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# **Interweaving Resources**

**From Economic  
Hegemony towards a  
New Understanding of  
Resources**

## **Abstracts**

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## About the Conference

The term “resource,” derived from the Latin *resurgere* (“to rise again”), has evolved significantly over time, encompassing a wide range of meanings across disciplines. Often understood through an economic lens, resources are traditionally seen as external entities to be studied, appropriated, and exploited for human benefit. This perspective frames humans as active agents, with the material world as passive receivers.

However, recent theoretical developments propose a relational perspective, viewing resources as deeply embedded in social, cultural, and material networks. In this view, resources are not only socially and culturally constructed but also inherently active, with physical properties and material affordances that shape interactions and outcomes.

This transdisciplinary shift calls for a holistic understanding of resources, addressing complex, non-linear causalities, such as those tied to climate change. Resources are never isolated; their use generates unforeseen societal challenges and opportunities, such as economic inequalities, unsustainable practices, and innovation races. Some approaches even dismantle the human-resource dualism, suggesting a flat ontology where all entities—human and non-human—share agency within entangled relationships.

Do we still need the utilitarian concept of resources, or should we rethink them entirely? Revisiting the notion of “living” resources may inspire science to connect material properties and their sensory qualities to humans and other species, deepening our understanding of (geo)resource interdependencies.

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*Dorothee Meer*  
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### **Hydrogen vs. LNG - On the Handling of (Geo-)Resources in the Hegemonic German Interdiscourse. Empirical Observations on a Bifurcation of the Current Energy Dispositive**

Whether we are talking about Jules Verne's vision in 1874 of hydrogen as the 'clean coal of the future' or about the assumption of the European Green Deal that by converting the fossil economy to a hydrogen economy, humans will be able to give nature 'more back than they take away from it' (Green Deal 2019): We are dealing with the idea that it is humans alone to decide on the use of (geo)resources, both in the handling of material resources and with regard to the discourses that enable forms of world-appropriation. This assumption seems also to be crucial to the more recent German political discourses since the beginning of the Russian invasion of Ukraine in February 2022. One reaction to the war of aggression observed in Germany was the assumption that on our way to climate neutrality we (only) need to replace „bad Russian natural gas“ with „good Western LNG“ as a „bridging technology“ and that this strategy will enable our transition to the hydrogen economy of the future (Meer 2023, 2024, Coro Blauert forthcoming).

Based on discourse data from German media news in 2022, the first step of my presentation will be to examine the influence of the Russian war on the German discussion about an accelerated transition to renewable energy sources within the so-called „Energiewende“ (‘energy system transition’). By examining linguistic and visual elements, I will illustrate how the idea was constructed that it is possible to overcome the fossil past by splitting the energy discourse in form of a bifurcation into a (still) fossil LNG-based present parallel to a promised hydrogen-based future. In the context of this argumentation, it can be said that climate change itself, with all its material evidence, does not play an important discourse-integrated role in the present. Although there is a great deal of discursive work in German media news on the consequences of climate change, such as weather catastrophes, floods, or droughts, in German inter-discourse these phenomena are mainly treated as natural instances, mostly discursively separated from current questions of energy supply or energy system transition. Building on this initial media analysis, it should be made clear how a highly complex entanglement of interwoven discursive and projected material practices narratively

constructs a chronotopos (Bachtin 1989) that projects a wonderful future for humanity through the coexistence of fossil and non-fossil practices in the present. Within this narrative construction there will be evidence that it is still human hegemony over the use of (geo)resources that is at the root of recent political decisions.

In the second step of the presentation, these (initial) empirical findings based on narrative constructions will be used to pursue the question of how the economic “hegemony of the human over the material world” (see conference call) could be potentially changed. Based on the conference call, which raised the question of whether there are ways to characterize the relationship between humans and georesources from a more interdependent perspective, this question will be discussed anew with reference to media data. On the basis of Foucault's idea of restoring materiality to discourse (Foucault 1979), it is also crucial for recent inter-discourse practices to find traces and indications in this direction. Within our discourse analysis, we found pieces of discursive particles (Hillebrandt 2023) in form of counter-narratives (Wessel/Meer forthcoming) that could be developed to emphasize the dependence of humans on the geo-resources of the planet. Some of these strategies can already be based on our media findings:

- Disclosure of the fossil use of gray hydrogen as opposed to green hydrogen, which is often not differentiated in media reports, must emphasize the need to accelerate the development of wind and solar energy as the basis for a green hydrogen economy even faster.
- The extent of environmental destruction caused by practices such as fracking (in Canada and the US) as a basis for LNG production needs to be highlighted. In this context, the destructive fossil character of LNG as „good Western gas“ needs to be exposed (Meer 2024).
- The relationship between the promises of energy system transition on the one hand, and recent policy-driven industrial development on the other, needs to be made more explicit. In this context, evidence of so-called “delayed” developments (e.g. the recent situation of ThyssenKrupp in Duisburg) is just as crucial as inadequate transportation infrastructure. However, they should be more clearly analysed as consequence of the lack of political and economic action, rather than as an indication of the impossibility of changing the current energy system.
- There are indications of political and economic resistance to the implementation of the so-called hydrogen economy both in Germany itself (see the island of Rügen) and in countries involved in the hydrogen strategy such as Spain, Canada or Namibia. The destruction of natural reserves and the natural livelihoods of affected populations must play a greater role in these planned or existing practices of extractivism.

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*(University of Stavanger / Deutsches Technikmuseum Berlin)*

### **Petrocultures of Progress in History of Technology Museums**

*The proposed paper was written as part of the international Project “Petroculture’s Intersections with The Cultural Heritage sector in the context of green transitions” (PITCH), which began work this year and is funded by the EU as part of the Horizon funding program.*

The mounting environmental crises of our times are well-known: climate change, resource extraction, pollution, and land use change are leading to radical ecological changes on both local and global scales. Much of this environmental destruction is due to the rise of fossil fuel and mineral extraction practices: local ecosystems are destroyed through open pit mining, pollution from tailings and contaminated wastewater, emissions from processing facilities, and infrastructure installation; global ecosystems are altered through increased carbon and sulphur emissions, colonization, and worldwide waste trade. These practices are driven by use of fossil resources. Modern societies have become dependent upon petrocultures and imagined through fossil fuels in all aspects of society.

While many cultural heritage institutions have responded to these

environmental challenges with plans of their own to decrease energy and resource consumption and have begun to discuss divestment from funding by fossil fuel companies, fewer have taken on the mission to reinterpret their collections and permanent exhibitions within these environmental frameworks.

In this paper, we examine how history of technology museums are founded on and display narratives of progress and what that might mean for petrocultures and rethinking cultural heritage. The narrative of progress as adopted in Western thought reifies historical directionality (i.e. that things should always get ‘better’) and confidence in rationality. Rationality is understood to both be boosted by scientific and technological advances and evidenced through them. Further the narrative of progress is related to the pursuit for growth and prosperity as good and positive intentions. Progress becomes the foundation of how cultural heritage tied to technology has been both collected and is currently displayed in museums.

The problem is that this narrative of progress covers up the environmental cost of modern dependence on fossil fuels. We can explore how this happens in two history of technology museum exhibits focused on technical revolutions: Revolution of Science & Technology in the National Science Museum, Daejeon, South Korea, and Railway Revolution and Everyday Life in the German Museum of Technology, Berlin, Germany.

The National Science Museum’s Revolution of Science & Technology gallery tells the Industrial revolution as a progress narrative. The exhibition is designed around four phases of the Industrial Revolution, so from the beginning, it is set up as a timeline that moves left to right, in which things are getting better all the time. The narrative throughout is that efficiency of power leads to progress through expansion. Steam power is behind the first industrial revolution, followed by electricity for the second, information and automation for the third, and data for the fourth. Yet the power behind the power sources—the fossil fuels that make the engines go—is unremarked.

The German Museum of Technology’s *Railway – Revolution and Everyday Life* tells the story of the German railways from the original locomotive sheds of the Anhalter Bahnhof station. The exhibition ties in the traditional perspective of this museum and treats the history of technology as cultural history. Railways, particularly when first powered by steam locomotives, “were the symbol of speed, progress and modernity par excellence for a long time,” according to the exhibition text. But although the text about the industry makes the point that Berlin’s railway industrial district was known as “Feuerland” (Fireland) “because of the glow from the fires and the smoke from the furnaces,” there



is no mention of the fossil fuels behind that fire. Although there are steam locomotives displayed with their coal cars behind, coal itself is not discussed.

Mechanical engines are some of the largest and most iconic technological artefacts on display in history of technology exhibitions. But as demonstrated with the South Korean and German exhibitions, power is displayed as progress. The reason museums collect these artifacts of technology is that they are a heritage of power, and progress becomes this powerful narrative behind the display. The physical power behind the power is completely immaterial in this presentation. This means necessarily that it excludes the environment and fossil fuel extraction. All of the downsides then in this narrative of progress are downplayed because progress is seen automatically as a good. Societal dependence on fossil fuels that has created the petroculture present is taken as an uncommented baseline.

In the conclusion we offer two examples of how these artefacts might be interpreted differently: examining their materiality and changing their contexts. As a result, it will then be possible to break through the common narrative of industrialization and clarify the consequences of industrialization for the climate and environment. It is easy for history of technology exhibitions to display early industrialization as a triumphalist march forward. The challenge is for them also to explain that progress in one area does not necessarily lead to progress in others, but comes at the expense of the environment. There have been and continue to be environmental costs of industrialization powered by fossil fuels and the petrocultures it has created, and a reckoning with them is required.

*Shu Wan*  
*(University at Buffalo)*

### **Making the Deaf Useful: The Human Resources Policy of Deafness in 1950s China**

Based on rarely referenced historical newspapers and state archives, this essay examines the nascent socialist state's human resources of making deaf people useful in the 1950s. The essay includes sections regarding the communist government's agendas of furthering literacy and vocational education for deaf youth and adults, organizing the deaf population, and developing deaf medicine. In terms of the shortage of deaf education in China before 1949, the communist government nationalized existing private deaf schools and established many new ones for deaf youth in the early and mid- 1950s. In the name of „welfare,“ deaf adults were also given vocational training and job opportunities in factories, which represents the state's concern about making all people self-sufficient under the communist regime. Furthermore, the inauguration of Society of Welfare for the Deaf and Dumb in China („Zhongguo longyaren fuli hui“) in 1956 and proliferation of local branches in subsequent years indicated the communist government's efforts to take institutional control over the deaf people. Moreover, the Chinese government also pathologized deafness as a disease by developing the relevant therapy and technology. Through these measures, the newborn socialist state managed to mobilize the deaf population and make them useful as a communist miracle.

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### **Cosmologies and Resources across Geographies and Time Periods**

To live their lives, humans developed different cosmologies and assigned value to elements of natural (e.g. materials) and human environments (e.g. skills, knowledge). Everywhere, all the time, varying cosmologies determined that not all materials or skills were considered resources. For example, iron (Fe), a key material and technology in AfroEurasian antiquity was neither smelted nor used in Pre-Columbian Americas. In ancient sub Saharan Africa and China, copper (Cu) and jade were respectively more valued than gold, a metal treasured by ancient Egyptian elites. The expansion of Europe post 1500 and the evolving globalisation exported elements of western worldviews to the rest of the world, creating a hegemonic monoculture where resources are rarely considered beyond economic utility. Supported and greased by the confluence of science, capitalism and big technology, the exploitation of the world and its contents is primarily driven by a desire to provide comfort to humans. This continues to create a crisis of hyper production and consumption, and the crystallisation of globally intractable problems like inequality, climate change, and unsustainability. Using examples of cosmologies in different world areas, argues for a retreat to plural cosmologies where resources, as part of human-material-environment relations have sentience and value beyond utility. The conclusion is that such a pluriversal approach may promote co-existence of worldviews, with the more conservation minded cosmologies allowing for sustainable earth stewardship.

*Tina Asmussen*

(Deutsches Bergbau-Museum Bochum / Ruhr University Bochum)  
**Active Matter and Cosmological Entanglements in Early Modern European Mining**

This presentation reconceptualizes early modern European mining landscapes as dynamic arenas where minerals and metals were not inert commodities, but active matter imbued with vitality. Drawing on analyses of 16th- and 17th-century technical literature, mining chronicles, theological writings, and material artefacts, the talk examines how early modern actors perceived the subterranean realm as both animated and extractable. Minerals were widely believed to “grow” within the earth, a notion that attributed them with self-organizing properties and a life-like agency. This active matter perspective challenges conventional narratives of resource extraction as a unidirectional process of domination over inert nature, instead revealing a multifaceted negotiation with non-human forces.

By foregrounding the vitality of georesources, the presentation demonstrates how technical expertise, legal regulation, and metaphysical understandings converged to mediate interactions between human agencies and the spirited dynamics of minerals. This framework not only elucidates the active participation of matter in shaping early modern extractive practices but also provides a historical counterpoint to contemporary debates on extractivism.

*Julia Mariko Jacoby*  
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### **Optimizing Spares: Paper in Early Modern Japan**

For premodern societies, it is often claimed that they had to operate with limited resources, and thus were much more careful and effective in making use of them. Abundance was only made possible because of fossil fuels. However, early modern societies, especially East Asian societies like Japan, experienced significant economic growth before the introduction of fossil fuel. This is often explained by the “industrious revolution”, a concept developed by Japanese historian Akira Hayami using Edo period Japan (1603-1868) as an example, which states that the increase and effective allocation of labor enabled economic growth. Using the example of paper, this paper shows how entire resource assemblages were employed to effectively make use of the limited resources of land and labor to increase the production of commercial goods in Edo period Japan. Paper, because of its materiality and

distinctive production technology, worked particularly well to make use of spares and surpluses to raise productivity.

Paper, a technology that was transmitted to Japan over the Korean Peninsula and used in Japan since before the 7th century, was prone to make use of resources not otherwise required since early on. Originally made from hemp fibers, paper making shifted to other shrub plants like Japanese paper mulberry (kōzo) to not compete with the making of clothes by the 8th century. Until the Middle Ages, paper was a precious good only used by the elite and educated clergy, and its production remained limited and controlled by guilds. This all changed in the 16th and 17th centuries, when administration became more developed and reliant on paper. In addition, literacy among the common people rose and a popular book culture developed in the 17th century. With the growing demand, the power of the paper guilds waned and paper making technology spread to the rural population. The feudal rulers – Tokugawa Shogunate and many local domains – quickly established and fostered new paper making places. By the end of the 18th century, books circulated that advertised paper technology as an effective way to earn an extra income in agriculture (Kamisuki chōhōki, 1798).

These Edo period forms of paper production were fit into the existing production cycles of agriculture and made use of the lifecycle and materiality of kōzo and paper technology itself. As a result, paper making utilized land resources and human labor that was not required for the main forms of agriculture such as rice production, which formed the backbone of the Edo period economy. Kōzo is a shrub that grew everywhere in the mountains on the Japanese main island and does not require extensive nutrients. Thus, paper was usually produced in mountain valleys that did not provide much land suitable for rice production but a decent water supply. Kōzo was often grown in newly claimed mountain fields by clearing or slash-and-burn, and was said to be best to grow as an extra income plant at field margins. In addition, kōzo was planted and harvested in winters, which made use of the traditional off seasons of agriculture. It was said that paper production during coldness resulted in the most durable and insect-repellent paper. Thus, paper production was introduced into the agricultural cycle of many farmers in the mountains, resulting in a decentral and broad base of paper production.

The varieties and differing qualities, as well as the cheap availability of paper, produced a rich paper culture in Edo period Japan, where the use ranged from high quality writing paper, printed books, wrapping paper, to popular toys, clothes, and translucent insulating material for walls and doors (shōji). The differing materialities of the kōzo grown in different regions and varying production technologies were reflected in how much detail it was

differentiated which paper from what region was especially suitable to use for what occasion. Consequently, local production branding became more and more sophisticated during the Edo period. In the 18th and 19th centuries, paper outgrew its “niche production”: the pressure to meet production demands led to the increasing commodification of kōzo and revolts among the paper making populations. However, Japanese paper making still retained its ability to make use of surplus resources in the modern period since 1868, despite the growing competition by Western paper using wood pulp: After entering the global trade market, Japan increased the production of silk and thus more mulberry trees (kuwa) were grown in mountainous areas to feed the silkworms. Kuwa were then also used in local Japanese paper production – for example, during crises of the silk industry.

This paper uses the resource assemblage surrounding paper, a form of production that takes advantage of surplus and spare resources, as an example to shed light on the interweaving of resources, agricultural production, labor, technology and knowledge, as well as consumption. It especially illuminates the dynamics and interweaving between different types of agricultural and manufacturing production. Finally, the paper reflects on how paper making oscillated between making use of surplus and spare resources and dominating its respective resourcescapes.

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### **Green Narratives and Colonialism in India (1860- 1900)**

The advent of colonial power in the Indian subcontinent marked the inauguration of imperial systems of anglicized polity driven by utilitarian political economy. New manufactured structures of authority were part of a well-knitted discourse of colonial agendas that weaved to deliver materialistic gains to the British power. In the mid-nineteenth century, forests had come into the ambit of professional scientific conversations, and shortly, timber became analogous with revenue, development, and infrastructure. Next, we locate that forests were considered equivalent to another integral economic endeavor of agro-economy. These economic aggravations and appraisals in the status of forestry were part of a bold and extensive scheme aiming sharply at the commercialization of natural resources. The elevation of the status of forests from a ship-building material to being a primary concern of a full-fledged department had clear materialistic impulse and implications. Subsequently, new-found 'conservationist' sensibilities shrewdly reinforced the schemes of forest control.

The discourses on the science of conservation did not overtly but somewhat tactfully aimed at rationalizing the government's endeavors to obtain control over vast tropical forest landscapes. The new forestry science gained momentum as a prudent force emerging to contest wasteful practices of native forestry and to save ecological systems. It is primarily in this light, that a deeper study of the implications of these colonial measures needs to be reviewed and analyzed from a historical perspective to gain a clearer understanding of contemporary forest politics.

Pre-colonial regimes displayed fluid structures of forest usage that granted access to community forest lands, unrestrictive grazing, adequate wood collection, minor forest products, shifting cultivation rights, etcetera, in return for a minor fee by the state. Interestingly, these traditional patterns of forest use formed the crux of crucial state discourses on political economy. India's sub-tropical timber wealth had the potential to foster Britain's imperial dreams. Subsequently, in this imperial backdrop, one needs to examine the nature of professional discourses that arose around the issues of resource usage patterns. Analytically we discover various voices emerging in the discourses on scientific forestry. Upon closer examination, a dichotomous picture from colonial standpoints on native resource use structures emerges on the scene.

The study highlights the different professional viewpoints on the native usage of resources by touching on both the green orientalist stances and the eco-utilitarian stance of nineteenth-century foresters. A historical analysis expounds that these intellectual arguments were instrumental in providing the colonial power an entry into the Indian landscape. The study further locates that the two stances share a dialectical relation, though working simultaneously in synchrony toward the material goals of the empire.

The paper has three sections that aim to capture the social reality of resource use in late nineteenth-century India. The first section provides a glimpse into the important historical works of environmental history that shed light on the question of scientific forestry in its early stages. The second section deliberates on the debates surrounding the native usage of the forest resource base and further examines the colonial justifications and scientific creed crafted around the ecological urgency rising against Indigenous usage of forests. The last section provides an insight into the colonial measures taken shrewdly in forest policy, forestry education, conservation, and forestry expansion. The study delivers a clearer picture of the emancipatory-cum-development oriented politics of the colonial empire.

The study helps analyze the trajectories of scientific forestry networks in the Indian landscape. It further sheds light on the material realities of the empire from the environmental perspective. Conclusively, the study reflects on the contemporary reality of resource usage in present-day India.

Vanessa Arteaga Bernal and Eduardo Erazo Acosta  
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### **The Power of the Ancestral Philosophy of Alli Kawsay (Buen Vivir) in the Indigenous Movements of Colombia - Ecuador vs. the Exclusion by the Big Mining Development, Contribution to the Rights of Mother Nature from the Global South in Middle of Climate Change**

The purpose of this research is to present the urgency of listening to indigenous epistemologies of Sumak Kawsay (in kichwa language: *Buen vivir*-Good Living) and also to accompany the care/defense of the biodiversity-rich indigenous territories of the Andean region. As a research question: How is the anthropocene affecting the indigenous territories and with it the threats of the epistemologies of *the Sumak Kawsay/Buen vivir*?

This ethnographic research has been carried in the last 7 years, in Republics of Colombia and Ecuador, in Indigenous Regional Council of Cauca CRIC, and The Indigenous Confederation of Ecuador CONAIE. Theoretical references: epistemology of indigenous communities, indigenous intellectuals.

The anthropocene affects considerably the species of flora and fauna, the glaciers, water reserves, páramos understood as places where the water is born for the species. With it the territories Pan Amazonas region of native communities are strongly affected in their cosmivision to know.

Due to its high impact in high mountain areas, climate change affects the melting of glaciers, strong droughts, seasonal changes for food production, water shortages and with this the displacement of animals and indigenous people and with it affects their traditions and cosmivisions due to geographical relocation and spatial - socio-cultural changes.

Ethnographic work is used: interviews, participant observation, and documentary analysis. Key to comment how from the epistemologies, their spirituality's, indigenous cosmivision, the elders (grandparents and grandmothers) announce that if there is no respect for the species on earth comes catastrophe, which from modern science is already evident.

#### **Results:**

This is considered from the Decolonial theory as an alternative to development or alternative development, based on the epistemological basis of the indigenous movement, the basis of current governments/states. Without a doubt the *Sumak Kawsay* is difficult to implement or live in praxis in the midst of individualistic societies with accelerated urban growth or in

societies structured in fossil fuels, in addition to the radical reactionary anti-movement indigenous right that watches over environmental care.

The *Sumak Kawsay* is part of the alternatives to the development taken care of from the indigenous cosmivision the dimensions: cosmivision, solidary economies, own right, own health, own education as alternatives with strong spiritual base of respect to the mother earth. The *Sumak Kawsay* as an epistemology of respect for life, is linked to „The Rights of Nature“ already included in articles 70 to 74 of the Political Constitution of the Republic of Ecuador in 2008. In the midst of the great destruction by mining and resource extraction at a global level, indigenous communities are more affected because it is precisely in territories//species where there is mineral wealth that great mining increases, putting at greater risk the animal and plant species that live in indigenous territories, as well as the ancestral knowledge/indigenous worldview is threatened. In this way, when indigenous communities defend Mother Nature (*Pachamama*) politically, they also take care of the biological chain in terms of wealth and biodiversity or geostrategic areas, life reserves at a global level.

Thomas Stöllner

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### **The beginnings of extractivism: A perspective from the prehistory**

The unchecked and commercialised exploitation of the world and its mineral resources is now a feature of our global reality. This has positive consequences for an ever smaller part of humanity. And it has growing negative consequences for the global climate, social inequality and the destruction of the ecological balance. But this increasing extractivist relationship to our environment is not a phenomenon of modernity. It goes back much further. It thus raises the question of when and, above all, how humans have left their closely embodied environment, the sphere of their Gaia, in favour of another and different world perspective? And what role have the raw materials themselves played in this? Coming from a broad perspective, the increase in an extractive relationship to one's own life world can also be understood as a process of an alienation. Alienation in fact also is not a simple process. It also is related to various phenomena of which learned and incorporated bonds in whatever direction get lost.

The article thus attempts to cover a wide range, which, based on my own research, leads into the depths of prehistory. First, a theoretical and empirical

framework of the concept of interwovenness is spanned within those parameters that are crucial for the question of social and ecological distortion of early raw material extraction. Interwovenness is discussed as a concept of an ultimately inescapable relationship to resources and, in particular, to geo-resources. Material and discursive practices play a major role here, for example in the question of how specific dispositifs came about in the resource assemblages of individual societies and in individual eras. This cannot be visioned as a teleological retrospective in the sense of an Anthropocene discourse. The article will primarily consider individual raw material cycles in order to approach the question of what changes have led human societies to accelerate the exploitation of resources. Of course, this approach has its pitfalls, because the tradition of (pre)historical narratives in written and material testimonies is usually a perspective of the beneficiaries, such as the dominant elites. Thus, the observability of marginal groups is limited against the background of a tradition shaped by dominant discourses of power. This also applies to the specific social practices that have become dominant in the context of resource use. In this sense, the appropriation of geo-resources is not only thought of in terms of a dichotomous appropriation of property for one's own purposes. The lecture attempts to understand appropriation, especially against the background of the emergence of cultural practices, as a process of sensory embeddedness that places the perception of particular things in an environment (e.g. special rocks such as green malachite and blue azurite ores) at the beginning of a complex process. Only by taking this broad social and cultural embeddedness of appropriation into account can the emergence of alienation be understood, as is to be assumed in the context of extractive practices.

The 'metallisation or mineralisation' of the societies of the Old World since the Neolithic is chosen as a special example in the article. In particular, the development of the first capacity-oriented mining companies is considered. They were located in West Asia and Eurasia, each in its own area of tension with social processes and the emergence of centralised state rule in the 4th to 2nd millennium BCE. If one wanted to understand this development teleologically, one would be tempted to draw an evolutionary line here. However, the opposite is the case. Through (montan)archaeological research in recent decades (in Oman, the Iranian Plateau, the Caucasus, Egypt or Europe), a much more diverse picture has emerged than the old research narratives seemed to suggest. Mining enterprises are by no means always to be seen as centrally state-controlled enterprises. Even in periods of increased economic acceleration through trade and population growth (such as in 4th/3rd millennium BCE in Mesopotamia), simple equations cannot be presented. Seemingly marginal groups, such as the producers of raw materials like copper, gold and tin, developed their own agency in relation to traders

and consumers. Nevertheless, they remained part of a fragile complexity of dependencies, like other parts of the raw material networks, which were already remarkably extensive during this period. The question remains as to how the extraction of raw materials and the actors associated with it could develop from a rather small-scale embeddedness into a driver of fragility. Intensification through rising demand and commercialisation undoubtedly played a role in this. In such skilled craftsmanship in production had to be increasingly replaced by unskilled labour and finally by forced labour (slavery). Sustainable small-scale extraction was replaced by unsustainable extraction complexes, which led to excessive consumption of natural resources (e.g. in the smelting process through the consumption of fuels) and the available subsistence (e.g. through crises in food supply). Complexes such as the mining landscapes of Faynan (Jordan) or Mitterberg (Austria) could provide initial clues. In this respect, it should be considered whether there could have been precarious tipping points during the Bronze Age in the course of the progressive 'metallisation' of Eurasian and West Asian societies. While such tipping points are much more clearly recognisable for the later Iron Ages and especially for Greco-Roman antiquity, they are still debatable to some extent for the preceding periods. Thus, early examples of sustainable practices can also be found: In early mining, for example, these ranged from the ritual management of disturbed and violent experiences to the first resource planning for the future. Against this background, the question is also explored to what extent social practices, e.g. the ritualisation of access to mineral resources, served as a control mechanism to prevent extractive practices or had the exact opposite effect. They may have been part of early sustainable perspectives of the raw material producing communities. Their narratives are likely to be reflected in complex interwoven cosmologies with the raw materials, which can already be seen in outline for the early metal ages. Human societies shaped by raw materials have thus by no means emerged in a perspective space characterised solely by a social and primordial dichotomy.

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### Unveiling the Interwoven: Small-Scale Mining in Peru, the Overlooked Aspect of Extractivism

In recent years, extractivism has gained prominence in academic debates, particularly from a Latin American political science perspective rooted in dependency theory. This framework views extractivism as a national development model that emerged in the 1990s, characterized by reprimarization—the export of unprocessed primary goods such as minerals and agricultural products. This reliance on primary materials fosters resource dependency, which undermines industrial competitiveness and exacerbates socio-ecological issues. These include environmental contamination, inequitable wealth distribution, and employment challenges. Such conflicts frequently escalate into violence, often met with state repression during protests and roadblocks. Despite growing recognition of extractivism's diverse impacts—ranging from transformations in the perception of nature to epistemological questions—scholarship continues to focus on large-scale mining projects involving international investors. This emphasis often neglects the critical role of small-scale mining. Unlike large-scale operations, small-scale mining generates local rather than enclave economies. However, it frequently operates without permits, classifying it as illegal and associating it with shadow economies tied to criminal activities and illicit trade. Nevertheless, small-scale mining often enjoys local community support due to its economic contributions. Traditional understandings of extractivism fall short of addressing the complexities of small-scale mining. A New Materialist (NM) perspective offers valuable insights by framing nature or parts of it—such as gold or the remaining toxins—as an active agent rather than merely a representation of power structures as imagined by political ecologists. Following Karen Barad, I ask how gold „comes to matter“, looking into small-scale mining as an interwoven assemblage. It incorporates gendered bodies and interactions with large-scale operations, reflecting the entangled relationships shaping mining practices and sheds new light on the extractivism debate. This study explores how NM approaches can better account for these assemblages, shedding light on the socio-material dynamics of small-scale, often illegalized, mining that sustains millions of livelihoods in the Andes.

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### **Investigating the Dynamics of Inequality, Productivity and Resource Flows in the Deep Past**

Identifying sources of economic inequality is a pressing societal challenge, but inequality studies struggle to understand the alignment between divergences in income or wealth and divergences in resource systems. Research on resource management often overlooks the economic inequalities that can result from resource heterogeneity, while research on inequality rarely considers differentials that arise from the spatial proximity to different environmental settings. Resolving this quandary requires better alignment between resource datasets and inequality datasets. Given that it is impossible (and unethical) to know how differential access to resources drives changes in inequality through experiment, we must look to data from past human economies to better understand these dynamics.

In this paper, we outline how archaeological data can provide a mechanism for bridging the gap between inequality studies and resource management. In inequality studies, economists like Thomas Piketty have demonstrated that the discrepancy between returns on assets and economic growth has driven inequality over the long term, but there is considerable debate surrounding why some societies allow the collection of more returns than other societies. At the same time, Elinor Ostrom investigated baseline consideration of resource heterogeneity, outlining the specific characteristics of specific kinds of resources—common pools, excludable, private, etc. She argued that the key to resource sustainability was agreement between specific resource forms and particular forms of economic governance. Resources that were not excludable required collective management, though building that collective management often worked best from the bottom up. We explore these ideas through a systematic review of economic evidence from the deep past, revealing how a consideration of the material basis of inequality can bridge these disparate economic paradigms, and help us envision pathways for creating more sustainable economies today.

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### **From Humans to Resources: The Materiality of Precarious Migrant Labour in Agriculture**

With the rise of capitalism and the increasing industrialization of the 18th and 19th centuries CE, a significant shift occurred in the meaning of the term 'resource.' Previously, this term referred to an individual's internal attributes that enabled them to overcome personal crises. However, resource—or more commonly, its plural form resources—came to primarily designate external objects that humans could manipulate and multiply (Hausmann and Hausmann 2018: 190).

From the very beginning of capitalism, the concept of resources was not limited to the material world but was also applied to human beings. The agricultural production system of European plantations in Brazil, the Caribbean islands, and the islands of the Indian Ocean, for example, were fundamentally based on the displacement and transfer of both people and plant species across different regions of the world. In these unfamiliar environments, far from their places of origin, enslaved individuals were socially isolated—an essential precondition for their forced exploitation as mere labour force. As Anna Tsing argues, this socio-spatial separation functioned as a form of alienation, transforming people, other living beings, and things into resources (Tsing 2015: 5–6, 19, 39).

Of course, the cruelty and violence of slavery in modern-era plantations distinguish it from contemporary labour practices in industrial agriculture. Nevertheless, the agricultural sectors of many countries around the world continue to rely on the alienation of people. This is especially true for migrant labour, which may appear free at first glance but is not.

As borders in the Global North become increasingly restrictive, many migrants cross them clandestinely, resulting in an undocumented legal status. Because of this uncertain position, they are often forced to accept low-paid employment as "unskilled" farm workers, carrying out degrading and potentially hazardous tasks. Therefore, the border regimes in the Global North play a pivotal role in creating a vast pool of cheap and flexible migrant labour for the agricultural sector (Raeymaekers 2023). The precarity of migrant workers due to their uncertain legal status is not limited to working conditions but also extends on living conditions.

The intensive cultivation of strawberries in western Greece, for instance, depends on thousands of migrants, primarily from one of the world's poorest



countries: Bangladesh. In addition to enduring the challenging working conditions, Bengali migrant workers often live in precarious makeshift camps situated in the middle of the strawberry fields (Papadopoulos and Fratsea 2016).

This paper explores the living and working conditions of migrant workers in contemporary Greek agriculture through the lens of archaeology. Specifically, it examines how the material dimensions of precarious migrant labour contribute to the reduction of people to mere human resources. By revealing the material worlds of Bengali migrant workers in Greece, this study highlights the practices they employ to endure harsh conditions and challenge their exploitation as human resources.

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## **Resource Use in Past Societies: From Operational Sequences to Computational Modelling through an Archaeological Perspective**

### **Introduction**

The study of resource use in past societies is a crucial topic in archaeology, providing insights into how human groups managed resources, interacted with their environments, and adapted to changing climatological, ecological, and socio-economic conditions.

This paper seeks to critically evaluate two dominant frameworks in archaeological thought that have shaped – and continue to shape – our understanding of past resource use: operational sequences and computational modelling. By analyzing how these frameworks have been applied in archaeology, this paper explores different approaches to the concept of resource use, strategies of resource exploitation, and patterns of resilience in complex socio-ecological systems. Through the case studies covered in this talk, I aim to outline how these perspectives can help develop a common ground for future interdisciplinary research on the concept of resource.

### **Operational Sequences: Tracing Resource Networks**

The operational sequences approach, derived from French archaeology and anthropology – first coined by Leroi-Gourhan (1964) – is a methodological framework that traces the sequence of technical processes involved in the production and use of material culture, from raw material acquisition to the final use and discarding of an object (Roux, 2016).. This approach highlights the technical knowledge and decision-making processes involved in resource transformation, making it a valuable tool for understanding how past societies organized labour, technology, and resource management. Central to the operational sequences framework is the recognition that each stage of production involves choices that reflect both environmental constraints and cultural factors, such as social organization, technological skills, and symbolic meanings attached to materials.

Operational sequences are ideally suited to explore the complexities and interrelations of resource use in the production and consumption of material culture, thus shedding light on the intricate relationships between resource exploitation, technological innovation, and social structure. The framework inherently focuses on the role of human agency and decision making as the driving factors behind production processes. However, this means that studies of operational sequences rarely explore the interplay between society and environment, especially with regard to human impact on the environment

and the sustainability of resource usage and exploitation strategies.

### **Computational Modelling: Complex System Dynamics**

Computational modelling involves using computer programs to simulate and study complex systems through mathematical, physical, and algorithmic approaches (Wikipedia definition from “Computational Model,” 2024). I will focus in particular on the combination of agent-based modelling (ABM) and geospatial modelling (using Geographical Information Systems or GIS). ABM simulates interactions between autonomous agents and their environment – based on heterogeneous rulesets and bounded information – to assess the emergent effects of their decision-making processes within the overall complex system (Romanowska et al., 2021). GIS are computer systems designed to capture, store, analyse, manage, and visualize spatial or geographic data (Conolly & Lake, 2006). GIS integrates location data with various types of descriptive information, enabling users to understand spatial patterns, relationships, and geographic context.

The combination of ABM and GIS allows archaeologists to reconstruct past landscapes, predict and assess resource availability, and simulate the interaction between society and environment through feedback loops between human impact on the environment, environmental shifts, and human responses to corresponding ecological and socio-economic changes. While computational modelling offers powerful tools for analyzing complex systems, the method is highly dependent on the availability of empirical data, which can be scarce or incomplete in archaeological contexts.

### **From Operational Sequences to Modelling: Resource Networks in Complex Social Systems**

Operational sequences and computational modelling each tend to operate at different scales – the former focusing on the micro-level processes of production processes, and the latter rather emphasizing emergent outcomes in macro-level systems – yet, they are not mutually exclusive, and significant potential is left untapped in the integration of both. Using case studies from my own research on craft production (Daems, 2021b), community formation (Daems, 2019), and social complexity trajectories (Daems, 2021a) in Iron Age to Hellenistic Anatolia, I will explore some of this potential to be found at the interface between operational sequences and computational modelling.

By combining the micro-level, qualitative and macro-level, quantitative components of, respectively, operational sequences and computational modelling, I will present a more robust approach that aims to generate a more comprehensive and holistic understanding of resource use and management strategies in past societies, and their long-term interactions with and impact

on the environment. This combined approach not only enhances our understanding of the technological processes and decision-making involved in resource transformations, but also situates those processes within larger ecological, economic, and social systems. Ultimately, this synthesis can help archaeologists address contemporary concerns about long-term patterns of sustainability, resilience, and resource management by providing robust historical perspectives on how human societies have responded to environmental changes over time, and thus help develop a common ground for future interdisciplinary research on the concept of resource.

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### **Integrating Urban Metabolism With Landscape Disciplines by Applying Technomass**

Urban metabolism provides a robust framework for analyzing urban development and its impacts. However, several conceptual and operational shortcomings have constrained the application of urban metabolism in understanding the overall urban processes, limiting the transfer of its potential benefits to design and planning. This article systematically analysed the rationale of the current urban metabolism models, focusing on four prevailing shortcomings from a transdisciplinary perspective: 1) utilizing an isolated state approach, which treats urban systems as isolated from other ecosystems; 2) ignoring internal processes within urban systems, known as the black box paradox; 3) employing a linear material approach that focuses on the path of single materials; and 4) overlooking the material productivity of urban systems, where energy and materials entering the system are used to reproduce the urban material structure and generate goods and tradable products. While these issues have been identified individually in existing scientific literature, there is a lack of holistic solutions. This article proposes an enhanced urban metabolism analytical approach—the ecosystem approach applying „technomass“—to address these shortcomings and provide practical solutions in landscape architecture and planning disciplines for sustainable urban development.

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### **Planetary Humanism: A Framework to Combine Sustainable Resource Metabolism and Planetary Intelligence**

This paper introduces Planetary Humanism as a comprehensive framework to address the pressing challenges of the Anthropocene by integrating sustainable resource metabolism with planetary intelligence. Planetary humanism posits a synthesis of philosophical and scientific perspectives, including materialism, empiricism, transdisciplinarity, and panpsychism, to redefine humanity's role not as a planetary disease, but as a crucial agent within the Earth system, driving complexity towards planetary intelligence through the redirection of material and energy flows. The context of the Anthropocene, characterised by the so-called “Great Acceleration” and the growing influence of the technosphere, has brought numerous benefits

for us as species, but also have raised planetary intelligence to levels unimaginable a century ago. However, gains came with multiple costs, most importantly the overstepping of planetary boundaries, which seems doomed to undermine and destroy the very system driving those changes: human industrial civilisation. This current human predicament highlights the urgent need to rethink the concept of resource and the reality of human existence within a planetary system.

To navigate this conceptual challenge, we present a multimodel thinking approach—a narrative in models ranging from classic and novel toy models, with references to the empirical context that prompts their formulation. This includes exploring growth models focusing on overshoot and collapse dynamics and the role of causal feedback loops. It emphasises the prevalence of mutualism and symbiosis as evidence of stabilising coevolution, wherein biological entities, including humans, function as resources across individual, community, and planetary (Gaia) levels. The paper delves into metabolic networks and web-of-matter models, highlighting the importance of thermodynamic constraints and entropy/negentropy gradients to achieve a more unified, cross-disciplinary understanding of matter. Furthermore, the manuscript addresses the modelling of paradigm shifts, considering how qualitative system changes and new environmental constraints can lead to emergent dynamics within deterministic mechanisms, exemplified through stochastic jumps to represent discovery and adoption. Finally, it explores the implications of Planetary Humanism and the models discussed for resource use and planetary civilisation strategy. It considers future explorative pathways such as expanding our ecological community, improving planetary system efficiencies, and extending planetary metabolism beyond Earth. Planetary humanism is not new, but it provides a fresh perspective for fostering a sustainable coexistence within the Earth system that balances pessimism with awe and optimism with responsibility.

## The Metabolic Rift: Why Circular Flows of Resources Cannot Sustain Contemporary Society

This paper uses a set of lesser-known scientific concepts developed over the past decades in non-equilibrium thermodynamics and complexity theory (group autocatalysis) to provide a more complex narrative about the interaction of human societies with their environment. The concept of metabolic pattern of societies is proposed as an analytical tool to characterize what is a „resource“ for a metabolic system. In the jargon of non-equilibrium thermodynamics, a resource is what provides the required flux of negative entropy needed to sustain the process of reproduction and adaptation of the metabolic system. An analysis of autocatalytic loops requires abandoning the traditional linear narrative of input/output when studying the use of resources. That is, a resource provides a benefit for the system exploiting it, but it also requires the investment of an input from the system using it. This framework flags the relevance of two points relevant for the definition of a resource: (1) it is the identity of the system that processes a resource that defines whether a given input is a resource or not (Cottrell, 1955). For example, electricity is not an energy input for a cow, and gasoline is not an energy input for a computer. Even ham (a form of food energy perfectly compatible with human physiology), may or may not represent an energy carrier for a Christian or for an Islamic consumer; (2) the quality of a resource is not related to its intrinsic characteristics, but to the factors determining the performance of the process of exploitation. The foraging theory (Stephens and Krebs, 1986) clearly indicates that the nutritional quality of a food resource is not the only aspect determining the convenience of its exploitation. Other factors to be considered are the energy cost of exploitation, the time required, potential risks, negative consequence on other functions to be expressed by the system. A similar concept has been used in energetics to define a quality indicator for primary energy sources (the Energy Return on the Energetic Investment – Hall, 2017) and in ecological economics (Georgescu-Roegen, 1975) when proposing the distinction between available resources (determined by their intrinsic characteristics) and accessible resources (when considering the cost of their exploitation).

The revolution entailed by the concept of autocatalysis is associated with a representation based on impredicative loops. The possibility of metabolizing food for a living system starts with “foraging” – i.e. an output of applied power going from the system to its environment. This representation is totally incompatible with the traditional linear framing (input – transformation – output) adopted by conventional metabolic studies. That is, a metabolic

system must: (i) already have stored energy carriers to be invested in the exploitation; and (ii) be capable of converting it into applied power, before getting access to the energy provided by the resources. An analysis of the functioning of impredicative loops (chicken-egg phenomena) is not possible when adopting the simplifications typical of reductionism because, the identity of metabolic systems is path dependent. That is, their characteristics are defined before the actual process of metabolic transformations takes place. An historic identity requires the adoption of situated knowledge to study the feasibility and viability of the metabolic system.

In conclusion a society requires resources to carry out three distinct functions: (1) structural autopoiesis - reproducing its structural elements; (2) establishing a structural coupling with the environment to stabilize the metabolic throughput (supply of inputs and disposal of waste); (3) functional autopoiesis – i.e. expressing a set of ancillary functions of generating an “emergent property of the whole” allowing the reproduction and adaptability of a given metabolic pattern (security, services, cultural activities in human societies).

This categorization allows us to identify the factors to be considered when studying the feasibility and viability of a given metabolic pattern of a given society.

1. the cost of reproducing the structural elements of society. There are two types of autocatalytic loops associated with the metabolism of human societies: (i) endosomatic metabolism (people producing food to produce people - pre-industrial societies). Here, relevant attributes are body mass, dietary intake, demographic structure, determining the ratio between energy input required and the applied power used in the interaction with the environment (cost of power generation); (ii) exosomatic metabolism (people + machines producing the inputs required to produce people + machine - post-industrial societies). Here, the relevant attribute is the amount of exosomatic power capacity (technical devices) used in the different functional compartments, determining the ratio between energy input required and the applied power used in the interaction with the environment (cost of power generation).
2. the characteristics of the structural coupling. In an endosomatic metabolism we are dealing with the aggregated requirement of labor and other inputs (end uses) invested in the extraction of useful biomass from surrounding ecosystems. In an exosomatic metabolism we are dealing with the aggregated requirement of labor and other inputs (end uses) invested in the structural coupling to provide the net supply of exosomatic inputs (energy carriers and materials) required and used by the rest of society.

3. the implications of the zero-sum game determined by the profile of allocation of end uses on the set of functions to be expressed (the SUDOKU effect) by society. They refer to: (i) structural autopoiesis; (ii) structural coupling; and (iii) functional autopoiesis. That is after considering the internal loop of end uses required by the structural coupling the resulting net supply must be able to support the consumptions of structural and functional autopoiesis.

The paper uses this approach to illustrate quantitative examples of analysis of the metabolic pattern of pre-industrial and post-industrial societies. In this way, it is possible to show that our modern societies as dissipative structures operate at a density and at a pace of dissipation that makes it impossible to rely on a structural coupling based on cycles of biomass (the circular agriculture of pre-industrial times). As illustrated by Tainter (1990) when dealing with the metabolism of complex societies, the requirement of end uses to be invested in functional autopoiesis (ancillary activities beside reproducing people and food) is so high that cannot be sustained by the net surplus generated by the exploitation of resources in agriculture.

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#### **Waiting in Readiness? Reflections on Resources and Abandoned Things**

The concept of resource has been criticized for implying a utilitarian understanding of things and natures. Starting from this, though with a twist, I will address how the experience ("consumption") of things ("goods") has become immensely affected by their increasingly shorter use-lives, making our cohabitation with them more and more fleeting and instantaneous. Moreover, being alienated both from their condition of production and from their ruination and disposal, we mostly experience things in their state as pliant and useful (i.e. as things-for-us); that is, as relatively new, working, and intact.

I will contrast this instantaneous "consumption" with some personal memories of how things were dealt with in a small, isolated village in the Arctic, where I grew up many decades ago. Though things were bought, of course, they were also made and irrespective of their coming into being they were commonly subject to prolonged lives. Usually this happened through the now nearly extinct practice of repair, but also by being re-sourced for new tasks, or just allowed to heap up in a kind of redundant waiting mode for undecided futures. Thus, contrary to their current fate, things were experienced both throughout their entire use lives and in their destinies as temporarily or permanently paused or abandoned. In short, as what became of them. Hence, the useful were allowed to encounter the stranded, ruining and redundant far more generously than what is currently voluntarily allowed.

These rather trivial observations and reflections constitute the background for an extended discussion of how the concept of resource (as resourcing) may take on new and less instrumental meanings (partly in critical dialogue with new materialist approaches, e.g Harman, Morton). Among these are notions of care, inclusiveness, and learning (by hand), that also connect to urgent environmental issues. I will furthermore reflect on the role of the archaeologists in all this. Contrary to other thing scholars (thing theorists in particular), who mostly are preoccupied with working things, things fulfilling their tasks (for us), archaeologists are predominantly encountering things in their human desertion, in their abandoned state of being. To what extent may this unique experience inform a wider concern – both practical and theoretical - with resources and re-sourcing?



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### **The Social and Comparative Dimensions of Resource Use: Examples from Africa**

Dominant thinking about resources were for a long time based on an in-built distinction between nature and culture: Human capacities to interact with the environment were objectified as qualities of „natural“ resources that can be exploited and the successful exploitation of these resources became the hallmark of conceiving human „cultural“ achievement. This narrative about the successful conquest of culture over nature becomes increasingly brittle and for good reasons. A major aspect of this change is the reconceptualization of human practices that generate „resources“ in the first place, largely inspired by an anthropological critique of technology and techniques. If when establishing the power of a resource of „nature“ we are ultimately tapping into our collective human creativity, stored in technology, to use environmental potential, and if that is the dominant way of thinking about human „culture“, then our understanding of technology as the cover term for resource use is of central importance.

In this presentation I investigate three social and comparative aspects of resource use practices: Firstly, I remind us of the problems of narrowing down all techniques to technology which is - comparatively speaking- a rather special case of disembodied procedures that externalises cognitive and practical processes and decouples them from embodied skills. Secondly, I emphasize that cultural technologies (*Kulturtechniken*) are at least as much informed by the logic of creating cultural distinctions (being distinct from other humans but also being distinct from the non-human world) as by the logic of problem solving, Thirdly, I suggest a new perspective in which techniques and resources, including human and non-human participants, form a „community of practice“. This community of practice is characterized by the fact that the participation of every entity is only partial. As a consequence, this leads to an open process of resource use that is not entirely predictable but where our understanding of who and what takes part in this process is improved. The empirical case material I refer to is largely, but not exclusively, based on ethnographic cases from Africa.



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