (2017): Party support for post-exceptionalism in agri-food politics and policy: Germany and the United Kingdom compared. *Journal of European Public Policy* 24(11): 1623–1640.
- Turner, J. H. (1975): Marx and Simmel Revisited: Reassessing the Foundations of Conflict Theory. *Social Forces* 53(4): 618–627.
- UBA/BMU – Umweltbundesamt/Bundesministerium für Umwelt, Naturschutz und nukleare Sicherheit (Hrsg.) (2017): *Wasserwirtschaft in Deutschland – Grundlagen, Belastungen, Maßnahmen*. Umweltbundesamt.
- VKU - Verband kommunaler Unternehmen (2022, 05.08.): Aktualisierte VKU-Grafik zeigt Wasserentnahmeentgelte der Bundesländer im Vergleich. URL: <https://www.vku.de/themen/preise-und-gebuehren/artikel/aktualisierte-vku-grafik-zeigt-wasserentnahmeentgelte-der-bundeslaender-im-vergleich/>
- Weber, Max (1976): *Wirtschaft und Gesellschaft: Grundriß der verstehenden Soziologie*. Tübingen: Mohr.
- WHG (Wasserhaushaltsgesetz) (2009): *Wasserhaushaltsgesetz*. Bundesgesetzblatt Jahrgang 2009 Teil I, S. 2585. URL: https://www.gesetze-im-internet.de/whg_2009/
- Winterfeld, U. von (2022): Herrschaft und Macht. In: Gottschlich, D./Hackfort, S./Schmitt, T./Winterfeld, U. V. (Hrsg.), *Handbuch Politische Ökologie: Theorien, Konflikte, Begriffe, Methoden*. 1. Aufl. Bielefeld: transcript Verlag, 385–391.
- WorldTimes-Online (n.d.): Hamburg droht Wassermangel. WorldTimes Online-Magazin. URL: <https://www.worldtimes-online.com/news/391-hamburg-droht-wassermangel.html> (18.04.2024).
- Zamponi, R. (2021, 15.06.): Kampf ums Wasser: Was die Landwirte in Harburg fordern. *Hamburger Abendblatt*. URL: <https://www.abendblatt.de/region/harburg-landkreis/article232533561/Kampf-ums-Wasser-Was-die-Landwirte-der-Region-fordern-Harburg-Ernte-Regen-Bewaesserung.html>
- Zdrzalek, S. (2023, 20.06.): Wassermangel in Deutschland: Gießen verboten. *tagesschau.de*. URL: <https://www.tagesschau.de/inland/gesellschaft/wassermangel-100.html>