Artículos / *Articles*

The relational sociology of eco-innovation / *La sociología relacional de la eco-innovación*

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ABSTRACT

While sociology often adopts a firm's capacity perspective when looking at innovation, this article intends to provide a relational perspective on innovation stemming from the relational sociology of Norbert Elias. Taking the example of a German scrap metal recycling network, understood here as an eco-innovation, the article strives to conceptually re-embed innovation in socio-historical contexts. This re-embedding also includes examining the role of values during innovation-creating processes, which is treated with great ambiguity in the eco-innovation literature. Despite showing that ecologic values play a minor role in the eco-innovation process, the article points to that the eco-innovation is deeply related to complex historical developments which comprise scientific knowledge creation.

RESUMEN

Mientras la sociología ha analizado habitualmente la innovación desde la perspectiva de las capacidades de la empresa, este artículo ofrece una visión más relacional sobre la innovación derivada de la sociología relacional de Norbert Elias. Tomando el ejemplo de una red alemana de reciclaje de basura electrónica y de escoriales de minería, entendida aquí como una eco-innovación, el artículo intenta re-integrar conceptualmente la innovación en contextos socio-históricos. Esta re-incorporación también incluye examinar el rol de los valores durante los procesos de creación de innovación, lo cual ha sido tratado con gran ambigüedad en la literatura de eco-innovación. A pesar de mostrar que los valores ecológicos desempeñan un papel menor en el proceso de eco-innovación, el artículo señala que la eco-innovación está profundamente relacionada con desarrollos históricos complejos que comprenden la creación de conocimiento científico.

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INTRODUCTION: ECO-INNOVATION

Eco-innovations aim to replace environmentally harmful services, processes, or products (Kemp and Pearson, 2007; Reid and Miedzinski, 2008; Schiederig *et al.,* 2012) and have become an important issue for EU environmental policy making (EcoAP, 2011). Eco-innovations aim, for instance, to reduce resource use in value and supply chains by increasing efficiency in logistics (Sarkis *et al.,* 2011) or water services (Levidow *et al.,* 2016), or by using forms of "material recycling and re-use" (EIO, 2011: 11) such as metal recycling (Duwe, 2015). However, definitions of eco-innovation actually demonstrate ambiguity: some definitions highlight that eco-innovation is "less environmentally harmful than the use of relevant alternatives" (Kemp and Pearson, 2007: 6). Others state that eco-innovation is "closely related to competitiveness and makes no claim on the 'greenness' of varios innovations"; hence, it is mainly oriented towards market integration (Andersen, 2008: 5).

The literature in this regard acknowledges that both companies' capacities to generate expertise (Dahlin, 2014, Hojnik and Ruzzier, 2016) and especially the knowledge produced by scientists (Nair and Ndubisi, 2011; Schiederig *et al.,* 2012) are relevant for the creation of eco-innovations and also notes the role of entire geographic regions in linking these capacities (Rennings, 2000; Reid and Miedzinski, 2008; Cooke 2012; Klewitz *et al.,* 2012; Levidow *et al.,* 2016). Innovation sociology has taken up on this and has recognized the positive role that organizational capacity plays in creating knowledge by crossing organizational boundaries in social networks (Obstfeld, 2005; Uzzi, 2005; Dahlin, 2014). Regional social networks have been found to mobilize knowledge for innovation (Granovetter, 1973, 1983; Podolny and Baron, 1996).

The literature mainly addresses the phenomenon of eco-innovation from the perspective of how capacities, expertise, and scientific knowledge related to resource-efficient innovations are created and pooled by regional business clusters (Schiederig *et al.,* 2012; Karakaya *et al.,* 2014; Hojnik and Ruzzier, 2016), while the socio-historical embedding of eco-innovation is an under-addressed topic. This area of investigation concerns the role of values in the creation of innovations in general. The work of Granovetter (1983), which often serves as a prominent sociological network perspective on innovation (*e. g.* Wright and Rains, 2014; Nelson *et al.,* 2014), is symptomatic for this oversight. Whereas Granovetter's study of subcultures has shed light on the diffusion of values in geographically distributed networks, it has done little to answer the question of how such values emerge in first place and who has the power to integrate them into the production of scientific knowledge. It is not entirely new that values originate from and are steadily reproduced in ever-changing relational, social interactions between actors, which is also the case for scientific research. It is also well established that values are shared in very different ways among different actors (Rezsohazy, 2001). It is furthermore established that values can exist in different hierarchical orders to each other, depending on the specific social context (Schwartz, 2012). Nevertheless, it seems that literature strictly separates value-laden information and scientific knowledge without recognizing the intrinsic values underpinning scientific endeavor, thereby overestimating its isolation from socio-historical contexts. Given that scientific endeavor is implicated in finding more environmentally friendly solutions, such a perspective limits a socio-historical understanding of eco-innovation.

This sets the scene for the arguments detailed in this article. By trying to re-embed eco-innovation in the ever-changing socio-historical regional context with its ongoing power structures resulting in ever chaning power balances, the article seeks to provide a sociological perspective on innovation by drawing on the case of eco-innovation and by asking the following research question: *what motivates eco-innovation?* This concerns the understanding of the role of organizational knowledge creation but also the normative bases of eco-innovation, which at present do not state whether eco-innovations relate to ecological or market values. The majority of works in relational sociology on innovation that build for instance on Norbert Elias' relational thinking examine organizational perspectives and how they are interwoven with wider socio-historical perspectives (*e. g.* Dopson, 2005; Frerichs, 2014; David, 2016). This article tries to extend this focus

by drawing more explicitly on the socio-historical essence of innovation by relying on Elias's sociology of knowledge and by introducing a values perspective (Elias, 1939, 1956). Elias's sociology provides a framework that is able to re-construct knowledge creation and socio-historically re-connect values to the social contexts of innovation. To make this implicit component more explicit, this article uses the example of eco-innovation, since it is highly normative and thus serves as a perfect example of how values come into play when creating sociotechnical eco-innovation and how they change over time.

This article seeks to understand the long-term emergence of the expertise and capacities which are relevant for the development of eco-innovation. Light is shed on how values influence these processes by assuming that norms and values become enacted in practice when people learn to act according to them over their lifetimes (Elias, 1978). With regard to the analysis of eco-innovation, this means that values might influence the causes that lead to the creation of eco-innovations. Therefore this article aims to achieve a deeper understanding of the associated production of academic knowledge and then seeks to determine the relationship between those processes and values. This approach differs from innovation sociology literature, which asks for whom an innovation is actually new within a social network (*e. g.* Rogers, 2003) and how networks act to enhance scientific knowledge creation (*e. g.* Rennings, 2000; Kemp and Pearson, 2007; Reid and Miedzinski, 2008) as well as practical expertise (*e. g.* Podolny and Baron, 1996; Obstfeld, 2005; Uzzi, 2005) to improve an organization's capacity to innovate (*e. g.* Levitt and March, 1988; Dahlin, 2014). The approach emphasized in this article extends this perspective by investigating the socio-historical foundations and the balance of power influencing the creation of eco-innovation. By so doing, we wish to contribute to existing works on innovation based on Elias's seminal sociological work.

We have chosen to look at a scrap metal recycling network in a former primary mining area in the Upper Harz region of Germany, which is currently seeking to promote scrap metal recycling as a regional business model. We consider this recycling process to be an eco-innovation. Recycling is interpreted here as a "steady increase in the capacity of

men, both for a more detached approach to natural forces and for controlling them" (Elias, 1956: 231), which aims to control resource flows to prevent a loss of quality of life. Since the recognition of ecological footprints and the production of "greener" services and products are deeply normative, the chosen case study is ideal for investigating the role of values in the creation of innovation. The practice of recycling is interesting with regard to the research question posed here, especially from the perspective of what was in the past and what is. Recycling is a practice that extends the use of resources from yesterday until today —resources that would have otherwise been lost— in order to reduce unsustainable resource extraction. This entails not only a focus on the resource itself. It also involves a socio-historical perspective on values, capacities, expertise and scientific knowledge. This perspective is necessarily utilized and possibly modified to support the eco-innovation, and influences the figurational balance of power.

The remainder of the article is organized as follows. The next section sets out the scope of the research and the theoretical concepts that will guide the analysis. This involves two core concepts of Elias' knowledge sociology, detachment and involvement. The methodological section outlines the article's research approach and the subsequent section draws on the figuration analyzis of the network in question. In a more detailed manner, the network is then examined from the perspective of detachment in one section and in a subsequent section from the perspective of involvement. The discussion condenses the findings and is followed by a conclusion.

FIGURATIONAL SOCIOLOGY AS A PERSPECTIVE TO RE-EMBED ECO-INNOVATION

The figurational knowledge sociology of Norbert Elias seeks to bridge the dichotomy of social structure and social change (Dunning and Hughes, 2013) by pushing for a sociological program based on relational knowledge (Quilley and Loyal, 2004). In this regard, figurations are the places where actors' knowledge is created (Elias, 2000). Elias's figurational sociology is centrally concerned with

understanding processes of constant change in the social settings in which people are born, in contrast to theoretical and methodological approaches that functionally understand the investigated subject as a given (Mützel, 2009). Figurational relations can be deliberately changed, quickly and at short notice, but also over long periods of time (Goudsblom, 1977; Loyal and Quilley, 2013). As such, it is necessary to reconstruct the figuration's embedding context from a socio-historical perspective (Quilley and Loyal, 2004).

The empirical basis for the concept of figuration is Elias's main work *The Civilizing Process* (Elias, 1969, 1982), which explores the socio-historical evolution of manners and the associated changes to the societal power equilibrium, as well as the creation of values and norms over a period of time. Values and norms are tied to the social practices of actors, who are embedded in interdependent and ever-changing relations with each other[1]. It is important to note that, from this perspective, a process has no defined beginning or end (Quilley and Loyal, 2004). Similarly, the balance of power that actors exert on each other also changes over time (Elias, 1969, 1982). The relations thus described may take many forms —they may involve different actors who are interdependently interrelated in figurations or even interrelated across different figurations, which can result in advantages or disadvantages for actors and thus impact on power relations— (Elias, 1978, 1984). It is common for the people who form figurations as communities to feel that their "personal identity is closely connected with the 'we' and 'they' relationships of one's group and with one's position within those units" (Elias, 1978: 128). Defending such identities and the meanings into which people are born is of key importance to the communities' power equilibrium (Elias, 1973). Therefore, actors of a given figuration refer to a "we" group (*us*), whereas actors outside the figuration are perceived as "others" (*them*) (Elias, 1978).

Two concepts within Elias's figurational knowledge sociology are central to this analysis: detachment and involvement. These categories possess specific social functions. They describe the historically evolving forms of knowledge creation about "non-human complexes" and "interpersonal relationships" (Elias 1978: 156) and its underlying values. As Elias (1956: 226) points out, "[i]n using these terms, one refers in short to changing equilibria between sets of mental activities which in man's relations with men, with non-human objects and with himself (whatever their other functions may be) have the function to involve and to detach".

Detachment is described as a process "in course of time, to form and to face a picture of the physical universe" that "agrees better with the cumulative results of systematic observations" and increases men's foresight (Elias, 1956: 230). One aspect of such processes of detachment is the generation of rational scientific knowledge about the natural world. This is enabled by scientific methods that aim to achieve distance from emotions and values and seek to gain control over nature (Elias, 1978). Elias ultimately hints that detachment is a force that counteracts involvement and recognizes, however, the somewhat paradoxically societal consequences of increased detachment over time (Elias 1956: 231):

> [T]he growth of men's comprehension of natural forces and of the use made of them for human ends is associated with specific changes in human relationships; it goes hand in hand with the growing interdependence of growing numbers of people. The gradual acceleration in the increment of knowledge and use of non-human forces, bound up with specific changes in human relations as it is, has helped, in turn, to accelerate the process of change in the latter. The network of human activities tends to become increasingly complex, far-flung and closely knit. More and more groups, and with them more and more individuals, tend to become dependent on each other for their security and the satisfaction of their needs in ways which, for the greater part, surpass the comprehension of those involved.

Involvement refers to people's emotional engagement with their natural environment. This

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1   Elias's aim, often misunderstood as evolutionarily headed to deepen the understanding of progressive development as a normative end, represents rather "'sequential order', but certainly not progress" (Quilley and Loyal, 2004: 9).

concerns social relations and focuses "on short-term, present-day problems and values" (Elias, 1978: 154). In this article, involvement is seen as a means of emotionally connecting with the physical environment that has an impact on knowledge creation (Elias, 1956) and which differs from "an inter-generational social stock of knowledge" (Quilley, 2011). Central to involvement is the question "What does it mean for me or for us?" (Elias, 1956: 229). This indicates a reference to subjectively perceived norms and values. Yet —and despite the short-term focus of involvement— Elias (1956: 203) hints that the meaning of involvement is transformed over time:

> More involved forms of thinking, in short, continue to form an integral part of our experience of nature. But in this area of our experience they have become increasingly overlaid and counterbalanced by others which make higher demands on men's faculty of looking at themselves as it were from outside and of viewing what they call "mine" or "ours" as part systems of a larger system. In their experience of nature, men have been able, in course of time, to form and to face a picture of the physical universe which is emotionally far from satisfactory, which, in fact, seems to become less and less so as science advances, but which at the same time agrees better with the cumulative results of systematic observations.

This suggests that involvement with physical environments has an emotional function, but one which many others can agree upon. In this article we understand involvement as a function to re-orientate towards environmental values. To address the research question, this article is based on an understanding of detachment and involvement as two important dimensions of knowledge creation that determine the role of values throughout the creation of eco-innovation.

METHODOLOGICAL APPROACH AND PROCEDURE

Even though Elias's work mainly focuses on macro-figurational processes, the study *The Established and the Outsiders* by Elias and Scotson (1965) illustrates that the community level can also be studied through a figurational lens. The community-like constellation analyzed in this article is the Recycling cluster for critical metals Lower-Saxony (REWIMET) network, which is based at the Clausthal University of Technology in Germany. The REWIMET network was founded on October 19, 2011, by the regional development fund Initiative Future Harz. Since the region boasts actors involved in metal exploitation and processing, the underlying idea of the network is to connect companies and research actors so that they can engage in joint projects to extract so-called critical metals from scrap materials[2]. It is highlighted that the network aims to generate growth and put in place a permanent funding scheme. The network's mission statement is: "Promotion of science and research to secure the availability of rare materials through the development of recycling strategies and processes for industrial implementation" (REWIMET, 2017a).

Figurational analysis is more complex than typical network analysis, because figurations "involve unfolding processes and flows, and are accruing differences (and shifting power-ratios) over time" (Stanley, 2015: 94). Therefore, the article addresses the research question as follows. Resource extraction is understood as a practice requiring a great deal of scientific knowledge and experience and therefore an expression of detachment over a period of time. Whereas involvement is understood here as an emotional practice that brings people closer to the environment, which in turn can begin to determine the cause of detachment. In this sense, it is assumed that environmental thinking leads to a rethinking of the environmental effects of primary mining practices and by so doing, begins to support knowledge creation for technologically feasible, environmentally friendlier ways of extracting resources. Processes of involvement and detachment might develop in different speeds and one process might predominate over the other and therefore change figurational power equilibria. Therefore, the article seeks to identify figurational constellations that determine detachment, includ-

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2   The network focuses mainly on extracting critical metals like gallium, tantalum, germanium, rhenium and indium from residues produced by the primary resource mining and metal industries.

ing collaborations between specific actors and the exertion of power over others. At the same time the investigation looks at figurational constellations that support processes of involvement, which can lead to more environmentally friendly methods of resource extraction and, in turn, change modes of detachment.

As is typical for process reconstruction (Poole *et al.,* 2000; Lange, 2013), the analysis in this article relies on both primary sources and secondary sources. The primary sources consist of semistructured interviews conducted between 2015 and 2017. The secondary sources are mainly comprised of socio-historical publications about the Harz region and the REWIMET network; these are used to reconstruct organizational aspects of detachment in relation to regional knowledge production in universities, institutes, companies and projects.

Interviewees were selected from among the representatives of REWIMET's founding member organizations, as well as from universities, research institutes, companies and the municipal authorities. This seemed a useful strategy since these organizations appear to have represented mining in this region for centuries. The assumption is therefore that when taking part in the REWIMET figuration, interviewees will act in different roles and contexts according to their affiliated organizations. The interviews consisted of one group interview, four expert interviews (both held in 2015) and two workshops (both held in 2017). The group interview involved seven people from local research institutes (three people from the Institute of Mineral and Waste Processing (IFAD) at Clausthal University of Technology and four people from Clausthal Institute of Environmental Technologies (CUTEC)), two municipal representatives and two engineers, who were active in communal recycling business development]. The first of the four expert interviews involved two people from CUTEC, the second involved one person from the municipal office for the promotion of business, the third interview was conducted with an employee from the municipal authorities and the fourth was conducted with a person from the municipal environmental office. In the interviews and the group discussion, interviewees were mainly asked what they perceived as innovative about the envisioned recycling network

in the Upper Harz region, how they view the origins of the network and where it is headed in the future. The responses provided at the two workshops—which were in part attended by people from the region—aligned with the answers given during the interviews and were valuable for "identifying the individual's placement within, perception of, and ability to change the figuration" (Bauer and Ernst, 2011).

The workshops and interviews were recorded, transcribed and analyzed using the qualitative data processing software MAXQDA, in part according to the grounded theory method (Glaser and Strauss, 1998). The interviews were analyzed in relation to the information they provide about processes of involvement (*e. g.* reconnection with nature, taking notice of environmental problems caused by mining) and detachment (*e. g.* scientific knowledge production). While mainly confirming our understanding of the organizational context of knowledge production and aspects of detachment, the interviews especially shed light on aspects of involvement regarding values and environmental issues related to the regional mining tradition and the network's activities.

The network's members are listed in Table 1.

THE REWIMET FIGURATION

Antecedents of the REWIMET Figuration

The REWIMET figuration is embedded in a region that has a long tradition in mining activities and practices. Primary mining not only shaped the region's natural environment, economic structure, and the daily lives and identities of its population, but also its scientific environment. Mining —as a craft and an industry— was the origin of manifold technological innovations in the region. In the Middle Ages, innovations in aeration were developed in the Upper Harz and were subsequently embraced worldwide. Scientific approaches to mining first established in the German-speaking world and then spread to other European countries and beyond (Brianta, 2000). The world's earliest advanced mining watering system was developed and used in the Upper Harz mining area in the 16th century (UNESCO,

Table 1. Network Actors.

Businesses	Field of Expertise
Aurubis AG***	Copper recycling and processing
Harz-Metall GmbH (Recylex-Group)*	Metal recycling
PPM Pure Metals GmbH (Recylex Group)*	Metal recycling
Exner Technology GmbH*	Recycling infrastructure, processing, logistics
Electrocycling GmbH*	Recycling of electronic waste
H.C. Starck GmbH*	Steel and ceramic processing
RHM Rohstoffgesellschaft mbH**	Steel processing, infrastructure, logistics
Spedition Hahne GmbH*	Logistics
pdv-software GmbH*	Software solutions
WiReGo GmbH & Co.KG*	Promotion of economic development
Stöbich Brandschutz GmbH	Fire protection
Prof. Burmeier Ingenieurgesellschaft mbH	Remediation of contaminated sites
SeRohCon GmbH	Commercialization of secondary material
MPM Environment Intelligence KG	Recycling of electronic waste
Norzinco GmbH*/***	Zinc production and commerce
Research Institutes	**Research Area**
CUTEC-Institut GmbH *	Engineering and recycling
TU Clausthal *	Engineering
IGAS Research	Chemical analysis, metal recovery
TU Braunschweig	Engineering
Hochschule Nordhausen	Engineering
Ostfalia Hochschule für angewandte Wissenschaften	Engineering
Associations	**Aims**
Bundesverband Sekundärrohstoffe und Entsorgung e.V., Bonn**	Promotion of recycling
GDMB Gesellschaft der Metallurgen und Bergleute e.V.*	Promotion of metal mining and processing
pro Goslar e.V.	Promotion of economic development
Municipal Bodies and Cities	**Competencies**
Landkreis Goslar*	Administration
Landkreis Osterode	Administration
Landkreis Göttingen**	Administration
Stadt Bad Harzburg	Administration and Representation
Stadt Goslar	Administration and Representation

* Founding members (Goldmann *et al.,* 2012: 283).
** From outside the Harz region (Goldmann *et al.,* 2012: 283; REWIMET, 2018).
*** No longer part of the network (REWIMET, 2018).

2010). Furthermore, the region's mining sector is also known for being the first to use black powder to extract minerals in the 17th century (Young, 2016) and for the invention of the steel cable in the 19th century (Wyszomirski, 1920). These technological developments were often driven by individuals hired and employed by the mining authority.

The oldest archaeological evidence of mining in the Harz region dates back to the time of the Roman Empire, while the earliest documentation is linked to the Middle Ages (Deicke and Ruppert, 2013). During this era, mining activities became inseparably bound to the central power of the German king and the Holy Roman Emperor (Liessmann, 2010). Later, during the 13th century, the dukes of Braunschweig assigned their mining rights to the city of Goslar. This marks the beginning of a shifting power equilibrium towards a mining area under stronger jurisdiction of local authorities than before. Even though figurational sociology is at odds with beginnings and endings, this is the entry point of analysis. Granting miners privileging labor and exercizing rights and a developing monopoly over copper trade ensured Goslar's membership in the Hanseatic League. This in turn dramatically changed not only the region's vision of mining business opportunities, but also the regional power equilibrium, since the Upper Harz gained increasing popularity as a mining region.

Given the developments of the Thirty Years' War during the 17th and 18th centuries and the fading power of the dukes of Braunschweig, mining was economically reorganized by means of a beginning nationalization. A centralized mining system was established that became a deep-seated part of the fledgling nation state. The new system put metallurgical works and forests under the control of a powerful and highly expert mining authority, which was responsible for maintaining the profitable production and supply of metal. Regulation enforced by the authority not only shaped the economic and public sphere, but infiltrated the private lives of people within the region. For instance, the authority sought to limit private agriculture and trade to ensure manpower in mining (Liessmann, 2010). Thus, the figuration "mining in the Upper Harz" became more and more interwoven and in-terdependent with evolving structures that later formed the national state, but it lost its autonomous power to a higher authority. The role of the centralized mining system culminated in technological advancements and the Upper Harz became recognized worldwide as a pioneer in modern mining technology (Liessmann, 2010). In 1775 a mining-oriented institution for educating miners became part of the system that later developed into the internationally recognized mining academy in 1864 (Clausthal University of Technology). The establishment of mining-related sciences at this academy was closely connected to the mining system and the Prussian state's interests in metal extraction, and culminated in the strongly intervening mining administration of the Prussian state (Liessmann, 2010).

In 1923 the mines and metallurgical works owned by the Prussian state were transformed into a corporation called Prussian Mine and Foundry Company (PREUSSAG), because the state-owned business had become inefficient, even though the influence of the mining administration and regulation remained strong. This changed the power equilibrium of the state towards business, backed up by science. Extraction of metal increased rapidly in the 1920s and even more during the period of Nazi Germany and in the 1950s (Deicke and Ruppert, 2013; Liessmann, 2010). After WWII, the Western part of the Harz region remained one of Germany's "closed industrial systems" (Liessmann, 2010: 3). Increased mechanization drove up extraction rates, but also meant more and more miners lost their jobs; ore mining ceased in the Upper Harz in 1988 (Deicke and Ruppert, 2013). The interviewees reported that even during the early 1980s, new economic sectors such as tourism had developed in the region.

During the 1990s, the Clausthal University of Technology began setting up the CUTEC institute. In the early 1990s, the institute, which received third-party funding, began its work in environmental technology development and life cycle assessment, as interviewees pointed out. Today, the institute's stated aim is to support Germany's transformation process towards a sustainable industrialized society by combining mineral planning with resource efficiency (CUTEC, 2018). All the interviewees

reported that this pathway was primarily scientifically-oriented before a new resource extraction pathway began to open up. Given that CUTEC is a representative of REWIMET, this pathway diverged from primary mining towards secondary mining recycling, borrowing methods and practices from primary mining.

The Birth of REWIMET

The REWIMET network is what Dunne (2009: 50) calls a "political intervention" in a given figuration that externalizes the interdependencies between actors. In 2009, the Initiative Future Harz (IZH) project was initiated by administrative bodies of two counties in the region. It received national public funding and was politically supported by the Ministry of the Environment, Energy and Climate Protection and the Ministry of Science and Culture of the federal state of Lower Saxony (Ministry of the Environment, Energy and Climate Protection Lower-Saxony, 2017). IZH aimed to initiate and foster regional (economic) development by identifying promising business ideas and bringing together regional actors to realize those ideas. One such idea was the establishment of a research cluster focused on recycling strategic resources and connecting relevant businesses and scientific institutions within the region to promote research and development in the area of recycling technologies. REWIMET was seen as a way of potentially boosting research and the local economy with the aim of developing the region, which is economically underdeveloped. The region has high rates of unemployment and a shrinking population (Group Interview 1, Interview 4). Thus, from the perspective of state ministries, local scientific institutes and regional authorities, REWIMET would generate economic stimuli like more employment in processing, research and services (Goldmann *et al.,* 2012: 290; Duwe, 2015: 65).

At the beginning, the network was financially supported by the European Regional Development Fund and the German state of Lower Saxony (Initiative Future Harz, 2016a). Its members are local recycling businesses and industries, research institutions and administrative bodies from the Gos-lar municipal area (Initiative Future Harz, 2016b). An overview of the founding members is shown in Table 1. The network developed in two stages. First, between 2010 and 2012, the IHZ initiated a series of meetings whereby research institutes like the IFAD and CUTEC invited regional businesses active in recycling, processing, logistics and IT to come and brainstorm new recycling business ideas. Once a business model based on regional research and recycling had been developed, the second stage (2012 onwards) involved inviting more companies and institutes to join the network; this included two firms from outside the region. Hence, in 2015 REWIMET already boasted 11 secondary mining projects (Duwe, 2015: 68).

All the interviews and workshops revealed that knowledge production seems to determine the interviewees' 'we' and 'them' perceptions. In the interviews, actors identified with REWIMET in a specific way, as a 'we' group, and as a point of contrast to what could be called the 'others' (Elias, 1978). The frequent references to mining history and regional technological innovations in interviews and workshops hint at an awareness of being part of the socio-historical origin of the figuration we examined (Interview 2: "I have industrial roots"). The phenomenon that Elias called place identification of communities (Elias, 1973) has been proven to exist among residents of industrial regions who identify with the practices of their industrial heritage (Gouthro and Palmer, 2010; Naja and Mali, 2012; Wirth *et al.,* 2012).

The interviewees' strong identification with the region's prosperity generated by primary mining hints at the primary mining community's claim to power in the region. All interviews and workshops pointed to a strong belief in the legitimacy of scientific institutes and research through primary mining. In contrast to the "we-relationships", there are also examples of "they-relationships" (Elias, 1978) that seem to foster REWIMET's "we-identity". One scenario that has been accorded much importance is the availability of rare materials in a time of global market contraction due to the raising resource demands of the BRIC countries (Goldmann *et al.,* 2012). This points to the shifting power equilibrium between the local and the global.

RECYCLING AS DETACHMENT FROM REMNANT MINING PRACTICES

Within the mineral resource extraction sector, the close collaboration between administration, science and technological development have gone hand in hand with resource exploitation since the 18th century (Vogel, 2013; Konečný, 2012; Klein, 2012). The relevant knowledge for detachment was mainly created by the Clausthal University of Technology over centuries. Even today, research and innovation are still closely linked to the mining industry (Lynas and Horberry, 2011; Jayawarna and Holt, 2009). The university maintains close relationships with various industries, a fact that was confirmed in all the interviews and workshops. Today's detachment is therefore understood here as interdepently fueled by the collaboration of science and business to further develop methods to explore, exploit and process resources.

REWIMET builds on an industrial infrastructure left by the region's metal mining, smelting and chemical processing tradition. Whereas two of its founding firms come from the metal recycling sector, other firms that subsequently joined the network specialize in recycling processing and logistics, the recycling of electronic waste, steel processing, logistics, software solutions and economic promotion (see Table 1). Interviewees especially linked these capacities to two businesses —the big mining holding group PREUSSAG, which operated from 1920 until 1997 (Stier, 2005), and the H. C. Starck Company, which has been in business since 1920 and is still active in the metallurgical sector— but they also referenced other important regional firms that originated in the mining sector. Furthermore, interviewees indicated that intentions to establish a recycling center failed during the 1990s (Group Interview 1). It was reported that after the closure of PREUSSAG, employees continued working in other firms related to resource extraction in the region (Interview 4). PREUSSAG not only developed processing methods (Group Interview 1), but also created networks among employees (Interview 2, Interview 5), which is typical for community bonding (Elias and Scotson, 1965). These networks are now valuable for REWIMET. The interviews confirmed that REWIMET actors perceive themselves

as having been transferred a vivid mining tradition (Interviews 1, 2 and 4). The fact that respondents stylized their own origins in a region that will be the future "Silicon Valley of recycling" (Duwe, 2015; Group Interview 1, Workshop 1) supports the idea that interviewees perceive REWIMET as being innovation-oriented.

Today's scientific knowledge about recycling is created through research practices funded by research programs. This includes research into the recycling of various things: airplanes, mining heaps and sludge, as well as critical metals from motorcycles, electronic components and LCD screens and also the development of an industrial recycling technology chain (Duwe, 2015). Interviewees drew strong links between recycling practices and processing from primary mining, which had been practiced in the region for centuries (Group Interview 1, Interview 2). This shows that, from a figurational perspective, the resource-recycling field is perceived as originating in the field of primary mining.

Respondents of the group interview underscore that economically feasible solutions and efficiency are important hallmarks of REWIMET. Hence, from a perspective of detachment, the traditional collaboration between science and business entails an ability to produce knowledge to facilitate better management of the Earth's surface through recycling. IFAD and CUTEC, two institutes that are part of REWIMET, are significant for the shift to recycling in scientific knowledge production. Whereas IFAD has existed since 1927 and has its roots in primary mining, during the 1990s it began looking at issues like waste, water and soil management (IFAD, 2017). CUTEC was founded in 1990 and "operates at the science-industry interface and conducts research which has direct application relevance. The goal is to quickly translate basic research results into practicable technologies" (CUTEC, 2017).

INVOLVEMENT AND RECYCLING IN THE UPPER HARZ

Transforming the Earth's crust through mining goes hand in hand with environmental degradation (Heckens *et al.,* 2016; Bridge, 2004; Down and Stocks, 1977) and health issues among residents

living close to contaminated mining sites (Claus Henn *et al.,* 2016; Hime *et al.,* 2015; Taylor *et al.,* 2015). Studies have proven that environmental degradation has been an effect of mining in the Upper Harz region since the year 3500 BP (Monna *et al.,* 2000) and they have confirmed that it has strongly affected ecosystems (Kempter and Frenzel, 2000). It is reported that public perception of emissions-related environmental problems started in Germany at the end of the 19th century (Bemmann, 2012) and was linked to issues such as environmental degradation related to mining and smelting in mining areas such as the Upper Harz (Schramm, 1990).

Aware of soil contamination caused by mining-related heavy metals, the State Office for Soil Research of Lower Saxony began systematically assessing soil in the 1950s (Nowak and Preul, 1971). Bird die-offs indicated that the region's ecosystem was contaminated with high levels of heavy metals (Knolle and Knolle, 1983), which soon became a bone of contention for various emerging regional citizens' initiatives (Öko-Institut, 1980), as well as for other environmental protection associations like the Bund für Umwelt und Naturschutz Deutschland (BUND) (BUND, 2017). Today Upper Harz BUND association deals mainly with the environmental effects of mining (BUND, 2017a, 2017b). In 1978, the Ministry of Social Affairs in Lower Saxony recommended restricting consumption of regional vegetables and fruit, and in 1980 the German health authority detected elevated levels of lead in children's blood (Knolle, 2009). This profoundly changed the perception of mining in the region (Group Interview 1, Interview 2) and led to the initiation of the first soil protection area in Germany in 2001 (Knolle, 2009). The environmental history of the Upper Harz can easily be understood as a transition towards involvement with nature (Elias, 1956) spurred on by civil society groups, which led to new environmental regulations in the region.

Interviewees confirmed this mining-related environmental history of the region, and two scientific institutes, IFAD and CUTEC, link their activities to environmental issues. The IFAD developed a study program on environmental engineering in 1995, and in 2001 it added a program on environmental process engineering and recycling (IFAD, 2017).

Furthermore, REWIMET's association charter states that it aims to assess the environmental sustainability of existing and new recycling methods (REWIMET, 2017c). This is also reflected in articles about REWIMET: these articles reveal an understanding of recycling as a practice that will ultimately generate regional employment in resource processing, research and services, but will also promote sustainability at the regional level (Goldmann *et al.,* 2012: 290; Duwe, 2015: 65).

Consequently, one is tempted to understand REWIMET as the evolutionary consequence of figurational transformation towards the establishment of environmental norms and values; that is, as a product of an intense involvement with nature and the devastating environmental conditions that resulted from the mining tradition in the Upper Harz. Paradoxically, when asked why REWIMET should be developed, almost no interviewees linked REWIMET to environmental values or to an emotional urge to move towards more environmentally friendly resource extraction. Only one interviewee carefully expressed that "if done correctly, recycling could contribute to sustainability" (Interview 5). Other interviewees strongly emphasized economic values, such as ensuring that rare materials would continue to be available for industries (Group Interview 1, Interview 4). Only one interviewee made the connection between environmental learning and recycling technologies "as an international example" (Interview 2). It therefore seems that environmental values do not necessarily play an important role in the creation of the REWIMET eco-innovation. Rather, this process is dominated by economic values.

THE RELATIONAL SOCIOLOGY OF ECO-INNOVATION BY ACCIDENT

The establishment of REWIMET by public government bodies contrasts with REWIMET's image of itself as a network that builds on an autonomous "we-group" driven by regional scientific endeavor to serve as an inspiration for regional businesses (REWIMET, 2017a). In its public communication REWIMET stresses that whereas commercial actors seek to develop recycling business opportunities, research actors focus on industrial waste manage-

ment, the collection and recovery of metals from residual scrap metal waste and mining heaps, tailing ponds and dumps, reprocessing technologies, as well as recycling processes for the recovery of metals from electric cars (REWIMET, 2017b). In this regard it seems that the REWIMET figuration emphasizes the role of business. This offers a figurational perspective on power related to the practice of recycling: the increasing practice of secondary resource exploitation like metal recycling is seen as determined by a scientific practice oriented towards the delivery of feasible results for businesses, which in turn re-legitimizes actors from the administrative and political establishment. This means that scientific practice —detachment— depends on the perceived business opportunities and contrasts with the "mining in the Upper Harz" figuration during the time of the foundation of the Clausthal University of Technology.

Detachment also relates to the global; powerful international actors active in primary mining seem to dictate market conditions through pricing, which in turn poses a challenge for recycling (Interview 3). Interviewees believe this is due to the fact that recycling promises to provide substitutes for primary resources and that China deliberately supports price dumping strategies for resources, "like they already did in previous years" (Interview 2, see also Interviews 1, 3 and 4). This, according to the respondent, directly influences local resource economies like the Harz economy. Hence, falling international resource prices have led to a competitively unfavorable situation for domestic resource exploitation practices in the region. Identities of REWIMET are therefore also based on so called "they-relationships" which refer to the global level. The Chinese narrative can thus be understood as a perceived threat from "outside" the described figuration. This reveals a relationship between the local and the global: REWIMET actors base their identity on the very fact that their core practice —regional primary mining— is endangered by the market power and activities of (new) actors in the field and therefore push for recycling.

The analysis has shown that interviewees reflected on the environmental history of the Upper Harz, but seemed not to relate this history to recycling. Environmental values seemingly do not play

a role in arguing for REWIMET as an eco-innovation. Instead, interviewees tended to talk about business values like the monetary value and economic feasibility of recycling and its regional economic impact. This means, the eco-innovation we analyzed in this article might be described as replacing environmentally harmful business practices (Kemp and Pearson, 2007; Reid and Miedzinski, 2008; Schiederig *et al.,* 2012) with economically feasible "material recycling and re-use" (EIO, 2011: 11). The picture fits rather with Andersen's (2008: 5) assertion about eco-innovation that "makes no claim on 'greenness'" in light of competitiveness and market integration. Keeping in mind the sociohistorical relationship of REWIMET to the region's past mining tradition, the decline of mining activities in the 1990s, and the region's hazardous environmental history related to past mining activities, it seems that REWIMET is an eco-innovation by accident. This finding raises an important question: namely what explains the enormous discrepancy between the region's environmental history and the articulation of the eco-value of REWIMET?

The nearest available explanation given our proposed framework —and again, this corresponds with Andersen's (2008) perspective— is that business plays an important role and exerts power over detachment and involvement. For centuries primary mining was dominated by business rather than by science. This power equilibrium changed with the rise of the idea of the modern, administrative state with hegemony over knowledge creation. Considering that the figuration under analysis is dominated by research institutes stemming from a primary mining tradition that emphasized business, it is easy to understand why the values of primary mining (like safeguarding the provision of raw materials and related technical innovations) are steadily highlighted in the REWIMET narrative. Furthermore, given the perceived market pressure caused by high demand for rare materials in China and India, which was reported by the interviewees, it becomes even easier to understand why market values are frequently stressed and there is desire for cooperation between science and industries.

Yet our analysis shows that not only scientific capacities, but also values of given eco-innovations are linked to developments of the past. This

has been demonstrated by environmental interest groups evolving in the Upper Harz that have influenced environmental policymaking in the region —but as it seems not resource businesses—. Nevertheless, the figurational perspective on norms and values is twofold. On the one hand, practices are always value-laden. Elias indicates that the detachment embodied by scientific methods is never value-free and points out: "Even the aim of finding out the relatedness of data, their inherent order or, as it is sometimes expressed, at approximating to the 'truth', implies that one regards the discovery of this relatedness or of the 'truth' as a 'value'" (Elias, 1956: 229). On the other hand, norms and values link the "gap between the 'is' and the 'ought' the separation of facts and value" (Quilley, 2009: 122). This means that envisioning how the future should be is not necessarily the driver of how society develops, which is important for Elias's take on the figurational development of social futures like innovations. Elias illustrates this with reference to the French revolution, which was based on the ideal of equality. While societies might have moved in this normative direction, he argues that "it is absolutely certain that no one consciously planned it or intentionally brought it about" (Elias, 1978: 154). This is related to society's complexity, as well as to unforeseen and unalterable changes in figurations. At the same time, one could argue that the values in question were already in place when the French revolution began and were articulated as a vision for future societal development. Yet, returning to our case study, it is hard to say if REWIMET promotes metal recycling as an eco-innovation *by definition*.

A possible approach to understand this is to acknowledge that a certain degree of forgetfulness also constitutes such processes of *longue durée*. As Gabriel and Mennel (2011: 9) argue, Elias emphasizes that "individual searches for meaning [...] can have a 'strange form of forgetfulness', because they encourage us to treat personal achievements as if they were not dependent on others, but existed in isolation". This definition invites us to think of what could be called "environmental forgetfulness". From this perspective it seems that recycling is a social practice which has "forgotten" its socio-historical origin, that it once was environmentally

motivated and pushed by a growing environmental movement in the region and throughout Germany more generally. According to Newton (2010), Elias agreed that new creations are often a recycling of the past itself. One such example of environmental forgetfulness could be found in Interview 3: the respondent explicitly underlined that the closing down of primary mining in the region was not directly related to environmental considerations, but rather to an "oversupply of capacities". However, later in the interview, respondents explained that the development of recycling methods was due to a rising waste problem, which points to environmental concerns. The forgetfulness assumption would explain to a certain degree why environmental values are not dominant in the interviewees' comments about the network. On the other hand, an example of industrial forgetfulness was evident in Interview 2, with a respondent stating that members of the recycling network would not know about the region's industrial recycling history. A reference was made to the so-called Pape method, which refers to the recycling of zinc from slag to enhance the efficiency of zinc extraction. This method has been used in the region since 1909 (Mehner, 1991), but is not officially shared in the network's historical narrative. A forgetfulness perspective could also suggest the use of a "wall of forgetfulness" (Elias, 1939: 410) as a strategy to compete with other recycling business for highlighting an innovation.

Another concept that could be helpful for understanding why environmental values are underrepresented in interviewees' narratives about REWIMET is what we would term industrial survival. Even though Elias mainly refers to the family as the central unit of figurational survival (Elias, 1969, 1978; Kaspersen and Garbiel, 2008), it can be argued that the REWIMET figuration represents a survival unit around a specific technological practice. This practice is primary mining and efforts are undertaken to reframe fragments of this practice, for instance, as resource processing. Technology and the development of methods for eco-innovation could then be understood as a way for a mining community to reinvent itself. Involvement might point towards a new meaning; even though Elias has pointed to the differing speeds of evolving processes of detachment and involvement and has

also indicated that today's dominant form of knowledge creation is detachment (Elias, 1956). This means it is possible that involvement has started, but has not yet fully evolved.

CONCLUSION

Addressing the question what motivates eco-innovation, the article related an eco-innovation to its socio-historical figurational context of origin to advance a relational understanding of innovation. Figurational knowledge sociology provided a good tool to assess sociological perspectives on innovation. Innovations are knowledge-intense; Elias' concepts of detachment and involvement helped to explain the creation of knowledge and the involvement of values relevant for eco-innovation. The framework we stressed demonstrated that eco-innovations are relational in terms of their socio-historical embedding with regard to historically derived practices, expertise and scientific knowledge. REWIMET evolved in a former primary mining region; our research demonstrated that recycling in the Upper Harz is a practice located within the knowledge-creating tradition of primary mining. We described the Clausthal University of Technology with its associated research facilities as a traditional place that creates scientific knowledge and enables detachment from practices for mining the Earth's crust. Its activities align with the economic practices that have shaped the Upper Harz for centuries and continue to do so today.

We assume that any kind of innovation shares such a socio-historical connection. The socio-historical context of a figuration can therefore not be separated from what a given innovation stands for today, but dates far back into the past. This radically questions the basic idea of *innovare*, to introduce something new that replaces the old.

However, our analysis revealed a paradox regarding the eco-innovation's underlying values. Unlike what one might expect when thinking in terms of the social qualities defined by Elias's "involvement" (*i. e.* that emotionally based knowledge creation begins to influence social practices), in our case study there were no signs of awareness about the role of ecological values in the creation of eco-innovations. Although one would assume this is related to the predominance of business values, we assert that any intention to envision how the future should be —and this includes innovation— is not necessarily reflected in the creation of future sociotechnological pathways. It is therefore misleading to view innovation as a process that can be planned.

In the case of innovation, it is not yet possible to understand the speed at which "involvement" develops, *i. e.* a community's reconnection with values. At the same time, a certain degree of forgetfulness might be involved in the apparent neglect of specific values. Seen from this angle, actors seek to develop innovations consciously, or in a ritualistic way that is hidden and intertwined with everyday practices. This forgetfulness might involve an understanding of innovations as necessary for technological survival. In the case study, the dominant direction of the figuration seemed to be survival of primary mining in the Upper Harz. This would explain the social construction of the recycling industry as an innovation.

Innovations might be phenomena that cannot exactly be dated back to a creator, which poses an ongoing challenge for sociologists. Relational sociology might therefore be a good way to examine such phenomena in future innovation research.

ACKNOWLEDGEMENTS

REFERENCES

Andersen, M. M. (2008). Eco-innovation towards a taxonomy and a theory. *25th Celebration DRUID Conference.*

Baur, N., Ernst, S. (2011). Towards a process-oriented methodology: modern social science research methods and Norbert Elias's figurational sociology. *The Sociological Review*, 59(1), 117-139.

Bemmann, M. (2012). *Beschädigte Vegetation und sterbender Wald: Zur Entstehung eines Umweltproblems in Deutschland 1893-1970*. Vol. 5. Göttingen: Vandenhoeck & Ruprecht.

Brianta, D. (2000). Education and Training in the Mining Industry, 1750-1860: European models and the Italian Case. *Annals of Science*, 57(3), 267-300.

Bridge, G. (2004). Contested Terrain: Mining and the Environment. *Annual Review of Environment and Resources*, 29, 205-259.

BUND - Bund für Umwelt und Naturschutz Deutschland e.V. (2011). 30 Jahre BUND-Kreisgruppe Goslar. *BUNDinfo Kreisgruppe Goslar*. Vol. 17.

BUND (2017a). *Bodenschutz im Landkreis Goslar - Sachstand und Forderungen* (online). http://www.bund-westharz.de/themen/bodenschutz_im_landkreis_goslar/, access 29.08.2017.

BUND (2017b). *Die Deponien in der Grube Morgenstern zwischen Goslar-Hahndorf, Liebenburg und Vienenburg - einer der größten Harzer Umweltskandale* (online). http://www.bund-westharz.de/themen/grube_morgenstern/, access 20.08.2017.

Claus, Henn. B., Ettinger, A. S., Hopkins, M. R., Jim, R., Amarasiriwardena, C., Christiani, D. C., Coull, B. A., Bellinger, D. C., Wright, R. O. (2016). Prenatal Arsenic Exposure and Birth Outcomes among a Population Residing near a Mining-Related Superfund Site. *Environmental Health Perspective*.

Cooke, P. (2012). Transversality and transition: Green innovation and new regional path creation. *European planning studies*, 20.5, 817-834.

CUTEC (2017). *The CUTEC institute* (online). https://www.cutec.de/en/, access 29.08.2017.

CUTEC (2018). *CUTEC* (online). https://www.cutec.de/de/, access 05.07.2018.

Dahlin, E. C. (2014). The Sociology of Innovation: Organizational, Environmental, and Relative Perspectives, *Sociology Compass,* 8(6), 671-687.

David, M (2016). Bürger-Energiewende: Wissen durch Handeln? *Nomos Verlagsgesellschaft.*

Deicke, M., Ruppert, H. (2013). Bergbau- und Umweltgeschichte des Oberharzes. *Jahresberichte und Mitteilungen des Oberrheinischen Geologischen Vereins*, Vol. 95, 259-288.

Dopson, S. (2005). The diffusion of medical innovations: can figurational sociology contribute? *Organization Studies*, 26.8, 1125-1144.

Down, C. G., Stocks, J. (1977). *Environmental Impact of Mining*. New York: Wiley.

Dunne, S. (2009). The politics of figurational sociology. *The Sociological Review*, 57.1, 28-57.

Dunning, E., Hughes, J. (2012). *Norbert Elias and modern sociology: Knowledge, interdependence, power, process*. London: A&C Black.

Duwe, C. (2015). REWIMET - das Recycling-Cluster wirtschaftsstrategischer Metalle. *Akademie für Geowissenschaften und Geotechnologien Veröffentlichungen*, 31, 65-71.

Eco-Innovation Action Plan - EcoAP (2011). *European Commission*, Newsletter 23, December.

EIO (2011). The Eco-Innovation Challenge: Pathways to a resource-efficient Europe. *Eco-Innovation Observatory*. Brussels: DG Environment.

Elias, N. (1956). Problems of involvement and detachment. *The British Journal of Sociology,* 7.3, 226-252.

Elias, N. (1969). *The Civilizing Process, Vol. I. The History of Manners*. Oxford: Blackwell.

Elias, N. (1974). Towards a Theory of Communities. En C. Bell, H. Newby (eds.), *The Sociology of Community: A Selection of Readings* (pp. ix-xvi). London: Frank Cass and Co. Ltd.

Elias, N. (1982). *The Civilizing Process, Vol. II. State Formation and Civilization*. Oxford: Blackwell.

Elias, N. (1983). *The Court Society*. New York: Pantheon.

Elias, N., Scotson, J. L. (1965). *The Established and the Outsiders, A Sociological Enquiry into Community Problems*. London: Frank Cass and Co. Ltd.

Frerichs, M. (2014). *Innovationsprozesse und organisationaler Wandel in der Automobilindustrie: Eine prozesssoziologische Analyse betrieblicher Machtproben*. Vol. 10. Wiesbaden: VS Verlag für Sozialwissenschaften.

Gabriel, N., Mennell, S. (2011). Handing over the torch: intergenerational processes in figurational sociology. *The Sociological Review*, 59.1, 5-23.

Glaser, B., Strauss, A. (1998). Grounded Theory. *Strategien qualitativer Forschung.* Bern: Hans Huber Verlag.

Goldmann, D. (2016). Transdisziplinäre Forschung und breite Verbünde aus Industrie und Forschungseinrichtungen als Antwort auf neue Herausforderungen. *Akademie für Geowissenschaften und Geotechnologien Veröffentlichungen*, 31, 55-58.

Goldmann, D., Kruckow, T., Westphal, R. (2012). Der Recycling-Cluster wirtschaftsstrategische Metalle REWIMET e.V. En K. J. Thomé-Kozmiensky, D. Goldmann (eds.)*, Recycling und Rohstoffe* (pp. 281-290). Nietwerder-Neuruppin: TK Verlag Karl Thomé-Kosmiensky.

Goudsblom, J. (1977). *Sociology in the Balance, A Critical Essay*. Columbia University Press.

Gouthro, M. B., Palmer, C. (2010). Pilgrimage in Heritage Tourism: Finding meaning and identity in the industrial past. En M. V. Conlin, L. Jolliffe (eds.), *Mining heritage and tourism: A global synthesis* (pp. 33-43). London: Routledge.

Granovetter, M. S. (1973). The strength of weak ties. *American journal of sociology*, 78.6, 1360-1380.

Granovetter, M. S. (1983). The strength of weak ties: A network theory revisited. *Sociological theory*, 201-233.

Hime, N., Cowie, C., Marks, G., (2015). Review of the health impacts of emission sources, types and levels of particulate matter air pollution in ambient air in NSW. *Report, Woolcock Institute of Medical Research, Centre for Air Quality and Health Research and Evaluation (CAR)*. Sydney: Australia.

Hojnik, J., Ruzzier, M. (2016). What drives eco-innovation? A review of an emerging literature. *Environmental Innovation and Societal Transitions,* 19, 31-41.

IFAD (2017): *Über uns. Rohstoffaufbereitung und Recycling* (online). https://www.ifa.tu-clausthal.de/lehrstuehle/lehrstuhl-fuer-rohstoffaufbereitung-und-recycling/ueber-uns/, access 12.08.2017.

Jayawarna, D., Holt, R. (2009). Knowledge and quality management: An R&D perspective. *Technovation,* 29(11), 775-785.

Karakaya, E., Hidalgo, A., Nuur, C. (2014). Diffusion of eco-innovations: A review. *Renewable and Sustainable Energy Reviews,* 33, 392-399.

Kaspersen, L. B., Gabriel, N. (2008). The importance of survival units for Norbert Elias's figurational perspective. *The Sociological Review,* 56(3), 370-387.

Kemp, R., Pearson, P. (2007). Final report MEI project about measuring eco-innovation. *UM Merit*, Maastricht.

Kempter, H., Frenzel, B. (2000). The impact of early mining and smelting on the local tropospheric aerosol detected in ombrotrophic peat bogs in the Harz, Germany. *Water, Air, & Soil Pollution*, 121.1, 93-108.

Klein, U. (2012). Savant Officials in the Prussian Mining Administration. *Annals of Science*, 69(3), 349-374.

Klewitz, J., Zeyen, A., Hansen, E. G. (2012). Intermediaries driving eco-innovation in SMEs: a qualitative investigation. *European Journal of Innovation Management*, 15.4, 442-467.

Knolle, F. (2009). Bergbauinduzierte Schwermetallkontaminationen und Bodenplanung in der Harzregion. En C. Breitkreuz, C. Drebenstedt (eds.), *Sustainable mining and environment: a German-Latin American perspective* (pp. 79-84). Vol. 523. Technische Universität Bergakademie Freiburg.

Knolle, F., Knolle, F. (1983). Vogel-und Säugetiervrluste durch Umweltbelastungen im Gebiet des Harzes. *Vogelkundliche Berichte aus Niedersachsen*, 15.2, 47-49.

Konečný, P. (2012). The Hybrid Expert in the "Bergstaat": Anton von Ruprecht as a Professor of Chemistry and Mining and as a Mining Official, 1779-1814. *Annals of Science*, 69(3), 335-347.

Lange, M. (2013). *Comparative Historical Methods*. SAGE Publications.

Levidow, L. *et al.* (2016). Process eco-innovation: assessing meso-level eco-efficiency in industrial water-service systems. *Journal of Cleaner Production* 110, 54-65.

Levitt, B., March, J. G. (1988). Organizational Learning. *Annual Review of Sociology,* 14(1), 319-340.

Liessmann, W, (2010). *Historischer Begrbau im Harz*, 3rd ed, Springer.

Lynas, D., Horberry, T. (2011). Human factor issues with automated mining equipment. *Ergonomics Open Journal*, 4, 74-80.

Marot, N., Černič-Mali, B. (2012). Using Potentials of Post-Mining Regions-A Good Practice Overview of Central Europe. En P. Wirth, B. Černič-Mali, W. Fischer (eds.), *Post-Mining Regions in Central Europe-Problems, Potentials, Possibilities* (pp. 130-147). Munich: Oekom.

McKenzie, G. (2017). *Interpreting charles taylor's social theory on religion and secularization: a comparative study*. Springer.

Ministry of the Environment, Energy and Climate Protection Lower-Saxony (2017). Symposium "Chancen für den Harz" 2017 (online). https://www.umwelt.niedersachsen.de/aktuelles/veranstaltungen/symposium-chancen-fuer-den-harz-2017-155880.html, last access 29.08.2017.

Monna, F., Hamer, K., Lévêque, J., Sauer, M. (2000). Pb isotopes as a reliable marker of early mining and smelting in the Northern Harz province (Lower Saxony, Germany). *Journal of geochemical exploration*, 68(3), 201-210.

Mützel, S. (2009). Networks as Culturally Constituted Processes. A Comparison of Relational Sociology and Actor-Network Theory. *Current Sociology*, 57(6), 871-887.

Nair, S. R., Ndubisi, N. O. (2011). Stakeholder Influence on Environmental Marketing. *Journal of Management Research*, 11(2), 67-76.

Nelson, K. C., Brummel, R. F., Jordan, N., Manson, S. (2014). Social networks in complex human and natural systems: the case of rotational grazing, weak ties, and eastern US dairy landscapes. *Agriculture and Human Values*, 31(2), 245-259.

Nowak, H., Preul, F. (1971). Untersuchungen über Blei- und Zinkgehalte in Gewässern des Westharzes. *Beiheft zum Geologischen Jahrbuch*, No. 10.

Obstfeld, D. (2005). Social networks, the tertius iungens orientation, and involvement in innovation. *Administrative science quarterly*, 50.1, 100-130.

Öko-Institut (1980). *Umweltgift Blei - Basisinformationen zur Verseuchung des Raumes Goslar. - Öko-Berichte,* Freiburg i.Br.: Öko-Institut.

Podolny, J. M., Baron, J. N. (1997). Resources and relationships: Social networks and mobility in the workplace. *American Sociological Review*, 673-693.

Poole, M. S., Van de Ven, A. H., Dooley, K., Holmes, M. E. (2000). *Organizational Change and Innovation Processes, Theory and Methods for Research*. Oxford University Press.

Quilley, S. (2009). The Land Ethic as an Ecological Civilizing Process. *Environmental Ethics*, 31(2), 115-134.

Quilley, S. (2011). Entropy, the anthroposphere and the ecology of civilization: An essay on the problem of "liberalism in one village" in the long view. *The Sociological Review*, 59.1_suppl, 65-90.

Quilley, S., Loyal, S. (2004). Towards a "central theory": the scope and relevance of the sociology of Norbert Elias. En S. Loyal, S. Quilley (eds.), *The Sociology of Norbert Elias* (pp. 1-22). Cambridge University Press.

Reid, A., Miedzinski, M. (2008). Eco-innovation. Final report for sectoral innovation watch. *Europe Innova*. Technopolis group.

Rennings, K. (2000). Redefining innovation-eco-innovation research and the contribution from ecological economics. *Ecological economics,* 32.2, 319-332.

Rezsohazy, R. (2001). *Sociology of Values*. International Encyclopedia of the Social and Behavioral Sciences. Elsevier.

REWIMET (2017a). *Recycling-Cluster wirtschaftsstrategische Metalle Niedersachsen* (online). http://www.rewimet.de/rewimet-e-v, access 07.08.2017.

REWIMET (2017b). *Forschungsprojekte* (online). http://www.rewimet.de/projekte, access 25.10.2017.

REWIMET (2017c). *Satzung und Beitragsordnung des REWIMET e.V.* (online). http://www.rewimet.de/rewimet-e-v/satzung-beitragsordnung, access 29.08.2017.

Sarkis, J., Qinghua Z., Kee-hung, L. (2011). An organizational theoretic review of green supply chain management literature. *International Journal of Production Economics,* 130.1, 1-15.

Schiederig, T., Tietze, F., Herstatt, C. (2012). Green innovation in technology and innovation management-an exploratory literature review. *R&d Management*, 42.2, 180-192.

Schwartz, S. H. (2012). An Overview of the Schwartz Theory of Basic Values. *Online Readings in Psychology and Culture,* 2(1).

Stanley, L. (2016). Olive Schreiner, Sociology and the Company She Kept. En A. Law, E. R. Lybeck

(eds.), *Sociological Amnesia: Cross-currents in Disciplinary History* (pp. 89-104). Routledge.

Stier, B., Laufer, J. (2005). *Von der Preussag zur TUI, Wege und Wandlungen eines Unternehmens 1923-2003*. Essen: Klartextverlag.

Taylor, M. P., Mackay, A. K., Munksgaard, N. C., Hudson-Edwards, K. A. (2015). Comments on manuscript. En J. Zheng, T. Huynh, M. Gasparon, J. Ng, B. Noller, 2013. Human health risk assessment of lead from mining activities at semi-arid locations in the context of total lead exposure. *Environmental Science and Pollution Research*, 20, 8404-8416. *Environmental Science and Pollution Research,* 22(23), 19307-19312.

Technical University Clausthal (2016). *Sekundärrohstoffzentrum: Wirtschaftsministerium gibt 4,2 Millionen Euro für Harzer Recyclingwirtschaft* (online). https://www.tu-clausthal.de/presse/nachrichten/details/1971.html, access 12.07.2017.

UNESCO (2010). *Oberharzer Wasserwirtschaft ist Weltkulturerbe* (online). http://www.unesco.de/kultur/2010/uho-0810-wasserwirtschaft.html, access 12.07.2017.

Uzzi, B., Spiro, J. (2005). Collaboration and creativity: The small world problem. *American Journal of Sociology*, 111.2, 447-504.

Vogel, J. (2013). Aufklärung untertage: Wissenswelten des europäischen Bergbaus im ausgehenden 18. und frühen 19. Jahrhundert. En H. Schleiff, P. Konečný (eds.), *Staat, Bergbau und Bergakademie. Montanexperten im 18. und frühen 19. Jahrhundert* (pp. 13-35). Stuttgart: Franz Steiner Verlag.

Wirth, P., Černič-Mali, B., Fischer, W. (2012). Problems and Potentials of Post-Mining Regions. En P. Wirth, B. Černič-Mali, W. Fischer (eds.), *Post-Mining Regions in Central Europe-Problems, Potentials, Possibilities* (pp. 14-31). München: Oekom.

Wright, K. B., Rains, S. A. (2014). Weak Tie Support Preference and Preffered Coping Styles as Pre-dictors of Perceived Credibility Within Health-Related Computer-Mediated Support Groups. *Health Communication*, 24(3), 281-287.

Wyszomirski, A. (1920). Die Konstruktion der Drahtseile. En A. Wyszomirski (ed.), *Die Drahtseile als Schachtförderseile* (pp. 1-12). Berlin, Heidelberg: Springer.

Young, O. E. (2016). *Black powder and hand steel: Miners and machines on the old Western frontier*. 2nd edition, University of Oklahoma Press.

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