FROM SWAMP TO STRUCTURE: TOWARD A SYSTEMIC ARCHITECTURE OF LANDSCAPE, LABOR, AND MATERIAL

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ABSTRACT

Amidst growing ecological, social and economic challenges, paludiculture – the agricultural use of wet peatland sites – is becoming an increasingly important focus in sustainable architectural production. This paper examines how swamp ecosystems can form the basis of a new regional value chain. For sustainable building materials for Berlins construction industry. The theoretical framework is based on the SETS (social-Ecological-Technological Systems) model to reveal and utilize the complex interactions between landscape, society and built space.

KEYWORDS: *Regenerative design, Paludiculture, Peatland, Biobased Material, Regional Harvest, Reciprocal Landscape*

1. INTRODUCTION

What if architecture began with a plant, not a plan? What if building meant cultivation – and inhabiting meant participating? From reedbeds to rooms, this project traces the path of Paludiculture through water, craft and community. A systemic, circular approach unfolds – woven between ecology, economy and imagination.

"If ecosystems transforms, must not architecture transform with them?"

In times of ecological crisis and resource depletion, the role of architecture must be rethought: not as an endpoint of linear supply chains, but as part of a regnerative metabolism. Nearly 40 percent of the planet's Co2 emissions and over half of all waste are linked to the constrution industry. (Lloyd, 2023) It extracts, consumes and discards – often disconnected from place, ecology and material origin. In response, regenerative design theory emphasises, as Cole notes in his paper: " Transistioning from green to regernative design":

"A key destinction of regnerative design is the recognition and emphasis on the co-evolutionary, partenered relationship between human and natural systems, underscoring the importantce of project location and place. " (Cole et al., 2013, p. 1)

Wetlands – especially rewetted peatlands – emerge in this context as critical ecological infrastructures, offering not only carbon sequestration and biodiversity, but also a new material palette for architecture.

Berlin, whose very name stems from the slavic word for "swamp", (see appendix 1) is emblematic of this lost realtionship. Centuries of drainage have severed the region from its swampland roots – causing drought, biodviersity loss and increased carbon release.

Recently, however, a shift in political priorities and enviromental policy has begun to reframe this landscape – not as a burden, but as a climate asset. Germany´s national Peatland Protection Strategy (2022) now commits to a large scale rewetting, aiming to restorre 1,3 million hectares by 2050. The projected costs of this transfomation is €21 billion. If no action is taken, climate-related damages from drained peatlands are expected to each €67,5 billion by 2050 (Noordt et al., 2022).

This paper explores how paludiculture – the productive use of wet peatland – can be understood not only as a cliamte solution, but as a systemic model for architecture: linking ecological restoration, local economies, and material innovation. Using the SETS framework (Social-Ecological- Technological-Systems), it investigates how regnerative value chains can take root in the Berlin-Brandenburg region – from landscape to construction site.

Main research question:

How can the rewetting of peatland be understood as a systemic model, linking social, ecological and technological dimensions of regional value creation- and what kind of vision does this enable?

1.1. METHODOLOGY

The primary object of this research is to understand paludiculture not only as an agricultural model but as part of a socio-ecological-technological value creation system – and to translate it into a design vision, both architecturally and territorially. Accordingly, the methodology combines qualitative, cartographic and spatial design approaches.

Literature review and theoretical framing

The research is grounded in a broad assessment of publications that explore paludiculture, regnerative value creation, SETS critical regionalsim and circular models in constrctuion. Scientific publications and reports from research institutes, policy makers, enviromental specialists and planning institutions were taken into account.

Cartographic analyses and GIS ddata

To spatially locate relevant landscapes – inparticualr peatlands and wetlands in Berlin- Brandenburg – opnely accessible GIS data was analyzed. These provide the basis for location analyses, ecological potentials and infrastructural connections.

Excursions & fields research

As part of several field trips, several farms with paludiculture (e.g. Brandenburg) as well as urban locations in the inner city structures (e.g. Köpenicker Straße, Berlin) were visited. Observations were made on landscape use and water management.

Qualitative Interviews

A central element was an interview with a farmer, who has successfully practiced cultivation on rewetted peatlands for years. The aim was to understand the real challenges, potentials and actors constellations along the value chain. Further informal discussions with actors from research and planning (e.g. Bauhaus earth) complement these perspectives.

Vision prototyping and SETS analysis

The collected data was analyzed using the SETS framework. This systimatically presents interactions between social, ecological and technological processes, making it possible to think of regional value chains not only in technical terms, but aslo in terms of their social and cultural conditions.

2. THEORETICAL FRAMEWORK

2.1. PEATLANDS AS CULTURAL LANDSCAPES

Historically, swamplands in europe were considered to be unproductive an economically unvaible. In the 19th and 20th centuries in particular, large areas were drained to create space for agriculture and peat extraction for fuel. (Landgraf, 2014) While these interventions increased agricultural utilisation, they also led to significant ecological damage, including loss of biodiversity, soil subsidence and increased Co2 emissions due to the oxidation of peat. (Dewitz et al., 2023)

The process of draining peatlands began during the reign of Frederik the Great. In the 18th century, a period of 'land improvement' (from the french 'melorisation') began, involving the drainage of extensive areas to support the urban growth of Berlin and Potsda, as wellas the expansion of agriculture. Cultivating potatoes in the nutrient rich soil of the drained peatlands help to alleviate food insecurity of prussian farmers, earning Friedrich the nickname 'Kartoffel König' (King of Potatoes) (Landgraf, n.d.)

A second major wave of land drainage occurred around the 1960s during the GDR era. The construction of the 'Milchader für Berlin' canal based system enabled systematic drainage for cattle production. At that time, localised prodcution was necessary to avoid dependence on West Germany. (Haberl & Mosebach, 2023)

It was not until the late 20th century that the negative consequences of peatland drainage were widely acknowledged and protective measures were introduced. Today, peatlands are increaslingly recognised as valueable carbon sinks, water regulators and biodiversity hotspots. (Landgraf, n.d.)

In 2015, the german government introduced a programme to protect existing swamps. However, this has only been implemented in a few pioneering projects for drained peatlands and 93 percent of the regions peatlands remains drained (Haberl & Mosebach, 2023). Although they only cover eight percent of the region's surface, they emit 7,2 million tonnes of Co2 each year, accounting for around 10 percent of the regions total annual emissions (Haberl & Mosebach, 2023) – more than the transport sector. (See appendix 2) Meanwhile, the Berlin-Brandenburg region, once dominatred by wetlands, is now on of the driest in Germany. (Dorfner, n.d.)

The historic mismanagemnt of the peatland landscape clarifies, that future usage forms should be thought integrative, to bring together ecological, social and economical requirements.

2.2. PALUDICULTURE AS A REGENERATIVE MODEL

Paludiculture represents a regernative form of landuse that maintains ecological functions while allowing for productive cultivation. (Närmann & Tanneberger, 2021; Nordt et al., 2024) The cultivation of wet peatlands is characterised by a gradient in which the water level determines the species of plant. In most cases, these are permanent crops. (see appendix 3) (Nordt et al., 2024) These crops can be used in various ways, for example as fuel for biogas, in the building industry, as foodcrops and as animal food. (Nordt et al., 2024)

2.3. SETS – SOCIO-ECOLOGICAL-TECHNOLOGICAL SYSTEMS THINKING

The building sector is largely dependent on liinear production chains, energy intesive material production of (e.g. steel) long transportation ways and the permanent extraction of non renewable materials from the landscape. (Misselwitz & Organschi, n.d.) Additionally the delayed implemantation of key policy instruments like corbon pricing mechanism, to discourage fast demolition and to incentivise reuse. (United Nations Environment Programme, 2022)

The developments make it clear that the new models of thought and action are needed – models that recognize complex interrelationships and make them usable for design processes. SET model offer such a framework: it helps to visualise the consequences of the decisions within a broader systemic context.

The three layer (McPhearson et al., 2022) are described as:

- Social: Stakeholder, knowledge, work, participation
- Ecological: Climate, water, soil, vegetation
- Technological: machines, infrastructure, construction methods

2.4. "RECIPROCAL LANDSCAPES" (HUTTON, 2020)

Before the era of industrialization, landscape surrounding the settlements determined the material for buildings. Architecture therefore was directly linked to the ecosystem, the climate, and the provided ressources. (Weiss & Egli, 1959) In *"Houses and landscapes of Switzerland",* Rochard Weiss researches this trace in the very different types of framhouses found even in adjacent mountain valleys in Switzerland. (Weiss & Egli, 1959) (See appendix 4)

This link has long gone lost, severed by materials traveling thousands of kilometers before reaching the cosntruction site. The result is a disconnection between aerchitecture and its ecological context. (Buckton et al., 2023; Hutton, 2020) Jane Hutton wrties in her book *"Reciprocal landscapes": "Reciprocal Landscapes stems from a desire to think of construction materials not as fixed commodeties or inert products, but as continuous with the landscapes they come from, and with the peaople that shape them."* (Hutton, 2020 p. 5)

Today, a complete regional value chain that reconnects architecture with its landscape barely exists. Except for a few pioneering projects, most building materials are not sources or processed locally. Industrial agriculture and global construction markets operate in linear, extractive ways. The feedback loop – from soil to strucutre and back – is not closed. (Hutton, 2020) As Buckton et al (2023) argue, *"material choice is not neutral – it influences spatial identity. A regenerative material palette can generate new venaculars responsive to ecology."* This suggests that materials are not merely functional, but cultural and ecological mediators – capable of shaping new architectural languages grounded in place.

3. REGIONAL VALUE CREATION THROUGH REWETTED LANDSCAPES

A regional value chain can offer resilient alternatives to global raw material markets, in order to reduce ressource scarcity and avoid unstable and unjust supply chains, as well as long transportation ways. (United Nations Environment Programme, 2022) resilient value chains promote social participation and fair structures through educational formats and regional cooperations. (Noordt et al., 2022)

3.1. CULTIVATION AND HARVESTING

Plants species suitable for rewetted fields are: reed, cattail, canary grass, and balck alder tree, The regional value chian strats with the plantation. Fertilisers are not used since they are forbidden by law in water-rich areas. (Düngemittel-Verordnung DüV 20176)

The harvest is carried out mechanically, the water level determining the logostics of the harvest: fields with a water table of -20 cm or higher reguire external drying facilities (Nordt et al., 2024); a watertable lower than -20 cm allows the biomass to remain in the fields and be dried by the sun. (S. Petri, personal communication, May 20, 2025) (see appendix 5, 6)

Wet meadows (water table -20 or lower)	Paludiculture (water level -20 or higher)
Biomass mowed and sundried in September, turned twice pressed into bales	Cattail or reed harvested in autumns and removed immediately for off site processing

Watermanagement:

For Paludiculture waterlevels must not sink lower than -20 under the floor, otherwise peat oxidation will commence (Landesumweltamt Brandenburg, 2004). Drained peatlands will always need a managed water system to secure the needed waterbalance throughout the year. (Nordt et al., 2024) The most common water management is the reuse of drainage pits for seasonal water retention, however dry springs make it difficult to sustain optimal water levels. (S. Petri, personal communication, May 20, 2025) Summer irrigation must either be covered by the overflow during winter or be added artifically, depending however on the local water withdrawal regualtions. (S. Petri, personal communication, May 20, 2025)

3.2. Processing and Application

The usage possibilites can range from animal feed (pasture for buffalos), to biogas from fermentation of biomass, combustion, production of platform chemicals, carbon-based and organic substrate development for soils, healthcare-related uses, and phytomining applications. (Nordt et al., 2024) (see appendix 7)

However this paper primarily focused on the processing and application of building materials. Wetland crops have developed specific characteristics, to sustain the wet climate of swamps. (Nordt et al., 2024) Cattail for example has air pockets within the leaves that supply perfect properties for insulation, in various species we can find a " *storage of silicates (…), which have an anti-fungal and flame-resistant effect"* (Nordt et al., 2024, p. 54)

Right now there is an amount of promising product prototypes, while – on the other hand side – there is no established market for it so far. (Noordt et al., 2022) Following products can be produced: sheet, inuslation material, façade panels, interior linings (Nordt et al., 2024) (see appendix 8)

While reed is just bundled up and transported to the cosntruction site or prefabrication site, the other plants have to be further processed.

The production process typically involves the shreeding or breaking down of plant fibres into a size suitable for the desired product. (Nordt et al., 2024)

Subsequently, the fibres are subjected to heatpress (in various forms) that compresses them into sheets. In certain instances, the addition of binder or adhesive substances may be necessary. ("Zelfo," 2016)

The Panels are then left to cool, after which they are cut into the required format and transported either to a contractor, a construction market or a further prefabrication facility. (*Rohrkolben*, n.d.) a number of start-ups and companies have established production chains, including those of Zelfo, Istraw and Typha boards. (Nordt et al., 2024) (see appendix 9)

The utilisation of processed wetland biomass as a source of insulation materials signifies a promising developemnt within the market, which is currently dominated by non-renewable alternatives. In 2019, proportion of insulation materials derived from renewabel sources in Germany was a mere 9 percent. (Nordt et al., 2024)

Bio-based wetland insulation is characterised by its natural resistance to mold (Islam & Moatazed-Keivani, 2023), a porperty that renders the use of chemicals unnecessary. (*Rohrkolben*, n.d.) This attribute contributes to the enhancement of air quality by ensuring the maintenance of clean safe air. (Islam & Moatazed-Keivani, 2023) Moreover, in Germany the annual production of non-renewable insulation materials as waste is approximately 200,000 tons, these materials a typically disposed of through landfills or incineration. (*Dämmstoffe in der Kreislaufwirtschaft*, 2024) Nordt et al (2024) using wetland derived materials fro insulations as an alternative to rock wool or Eps foam can cut GHG emissions by up to roughly 8,5 kg CO_2 per square meter of insulated wall. (Nordt et al., 2024) (see appendix 10) For the u-values of the material refer to the appendix 11. It is evident that, due to their inherient resistance to mold, they could prove to be of significant value in the contrext of the renovation of existing building stock. Furthermore, their applications could extend to the design of public swimming pools ore amenities in proximity to water bodies.

3.3. MATERIAL CYCLES AND FEEDBACK LOOP

Building/Material perspective:

Wetland cultivation provides valuable materials for constrcution of the building envelop (insulation, cladding) and the space planning. Based on the sheering layer principle those require periodic replacement in intervals of 20 years. In the case of space planning, at intervals of three years.

The materials can be easily reintegrated into the loop by reintroducing the into the processing cycle or utilising them as compost on agricultural fields. (Nordt et al., 2024) The nutrients contained within the product would be returned to the soil. (see appendix 12)

Lanscape perspective (see appendix 13, 14, 15)

Through the sourcing of wetland derived materials the feedback loop of lanscape is turned from a positive (increasing): drained peatlands emits Co2, leads to the increase of the greenhouse effect, leads to more droughts and even more Co2 emissions.

Into a negative stabelised cycle: With the rewetting of landscape the emission of Co2 is reduced or comes to a complete stop, sometimes even starts the Co2 sequestration ability of peat again, the wetlands cool down the climate which leads to less evaporation, the water remains in the landscape which provides better growth conditions. (Närmann & Tanneberger, 2021)

To summarize regernated wetlands save water and creates a resilient ecosystem, that sequesters Co2 and creates a high yield in biomass. (Nordt et al., 2024) The products derived from the biomass can be easily processed and locally applied, decreasing the carbon emission of the grey embodied energy in construction industry. (Nordt et al., 2024)

3.4. STAKEHOLDERS

The Stakeholder in the paludiculture value chain include farmers, landowners, the local population, processing companies, contractors, architects, and consumers. (Nordt et al., 2024) Early involvement of local population is crucial for scaling up the value chain. (Nordt et al., 2024) One of the most significant shift is the emergance of new job profiles, particularly the transsition from conventional famring towards "Peatland Climate managers" (Nordt et al., 2024)

Accocrind to the german association of Landcare:

"*Peatland climate managers are farmers who provide climate protection services by managing peatland soils. This climate protection service is provided by reducing or avoiding greenhouse gas emissions from the peat soils. This is achieved by raising the water level to slightly above the level at which peat is depleted, or by restoring or maintaining high water levels typical of a peatland.*" (Nordt et al., n.d., p.19)

At present, training and knowledge sharing are often initiated by pioneering farmers involved in wetland regeneration. They offer practical courses in exchange for financial compensation. (S. Petri, personal communication, May 20, 2025)

4. Systemic analysis (Applied SETS thinking)

The predicted version I analysed is based on the surface potential for Paludiculture. This approach was published by Tanneberger et al. (2021) and provides a goal scenario for the complete rewetting of peatland soils in Germany by 2050. It has now been adapted to the Berlin-Brandenburg region. However the surface numbers provided stem from the research paper: "Klimaschonende, biodiversitätsfördernde Bewirtschaftung von Niedermoorböden" published in 2021.

The strategy suggests a three-step plan for the following three decades 2020-2030. 2030-2040 and 2040-2050. (Tanneberger et al., 2021) During this time, all peatland soils (186,012 hectares) will be rewetted and the water level is increased until the surface. In the first decade, all cropland (38,385 ha)(Närmann & Tanneberger, 2021) as well as a third of the green pasture (49,048 ha) (Närmann & Tanneberger, 2021), will be rewetted. In the following two decades, the remaining two third of the green pasture will be rewetted each decade, so that by 2050, all organic soils will have been rewetted. (Tanneberger et al., 2021) (see appendix 16 and 17)

Ecological layer:

The rewetting of peatland is projected to reduce from 5.500.000 t CO2-eq. ha-1 a-1 (Landgraf, n.d.) in 2020 to reduce to 3.531.480 t CO2-Eq. ha-1 a-1 in 2030, 1.765.740 t CO2-Eq. ha-1 a-1 by 2040, and to 0 by 2050. Wetlands have been shown to lead to regional cooling of the area (Landgraf, n.d.) and to store water in their soils, increasing resilience during dry summers and helping to prevent wildfires. (*Klimamoor Brandenburg*, n.d.; Närmann & Tanneberger, 2021) They are resilient in case of flooding. In addition, rewetting facilitates new groundwater accumulation. (Närmann & Tanneberger, 2021; Nordt et al., 2024) The water flowing through wetlands is filteres by plants, resulting in runoff with lower fertiliser content, which reduces the eutrophication of surrounding bodies of water (Närmann & Tanneberger, 2021; Nordt et al., 2024). Wetland restoration significantly improves habitat availability for amphibians and wetland birds, thereby supporting local biodiversity and enabling the return of threatened species. (Nordt et al., 2024; Tanneberger et al., 2021) Due to their evaporative cooling and moisture retention effects, rewetted peatlands can positively influence adjacent ecosystems such as forests, which have experienced significant drought stress in recent years. (*Klimamoor Brandenburg*, n.d.; Nordt et al., 2024) Finally, the materials harvested from paludiculture could substantially lower the embodied grey energy of the regional construction industry.

Social:

Rewetting peatlands is a matter of intergnerational social justice (Noordt et al., 2022) More than just.a tool for climate repair, in drought striken Brandenburg, a rewetted landscape might a public commons, a place to cool of during the summer. It could help knit together identity, meory and community resilience. (Noordt et al., 2022) Activities like hiking, observing wildlife, or enjoying accesible waterlandscapes help peopple form stronger emotional ties to restored enviroments, reinforcing public support for climate-resilient spaces. (McPhearson et al., 2022; Noordt et al., 2022) Over time, access to water-based recreation could extend to restored rivers (Nordt et al., 2024) such as Spree.

At the same time, paludiculture creates new economic opportunities: harvesting and monitoriing require specialised skills, while decentralised processing provides employment in rural areas with weak infrastructure. (Islam & Moatazed-Keivani, 2023; Noordt et al., 2022; Nordt et al., 2024)

Technological Layer:

Innovation in water managenment systems – suh as automated rewetting technologies and real time water level monitoring – enable the precise control necessary for peatland cultivations. GIS mapping and open-source data paltforms can connect farms, processors and designer within regional networks, improving coordination and transparency. (Närmann & Tanneberger, 2021; Noordt et al., 2022) The establishment of regional processing hubs and transport logistics – potentially using water ways to move materials into urban centers like Berlin – will strengthen the supply chain (Noordt et al., 2022; Tanneberger et al., 2021) These agricultural systems also drive the development of specialised harvesting marchinery and modular processing units. (e.g. mobile, on-site setups) (Noordt et al., 2022; Tanneberger et al., 2021)

The emergance of new raw material opens opportunities for innovation in machine fabrication and prefabricated building components. (Islam & Moatazed-Keivani, 2023; Tanneberger et al., 2021) Integration into the building sector will require will require testing, certification and developemtne of hybrid construction methods that combine paludiculture-derived products with conventional materials. (Islam & Moatazed-Keivani, 2023; Noordt et al., 2022)

As Tanneberger et al write in their paper:" Towards net zero CO2 in 2050: An emission reduction pathway for organic soils in Germany", in 2021:

" To build trust and accelerate adoption, publicly funded demonstrator buildings will be essential"

The materials need to be applied in order for them to get a chance to establish themselves in the building market. Engineered alder wood for example (*Novel Species, Novel Products*, n.d.), in particular, offers a regional available strcutural material that could complement or replace conventional softwoods (Tanneberger et al., 2021) Prefabricated façade insulation panels derived from wetland biomass could support the sustainable renovation of Berlins postwar housing stock, which includes over 800,000 units built between 1949 and 1978. (Amt für Statistik Berlin-Brandenburg, 2023, Icslam & Moatazed-Keivani, 2023; Noordt et al., 2022)

Implementation challenges:

Despite its potential, implementing a regional paludiculture-based value chain presents several challenges. High initial investment costs for water management infrastrcuture and specialised harvesting technology could prevent its apllication, particularly among small-scale farmers. (Noordt et al., 2022; Tanneberger et al., 2021) Without consistent certification standards and regulatory clarity, wetland deriveed materials face major entry barriers – depite their enviromental advantages. The lack of market demand further slows down innovation and investment. (Noordt et al., 2022; Tanneberger et al., 2021) A lack of exposure to ecological land-use strategies in some regions may result in skepticism or resistance, slwoing down the adoption of paludiculture. This underlines the importance of public engagement and awarenes-building. (Tanneberger et al., 2021) Prolonged drought are already becoming a reality in Brandenburg. For paludiculture to work, water needs to stay in the soil -but if rainfall fails, longterm planing is difficult. (Noordt et al., 2022; Tanneberger et al., 2021)

5. Conclusion

The paper shows, that a change to regenerative construction practice can actually succeed, if architecture is no longer treated as a isolated design product but as a part of a larger social ecological metabolism. Using the SETS framework enabled a multidimensional analysis that helped reveal the interlinked dynamics between architecture, landscape and materials.

The explorations with paludiculture as a regenerative use of peatlands made apparent, the the new value chains can be established, that connect ecological resilience. Local prouction and social engagement. The flora of wetlands – especially Cattail, reed, and alder tree – do not only provide ecological benfits (Tanneberger et al., 2021), but also open up new, pratical uses in sustainable construction, partical for insulation and façade systems. (Nordt et al., 2024; Tanneberger et al., 2021)

At the same time, it becomes clear: these processes are not only a matter of material logistics, but are deeply interwoven with cultural design-related dimensions – as Hutton (2020) notes, *“materials are continuous with the landscapes they come from, and with the people who shape them.”* (Hutton, 2020, p.5) this viewpoint demands that architecture should be viewed in relation to its enviroment, taking into account ecological, social and historical factors. (Hutton, 2020)

The vision for Berlin-Brandenburg till 2050 shows, that a complete rearrangement to a reagional valuechain is imaginable and possible. The basis here is provided by the transformation strategy outlined in *Peatland Strategy for Germany: Pathway for rewetting 2030 and 2050* (Närmann & Tanneberger, 2021) which presents a step-by-step plan for rewetting of all organic soilsin Germany by 2050.

Initial funding programmes and pilot projects demonstrate that the transition to regionally rooted, peatland-compatible valur chains is already underway. The National peatland Protection Strategy (2022) explicitly commits to the large-scale rewetting of peatsoils across Germany by 2050 – including their productive use trough paludiculture. In Brandenburg, the “ReReetBB” initiative is supporting thee developemnt of regional value chains for renewable building materials such as reed, with a targeted investment of €23.4 million. As the strategy states: *“The protection and restoration of peatlands is a key measure for achieving Germany’s climate goals.”* These developments make one thing clear: the socio-ecological transformation of the constrctuion sector is not merely a vision – it is achievable and already politically initiated. What remains is a fundamental question that runs through this work.

“If ecosystems transforms, must not architecture transform with them?”

This work suggestes that the answer should not be sought in abstract models, but in concrete, regional anchored action – by building with and not against the landscape. Perhaps then, as the region reclaims its relatioship with water and soil, Berlin will once again live up to its name – not merely as a city in the swamp, but as a city shaped by it.

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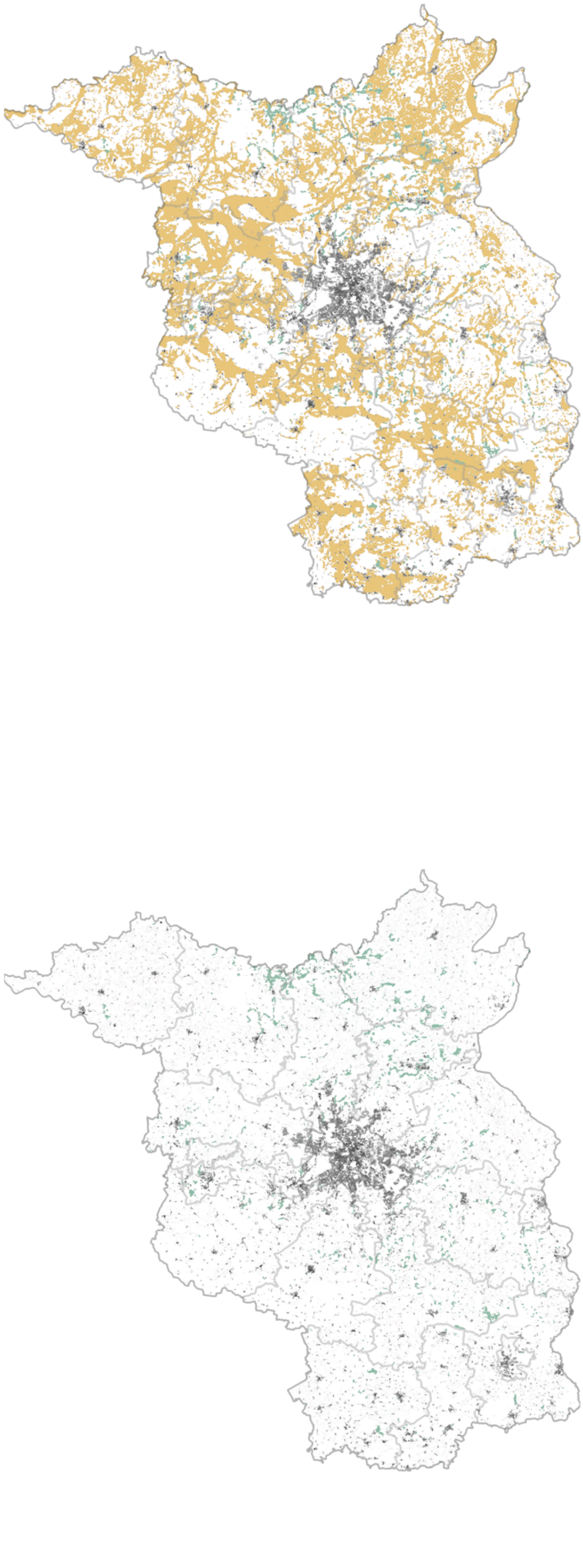
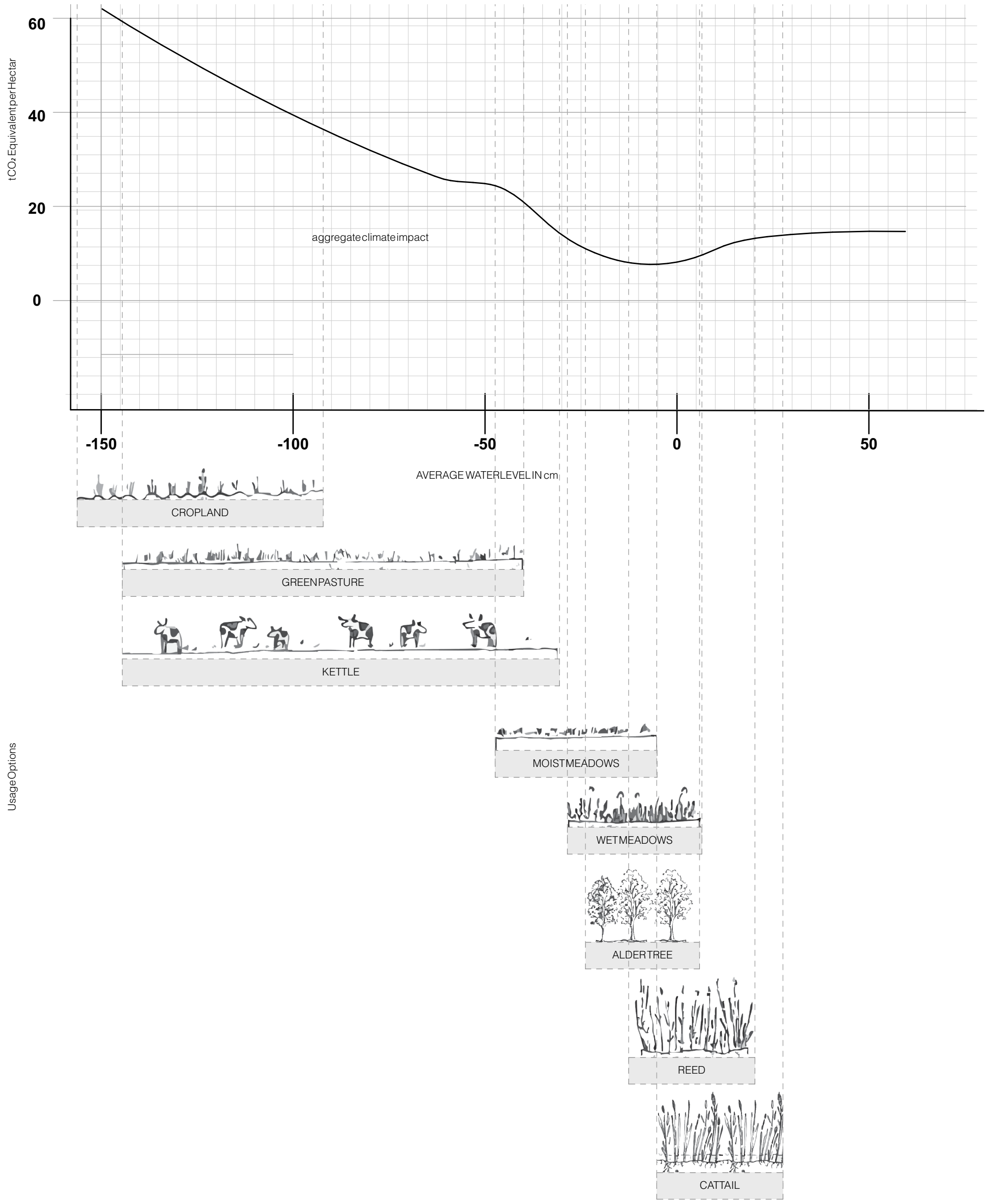
7. APPENDIX

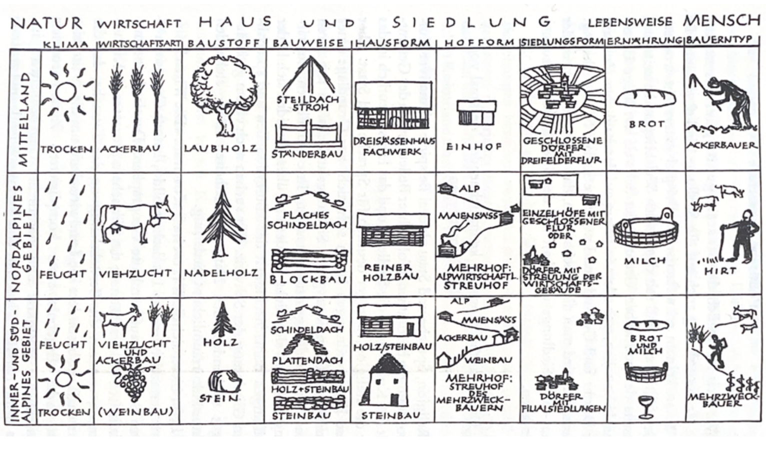
Appendix 1: Fête galante in märkischer Landschaft (Festivities in Fête in the Brandenburg countryside), Antoine Pesne, 1745 (Antoine, 1745)



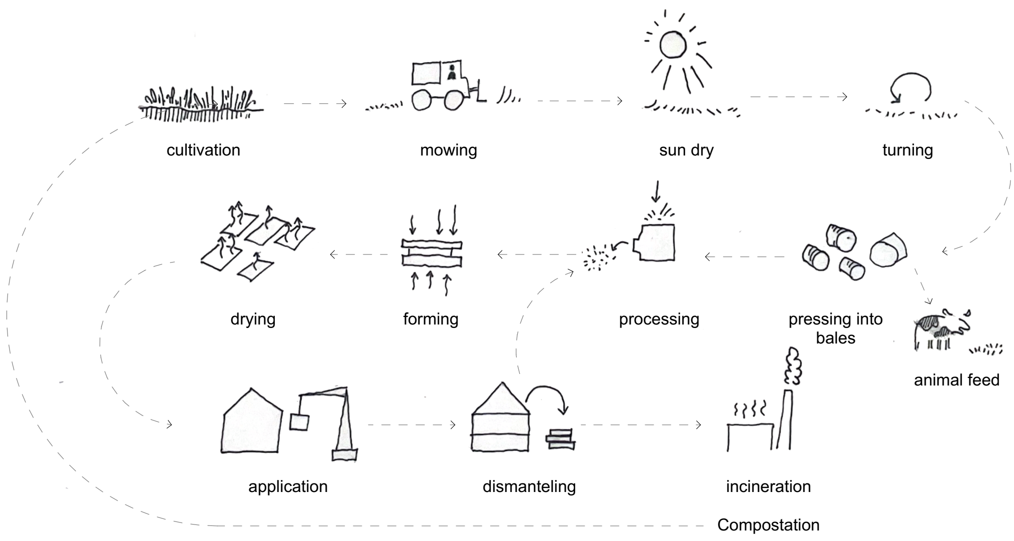
Appendix 2: Peatland distribution Berlin Brandenburg Yellow drained Peatland soil , green remaining peatland (*Geoportal Brandenburg - Detailansichtdienst*, n.d.)



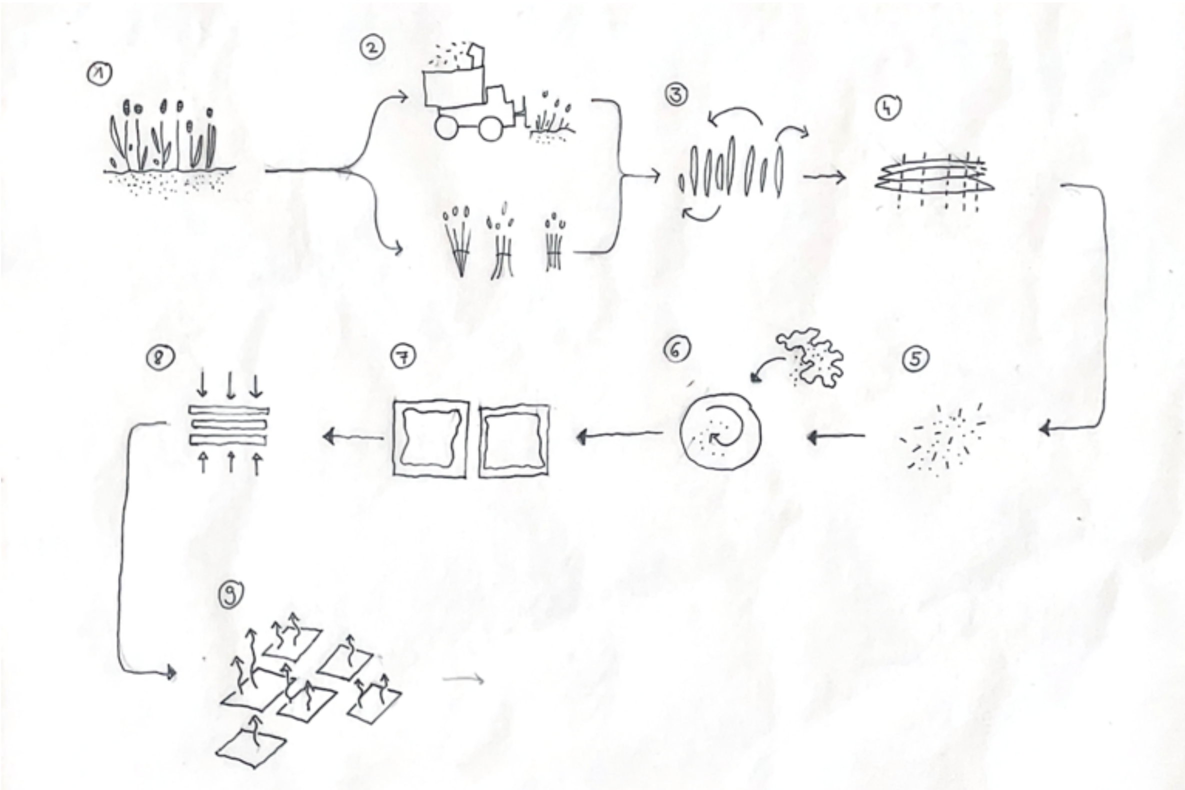
Appendix 4 : Waterlevel and usage options, reworked graphic based on (Nordt et al., 2024)



Appendix n. 4 : relation from landscape to architecture (Weiss & Egli, 1959)



Appendix 5: Meadow havest Lower than 20, Authors own image



Appendix 6: Wet harvest, authors own image

Tab. 3.1 Practical effectiveness (+ or ++) and suitability (colour-coded) of crop and wet meadow paludicultures for various uses. Practical effectiveness: + = prototypes or test facilities or areas available, ++ = already implemented on a larger scale; suitability: green = high potential, ochre = limited potential: technical adaptation/development necessary or suitable only for niche use, no colour = unsuitable or unknown potential. This overview is based on an expert assessment and reflects the current status (as of 2022).

Culture/Biomass	Peat moss	Sundew	Reeds	Cattail	Reed canary grass	Alder	Wet meadows
Animal-bound uses			+	+	++		++
Biogas wet fermentation			+	+	+		++
Biogas dry fermentation					+		++
Combustion			+		++	+	++
Construction and insulating materials			++	+	+	+	+
Panel material (furniture)			+	+	+	++	+
Paper, moulded parts			+	+	+		+
Platform chemicals			+	+	+		+
Organic and activated carbon			+		+		+
Substrates and soils	++		+	+			+
Medical applications		+					
Phytomining					+		+

Appendix 7: Usage options of Paludiculture material (Nordt et al., 2024)

Mineralbound strawboard
Manufactured by Strohplattenwerk Müritz

Wire bound reed panel
Manufactured by Hiss Reet

Fibreboard made from 100% wet meadow fibres
Manufactured by Zelfo Technology GmbH

Strawboard
Manufactured by Leibniz-Institut für Agrartechnik und Bioökonomie (ATB)

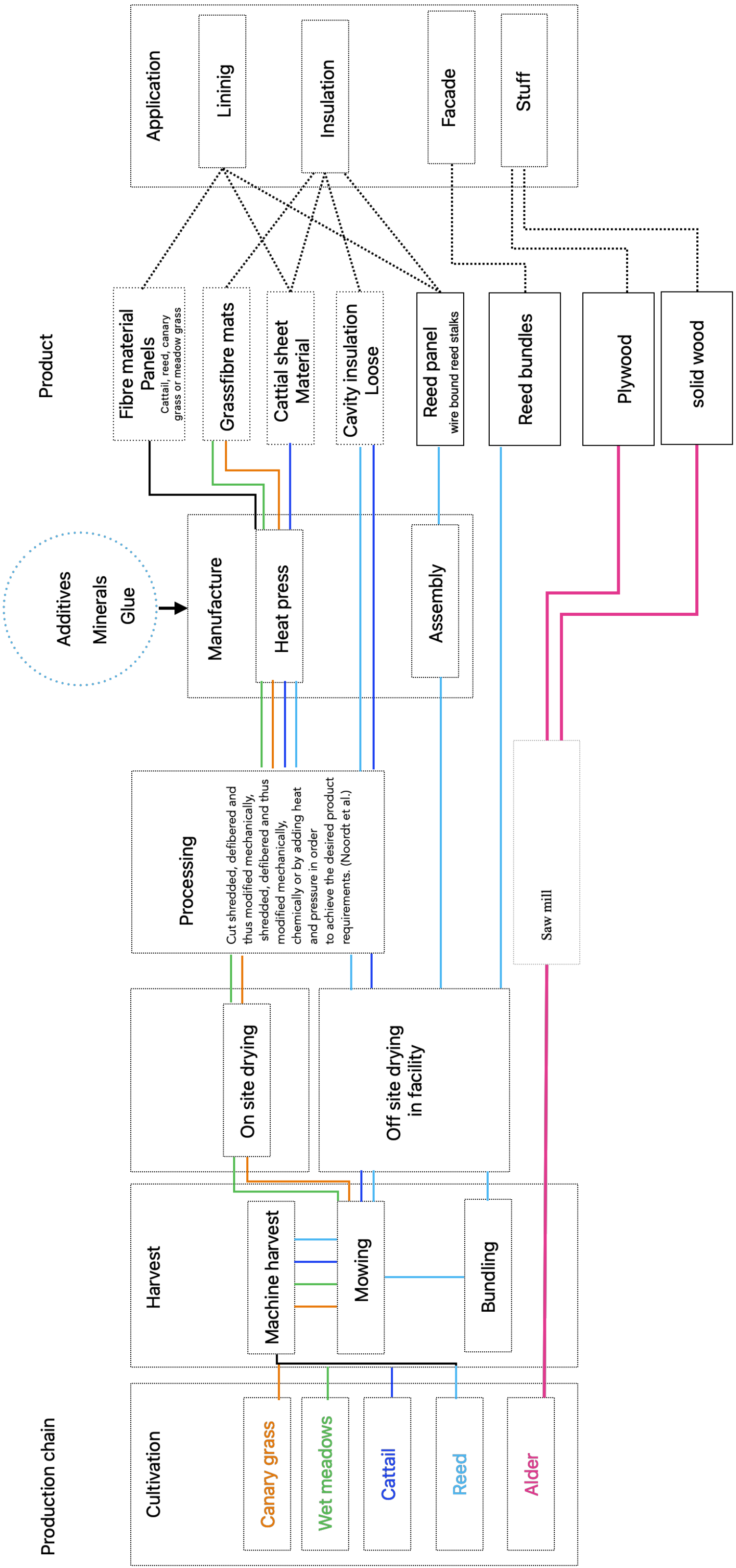
Typhaboard
Manufactured by Typha Technik Naturbaustoffe

Alder timber
Processed and milled in Berlin

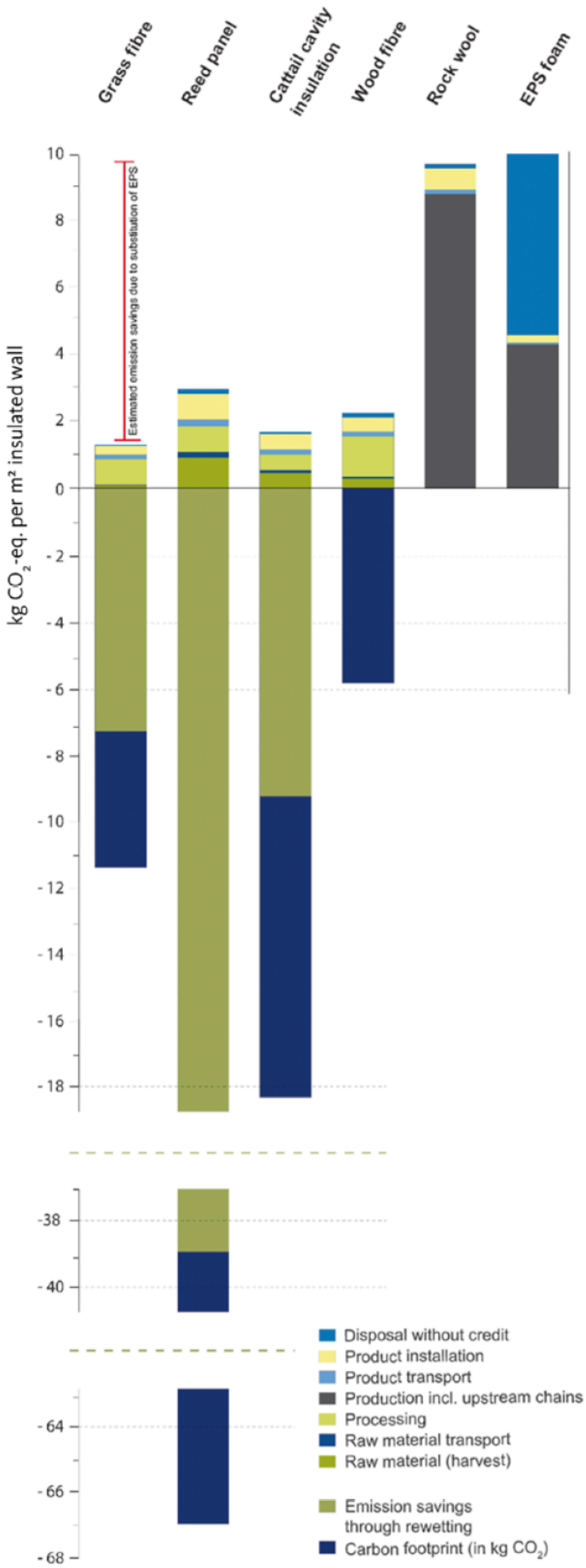
Paper back straw board
Distributed by Istraw

Processed meadow grass insulation
Manufactured by Gramitherm

Appendix 8: Construction Products (Islam & Moatazed-Keivani, 2023)



Appendix 9: Production chain (authors own image)

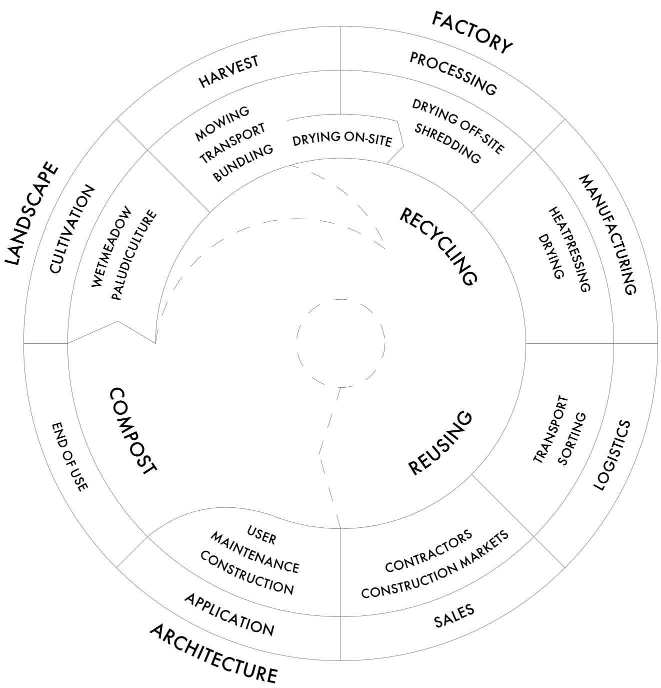


Appendix 10: Comparison of Co2 emissions of insulation materials (Nordt et al., 2024)

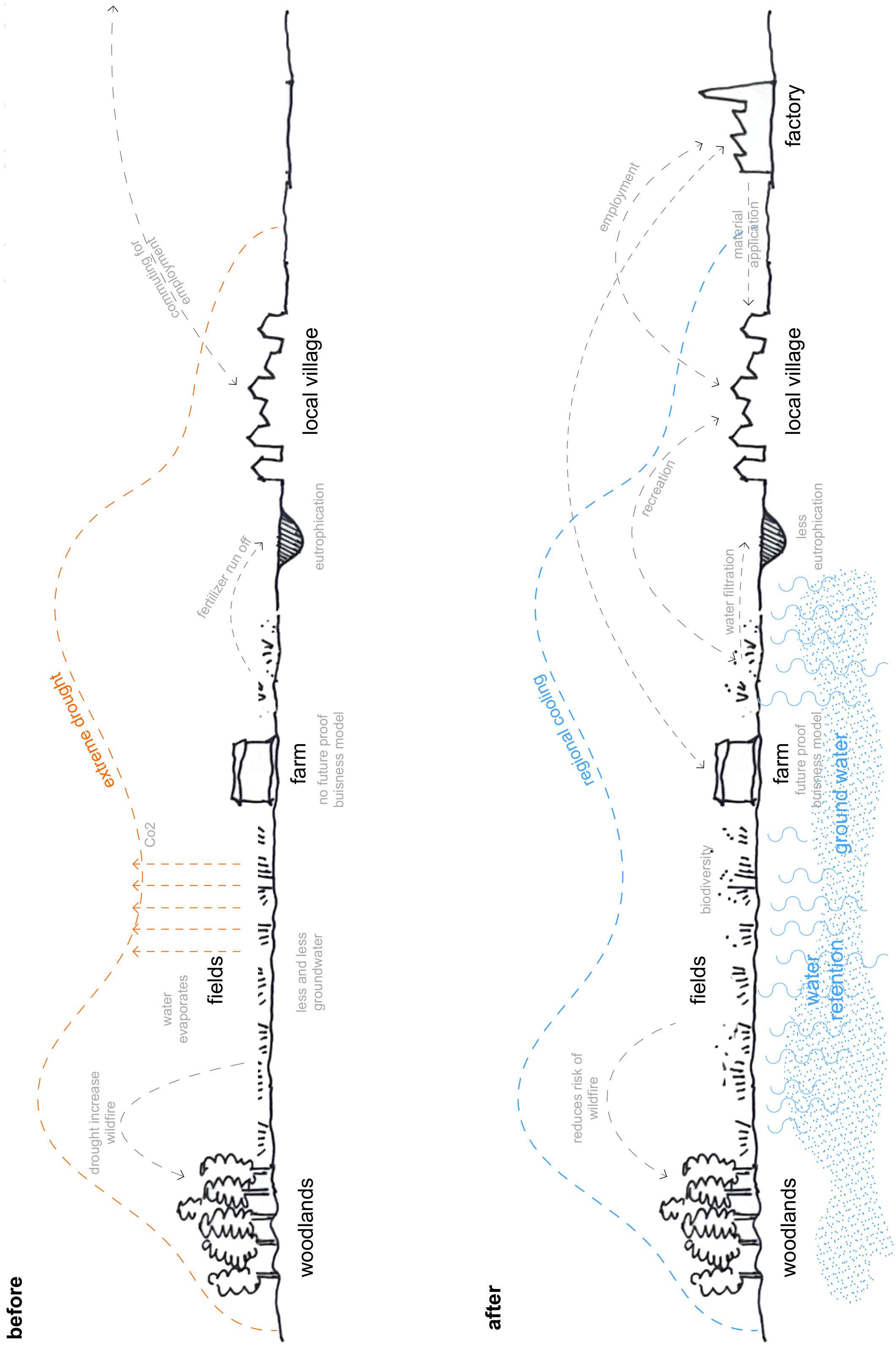
Tab. 3.5: Characteristic values of various insulation materials (prototypes and products) made from or with raw materials derived from paludiculture (Source: GMC 2022b: Steckbriefe „Produkte aus Paludikultur“ (Profiles “Products from paludiculture”))

Product	Application	Thermal conductivity [W/(m*K)]	Bulk density [kg/m³]
Reed panel	Interior insulation, interior fittings	0,065	145
	Plaster base	0,059	190–220
	Interior/exterior/roof insulation	0,061	155
	Insulation/sound/plaster base board	0,055	
TyphaBoard cattail plate	Interior/roof/sound insulation	0,040 0,048–0,060	
Cavity insulation	Insulation	0,040	80–90
Insulation mats	Grass: Interior/exterior/roof insulation	0,041	40
Foam boards	Insulation material	0,037–0,040	65–97

Appendix 11: Characteristic Values of Insulation materials (Islam & Moatazed-Keivani, 2023)



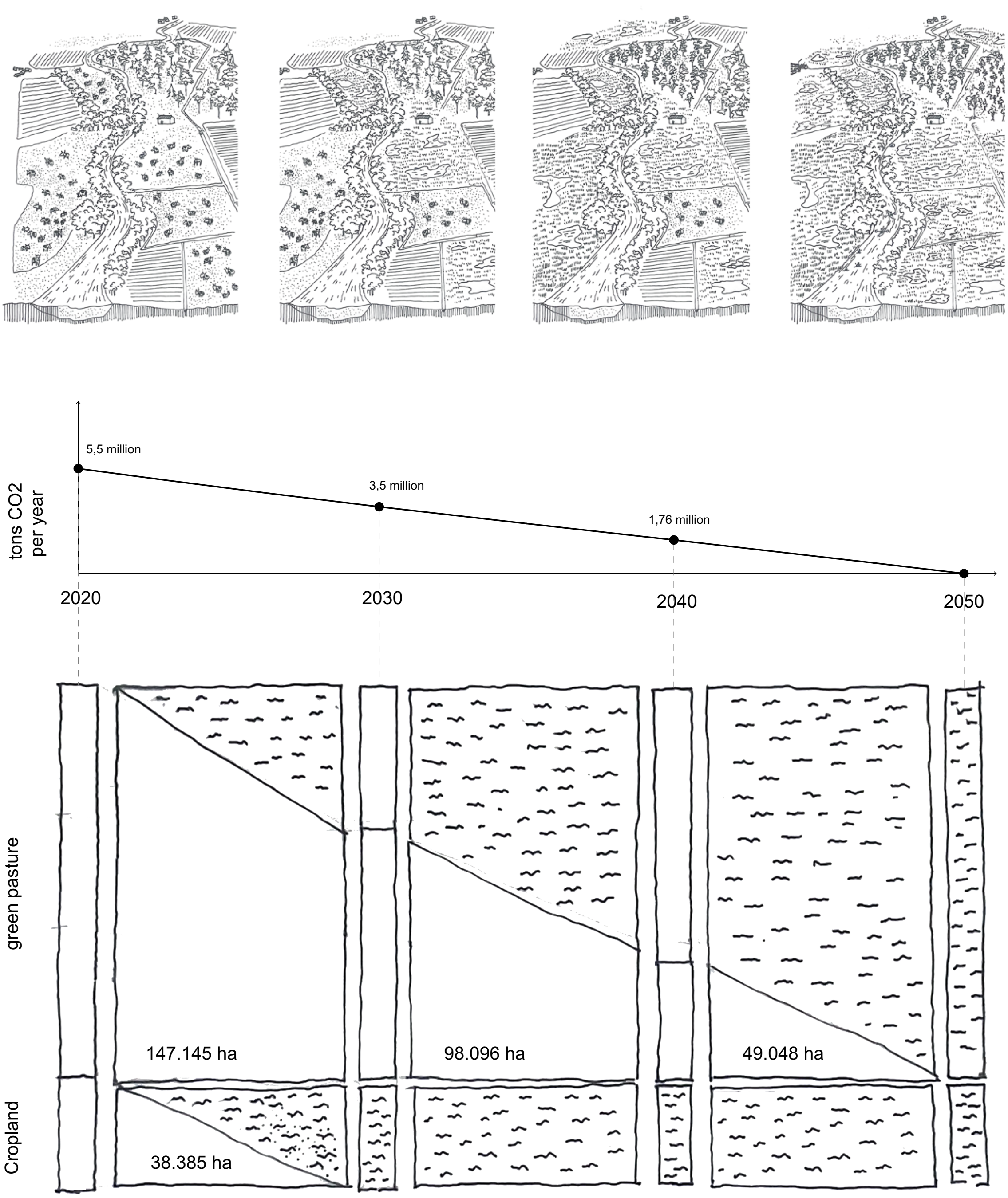
Appendix 12: Value chain Panel to End of Life (authors own image)



Appendix 13: landscape perspective (authors own image)

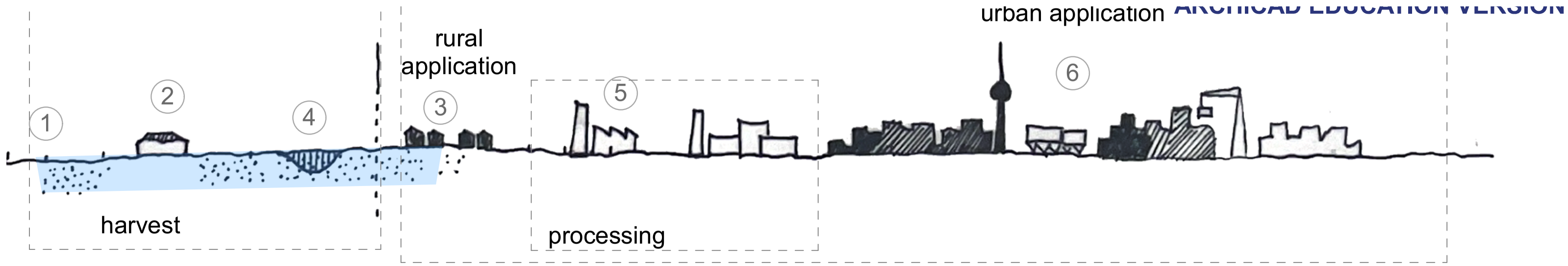
Appendix n. 14: future landscape authors own image

Appendix n.15: present day landscape authors own image



Appendix 16: Adapted Graphic 2030-2040-2050 rewetting of Cropland and Green pasture

(Tanneberger et al., 2021)



	1 fields	2 farms	3 local village	4 river	5 factory	6 city/demonstrator
	Landscape regeneration + biomass production	**Cultivation, harvesting, biomass delivery**	**Decentralized processing + employment**	**Water management + public ecology**	**Material transformation + product fabrication**	**Application + systemic integration**
STAKEHOLDER	National Peatland Protection Program, Landowners, Farmers / Peatland Climate Managers Environmental agencies, NGOs, Ecologists & hydrologists, Water engineers	Farmers, Machinery producer, Agricultural advisors, Certification bodies	Local municipalities Rural workforce / technical staff, Training institutions, Cooperatives, Logistics providers	River authorities Logistics provider City water utilities Wetland designers & constructed wetland experts Biologists Public users	Biomass processors, Bio-based start-ups, Certification & testing agencies, Engineers, Logistics	Architects / urban designers, Developers / housing cooperatives, Construction companies, City planners, Public housing agencies, Citizens
SOCIAL	- Stewardship of land = intergenerational climate justice - Restored landscapes as future commons and cultural memory	New rural jobs in cultivation and land restoration Training in ecosystem-based land management	Employment in decentralized processing facilities Keeps value creation in structurally weak regions	Public bathing returns to the Spree Water becomes a social and civic experience	New sector: paludi-fabrication & bio-based craft Local economic regeneration	Reconnection of citizens with material origins Urban identity linked to regenerative landscapes
ECOLOGICAL	- Increased soil moisture prevents wildfires and stores water - Evaporative cooling supports local climate - Biodiversity recovery (amphibians, wetland birds)	- Biomass harvest (cattail, reed, alder) with low input	Reduced emissions via local processing (less transport) Strengthened land-urban feedback loop	Constructed wetlands filter greywater & reduce eutrophication Climate-adaptive infrastructure along riverbanks	Materials with low embodied energy enter construction sector Reduced dependency on extractive materials	Retrofit potential: 800,000 postwar housing units Improved urban microclimate via better insulation
TECHNOLOGICAL	Automated water level control + remote monitoring Novel cultivation methods for wet biomass crops	Specialised machinery for wet biomass harvesting Use of GIS and open-source coordination tools	Modular mobile processing units Infrastructure for regional logistics	Water-filtration landscapes integrated into design Floating structures test climate-adaptive systems	Production of prefab façade panels, insulation, furniture Certification and standardization processes for materials	Integration of bio-based products into hybrid buildings Circular systems: waste → compost → field again

Appendix 17 : Vision 2020-2050 SET frame work

Apendix 18:

Interview transcript 21.05.2025

Josephine: Hallo Herr Petri, danke, dass Sie sich Zeit nehmen. Ich studiere Architektur und schreibe meine Masterarbeit zum Thema „Regionale Wertschöpfungskette Paludikultur in Berlin-Brandenburg“. Dabei bin ich auf Ihren Betrieb gestoßen, weil Sie einer der Pioniere sind, die das bereits umsetzen. Ich würde Ihnen gerne ein paar Fragen stellen, um einen praktischen Einblick zu bekommen – ist das okay?

Herr Petri: Ja, das ist in Ordnung.

Josephine: Super, vielen Dank. Vielleicht zunächst: Ist Ihr Hof schon lange in Familienbesitz?

Herr Petri: Ja, meine Eltern haben den Hof übernommen – das ist jetzt schon eine ganze Weile her, Mitte der 80er Jahre.

Josephine: Und wie lange bewirtschaften Sie wiedervernässte Flächen?

Herr Petri: Die ersten Flächen wurden Mitte der 80er Jahre wiedervernässt, vor allem im Rahmen des Naturschutzes. Richtig los ging es dann ab 2015 – seitdem betreiben wir das intensiver.

Josephine: Inwiefern merken Sie die Trockenheit der letzten Jahre?

Herr Petri: Die Trockenheit ist definitiv ein Thema. Besonders die Jahre 2008, 2009 und 2020 waren sehr trocken. In den Jahren danach hat sich das etwas erholt, aber dieses Jahr ist es wieder extrem. Was wir jedes Jahr merken, sind diese Frühjahrstrockenheiten – März, April, Mai ist es oft sehr warm und trocken. Dadurch verschiebt sich die Vegetation. Letztes Jahr sind viele Pflanzen vier Wochen früher in die Blüte gegangen, was dann wiederum zu Biomasseverlust führt.

Josephine: Wie hoch ist der Wasserstand aktuell auf Ihren Flächen?

Herr Petri: Das ist sehr unterschiedlich – wir haben Flächen mit 1–2 cm Wasser über der Grasnarbe, aber auch Flächen, bei denen der Wasserspiegel 20–30 cm darunter liegt. Das hängt stark vom Standort ab.

Josephine: Und wie läuft die Bewässerung? Haben Sie eine künstliche Steuerung?

Herr Petri: Wir bewässern nicht aktiv, sondern arbeiten mit Stauanlagen. Wir nutzen alte Entwässerungsgräben, in denen wir das Wasser zurückhalten. Oberflächen- und Regenwasser wird gestaut, sodass es nicht abfließen kann.

Josephine: Und wie wirkt sich diese Bewirtschaftung auf die Biodiversität aus?

Herr Petri: Sehr positiv. Wir haben eine hohe Insektenvielfalt, auch seltene Pflanzenarten, die auf der Roten Liste stehen. Vor allem bei Schmetterlingen und Pflanzenarten ist das gut sichtbar.

Josephine: Wie oft ernten Sie denn?

Herr Petri: Meist einmal im Jahr, maximal zweimal – je nach Nachfrage. Die Biomasse wird als Heu geerntet: gemäht, gewendet, getrocknet und dann zu Rundballen gepresst.

Josephine: Verarbeiten Sie die Biomasse auch selbst weiter?

Herr Petri: Teilweise. Hauptsächlich nutzen wir sie als Futtermittel, aber wir haben auch schon viele Experimente im Bereich Baustoffe gemacht: OSB-Platten, Dämmstoffe, Einblasdämmung, sogar Papier. Das alles in Zusammenarbeit mit dem Leibniz-Institut ATB.

Josephine: Was sind dabei die größten Herausforderungen?

Herr Petri: Der Markt fehlt. Es gibt keine standardisierten Produkte und keine Zulassungen für viele dieser Materialien. Auch geeignete Maschinen fehlen oft. Und ohne großes Interesse von Firmen und entsprechender Förderung (mind. 60–80 %), passiert da wenig. Die Herstellung ist außerdem noch relativ teuer – Paludi-Biomasse ist derzeit teurer als Holz.

Josephine: Und wie ist die Lage aktuell – gibt es Fortschritte?

Herr Petri: Wir sind Teil der „Allianz der Pioniere" und arbeiten in Expertengruppen z. B. zu Bau- und Dämmstoffen. Es gibt erste Partnerschaften, wie mit der Otto Group, die 10 % Paludi-Biomasse in ihre Kartonagen mischt. Aber wirtschaftlich tragfähig ist das noch nicht breit aufgestellt.

Josephine: Mussten Sie auf dem Hof viel umstellen für die Paludikultur?

Herr Petri: Nein, nicht wirklich. Wir machen reine Nasswiesenwirtschaft, ohne spezielle Kulturen wie Rohrkolben. Das heißt, wir mussten keine großen Umstellungen machen, außer im Denken: andere Schnittzeitpunkte, kein Düngen, etc.

Josephine: Unterstützen Sie auch andere Landwirte bei der Umstellung?

Herr Petri: Ja, wir versuchen Fragen zu klären und Hilfestellung zu geben. Es werden mehr, die sich dafür interessieren. Aber viele fragen auch: „Was mache ich mit der Biomasse, wenn ich keine Milchkühe mehr habe?" Die wirtschaftliche Perspektive fehlt vielerorts noch.

Josephine: Haben Sie Kontakt mit der Baubranche?

Herr Petri: Ja, durch die Allianz der Pioniere und die Expert Circles arbeiten wir eng mit Bauunternehmen zusammen. Ich bin Sprecher der Arbeitsgruppe „Biomassebereitstellung" – wir stimmen dort Anforderungen zwischen Landwirtschaft und Industrie ab.

Josephine: Das ist super spannend. Vielen, vielen Dank, Herr Petri! Wäre es okay, wenn ich Teile des Interviews in meiner Arbeit verwende?

Herr Petri: Ja, sehr gerne. Ich würde mich freuen, wenn ich am Ende auch einen Einblick in Ihre Arbeit bekomme.

Josephine: Natürlich – ich schicke Ihnen dann gerne die fertige Version per E-Mail. Vielen Dank und einen schönen Tag noch!