

Fluvio-social metabolism in the Echaz Valley: Resource conflicts using the example of oak bark procurement for tanning in the imperial town of Reutlingen

Marcel Schön, Iris Nießen

Abstract

The study of the imperial town of Reutlingen explores the interactions between urban development, resource use, and riverine landscapes through the lens of the concept of fluvio-social metabolism. At its core is the tanning trade, whose key resource – oak bark – was integrated into the urban system via complex material and social flows. The study analyzes conflicts over forest resource use, particularly in the context of territorial disputes with Württemberg between the 14th and 16th centuries. It shows how the tannery district significantly shaped the topographical development of the urban floodplain. Fluvio-social metabolism serves as an interdisciplinary bridging concept for analyzing material cycles and institutional frameworks, embedded within a regional environmental history. The case study of Reutlingen forms part of the DFG-funded project “Local Pathways to the Fluvial Anthroposphere” and offers a nuanced view of locally embedded interventions in fluvial spaces. The study combines historical and archaeological approaches to investigate the long-term transformation of river landscapes at the intersection of society and nature.

Die Untersuchung der Reichsstadt Reutlingen beleuchtet die Wechselwirkungen zwischen urbaner Entwicklung, Ressourcennutzung und Flusslandschaften im Rahmen des Konzepts des Fluvio-sozialen Metabolismus. Im Mittelpunkt steht das Gerberhandwerk, dessen zentrale Ressource – Eichenrinde – über komplexe materielle und soziale Flüsse in das städtische System eingebunden war. Die Studie analysiert Konflikte um die Nutzung von Waldressourcen, insbesondere im Kontext territorialer Auseinandersetzungen mit Württemberg im 14. bis 16. Jahrhundert. Dabei wird gezeigt, wie das Gerberviertel die topographische Entwicklung der urbanen Flussaue prägte. Der Fluvio-soziale Metabolismus fungiert als interdisziplinäres Brückenkonzept zur Analyse materieller Zyklen und institutioneller Rahmenbedingungen, eingebettet in die regionale Umweltgeschichte. Das Fallbeispiel Reutlingen ist Teil des DFG-Projekts „Local Pathways to the Fluvial Anthroposphere“ und erlaubt eine differenzierte Betrachtung lokal verankerter Eingriffe in Flussräume. Die Studie verbindet historische und archäologische Ansätze, um die langfristige Transformation von Flusslandschaften im Spannungsfeld zwischen Gesellschaft und Natur zu analysieren.

Keywords: Fluvio-social metabolism; Urban floodplain transformation; Resource conflicts; Tanning craft; Historical environmental change

Substances introduced by humans are today one of the most challenging problems in river and floodplain conservation.¹ As early as the pre-modern era, materials and substances introduced by human activity, such as construction materials or wastewater, significantly altered riverine landscapes through pollution and hydraulic engineering. One of the main driving forces behind these transformations was urban development, particularly phases of urban expansion and the growth of water-related industries, which often involved extensive infilling of riverbanks and the incorporation of former floodplains into the urban area.²

Our research on the imperial town of Reutlingen investigates how access to raw material sources influenced the town's fluvio-social metabolism. The fluvio-social metabolism serves as a bridging

¹ Maryna STOKAL/Zhaohai BAI/Wietse FRANSSEN u.a.: Urbanization: an increasing source of multiple pollutants to rivers in the 21st century. *npj Urban Sustain* 1, 24 (2021). <https://doi.org/10.1038/s42949-021-00026-w>; BMUV/UBA: Die Wasserrahmenrichtlinie – Gewässer in Deutschland 2021. Fortschritte und Herausforderungen, Bonn/Dessau 2022.

² Iris NIEßEN: Vorstadtentwicklung in der Aue. Archäologische Forschungen zu den Donaustädten Regensburg und Ulm im Mittelalter, in: Peter FÄßLER/Michael STRÖHMER (ed.), Kommunale Wasserregime à la longue durée. Zeitliche und räumliche Eingrenzungen 1350-1930, Paderborn 2025, p. 39-75.

concept for the interdisciplinary study of material flows and cycles within specific resource complexes.³ Specifically, we trace the material flows of the tanning trade and examine conflicts and regulations surrounding the procurement of oak bark as tanning agent for vegetable tanning. The processes of territorialization in the 14th century, as well as a phase of renegotiating timber rights in the 15th and 16th centuries, played a crucial role. The tanning trade significantly shaped the urban topography of Reutlingen and, together with the mills, represented an important economic factor for the town.⁴ (Fig. 1) Traditional questions of regional history are thus linked with an environmental-historical perspective on the development of rivers and floodplains within their social contexts. The overarching research concept of the “Fluvial Anthroposphere”⁵ addresses the central question of when and under what conditions humans became a decisive factor in shaping fluvial and floodplain environments. In contrast to the global scope of the Anthropocene, the anthroposphere approach emphasizes regional and local spatial perspectives, enabling a more nuanced understanding of these processes. The bridging concept of Fluvio-social Metabolism serves to integrate disciplinary approaches from history, archaeology, and geography. The studies in Reutlingen are part of the DFG-funded project “Local pathways to the Fluvial Anthroposphere along the Echaz (Rhine) and Eger (Danube). A comparative analysis from ca. 1100 to 1800 AD”, within the Priority Programme 2361 “On the Way to the Fluvial Anthroposphere”.⁶ Against the backdrop of our project’s fundamentally comparative approach, this article presents a case study on territorial resource conflicts, using the example of tanning in the Free Imperial Town of Reutlingen. The guiding question of local pathways towards a Fluvial Anthroposphere enables a regional history perspective on broader environmental-historical issues.

BRIDGING CONCEPT OF FLUVIO-SOCIAL METABOLISM – RESEARCH QUESTIONS

The fluvio-social metabolism⁷ is a concept that analyzes the complex interactions between society and nature, with a particular focus on rivers and floodplains as socio-natural sites. Its aim is to demonstrate how human societies, through both material and immaterial interactions with nature, bring about lasting transformations of their environments and social structures. These interrelations can be understood as a form of “metabolism” that encompasses not only material flows and cycles, but also the cultural and institutional frameworks that organize and regulate these exchanges.⁸

The fluvio-social metabolism functions as a bridging concept within the environmental sciences, linking various disciplines. Archaeology, history, and geography are integrated to connect the archives of society and nature. This approach is particularly effective in floodplain landscapes, where the close entanglement of social and natural processes reveals how such metabolic interactions have shaped environments and social structures over long timescales.

The fluvio-social metabolism investigates how human-influenced material flows and cycles have shaped the form and development of floodplains and their social structures over time. It considers the exchange of both material resources (such as raw materials and energy) and immaterial aspects (such as cultural techniques and institutions) between nature and society. This includes both intentional

³ Iris NIEBEN/Gerrit J. SCHENK/Marcel SCHÖN, Fluvio-sozialer Metabolismus als Brückenkonzept mittlerer Reichweite. Ein Vorschlag zur Untersuchung der Fluvialen Anthroposphäre (preprint). iDAI.repo. <https://doi.org/10.34780/dtuitqwl>

⁴ Cf. Willi A. BOELCKE : Zur mittelalterlichen und frühneuzeitlichen Wirtschaftsgeschichte der Reichsstadt Reutlingen, in: Reutlinger Geschichtsblätter [=RGB] 29 NF (1990), p. 179-216, here p. 183f.

⁵ Lukas WERTHER/Natascha MEHLER/ Gerrit J. SCHENK/ Christoph ZIELHOFER, On the Way to the Fluvial Anthroposphere. Current Limitations and Perspectives of Multidisciplinary Research, in: Water MDPI 16 (2021), H. 13, p. 1–25.

⁶ <https://www.physes.uni-leipzig.de/fluviale-anthroposphaere> (Stand 24.03.2025).

⁷ The proposal jointly developed by Nießen/Schenk/Schön (Fluvio-social Metabolism) 2025 goes back to discussions within the framework of the Priority Program 2361 “On the Way to the Fluvial Anthroposphere” of the German Research Foundation, also in project-related exchange with other colleagues from history, archaeology, geography, biology, ecotoxicology and geosciences at conferences and workshops.

⁸ Cf. Sabine BARLES: Urban Metabolism, in: Sebastian HAUMANN/Martin KNOLL/Detlev MARES (ed.): Concepts of Urban-Environmental History (Environmental and Climate History, vol. 1), Bielefeld 2020, p. 109-124; Sebastian HAUMANN u.a. (ed.): Perspektiven auf Stoffgeschichte. Materialität, Praktiken, Wissen, Bielefeld 2023.

interventions and unintended consequences (e.g. environmental change), as well as the intrinsic dynamics of materials themselves. These substances are selected and evaluated by society, meaning that material flows are subject to significant social influence. The evaluation of substances can shift over time due to technological innovations, knowledge transfer, or other cultural changes. Through material flows, immaterial aspects of society become materially embedded and exert transformative effects on rivers and floodplains. These flows follow resource complexes – specific combinations of materials, technologies, practices, and social structures – that shape the dynamics of fluvial landscapes. The term “resource complexes” is adopted from the conceptual framework of the Collaborative Research Centre ResourceCultures at the University of Tübingen.⁹ For analyzing the fluvio-social metabolism, a diachronic perspective on material flows and resource complexes is essential. The concept can be integrated into existing models such as the spheres model, the human ecosystem, or the socio-natural site.¹⁰ It captures the changes in river landscapes and social structures over time as a transformative process. Unlike the socio-natural site, which focuses on the co-evolution of arrangements and practices, this concept emphasizes the process of change itself. The framework rests on three key pillars: the material flows and cycles, the resource complexes driving these changes, and interdisciplinarity, which enables the integration of archives from nature and society.

The significance of metabolic concepts for environmental-historical research, especially regarding cities, has been debated in the past, particularly due to an insufficient consideration of social factors.¹¹ An example of integrating material flows is the interdisciplinary research conducted on the city of Vienna¹²: For example, it has been possible to quantify the wood resources in the Danube floodplains near Vienna for the 19th century using geographical and forestry approaches, relate them to the towns’s historical wood consumption, and carry out a vegetation-ecological reconstruction.¹³ The integration of (semi-)quantitatively determined material flows with historical sources on urban society closely aligns with the concept of fluvio-social metabolism, although this particular study focuses primarily on floodplain forests and excludes other relevant resource complexes. As early as 2007, Martin Knoll emphasized that a pure analysis of material flows must be followed by further inquiries. Starting from the externalization of urban metabolic processes – which occurs through the inflow of raw materials from a defined surrounding area and the impacts of their use as waste – the urban hinterland

⁹ Cf. Martin BARTELHEIM/Roland HARDENBERG/Thomas SCHOLTEN: Ressourcen – RessourcenKomplexe – RessourcenGefüge – RessourcenKulturen, in: Tobias SCHADE u.a. (ed.): Exploring Resources. On Cultural, Spatial and Temporal Dimensions of ResourceCultures (Ressourcenkulturen, vol. 13), Tübingen 2021, p. 9-22.

¹⁰ Peter SLOTERDIJK: Sphären, vol. 1-3, Frankfurt a. M. 1998, 1999, 2004; Kenneth E. BOULDING: Ecodynamics. A New Theory of Social Evolution, Beverly Hills/London 1981 (ursprünglich 1978); Verena WINIWARTER/Harald WILFING (ed.): Historische Humanökologie. Interdisziplinäre Zugänge zu Menschen und ihrer Umwelt, Wien 2002; Marina FISCHER-KOWALKSI/Andreas MAYER/Anke SCHAFFARTZIK: Zur sozialmetabolischen Transformation von Gesellschaft und Soziologie, in: Matthias GROß (ed.): Handbuch Umweltsoziologie, Wiesbaden 2011, p. 97-120; Verena WINIWARTER/Martin SCHMID: Socio-Natural Sites, in: Sebastian HAUMANN/Martin KNOLL/Detlev MARES (ed.): Concepts of Urban-Environmental History (Environmental and Climate History, vol. 1), Bielefeld 2020, p. 33-50.

¹¹ Andrew C. ISENBERG: Introduction: New Directions in Urban Environmental History, in: DERS. (ed.): The Nature of Cities. Culture, Landscape and Urban Space (Studies in Comparative History), Rochester 2006, p. XI-XIX, here p. XIII.

¹² Christoph SONNLECHNER: Wald der Wiener? Der mittelalterliche und frühneuzeitliche Wienerwald als Biomasse-Lieferant und Jagdrevier, in: Karl BRUNNER/Petra SCHNEIDER (ed.): Umwelt Stadt. Geschichte des Natur- und Lebensraumes Wien (Wiener Umweltstudien, vol. 1), Wien/Köln u. a. 2005, p. 165-169; Verena WINIWARTER/Christoph SONNLECHNER: Der soziale Metabolismus der vorindustriellen Landwirtschaft in Europa (Der Europäische Sonderweg, vol. 2), Stuttgart 2001; Christoph SONNLECHNER: Der „ökologische Fußabdruck“ Wiens im Spätmittelalter – eine Annäherung, in: Ferdinand OPPL/Christoph SONNLECHNER (ed.): Europäische Städte im Mittelalter (Forschungen und Beiträge zur Wiener Stadtgeschichte, vol. 52; Veröffentlichungen des Wiener Stadt- und Landesarchivs Reihe C: Sonderpublikationen 14), Innsbruck/Wien u. a. 2010, p. 351-364.

¹³ Severin HOHENSINER/Anton DRESCHER/Otto ECKMÜLLNER/Gregory EGGER/Sylvia GIERLINGER/Harbert HAGER/Gertrud HAIDVOGL/Mathias JUNGWIRTH: Genug Holz für Stadt und Land? Wiens Holzressourcen in den dynamischen Donau-Auen. Projektbericht, Institut für Hydrobiologie und Gewässermanagement, Universität für Bodenkultur Wien, Wien 2016.

is functionally incorporated into the town's metabolism. Central to this is the town's relationship with its supply and disposal area, raising the primary question of who holds decision-making authority over the regulation of these metabolic processes.¹⁴ Identifying and analyzing specific societal control mechanisms of material flows within the fluvio-social metabolism allows for the inclusion of aspects such as power relations, conflicts, and interests. Legal history, regional history, and social history perspectives can be particularly useful for this purpose. Therefore, the concept is especially suited for study areas characterized by the coexistence of diverse interests, which can significantly influence processes both within cities and in urban–rural relationships.

The fluvio-social metabolism of the red tannery in Reutlingen can be examined on multiple levels. Central to this are the material flows – from harvesting oak bark in the forests, through its processing into tanning extract at the bark mill, to the tanning process in the tannery itself. This also includes wastewater discharged into the river and the tanning cakes, which were often used as fertilizer or fuel¹⁵. Furthermore, other material flows related to the tannery involve the sourcing of raw hides and essential materials such as clean water, ash, urine, salt, and arsenic. Both the quantities and composition of these substances, during procurement and in wastewater, are of interest. Besides the “unwanted” by-products, the main product, red-tanned cattle leather, is a crucial part of these flows. Our detailed study focuses archaeologically and historically on a specific segment of these complex flows: the access to oak bark as a raw material for tanning and its processing in the town of Reutlingen.

The resource complex of tanning is central to this study, initially focusing on production processes, material remains, and the urban layout of the tannery district. The investigation then zooms in on questions of wood procurement as a resource, emphasizing the use of oak forests and their territorial affiliation. A key aspect is the interests of the involved actors, specifically the town of Reutlingen and the Württemberg territorial authority. The study is guided by questions such as: Which urban facilities were necessary for the tannery district, and how did they shape the development of the urban floodplain? What role did the tannery guild play within the imperial town, and how did the tanning craft influence urban development? How was wood procurement legally regulated? What conflicts arose between Reutlingen and Württemberg over forest use as a resource, and how do these fit into regional history? Our focus is therefore less on the environmental impact of wastewater on the fluvial ecosystem, and more on the shaping of the urban floodplain for the specific river-bound tanning craft, as well as the social and legal frameworks of resource procurement.

FREE IMPERIAL TOWN OF REUTLINGEN – DEVELOPMENT INTO A CENTER FOR CRAFT AND TRADE

The suburban settlement cores that merged into Reutlingen under the protection of the Achalm castle during the 11th and 12th centuries were already structurally shaped by crafts and trade, as suggested by archaeological finds. Besides the well-known early medieval cemeteries, the earliest securely dated settlement evidence comes from the area known as the “Hofstatt.” Excavations at the “Katharinenhof” site between 2018 and 2019 revealed continuous habitation there dating back to the 7th century.¹⁶ (Fig. 1) The area was part of an early medieval polycentric settlement complex located on both sides

¹⁴ Martin KNOLL: Wald und Holz als verknappte Ressourcen. Anmerkungen zur städtischen Brennholzversorgung im 18. und 19. Jahrhundert am Regensburger Beispiel, in: Bernd HERRMANN (ed.): Beiträge zum Göttinger Umwelt-historischen Kolloquium 2004-2006, Göttingen 2007, p. 189-211, here p. 190f; Sabine BARLES/Martin KNOLL: Long-Term Transitions, Urban Imprint and the Construction of Hinterlands, in: Tim SOENS/Dieter SCHOTT/Michael TOYKA-SEID/Bert DE MUNCK (ed.): Urbanizing Nature. Actors and Agency (Dis-)Connecting Cities and Nature since 1500, New York 2019, p. 29-49, here p. 31f.

¹⁵ Dried “Lohe” that remains after the tanning process. Johannes CRAMER: Gerberhaus und Gerberviertel in der mittelalterlichen Stadt (Studien zur Bauforschung Nr. 12) Bonn 1981, p. 34-36.

¹⁶ Sybil HARDING: Die archäologischen Ausgrabungen auf dem Katharinenhof-Areal – Einblicke in die Reutlinger Siedlungsgenese, in: RGB 59 NF (2020), p. 11-43, here p. 18-21. – bereits in den 1990er Jahren in der Nähe wenige Siedlungsgruben der Merowingerzeit aufgedeckt; Alois SCHNEIDER: Reutlingen (Archäologisches Stadtkataster Baden-Württemberg, vol. 23), Reutlingen 2003, p. 94.

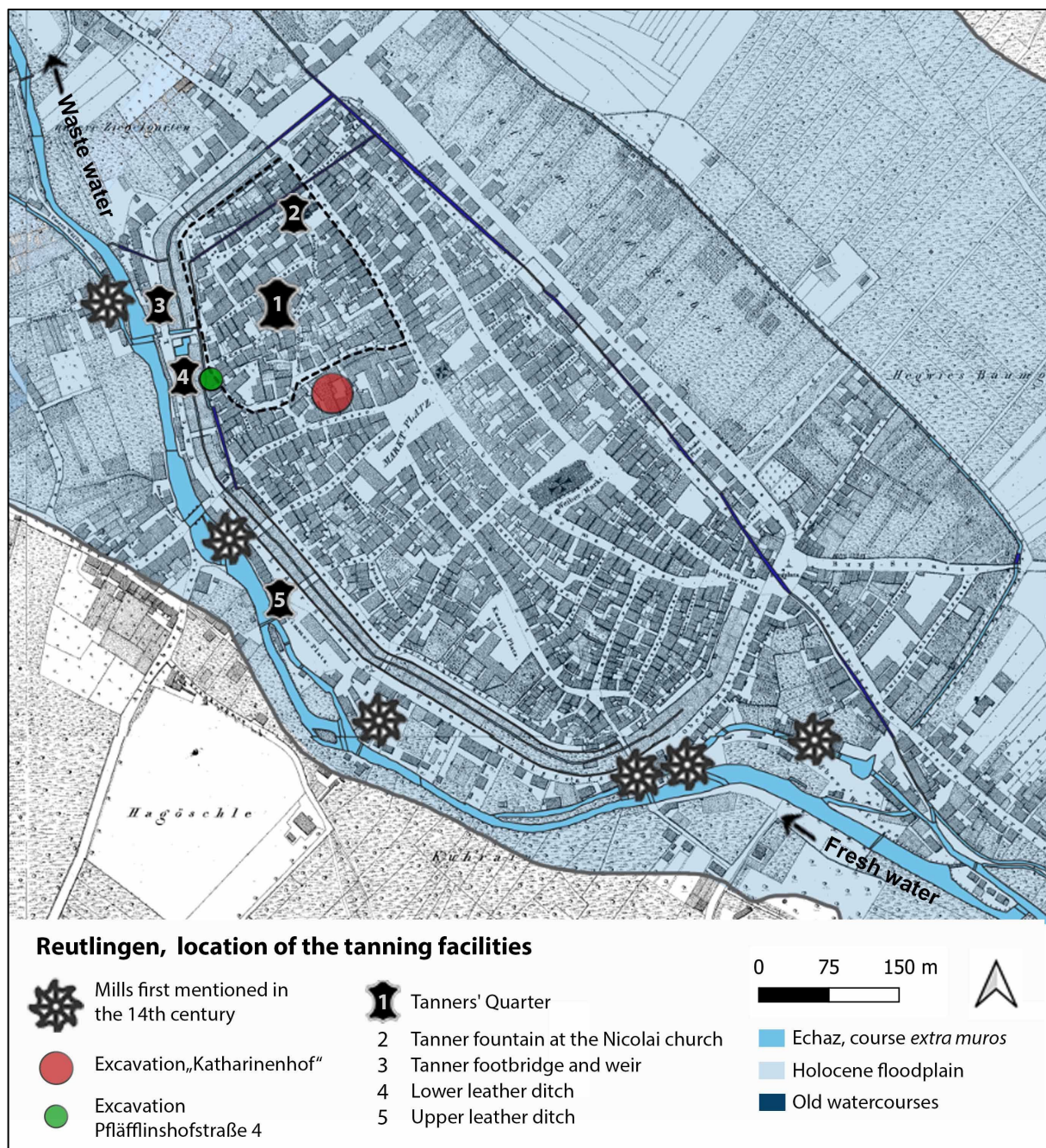


Fig. 1 Reutlingen within the Echazaue with the location of the tanning facility and the excavations mentioned in the text. (Map: Iris Nießen; map basis: Historical cadastral map of Württemberg 1818-1840; Landesamt für Geoinformation und Landentwicklung Baden-Württemberg)

of the Echaz River, which only later developed into a central settlement core. Reutlingen's position within the Echaz floodplain is evident in the geological stratigraphy at the "Katharinenhof" site. Beneath a thick cultural layer dating from the Early to Late Middle Ages, a sequence of talc layers and high flood sediments was found.¹⁷

Only a few archaeological features from the High Middle Ages are known. In the area of the Upper Bollwerk, a cultural layer with post pits was documented, with finds mostly dating to the 11th/12th to early 13th century. Excavations at Oberamteistraße 22 uncovered various pits from the 11th/12th

¹⁷ HARDING: Reutlingen "Katharinenhof" (Note 16), p. 17.

century.¹⁸ Another High Medieval cultural layer, dating from the 11th to early 13th century, was found in the area of the later town wall at Pfäfflinshofstraße 4.¹⁹ At the "Katharinenhof" excavation, four earth cellars or pit houses provide evidence of High Medieval occupation.

However, meaningful archaeological sources regarding the settlement structure of this pre-urban phase are still lacking.²⁰ The few features identified point to post-built and pit house architecture. The location along an imperial road leading from the Neckar through the Echaz Valley to the Swabian Jura favored the development of an urban center.²¹ Reutlingen is first mentioned in written records in the year 1089.²² During the Staufer period, the settlement was endowed with a series of imperial privileges, although the exact date of the granting of market rights remains unclear. The completion of the urbanization process is placed within the reign of Emperor Frederick II.²³ The construction of a town fortification began around 1235, and excavations at Pfäfflinshofstraße 4 indicate that a fortification already existed by the mid-13th century.²⁴ Finds of iron slag dating to before 1300 in the area of the Reutlingen Echaz floodplain²⁵ suggest that the early urban development may have been linked to iron processing, with the ore (Dogger iron) being extracted from the slopes of the valley.²⁶ The Dogger iron ore deposits were likely no longer exploited in the 14th century in favor of other sites along the Kocher and Brenz rivers. Other crafts, such as tanning, as well as the use of hydropower, became increasingly important.²⁷ The steady economic rise of urban crafts found its constitutional expression in the political participation of the guilds from 1343 onward, culminating in the establishment of a sole guild regime in 1374.²⁸

Long-distance trade was conducted only to a limited extent in Reutlingen until the end of the Middle Ages, and the Reutlingen market was primarily frequented by residents of the surrounding villages. Only in certain sectors, such as paper production, which had already begun before 1470, were Reutlingen's enterprises temporarily of supra-regional significance.²⁹ The refinement of raw materials was

¹⁸ SCHNEIDER: Stadtkataster Reutlingen (Note 16), p. 59; Gerhard KITTELBERGER: Fragen zur Frühgeschichte der Stadt Reutlingen, in: Heinz A. GEMEINHARDT/Sönke LORENZ (ed.): Liutold von Achalm (+ 1098), Graf und Klostergründer. Reutlinger Symposium zum 900. Todesjahr, Reutlingen 2000, p. 113-146, here p. 115f; Dorothee ADE-RADEMACHER: Die Grabungen Königsbronner Pflegehof und Oberes Bollwerk. Aussagen zur frühen Geschichte der Stadt Reutlingen, in: Barbara SCHOLKMANN (ed.): Unter Putz und Pflasterstein. Bauforschung und Mittelalterarchäologie in Reutlingen. Zum Beispiel Pfäfflinshofstraße 4. Heimatmuseum Reutlingen, Reutlingen 1999, p. 16-38.

¹⁹ Tilman MARSTALLER: Das Haus Pfäfflinshofstraße 4 – Bauen und Wohnen am Rande der Reutlinger Altstadt, in: SCHOLKMANN (ed.): Unter Putz und Pflasterstein, p. 57-106; Anne KÖPPEN: Zeugnisse des Alltags. Die archäologischen Funde der Pfäfflinshofstraße 4, in: SCHOLKMANN (ed.): Unter Putz und Pflasterstein, p. 111-122.

²⁰ HARDING: Reutlingen "Katharinenhof" (Note 16), p. 21-23.

²¹ KITTELBERGER: Frühgeschichte (Note 18), p. 125f.

²² Mentioned in the Bempflingen contract of 1089, which, however, is only recorded later in the Zwiefalter contract of around 1135; SCHNEIDER: Archäologisches Stadtkataster (Note 16), p. 31-34

²³ Herbert KOPP: Die Anfänge der Stadt Reutlingen. Ein Beitrag zur Stadtopographie, Reutlingen 1962, p. 94f.; Bernd BREYVOGEL: Von den dörflichen Anfängen zur stolzen Reichsstadt. Reutlingen im Mittelalter, in: Wilhelm BORTH/Bernd BREYVOGEL/Wolfgang JUNG (ed.): Reutlingen: Vergangenheit trifft Zukunft. Von der Stadtherlichkeit zur selbstbewussten Großstadt, Reutlingen 2013, p. 17-56, here p. 22f.

²⁴ MARSTALLER: Pfäfflinshofstraße 4 (Note 19), p. 57-106. Weiteres zur Stadtbefestigung, Tilman MARSTALLER: Das Tübinger Tor. Neue Daten zum ältesten Tübinger Stadttor, in: RGB 46 NF (2007), p. 9-56; Linda GAISER: Die Reutlinger Stadtmauer – Schutz, Repräsentation, Ressourcen, in: RGB 55 NF (2016), p. 9-66.

²⁵ Iron slag was found in the Königsbronner Hof, Oberamteistraße 30, Oberes Bollwerk excavations and in the Echazbett in front of the Tübinger Tor, SCHNEIDER: Archäologisches Stadtkataster (Note 16), p. 59.

²⁶ Dorothee ADE-RADEMACHER/Gunter GASSMANN: Eisenschlacken und Ofenreste – Nachweise für Eisenverhüttung in der Stadt?, in: Von Schmieden, Würflern und Schreibern. Städtisches Handwerk im Mittelalter (Almanach 4), Stuttgart 1999, p. 129-137; Gunter GASSMANN: Mittelalterliche Eisenerzverhüttung in und um Reutlingen, in: SCHOLKMANN (ed.): Unter Putz und Pflasterstein, p. 39-46.

²⁷ SCHNEIDER: Archäologisches Stadtkataster (Note 16), p. 59.

²⁸ Roland DEIGENDESCH: Die Reutlinger Friedensordnungen des späten Mittelalters. Aus der Arbeit am Reutlinger Urkundenbuch, in: ZWLG 77 (2018), p. 15-30, here p. 20f.

²⁹ BREYVOGEL: Reutlingen im Mittelalter (Note 23), p. 50; BOELCKE: Wirtschaftsgeschichte (Note 4), p. 201.

one of the defining characteristics of Reutlingen's economic structure. Milling, favored by the natural conditions of the Echaz Valley, was therefore one of the town's central crafts. From the late Middle Ages onward, owning mills became a popular investment opportunity for Reutlingen's upper class, with capital, often derived from mercantile activities, being directed into this sector. By the 16th century, around 25 milling operations existed within the town area.³⁰ The earliest evidence of such use of the Echaz dates back to around 1089.³¹ Among the oldest installations within the Reutlingen town area are four grain mills located along the town fortifications. Notably, all of them were situated in relatively close proximity to the suburban settlement areas.³² During the Staufer period, these mills were part of the imperial estate. After 1235, a close connection was established between the mills and the Achalm, which had been declared an imperial castle. From then on, the milling fees, along with other town lordly rights, belonged to the castle bailiffs.³³ This affiliation was of particular political significance, as the Achalm repeatedly came into the possession of the rival Counts of Württemberg from 1262 onward and was permanently taken over in 1376.³⁴

In the late Middle Ages, the hospital and other municipal care institutions were cornerstones of Reutlingen's economy. Through acquisitions of properties from patrician families and their endowments, these ecclesiastical institutions held not only real estate within the town walls but also extensive estates in the surrounding area and beyond the town's territory. In the 15th century, the hospital took on the function of an early credit institution, which significantly promoted the economic development of the community. By the 16th century, there was a remarkable concentration of private capital in the town, which had by then developed into an important commercial hub in the southwest German region.³⁵

RED TANNERY IN REUTLINGEN

Tanning has a long tradition in Reutlingen. The name "Ledergasse" (Leather Alley) appears as early as the 14th century for the area north of the "Hofstatt" site, indicating an established tanning craft in the district, which remained the town's tannery quarter well into modern times. (Fig. 1) Urbanistically, it is noticeable that the parcel shapes and street layouts are very irregular and therefore may indicate a pre-urban (ownership) structure that had to be taken into account during the town's formation.³⁶ This is suggested by the traces of suburban settlements uncovered in the excavation at the "Katharinenhof." Indeed, rows of posts were documented that aligned with the axis of later buildings.³⁷ Associations of Reutlingen craftsmen have been documented since 1295. In 1297, eight guild masters appear as witnesses in a document issued in the town.³⁸ The Tanners' Guild, first explicitly mentioned in 1320, was one of the oldest corporations in the town. During the late Middle Ages, it developed into the most politically influential guild, reflecting the economic strength of the tanning trade. Around 1430, a total of 64 master tanners were active in the town.³⁹ Several factors were decisive for this. The numerous butcher trades operated in Reutlingen ensured a sufficient supply of livestock from across the

³⁰ BOELCKE: Wirtschaftsgeschichte (Note 4), p. 187f.

³¹ KOPP: Anfänge (Note 23), p. 88f; Der Landkreis Reutlingen, ed. Landesarchivdirektion Baden-Württemberg in Verbindung mit dem Landkreis Reutlingen, vol. 2, Sigmaringen 1997, p. 309; BOELCKE: Wirtschaftsgeschichte (Note 4), p. 184.

³² KITTELBERGER: Frühzeit (Note 18), p. 129.

³³ Hans Martin MAURER: Die Achalm und der mittelalterliche Burgenbau, in: RGB 6 NF (1968), p. 7-24, here p. 12f; KOPP, Anfänge (Note 23), p. 71f.

³⁴ BREYVOGEL: Reutlingen im Mittelalter (Note 23), p. 26f; Dieter MERTENS: Württemberg, in: Meinrad SCHAAB/Hans-martin SCHWARZMAIER (ed.): Handbuch der baden-württembergischen Geschichte: Die Territorien im Alten Reich, vol. 2, Stuttgart 1995, p. 1-163, here p. 18-44.

³⁵ BREYVOGEL: Reutlingen im Mittelalter (Note 23), p. 43-44, 49; BOELCKE: Wirtschaftsgeschichte (Note 4), p. 192f, 199.

³⁶ SCHNEIDER: Archäologisches Stadtkataster (Note 16), p. 66.

³⁷ HARDING: Reutlingen "Katharinenhof" (Note 16), p. 18.

³⁸ DEIGENDESCH: Friedensordnungen (Note 28), p. 20-21.

³⁹ See StadtA Reutlingen A 2c Nr. 2640.



Fig. 2: Historical photos of "Lohschälarbeiten"/tillage work (1976). Left: Worker removes the oak bark from the trunk with a spoon, in the background peeled trunks; Right: Workers lay the peeled bark strips on a drying frame. (Author: Simons, Gabriel; rights management: Landschaftsverband Rheinland; data partner: LVR-Institut für Landeskunde und Regionalgeschichte; license: <http://creativecommons.org/licenses/by/4.0/>; URL: <https://www.deutsche-digitale-bibliothek.de/item/EN26IM3LXN22BFISY-UWWNNGR4M3CTY4W>; <https://www.deutsche-digitale-bibliothek.de/item/WCHYJMDZZMF4JR4WDY522L6EFGUL3VTQ>)

southwest German region and, consequently, an adequate availability of hides for red tanning. Additionally, the Echaz provided the opportunity to operate tanning bark mills, creating a locational advantage because tanning bark could be ground locally. As early as 1320, a tanning bark mill was already in existence, jointly used by guild members.⁴⁰ The smaller number of white tanners settled in the town were also likely able to use a fulling mill for processing hides from the 14th century onward.⁴¹

Red tanning produced durable leather, primarily cowhide, using a vegetable tanning process. For this, mainly oak bark from the tanning forests was used, which contains up to 16% of the tanning agent tannin.⁴² The bark was harvested through a process called "Lohschälen" from young oak trunks, about 15 years old, managed in coppice forestry. The peeling took place in spring and was usually done on young trunks, as the tannin content in the bark of older oaks decreases. Special tools, such as the "Lohlöffel" (bark knives), were used for this purpose. The peeled strips of bark were dried on site and, after transportation to the imperial town, ground into coarse powder at the guild mill. (Fig. 2) The Reutlingen bark mill was located downstream outside the town.⁴³ Since oak bark could only be harvested in the spring, it was necessary to store the bark for the yearly supply. This was usually done collectively in so-called bark barns. For Reutlingen, a drying house (drying barn) is documented for the year 1455, which was collectively owned by the 49 tanning masters.⁴⁴

⁴⁰ Johann SOMMER (ed.): *Aus der Geschichte dreier Gewerbe in Reutlingen. Gerber, Buchdrucker, Stricker, Reutlingen 1952*, p. 12f.

⁴¹ Gerhard FRITZ: *Wasserkraftnutzung im Mittelalter in Südwestdeutschland und angrenzenden Gebieten* (Veröffentlichungen der Kommission für Geschichtliche Landeskunde in Baden-Württemberg, vol. 216), Ostfildern 2024, p. 891.

⁴² CRAMER: *Gerberhaus und Gerberviertel* (Note 15), p. 7.

⁴³ SCHNEIDER: *Stadtkataster Reutlingen* (Note 16), p. 209-210.

⁴⁴ CRAMER: *Gerberhaus und Gerberviertel* (Note 15), p. 89-90.



Fig. 3: Historical photo of the "Gerbersteg" in Reutlingen (1956). (Reutlingen city archive + inventory + consecutive number Ex: S 105/3 Nr. 3689; <https://fotoarchiv.reutlingen.de/viewer/image/964d9a9e-02f3-4f35-a309-542fd1874495/1/>)

The tanning locations were mainly dependent on the availability of "Lohe" (crushed oak bark), as about five times the weight of the hide was required for the tanning process.⁴⁵ Before the hides could be tanned with the crushed "Lohe" in the workshops of the tanning district, they had to be freed from flesh and hair. For this purpose, the water workshop for washing and soaking the hides was essential. In Reutlingen, a communal tanning bridge already existed for this purpose in the late Middle Ages. (Fig. 3) It was first mentioned in writing in 1489, when the paper mill was referred to as „*vnnderhalb dem gerwersteg*“⁴⁶, and remained in operation for the tanneries until 1918. The tanning bridge was a long, open structure towards the Echaz, covered with a wooden roof and a stone rear wall, from which wooden walkways extended into the water.⁴⁷ The hides were hung in the Echaz to be cleaned of dirt, hair, flesh remnants, and preserving salt. To better loosen the hair, the hides were placed in ash pits in the tanning workshops after the first cleaning, where they were soaked in a mixture of water, potash, and lime milk. Other methods to loosen the hair included spraying with urine and hanging them in sweating chambers.⁴⁸ The ash-pit process was archaeologically proven during the excavation at the "Katharinenhof". There, an ash pit from the 16th century was found, as well as another one dated after the town fire of 1726. The older ash pit was about 2.5 m² in size, lined with clay, and contained a wooden tub made of staves, the filling of which included ash and lime. The newer ash pit was significantly larger at 6 m², but inside the clay-sealed pit, three birchwood tubs were placed, reinforced with willow branches, and also contained remnants of the ash-pit process.⁴⁹ (Fig. 4) After the ash-pit

⁴⁵ Klaus SCHLOTTAU: Von der handwerklichen Lohgerberei zur Lederfabrik des 19. Jahrhunderts (Sozialwissenschaftliche Studien, vol. 29), Opladen 1993, p. 54.

⁴⁶ StadtA RT: Urbare, vol. 189,9^a aus Schneider, Stadtkataster Reutlingen (Note 16), p. 211.

⁴⁷ SCHNEIDER: Stadtkataster Reutlingen (Note 16), p. 211.

⁴⁸ CRAMER: Gerberhaus und Gerberviertel (Note 15), p. 16-18.

⁴⁹ HARDING: Reutlingen "Katharinenhof" (Note 16), p. 35-36.

process, the hides were de-haired on the tanning frame and cleaned again in the river. The actual tanning process took place inside the workshops in the tanning district. For this, the hides were soaked in vats together with the "Lohe." Depending on the desired thickness and quality, this process could take one to three years.⁵⁰ A tanning pit from the 15th to 16th century was also uncovered during the excavation at the "Katharinenhof." The rectangular pit, measuring 6 m², was sealed with clay and only contained a rectangular depression inside, which could have come from a wooden vat.⁵¹ Large quantities of horn cores from cattle and goats found during the excavation are also evidence of the tanning craft, as the hides were typically delivered to the tanners along with the skulls.⁵²

For the ash-pit and tanning processes, the craftsmen required clean water at the workshops. In Reutlingen, this was provided by a town stream system. A canal was diverted from the Echaz above the town, which possibly followed the course of the present-day Metzgergasse. This is suggested not only by the width of the Metzgergasse but also by the mention of a building of the Zwiefaltener Pflegehof „an der Echaz“ in 1426.⁵³ Apparently, various small branches of the canal ran through the streets towards the Echaz.⁵⁴ In 1963, a section of such a town stream, with a width of about 0.6 m and a depth of 0.45 m, was excavated in the area of Katharinenstraße.⁵⁵ After tanning, the "Lohe" was pressed into "Lohkuchen" (bark cakes) and dried on "Lohkäseständern" (bark cheese racks). These were sold as fertilizer and fuel.⁵⁶ In addition, the "Lohe" was used as insulation material, and by the end of the 14th century, the vaulted ceilings of the Stralsund Town Hall were insulated with a total of 170 m³ of used tannery bark.⁵⁷

To better assess the raw material requirements for oak bark, a calculation of the material flows can be made. This should be understood as a rough estimate, as several assumptions are necessary. In 1430, 64 red tanners are recorded in Reutlingen⁵⁸, which suggests a total of 64 workshops in the town. Unfortunately, there is no specific information on the production volume of these workshops. It can be assumed that each of these workshops had at least one tanning pit. These could vary in size, so for the calculation⁵⁹, an average size of about 2 m² and a depth of approximately 1.5 m (3 m³) is assumed. The

⁵⁰ CRAMER: Gerberhaus und Gerberviertel (Note 15), p. 20.

⁵¹ HARDING: Reutlingen "Katharinenhof" (Note 16), p. 35.

⁵² HARDING: Reutlingen "Katharinenhof" (Note 16), p. 40-41. Further horn cone finds: Monika DOLL: Tierknochen als Zeugnisse mittelalterlicher Gerberei in Reutlingen, in: SCHOLKMANN (ed.): Unter Putz und Pflasterstein, p. 123-125.

⁵³ SCHNEIDER: Stadtkataster Reutlingen (Note 16), p. 61-62.

⁵⁴ „Die Echaz, wenn mans haben will, durch d'gantze statt kann laufen vill, in alle gaßen, wünckel und bügel“, Chron Frischlin, 199 aus SCHNEIDER: Stadtkataster Reutlingen (Note 16), p. 68.

⁵⁵ SCHNEIDER: Stadtkataster Reutlingen (Note 16), Fundstelle 70, p. 123.

⁵⁶ CRAMER: Gerberhaus und Gerberviertel (Note 15), p. 34-36.

⁵⁷ Jörg ANSORGE/Susann STOLZE/Julian WIETHOLD: Gerberlohe als Bau- und Dämmmaterial im mittelalterlichen Stralsunder Rathaus - eine interdisziplinäre Studie (Archäologische Berichte aus Mecklenburg-Vorpommern, vol. 10), 2003, p. 268-283.

⁵⁸ See Note 39.

⁵⁹ The calculation of the annual requirement of "Lohe" and the trees required for the 64 tanneries in Reutlingen is based on the following assumptions: Each tanning pit has an area of 2 m² and a depth of 1.5 m. This results in a volume of 3 m³ per pit ($V = 2 \text{ m}^2 \times 1.5 \text{ m} = 3 \text{ m}^3$). Over the course of the year, five times the amount of "Lohe" in relation to the weight of hide used is required for tanning (ratio 5:1 in relation to weight). The tanning process takes place over the course of a year, during which each pit is turned four times and the "Lohe" is completely replaced each time. The total amount of tannin is therefore distributed over four fillings. As the ratio of 5:1 refers to the entire year, only a quarter of the total amount of "Lohe" is used per filling. Accordingly, the ratio of "Lohe" to skin per filling is 1.25:1 by weight ($5 \div 4 = 1.25$). To calculate the volume proportions, the different densities of "Lohe" and hide must be taken into account. The density of "Lohe" is about 200 kg/m³, that of tanned or wet hide about 960 kg/m³. In order to calculate the volume ratio correctly, 1 kg of hide is assumed, for which 1.25 kg of "Lohe" is required. This results in a volume of 0.00104 m³ ($1 \text{ kg} \div 960 \text{ kg/m}^3$) for 1 kg of hide and a volume of 0.00625 m³ ($1.25 \text{ kg} \div 200 \text{ kg/m}^3$) for 1.25 kg of "Lohe". The total volume of this unit is therefore 0.00729 m³. Based on the pit volume of 3 m³, 411.36 such units can be accommodated per filling. This means that around 411.4 kg of hide and 514.2 kg of "Lohe" are used per pit ($411.36 \times 1 \text{ kg hide and } 411.36 \times 1.25 \text{ kg "Lohe"}$). The



Fig. 4: Exposed ashing pits, excavation "Katharinenhof" (Reutlingen) in 2018 (© Landesamt für Denkmalpflege im Regierungspräsidium Stuttgart/ArchaeoConnect)

actual tanning process took place in the pits, where a mixture of animal hides and ground oak bark was layered into the pit. It took about a year until the hides were fully tanned. The "Lohe" had to be changed every three months. During this process, the pit was emptied and refilled with fresh "Lohe." To ensure smooth operations, $\frac{1}{4}$ of the pit was restocked with fresh hides, so that with every turnover of the pit, $\frac{1}{4}$ of its contents could be processed into leather.⁶⁰ In total, five times the weight of the hide was required for the tanning process.⁶¹ By calculating the pit volume and the required amount of dried bark, the annual demand for 64 workshops (with one pit per workshop) is about 131.6 tons of bark, assuming full capacity of the tanning pits, with which 26.33 tons of raw hides could be tanned. This corresponds to an annual tanning of about 411.4 kg of raw hides per workshop, which were dried before tanning. Assuming 20 kg per dried cattle hide, this results in about 20.57 hides processed per tanning pit

hide remains in the pit throughout the year, while the "Lohe" is replaced four times a year. This results in an annual hide requirement of only 411.4 kg, but a quadruple "Lohe" requirement of $4 \times 514.2 \text{ kg} = 2,056.8 \text{ kg}$ per pit and year. For a tannery with one pit, this results in an annual requirement of 2,056.8 kg of "Lohe". Multiplied by the total number of 64 workshops, this results in a total annual requirement of 131.6 tons ($64 \times 2,056.8 \text{ kg}$). To cover this "Lohe" requirement, it was assumed that a 15-year-old oak tree yields around 12.5 kg of dry "Lohe". Such a tree provides around 22.5 kg to 30 kg of fresh bark (1.5 to 2 kg per year). During drying, the bark loses about 50 % of its weight. This results in a dried quantity of bark of $22.5 \text{ kg} \times 0.5 = 11.25 \text{ kg}$ to $30 \text{ kg} \times 0.5 = 15 \text{ kg}$, i.e. an average of 12.5 kg of bark per tree per year. This results in a requirement of 10,531 trees per year for one tanning pit per workshop ($131,635.2 \text{ kg} \div 12.5 \text{ kg/tree} = 10,530.816 \approx 10,531 \text{ trees}$). These calculations are based on rough estimates.

⁶⁰ SCHLOTTAU: Von der handwerklichen Lohgerberei zur Lederfabrik (Note 45), p. 84-85.

⁶¹ SCHLOTTAU: Von der handwerklichen Lohgerberei zur Lederfabrik (Note 45), p. 54. CRAMER schreibt, dass „zur Herstellung eines Zentners lohgeren Leders vier bis fünf Zentner Lohe notwendig sind“, CRAMER: Gerberhaus und Gerberviertel (Note 15), p. 46.

annually. Klaus Schlottau also describes larger tanning pits being stocked with a total of 100 hides.⁶² For this, a tanning pit with a volume of about 14.6 m³ would be required.⁶³

A 15-year-old tree provides about 12.5 kg of dried bark (oak bark). To supply the large amounts of bark needed for the tanners in Reutlingen, between 10,531 (one pit per workshop) and 21,062 trees (two pits per workshop) would have been required annually. If 100 hides were processed annually per workshop, the demand would rise to 51,200 trees. While these calculations are only rough estimates, they highlight the significant resource requirements of the tanning workshops in Reutlingen and the potential impacts on the surrounding forests. It is no coincidence that centers for red tanning generally developed near larger oak forests.⁶⁴ Due to the scarcity of the raw material, the cooperative organization of bark forests can be found since the 14th century, also in Württemberg and Baden. This system stipulated that 1/16 of the bark forest be felled annually, ensuring that all areas had the optimal growth period of oak trees, from 15 to 16 years.⁶⁵

RAW MATERIAL SOURCES AND TERRITORIALIZATION IN THE 14th CENTURY

The location of Reutlingen posed a structural disadvantage for local crafts, such as tanning. The town's territory was almost entirely located within the floodplain of the Echaz, which made it geographically limited and left it behind much smaller towns in the surrounding area in this regard. There was no significant imperial city forest ownership – a fate shared by Reutlingen with several other imperial towns, such as Regensburg or Schwäbisch Hall.⁶⁶ The enormous wood demand, as a material for crafts, construction material for residential houses, town buildings, and mills, as well as fuel for heating, could not be met from its own resources.⁶⁷

Northwest of the town, beyond the Neckar, lay the vast imperial forest of Schönbuch, which had been under the rule of the Counts Palatine of Tübingen since the mid-12th century.⁶⁸ (Fig. 5) It is unclear when the citizens of Reutlingen first exercised usage rights beyond their own territory in the form of a „Fernallmende“⁶⁹ (distant common land), although they may have had such rights as early as the 13th century. In 1304, Count Palatine Rudolf II of Tübingen assured the towns of Esslingen, Reutlingen, and

⁶² SCHLOTTAU: Von der handwerklichen Lohgerberei zur Lederfabrik (Note 45), p. 84.

⁶³ Based on the calculations explained above, 2,500 kg of "Lohe" is required to tan 100 hides with a total weight of 2,000 kg per filling, as the ratio of "Lohe" to hide is 1.25:1. With a density of 960 kg/m³ for hide and 200 kg/m³ for "Lohe", this results in a total volume of around 14.6 m³ for a complete pit filling. This corresponds, for example, to a base area of 2.7 × 2.7 m at a depth of 2 m.

⁶⁴ CRAMER: Gerberhaus und Gerberviertel (Note 15), p. 46-56.

⁶⁵ CRAMER: Gerberhaus und Gerberviertel (Note 15), p. 88.

⁶⁶ Paul SCHWARZ: Die Grundherrschaft der ehemaligen Freien Reichsstadt Reutlingen von der Gründung der Stadt bis zur Reformation, Dissertation Universität Tübingen 1953, p. 30; DERS.: Die Schönbuchgerechtigkeit der Reichsstadt Reutlingen, in: Hermann GREES (ed.): Der Schönbuch. Beiträge zu seiner landeskundlichen Erforschung (Veröffentlichung des Alemannischen Instituts, vol. 27), Buhl 1969, p. 65-90, here p. 68; KNOLL: Brennholzversorgung (Note 14), p. 199; Rudolf KIESS: Der Wald als Lebensgrundlage. Waldbesitz und Waldnutzung vom 14. bis ins 18. Jahrhundert, in: Ingrid GAMER-WALLERT (ed.): Der Schönbuch. Mensch und Wald in Geschichte und Gegenwart, Tübingen 1999, p. 105-121, here p. 92-93.

⁶⁷ Sabine HOLTZ: Waldnutzung, Forstordnung und Forstkultur. Der Wald um 1500 in landesgeschichtlicher Perspektive, in: Daniela BOHDE/Astrid ZENKERT (ed.): Der Wald in der Frühen Neuzeit zwischen Erfahrung und Erfindung. Naturästhetik und Naturnutzung in transdisziplinärer Perspektive, Köln 2024, p. 197-218, here p. 198; R. Johanna REGNATH: Energie – Werkstoffe – Nahrung. Wald als zentrale Rohstoffquelle der Frühen Neuzeit anhand südwestdeutscher Quellen, in: Sigrid HIRBODIAN/Tabea SCHEIBLE (ed.): Mensch und Wald seit dem Mittelalter. Lebensgrundlage zwischen Furcht und Faszination (Schriften zur südwestdeutschen Landeskunde, vol. 87), Ostfildern 2024, p. 77-96, here p. 78f.

⁶⁸ Rudolf KIESS: Die Rolle der Forsten im Aufbau des württembergischen Territoriums bis ins 16. Jahrhundert (Veröffentlichungen der Kommission für Geschichtliche Landeskunde in Baden-Württemberg, vol. 2), Stuttgart 1958, p. 44.

⁶⁹ KIESS: Wald als Lebensgrundlage (Note 66), p. 117.

Rottenburg that the forest would not be sold in the future.⁷⁰ In 1310, the citizens of Reutlingen succeeded in concluding a contract with significant economic importance. In exchange for a payment of 740 pounds of Heller, they acquired extensive rights to use the Schönbuch forest. These rights included not only the extraction of building timber but also numerous other forms of use, which were detailed in the contract.⁷¹ With the conclusion of the contract, Reutlingen became part of the Schönbuch co-operative. This included not only towns, such as Tübingen, and the Bebenhausen monastery, but also villages, individual farms, and mills, totaling around 100 beneficiaries.⁷²

The involvement of the Reutlingen tanners in the shaping of the Schönbuch rights is evident from Article 22, which stipulated a fee of 3 Heller for transporting a cartload of oak bark.⁷³ The tanning craft is not explicitly mentioned in the contract text, but clear representation of its interests can be discerned. The rents negotiated with the Counts Palatine were very favorable for the imperial towns, although higher than the rates in the town of Tübingen.⁷⁴ Thus, the cartwrights had to pay 4 Heller for each day that wood was felled. Firewood could be transported to Reutlingen by cart for 3 Shilling Heller or by wagon for 6 Shilling Heller.⁷⁵ It is noteworthy that the Schönbuch rights included provisions aimed at protecting the stock, known as the "rechte Hau". For firewood, as well as for purposes of charcoal production and the removal of young shoots – i.e., for particularly wood-intensive uses – the felling of oaks, beeches, and all fruit-bearing trees was prohibited.⁷⁶

A central aspect of raw material procurement, especially when the source was located at some distance from the settlement, was transportation in pre-industrial times. When studying material flows and metabolic processes, these factors must be considered, as they can define the framework for the availability of raw materials.⁷⁷ In the Schönbuch, a network of roads apparently already existed by 1310, for which the citizens of Reutlingen were allowed to take wood free of charge for repairs. However, transporting wood deliveries across the Neckar required longer distances. In the Schönbuch rights, the citizens of Reutlingen secured the right to obtain free wood for the construction and maintenance of a bridge to facilitate crossing the river. This bridge was also located outside the Reutlingen territory, near Pliezhausen, making the areas of the Schönbuch along the Neckar conveniently accessible.⁷⁸ The citizens of Reutlingen were granted the right to collect a bridge toll, with the exception of the servants of the Counts Palatine and the Bebenhausen Monastery.⁷⁹

Part of Reutlingen's plans was to eventually acquire the parts of the Schönbuch that were temporarily granted for use. The chronic financial struggles of the Counts Palatine of Tübingen seemingly provided an opportunity, and based on the success of the negotiations in 1310, the town was at times in a promising position. However, it was by no means without competition. The imperial town of Esslingen

⁷⁰ SCHWARZ: Schönbuchgerechtigkeit (Note 66), p. 65.

⁷¹ Peter MAIER/Andreas HEUSEL: Schönbuchrechte und Gemeindewald, in: DIES. (ed.): Kirchentellinsfurt. Chronik eines Dorfes, Kirchentellinsfurt 2007, p. 431-441, here p. 432.

⁷² Peter RÜCKERT: Wald und Herrschaft im späteren Mittelalter, in: Sigrid HIRBODIAN/Tabea SCHEIBLE (ed.): Mensch und Wald, p. 57-76, here p. 72.

⁷³ See StadtA Reutlingen U 2253. Transcription at SCHWARZ: Schönbuchgerechtigkeit (Note 66), p. 65-68.

⁷⁴ Rudolf KIESS: Bemerkungen zur Holzversorgung von Städten, in: Jürgen SYDOW (ed.): Städtische Versorgung und Entsorgung im Wandel der Geschichte (Veröffentlichungen des Südwestdeutschen Arbeitskreises für Stadtgeschichtsforschung, vol. 8), Sigmaringen 1981, p. 77-98, here p. 94.

⁷⁵ See Note 73.

⁷⁶ MAIER/HEUSEL: Schönbuchrechte und Gemeindewald (Note 71), p. 432.

⁷⁷ KNOLL: Brennholzversorgung (Note 14), p. 191-192.

⁷⁸ Herbert SCHEURER: Die Zollpolitik der Herzöge von Württemberg, in: RGB 3 NF (1966), p. 7-45, here p. 35f.

⁷⁹ SCHWARZ: Schönbuchgerechtigkeit (Note 66), p. 74-75.

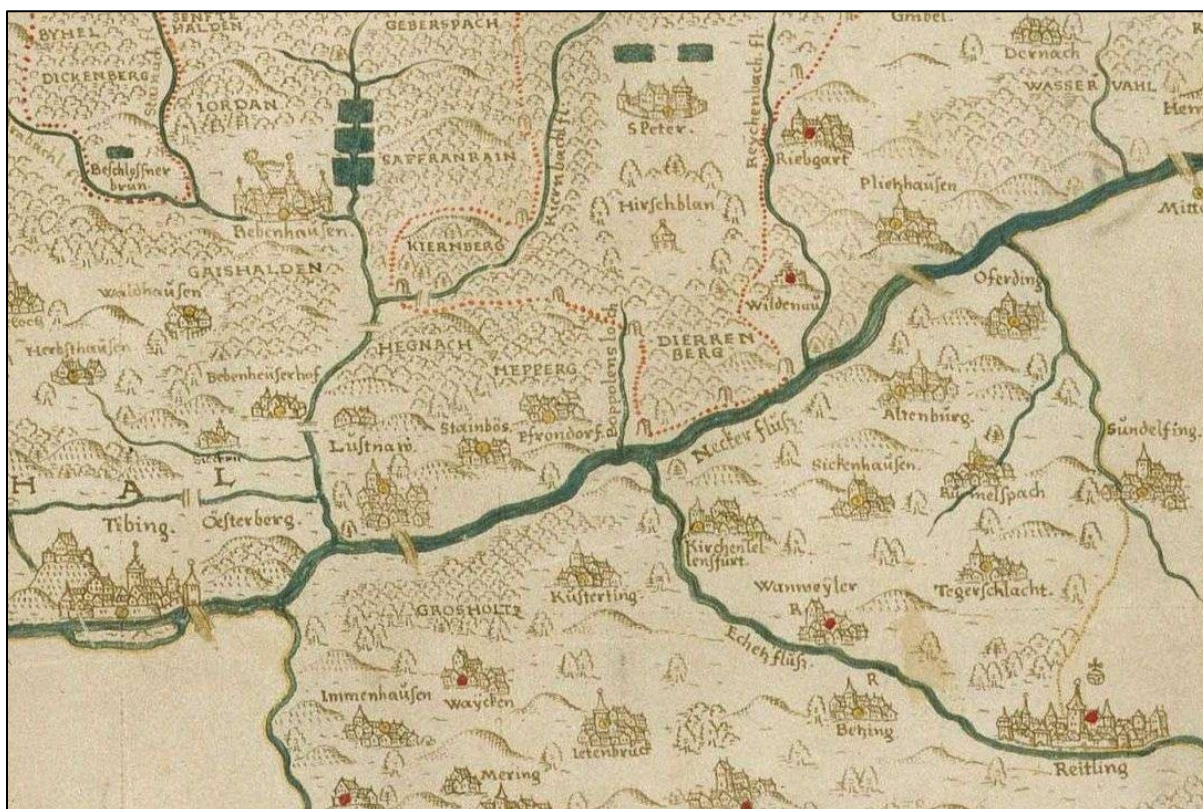


Fig. 5: The Echaz valley on a section of the Tübingen forest map by G. Gadner (1592). Northwest of the imperial town of Reutlingen, on the other side of the Neckar, were the areas in Schönbuch that had been authorized for timber extraction since 1310. (Landesarchiv Baden-Württemberg, Abt. Hauptstaatsarchiv Stuttgart, N 3 Nr. 1/16; https://www2.landesarchiv-bw.de/ofs21/bild_zoom/zoom.php?bestand=6643&id=3788976&qeloschtes-Bild=01_0001388881_0001_1-1388881-1.jpg)

and the region's most powerful authority, the County of Württemberg, were also interested in acquiring the Schönbuch, which, apart from being a hunting ground, was also attractive as an economic asset.⁸⁰ In 1342, the Württemberger succeeded in acquiring the town and castle of Tübingen, and between 1348 and 1382, they acquired the entire Schönbuch.⁸¹ At this point, an agreement made in 1310 came into effect, stipulating that Reutlingen's usage rights would remain intact even in the event of a transfer of ownership. Therefore, the question of Reutlingen's usage rights at the time of the Schönbuch's transition to Württemberg apparently was not up for debate.⁸²

From Reutlingen's perspective, these events likely caused significant concern. Not only were plans for territorial expansion in the Schönbuch and the territory of the Counts Palatine rendered obsolete, but the Württemberg counts could now also control the most important competitors of the imperial town regarding its wood supply. This marked another step in the steadily increasing encirclement of Reutlingen by the County of Württemberg. In 1261, the County of Urach, bordering the Echaz Valley to the east, had been acquired by the Württembergers, followed in the 14th century by Gönningen and the nearby town of Eningen. In the Echaz Valley, the counts seemingly succeeded in integrating free noble and lower noble families, such as the Lords of Greifenstein and Lichtenstein, whose estates, along with associated rights in Honau, Oberhausen, Unterhausen, and Pfullingen, were eventually entirely transferred to Württemberg. In Pfullingen, the Württembergers temporarily held lordly rights as part of the

⁸⁰ KIESS: Rolle der Forsten (Note 68), p. 47.

⁸¹ MAIER/HEUSEL: Schönbuchrechte und Gemeindewald (Note 71), p. 433.

⁸² SCHWARZ: Schönbuchgerechtigkeit (Note 66), p. 68-69.

Achalm Castle possessions.⁸³ Not only on Reutlingen, but also on other imperial towns in the region, the counts' legal claims extended in their capacity as Imperial Landvogts for Swabia (Reichslandvögte für Niederschwaben).⁸⁴ Their dominance in the Swabian region was periodically supported by the emperor, enabling the Württembergers to pursue an expansive territorial policy. Their access to the increasingly powerful imperial towns within their sphere of influence, including Reutlingen, as well as Heilbronn and Esslingen, was primarily motivated by economic interests.⁸⁵ There was also the problem of Württemberg subordinates moving to the urban centers.⁸⁶

This situation was repeatedly the cause of conflicts throughout the 14th century, some of which were also fought with military means. For example, a Reutlingen advance into the upper Echaz Valley, during the period surrounding the "Städtekrieg" (War of the Towns) in 1311, was initially successful. Both Pfullingen, which at the time may still have been a competitor for the status of a central settlement, and a number of castles were destroyed by the town's forces. However, the position achieved was not permanent and could not be maintained beyond the peace settlement.⁸⁷ At the height of the conflict, shortly after the counts successfully retook the Achalm, the Battle of Reutlingen took place on May 14, 1377, ending in a significant defeat for Württemberg. However, in the First War of the Towns, the Swabian imperial towns, which had formed an alliance, were defeated by the local lords at the Battle of Döffingen in 1388.⁸⁸

The contractual reconciliation of 1389 again involved Reutlingen's withdrawal from the upper Echaz Valley, but in return, they were once again allowed to cut wood in the Schönbuch, which had been prohibited during the hostilities. It was also granted that the Reutlingers could continue to drive their pigs into the forest.⁸⁹ Fattening pigs in autumn forests was common practice because feeding them with acorns and beechnuts, which were rich in nutrients, made it possible to provide the animals with sufficient food without having to resort to foodstuffs that were needed to feed the population.⁹⁰ The failed acquisition strategy, particularly with regard to access to raw materials in the surrounding area, left the town in an isolated position and dependent on Württemberg, which was to have an impact on the movement of goods and material flows until the end of the early modern period. From the middle of the 15th century, Reutlingen was almost completely surrounded by Württemberg territory as a result of further acquisitions to the north-west of the town.⁹¹

RENEGOTIATION OF TIMBER RIGHTS IN THE 15th AND 16th CENTURIES

The competition between Reutlingen and Württemberg was also evident in the use of the Schönbuch. Disagreements between the Tübingen forest bailiff based in Waldenbuch on the one hand and farmers living on farms in Reutlingen and the townspeople on the other have been handed down in part. Frequent points of contention were logging practices and various taxes and fees. It is possible that as early as 1443 a restriction was placed on the areas of the forest that could be cleared for logging, as indicated by a boundary stone in the area of the forest closest to Reutlingen. The agreements made at the time

⁸³ SCHWARZ: Grundherrschaft (Note 66), Sp 7, 15; Wilhelm KINKELIN: Das Pfullinger Heimatbuch, Neuauflage des 1937 ersch. Werks, Reutlingen 1956, p. 158; Carl C. GRATIANUS: Geschichte der Achalm und der Stadt Reutlingen in ihrer Verbindung mit der vaterländischen Geschichte, vol. 1, Tübingen 1831, p. 239f.

⁸⁴ MERTENS: Württemberg (Note 34), p. 23, 33f, 40f.

⁸⁵ Roland DEIGENDESCH: Die Schlacht bei Reutlingen 1377. Geschichte – Wirkung – Erinnerung, in: DERS./Christian JÖRG (ed.): Städtebünde und städtische Außenpolitik. Träger, Instrumentarien und Konflikte während des hohen und späten Mittelalters (Stadt in der Geschichte, vol. 44), Ostfildern 2019, p. 19-46, here p. 21.

⁸⁶ Peter RÜCKERT: Die Grafen von Württemberg, die schwäbischen Reichsstädte und Kaiser Karl IV. in Konflikt und Kooperation, in: Roland DEIGENDESCH/Christian JÖRG (ed.): Städtebünde und städtische Außenpolitik, p. 103-124, here p. 105f.

⁸⁷ SCHWARZ: Grundherrschaft (Note 66), p. 9.

⁸⁸ DEIGENDESCH: Die Schlacht bei Reutlingen 1377 (Note 85), passim.

⁸⁹ SCHWARZ: Grundherrschaft (Note 66), p. 14.

⁹⁰ REGNATH: Wald als zentrale Rohstoffquelle (Note 67), p. 87.

⁹¹ Cf. SCHWARZ: Grundherrschaft (Note 66), p. 14; BREYVOGEL: Reutlingen im Mittelalter (Note 23), p. 43f.

with the Counts Palatine regarding timber extraction were also put up for discussion. In 1466, the Ulm Council decided in this matter that the provisions of the Schönbuchgerechtigkeit treaty should remain in place.⁹²

Under Count Eberhard V (reigned 1457-1496, from 1495 Duke Eberhard I), Württemberg's strategy therefore shifted to ousting the Reutlingers from the forest. Around 1483, the reversion of Schönbuch justice was claimed as a result of an oath of fealty that had not been fulfilled and a corresponding complaint was submitted to the emperor. Once again, external authorities were called in to arbitrate. In 1485, Margrave Albrecht of Brandenburg invited both parties to a conference in Onolzbach. The Reutlingen legation argued that the transfer of the Schönbuch rights was by no means a fief and therefore not a good deed on the part of the Count Palatine. Rather, the rights of use had been acquired by purchase, whereby the Count Palatine had also gained an economic advantage from the transaction. This was supported by the fact that the transfer was not accompanied by any official obligations or a binding confirmation by a new lord. The margrave evidently considered this argument to be valid, and a second day of hearings originally scheduled was therefore no longer held. An agreement from 1487 on the use of paths proves that the Reutlingeners were still able to make extensive use of the Schönbuch.⁹³

In the 16th century, disadvantageous changes set in for Reutlingen, which were related to the generally increasing sovereign control over the forests. Rudolf Kies assumes that as early as the 15th century, the Württembergers claimed a supervisory function on the basis of their game ban, even over forests that did not belong to their own domain. In his opinion, game ban districts formed the basis for the creation of sovereign forests, whose designation was based on the older royal forests. Kies points out that the Schönbuch, which was actually an imperial forest, has only been referred to as a forest since the 15th century.⁹⁴

The manorial forests reveal a two-tier legal structure: On the one hand, they consisted of a sovereign district, which was based on the hunting rights from the game ban, and on the other hand, of a utilization district, which was assigned to the manorial estates, yielded economic income and was provided with administrative structures.⁹⁵ Forests therefore played a central role in the process of territorialization. Their clearly defined, linear boundaries enabled the precise application of forest sovereignty to certain areas and thus contributed to the consolidation of sovereign rule.⁹⁶ The Schönbuch was part of the Tübingen forest, the extent of which went back to the game ban of the counts palatine and also included the small territory of Reutlingen in the Echaz valley.⁹⁷

As early as the end of the 15th century, timber extraction as a central element of resource management had increasingly become the focus of official measures. Provisions similar to those in the Schönbuchgerechtigkeit of 1310 were gradually introduced for other forests. The first Württemberg state ordinance of 1495 contained regulations for the entire duchy, which were justified by a general shortage of timber and firewood and stipulated an orientation towards the common good. The intention here was certainly to increase revenue, but it can also be assumed that there was considerable pressure to use the forests at this time.⁹⁸

⁹² MAIER/HEUSEL: Schönbuchrechte und Gemeindewald (Note 71), p. 433-434; REGNATH: Wald als zentrale Rohstoffquelle (Note 67), p. 90f; SCHWARZ: Schönbuchgerechtigkeit (Note 66), p. 69.

⁹³ SCHWARZ: Schönbuchgerechtigkeit (Note 66), p. 69-70.

⁹⁴ KIESS: Rolle der Forsten (Note 68), p. 121f.

⁹⁵ KIESS: Rolle der Forsten (Note 68), p. 133.

⁹⁶ RÜCKERT: Wald und Herrschaft (Note 72), p. 73.

⁹⁷ KIESS: Rolle der Forsten (Note 68), p. 48.

⁹⁸ Dorothea HAUFF: Zur Geschichte der Forstgesetzgebung und Forstorganisation des Herzogtums Württemberg im 16. Jahrhundert (Schriftenreihe der Landesforstverwaltung Baden-Württemberg, vol. 47), Stuttgart 1977, p. 11f, 14f.

The stipulations in the state ordinance were to apply in principle to those forests within the forest districts that were not owned by the dukes, including communal forests.⁹⁹ Organizationally, compliance with these regulations was integrated into the area of competence of the forest administrations. However, they represented new types of intervention that were not derived from the older sovereign rights, which primarily related to hunting and hunting rights. On this basis, the forestry officials were able to enforce restrictions in the interests of the sovereign, although this was generally only successful in relation to their own subjects.¹⁰⁰ Soon after the restrictions on use were introduced, they became the subject of demands during the social unrest of the 16th century, above all the Poor Conrad's uprising (Aufstand des Armen Konrad) in Württemberg in 1514 and the Peasants' War of 1525. Despite some concessions following these conflicts, the supply of wood has since been much more difficult than in the late Middle Ages.¹⁰¹

The first genuine forestry regulations, which explicitly applied to all forests in the duchy, were issued in 1532 under the Habsburg governorship (1520-1534), but have not survived directly. The first printed regulations of Duke Ulrich (reigned 1498-1519, 1534-1550) date from 1540. Extensive additions were made in 1552 under Duke Christoph (reigned 1550-1568).¹⁰² In this version, a further expansion of the area of validity is recognizable, which now also extended to forests owned by monasteries and so-called umbrella relatives (Schirmsverwandte).¹⁰³ The imperial town of Reutlingen had already concluded a patronage treaty with the duchy in 1505, which, in addition to military agreements, also contained economic and legal provisions that were interpreted in Württemberg's favor. In its function, the patronage represented a successor institution to the Achalm rights and the powers that the Württembergers had exercised as imperial bailiffs in the late Middle Ages.¹⁰⁴ However, these rights of access were no longer based on an imperial enfeoffment, but on a bilateral agreement between the town and the duchy.

As far as the Reutlinger's access to Schönbuch was concerned, it was of course not necessary to access forests outside of the manor. In view of the comprehensive forestry regulation under Duke Christoph, it is not surprising that Schönbuch justice was once again up for discussion from 1554. The events were essentially similar to those of the 1480s, which applied both to the Württemberg accusation of a failure to take an oath and to the imperial town's defense strategy. The essential difference was that, against the background of the umbrella treaty, negotiations were exclusively bilateral and no arbitrating third party was involved, although the Reutlingeners had at times threatened to take the matter to the Imperial Chamber Court. Under the given circumstances, the town was forced to give in. In 1555, the municipality of Reutlingen received the "Schönbuchgerechtigkeit" by force in the form of a fief transfer.¹⁰⁵

Reports by the Tübingen forest bailiff from the second half of the 16th century indicate that the Schönbuch was in a poor state of conservation. The repeated republication of Schönbuch orders suggests that the countermeasures taken were only effective to a limited extent.¹⁰⁶ Once again, the people of Reutlingen were also affected: In the Tübingen decree of 1583, the areas permitted for use were moved significantly to the north-west, increasing the distance by several hours. It is not clear from the town's chronicles whether this shifted the flow of materials, but it is possible that firewood was obtained elsewhere.¹⁰⁷ It is striking that Reutlingen institutions, including the tanners' guild, acquired

⁹⁹ RÜCKERT: Wald und Herrschaft (Note 72), p. 72f; REGNATH: Wald als zentrale Rohstoffquelle (Note 67), p. 78f, 91.

¹⁰⁰ KIESS: Rolle der Forsten (Note 68), p. 139f.

¹⁰¹ REGNATH: Wald als zentrale Rohstoffquelle (Note 67), p. 91.

¹⁰² Cf. HAUFF: Forstgesetzgebung (Note 98), p. 28f, 34f.

¹⁰³ HAUFF: Forstgesetzgebung (Note 98), p. 45f.

¹⁰⁴ Herbert SCHEURER: Die Schirmverträge zwischen Reutlingen und Württemberg, in: RGB 2 NF (1965), p. 7-46, here p. 7f.

¹⁰⁵ SCHWARZ: Schönbuchgerechtigkeit (Note 66), p. 71.

¹⁰⁶ HAUFF: Forstgesetzgebung (Note 98), p. 66.

¹⁰⁷ Cf. SCHWARZ: Schönbuchgerechtigkeit (Note 66), p. 71f.

forests in Pfullingen in the 16th century.¹⁰⁸ Attempts by Württemberg to oust the Reutlingeners from the Schönbuch continued well into the 18th century. They were not finally replaced until 1830.¹⁰⁹

RESUME

The developments around the Schönbuch illustrate that, in addition to the raw material of wood, legal sovereignty over the forests was also a central resource for the Württemberg sovereigns. On this basis, decrees could be issued which served to territorialize the land on the one hand and which could be used to impose rule over subjects and third parties on the other. With regard to the wood procurement of the imperial town of Reutlingen, this possibility of access was based on long-standing path dependencies within the town's economic structure, which required a constant supply of raw materials from the surrounding area as well as a functioning trade in processed products. For the Reutlingen tannery, timber for the guild's own tannery mill, oak bark for tanner's dye and animal hides were central resources on whose sufficient availability not only the economic but also the social position of the tanners within the imperial town governed by the guilds was based. In the course of Württemberg's territorial expansion, the counts took control of raw material sources in the surrounding area, such as the Schönbuch, and entered into economic ties that were used as leverage for political and legal access to the imperial town. These processes became particularly evident from the 16th century onwards.

An environmental history study aimed at analyzing material flows and their social control can open up new perspectives on the history of the region. In the case of Reutlingen, a development of internal and external conditions along environmental-historical questions can be observed since the Middle Ages. The chosen approach makes it possible to consider the connections between resources, economy and rule and thus provides further impulses for environmental historical research on towns by interweaving material processes and social dynamics.

LITERATURE

ADE-RADEMACHER, Dorothee: Die Grabungen Königsbronner Pflegehof und Oberes Bollwerk. Aussagen zur frühen Geschichte der Stadt Reutlingen, in: Barbara SCHOLKMANN (ed.): Unter Putz und Pflasterstein. Bauforschung und Mittelalterarchäologie in Reutlingen. Zum Beispiel Pfäfflinshofstraße 4. Heimatmuseum Reutlingen, Reutlingen 1999, p. 16-38.

ADE-RADEMACHER, Dorothee/GASSMANN, Gunther: Eisenschlacken und Ofenreste – Nachweise für Eisenverhüttung in der Stadt?, in: Von Schmieden, Würfeln und Schreibern. Städtisches Handwerk im Mittelalter (Almanach 4), Stuttgart 1999, p. 129-137

ANSORGE, Jörg/STOLZE, Susann/WIETHOLD, Julian: Gerberlohe als Bau- und Dämmmaterial im mittelalterlichen Stralsunder Rathaus - eine interdisziplinäre Studie (Archäologische Berichte aus Mecklenburg-Vorpommern, vol. 10), 2003, p. 268-283.

BARLES, Sabine/KNOLL, Martin: Long-Term Transitions, Urban Imprint and the Construction of Hinterlands, in: Tim SOENS/Dieter SCHOTT/Michael TOYKA-SEID/Bert DE MUNCK (ed.): Urbanizing Nature. Actors and Agency (Dis-)Connecting Cities and Nature since 1500, New York 2019, p. 29-49.

BARLES, Sabine: Urban Metabolism, in: Sebastian HAUMANN/Martin KNOLL/Detlev MARES (ed.): Concepts of Urban-Environmental History (Environmental and Climate History, vol. 1), Bielefeld 2020, p. 109-124.

BARTELHEIM, Martin/HARDENBERG, Roland/SCHOLTEN, Thomas: Ressourcen – RessourcenKomplexe – Ressourcen-Gefüge – RessourcenKulturen, in: Tobias SCHADE u.a. (ed.): Exploring Resources. On Cultural, Spatial and Temporal Dimensions of ResourceCultures (Ressourcenkulturen, vol. 13), Tübingen 2021, p. 9-22.

¹⁰⁸ Siehe HStA Stuttgart B 201 U 174; StadtA Reutlingen A 1 Nr. 5769.

¹⁰⁹ SCHWARZ: Schönbuchgerechtigkeit (Note 66), p. 73f.

BREYVOGEL, Bernd: Von den dörflichen Anfängen zur stolzen Reichsstadt. Reutlingen im Mittelalter, in: Wilhelm BORTH/Bernd BREYVOGEL/Wolfgang JUNG (ed.): Reutlingen: Vergangenheit trifft Zukunft. Von der Stadtherrlichkeit zur selbstbewussten Großstadt, Reutlingen 2013, p. 17-56.

BOELCKE, Willi A.: Zur mittelalterlichen und frühneuzeitlichen Wirtschaftsgeschichte der Reichsstadt Reutlingen, in: Reutlinger Geschichtsblätter [=RGB] 29 NF (1990), p. 179-216.

BOULDING, Kenneth E.: Ecodynamics. A New Theory of Social Evolution, Beverly Hills/London 1981 (ursprünglich 1978).

CRAMER, Johannes: Gerberhaus und Gerberviertel in der mittelalterlichen Stadt (Studien zur Bauforschung Nr. 12) Bonn 1981.

DEIGENDESCH, Roland: Die Reutlinger Friedensordnungen des späten Mittelalters. Aus der Arbeit am Reutlinger Urkundenbuch, in: ZWLG 77 (2018), p. 15-30.

DEIGENDESCH, Roland: Die Schlacht bei Reutlingen 1377. Geschichte – Wirkung – Erinnerung, in: DERS./Christian JÖRG (ed.): Städtebünde und städtische Außenpolitik. Träger, Instrumentarien und Konflikte während des hohen und späten Mittelalters (Stadt in der Geschichte, vol. 44), Ostfildern 2019, p. 19-46

DOLL, Monika: Tierknochen als Zeugnisse mittelalterlicher Gerberei in Reutlingen, in: Barbara SCHOLKMANN (ed.): Unter Putz und Pflasterstein. Bauforschung und Mittelalterarchäologie in Reutlingen. Zum Beispiel Pfäfflinshofstraße 4. Heimatmuseum Reutlingen, Reutlingen 1999, p. 123–125.

FISCHER-KOWALSKI, Marina/MAYER, Andreas/SCHAFFARTZIK, Anke: Zur sozialmetabolischen Transformation von Gesellschaft und Soziologie, in: Matthias GROß (ed.): Handbuch Umweltsoziologie, Wiesbaden 2011, p. 97-120.

FRITZ, Gerhard: Wasserkraftnutzung im Mittelalter in Südwestdeutschland und angrenzenden Gebieten (Veröffentlichungen der Kommission für Geschichtliche Landeskunde in Baden-Württemberg, vol. 216), Ostfildern 2024.

GAISER, Linda: Die Reutlinger Stadtmauer – Schutz, Repräsentation, Ressourcen, in: RGB 55 NF (2016), p. 9-66.

GASSMANN, Gunther: Mittelalterliche Eisenerzverhüttung in und um Reutlingen, in: Barbara SCHOLKMANN (ed.): Unter Putz und Pflasterstein. Bauforschung und Mittelalterarchäologie in Reutlingen. Zum Beispiel Pfäfflinshofstraße 4. Heimatmuseum Reutlingen, Reutlingen 1999, p. 39-46.

GRATIANUS, Carl C.: Geschichte der Achalm und der Stadt Reutlingen in ihrer Verbindung mit der vaterländischen Geschichte, vol. 1, Tübingen 1831.

HARDING, Sybil: Die archäologischen Ausgrabungen auf dem Katharinenhof-Areal – Einblicke in die Reutlinger Siedlungsgenese, in: RGB 59 NF (2020), p. 11-43.

HAUFF, Dorothea: Zur Geschichte der Forstgesetzgebung und Forstorganisation des Herzogtums Württemberg im 16. Jahrhundert (Schriftenreihe der Landesforstverwaltung Baden-Württemberg, vol. 47), Stuttgart 1977.

HAUMANN, Sebastian u.a. (ed.): Perspektiven auf Stoffgeschichte. Materialität, Praktiken, Wissen, Bielefeld 2023.

HOHENSINNER, Severin/DRESCHER, Anton/ECKMÜLLNER, Otto/EGGER, Gregory/GIERLINGER, Sylvia/HAGER, Herbert/HAIDVOGL, Gertrud/JUNGWIRTH, Mathias: Genug Holz für Stadt und Land? Wiens Holzressourcen in den dynamischen Donau-Auen. Projektbericht, Institut für Hydrobiologie und Gewässermanagement, Universität für Bodenkultur Wien, Wien 2016.

HOLTZ, Sabine: Waldnutzung, Forstordnung und Forstkultur. Der Wald um 1500 in landesgeschichtlicher Perspektive, in: Daniela BOHDE/Astrid ZENKERT (ed.): Der Wald in der Frühen Neuzeit zwischen Erfahrung und Erfindung. Naturästhetik und Naturnutzung in transdisziplinärer Perspektive, Köln 2024, p. 197-218.

ISENBERG, Andrew C.: Introduction: New Directions in Urban Environmental History, in: DERS. (ed.): The Nature of Cities. Culture, Landscape and Urban Space (Studies in Comparative History), Rochester 2006, p. XI-XIX.

KIESS, Rudolf: Die Rolle der Forsten im Aufbau des württembergischen Territoriums bis ins 16. Jahrhundert (Veröffentlichungen der Kommission für Geschichtliche Landeskunde in Baden-Württemberg, vol. 2), Stuttgart 1958.

KIESS, Rudolf: Bemerkungen zur Holzversorgung von Städten, in: Jürgen SYDOW (ed.): Städtische Versorgung und Entsorgung im Wandel der Geschichte (Veröffentlichungen des Südwestdeutschen Arbeitskreises für Stadtgeschichtsforschung, vol. 8), Sigmaringen 1981, p. 77-98.

KIESS, Rudolf: Der Wald als Lebensgrundlage. Waldbesitz und Waldnutzung vom 14. bis ins 18. Jahrhundert, in: Ingrid GAMER-WALLERT (ed.): Der Schönbuch. Mensch und Wald in Geschichte und Gegenwart, Tübingen 1999, p. 105-121.

KINKELIN, Wilhelm: Das Pfullinger Heimatbuch, Neuauflage des 1937 ersch. Werks, Reutlingen 1956.

KITTELBERGER, Gerhard: Fragen zur Frühgeschichte der Stadt Reutlingen, in: Heinz A. GEMEINHARDT/Sönke LORENZ (ed.): Liutold von Achalm (+ 1098), Graf und Klostergründer. Reutlinger Symposium zum 900. Todesjahr, Reutlingen 2000, p. 113-146.

KNOLL, Martin: Wald und Holz als verknappte Ressourcen. Anmerkungen zur städtischen Brennholzversorgung im 18. und 19. Jahrhundert am Regensburger Beispiel, in: Bernd HERRMANN (ed.): Beiträge zum Göttinger Umwelthistorischen Kolloquium 2004-2006, Göttingen 2007, p. 189-211.

KOPP, Herbert: Die Anfänge der Stadt Reutlingen. Ein Beitrag zur Stadtopographie, Reutlingen 1962.

KÖPPEN, Anne: Zeugnisse des Alltags. Die archäologischen Funde der Pfäfflinshofstraße 4, in: Barbara SCHOLKMANN (ed.): Unter Putz und Pflasterstein. Bauforschung und Mittelalterarchäologie in Reutlingen. Zum Beispiel Pfäfflinshofstraße 4. Heimatmuseum Reutlingen, Reutlingen 1999 p. 111-122.

MAIER, Peter/HEUSEL, Andreas: Schönbuchrechte und Gemeindewald, in: DIES. (ed.): Kirchentellinsfurt. Chronik eines Dorfes, Kirchentellinsfurt 2007, p. 431-441.

MARSTALLER, Tilmann: Das Haus Pfäfflinshofstraße 4 – Bauen und Wohnen am Rande der Reutlinger Altstadt, in: Barbara SCHOLKMANN (ed.): Unter Putz und Pflasterstein. Bauforschung und Mittelalterarchäologie in Reutlingen. Zum Beispiel Pfäfflinshofstraße 4. Heimatmuseum Reutlingen, Reutlingen 1999, p. 57-106.

MARSTALLER, Tilmann: Das Tübinger Tor. Neue Daten zum ältesten Tübinger Stadttor, in: RGB 46 NF (2007), p. 9-56.

MAURER, Hans Martin: Die Achalm und der mittelalterliche Burgenbau, in: RGB 6 NF (1968), p. 7-24.

MERTENS, Dieter: Württemberg, in: Meinrad SCHAAB/Hansmartin SCHWARZMAIER (ed.): Handbuch der baden-württembergischen Geschichte: Die Territorien im Alten Reich, vol. 2, Stuttgart 1995, p. 1-163.

NIEßEN, Iris: Vorstadtentwicklung in der Aue. Archäologische Forschungen zu den Donaustädten Regensburg und Ulm im Mittelalter, in: Peter FÄßLER/Michael STRÖHMER (ed.), Kommunale Wasserregime à la longue durée. Zeitliche und räumliche Eingrenzungen 1350-1930, Paderborn 2025, p. 39-75.

NIEßEN, Iris/SCHENK, Gerrit J./SCHÖN, Marcel: Fluvio-sozialer Metabolismus als Brückenkonzept mittlerer Reichweite. Ein Vorschlag zur Untersuchung der Fluvialen Anthroposphäre (preprint). iDAI.repo. <https://doi.org/10.34780/dtuitqwl>

REGNATH, R. Johanna: Energie – Werkstoffe – Nahrung. Wald als zentrale Rohstoffquelle der Frühen Neuzeit anhand südwestdeutscher Quellen, in: Sigrid HIRBODIAN/Tabea SCHEIBLE (ed.): Mensch und Wald seit dem Mittelalter. Lebensgrundlage zwischen Furcht und Faszination (Schriften zur südwestdeutschen Landeskunde, vol. 87), Ostfildern 2024, p. 77-96.

RÜCKERT, Peter: Die Grafen von Württemberg, die schwäbischen Reichsstädte und Kaiser Karl IV. in Konflikt und Kooperation, in: Roland DEIGENDESCH/Christian JÖRG (ed.): Städtebünde und städtische Außenpolitik. Träger, Instrumentarien und Konflikte während des hohen und späten Mittelalters (Stadt in der Geschichte, vol. 44), Ostfildern 2019, p. 103-124.

RÜCKERT, Peter: Wald und Herrschaft im späteren Mittelalter, in: Sigrid HIRBODIAN/Tabea SCHEIBLE (ed.): Mensch und Wald seit dem Mittelalter. Lebensgrundlage zwischen Furcht und Faszination (Schriften zur südwestdeutschen Landeskunde, vol. 87), Ostfildern 2024, p. 57-76.

SCHEURER, Herbert: Die Schirmverträge zwischen Reutlingen und Württemberg, in: RGB 2 NF (1965), p. 7-46.

SCHEURER, Herbert: Die Zollpolitik der Herzöge von Württemberg, in: RGB 3 NF (1966), p. 7-45.

SCHLOTTAU, Klaus: Von der handwerklichen Lohgerberei zur Lederfabrik des 19. Jahrhunderts (Sozialwissenschaftliche Studien, vol. 29), Opladen 1993.

SCHNEIDER, Alois: Reutlingen (Archäologisches Stadtkataster Baden-Württemberg, vol. 23), Reutlingen 2003.

SCHWARZ, Paul: Die Grundherrschaft der ehemaligen Freien Reichsstadt Reutlingen von der Gründung der Stadt bis zur Reformation, Dissertation Universität Tübingen 1953.

SCHWARZ, Paul: Die Schönbuchgerechtigkeit der Reichsstadt Reutlingen, in: Hermann GREES (ed.): Der Schönbuch. Beiträge zu seiner landeskundlichen Erforschung (Veröffentlichung des Alemannischen Instituts, vol. 27), Bühl 1969, p. 65-90.

SLOTEDIJK, Peter: Sphären, vol. 1-3, Frankfurt a. M. 1998, 1999, 2004.

SOMMER, Johann (ed.): Aus der Geschichte dreier Gewerbe in Reutlingen. Gerber, Buchdrucker, Stricker, Reutlingen 1952.

SONNLECHNER, Christoph: Wald der Wiener? Der mittelalterliche und frühneuzeitliche Wienerwald als Biomasse-Lieferant und Jagdrevier, in: Karl BRUNNER/Petra SCHNEIDER (ed.): Umwelt Stadt. Geschichte des Natur- und Lebensraumes Wien (Wiener Umweltstudien, vol. 1), Wien/Köln u. a. 2005, p. 165-169.

SONNLECHNER, Christoph: Der „ökologische Fußabdruck“ Wiens im Spätmittelalter – eine Annäherung, in: Ferdinand OPPL/Christoph SONNLECHNER (ed.): Europäische Städte im Mittelalter (Forschungen und Beiträge zur Wiener Stadtgeschichte, vol. 52; Veröffentlichungen des Wiener Stadt- und Landesarchivs Reihe C: Sonderpublikationen 14), Innsbruck/Wien u. a. 2010, p. 351-364.

STROKAL, Marina/BAI, Zhaohai/FRANSSEN, Wietse u.a.: Urbanization: an increasing source of multiple pollutants to rivers in the 21st century. npj Urban Sustain 1, 24 (2021). <https://doi.org/10.1038/s42949-021-00026-w>; BMUV/UBA: Die Wasserrahmenrichtlinie – Gewässer in Deutschland 2021. Fortschritte und Herausforderungen, Bonn/Dessau 2022.

WERTHER, Lukas/MEHLER, Natascha/SCHENK, Gerrit J./ZIELHOFER, Christoph: On the Way to the Fluvial Anthroposphere. Current Limitations and Perspectives of Multidisciplinary Research, in: Water MDPI 16 (2021), H. 13, . 1–25.

WINIWARTER, Verena/SONNLECHNER, Christoph: Der soziale Metabolismus der vorindustriellen Landwirtschaft in Europa (Der Europäische Sonderweg, vol. 2), Stuttgart 2001.

WINIWARTER, Verena/WILFING, Harald (ed.): Historische Humanökologie. Interdisziplinäre Zugänge zu Menschen und ihrer Umwelt, Wien 2002.

WINIWARTER, Verena/SCHMID, Martin: Socio-Natural Sites, in: Sebastian HAUMANN/Martin KNOLL/Detlev MARES (ed.): Concepts of Urban-Environmental History (Environmental and Climate History, vol. 1), Bielefeld 2020, p. 33-50.

Der Landkreis Reutlingen, ed. Landesarchivdirektion Baden-Württemberg in Verbindung mit dem Landkreis Reutlingen, vol. 2, Sigmaringen 1997.

(PrePrint; German version will appear revised as Schön, M; Nießen, I. Fluvio-sozialer Metabolismus im Echaztal. Ressourcenkonflikte am Beispiel des Bezugs von Eichenrinde für die Gerberei in der Reichsstadt Reutlingen. In: Gabriel Zeilinger et al. (ed.), Umwelten verflochten. Ergebnisse, Methoden und Perspektiven einer Verbindung von Landesgeschichte und Umweltgeschichte [submitted])