*Routledge Studies in Ecological Economics*

# A HISTORY OF ECOLOGICAL ECONOMIC THOUGHT

Marco P. Vianna Franco and Antoine Missemer

ROUTLEDGE

# A History of Ecological Economic Thought

Contributing to a better understanding of contemporary issues of environmental sustainability from a historical perspective, this book provides a cohesive and cogent account of the history of ecological economic thought. The work unearths a diverse set of ideas within a Western and Slavic context, from the Renaissance and the Enlightenment to the late 1940s, to reveal insights firmly grounded in historiographical research and of import for addressing current sustainability challenges, not least by means of improving our grasp on how humans and nature can generously coexist in the long term.

The history of ecological economic thought offered in this volume is rich and diverse, encompassing views that are bound by the observance of the tenets of the natural sciences, but which differ significantly in terms of the role of energy and materials to cultural development and the normative aspects involving resource distribution, social ideals, and policy-making. Combining the approaches of independent scholarly figures and scientific communities from different historical periods and nationalities, the book brings elements that are still missing in the scarce literature on the history of ecological economic thought and highlights the underlying threads which unite such initiatives.

The book brings a fresh look into the historical development of ecological economic ideas and will therefore be of great interest to scholars and students of ecological economics, environmental economics, sustainability science, interdisciplinary studies, and history of economic thought.

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# A History of Ecological Economic Thought

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Thomas Cole (1836), *View from Mount Holyoke, Northampton, Massachusetts, after a Thunderstorm.*

# Introduction

On a spring day in 1836, the American painter Thomas Cole, retired to his Cedar Grove studio in Catskill, New York, put one of the finishing touches on one of his most famous paintings, the *View from Mount Holyoke, Northampton, Massachusetts, after a Thunderstorm*, also called *The Oxbow*. At the time, Cole was working on his masterpiece, *The Course of Empire*, a series of pictures on the ascension and fall of the Classical State. Meanwhile, he continued his exploration of the great American landscape, consolidating what would soon be known as the Hudson River School art movement. Mount Holyoke is located on the banks of the Connecticut River, 160 miles north of New York City. Cole used to travel regularly around the United States and Europe, where he could find inspiration. His concern for both precision and meaning placed him at the junction between naturalism and romanticism. *The Oxbow* masterly displays the confrontation of two types of natural landscape. On the left-hand side, pristine, luxuriant nature shows its richness; Cole is himself depicted, painting with relish. On the right-hand side, domesticated nature, put to good use, suggests the pervasiveness of the human reach: agriculture, navigation, and chimneys in the background. The painter looks out in this direction, witnessing the advance of civilisation and the concomitant transformation of the natural environment. These two views of nature—contemplative and instrumental—were thoroughly debated in 19th-century American society. Untouched nature would soon be considered as wilderness, an inherent part of American identity. Domesticated nature was, in contrast, a sign of humans', especially settlers', supposed ability to enhance their environment.

In fact, the tension between contemplative and instrumental views of nature should neither be limited to the North American context nor to the 19th century. It has played a structuring role in the development of Western thought at least since the 18th century. In his classic *Nature's Economy: A History of Ecological Ideas* (1994), Donald Worster recalls that the contemplative or Arcadian view of nature found its scientific basis in the work of the British naturalist Gilbert White, which remained influential throughout the 19th and 20th centuries. The instrumental perspective has also developed before Cole's time, in the context of Christian and Enlightenment traditions,

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according to which nature is at the disposal of human beings. Francis Bacon's empiricist revolution at the turn of the 16th century imparted new momentum to the idea that nature needed to be examined through its materiality, independently from the myths and symbols associated with it.

These two opposing outlooks, cunningly depicted by Cole in 1836, appear recurrently along history. Still today, our relationship with the natural environment is constantly torn between them. They shape, at least partly, debates over land-sparing versus land-sharing, which cut across topics such as agriculture, forestry, and biodiversity. In environmental philosophy, the confrontation between bio- and anthropocentric perspectives is of the same breed. In politics, Green parties, especially in Europe, are often caught between a *realpolitik* of compromise for the sake of economic development and a deeper ecological commitment in line with the Arcadian view of nature.

Economic ideas, theories, and policy recommendations are no exception to the rule. Disagreements between economists working on environmental issues often circle back to the same underlying tensions. Those grouped under the banner of mainstream *environmental economics* argue for tweaking the economic system at the margin to make environmental problems internal to it—the so-called internalisation of externalities—and thus minimise the detrimental effects of climate change, pollution, or resource depletion. In their approach, environmental concerns do not override other imperatives such as economic growth, full employment, or monetary stability. The relationship between humans and nature remains basically dual, as human societies possess their own logic when dealing with an external environment. While economics can address the interface between the two realms, they remain separate.

Another approach has gradually gained ground in academic circles since the 1970s and 1980s: *ecological economics*. Ecological economists claim to be more engaged with the biophysical aspects of human activities. They challenge the human-nature dualism and study economic activities as embedded in and emerging from society and the natural world. As a result, economic processes are regularly associated with their material and energy counterparts: production, distribution, and consumption require natural resources and generate waste of every kind. In a sense, the difference between environmental and ecological economics can be interpreted in the context of those two foundational conceptions regarding the relationship between humans and nature. The former favours an instrumental, albeit not quite materialistic, view of nature, while the latter adopts a more contemplative, but at the same time biophysically grounded, stance on the natural world.

The state of economics today is the legacy of at least two centuries of conceptual and theoretical evolution. As a science, economics has made progress, particularly in terms of methods, by means of the gradual introduction of new calculation tools, from differential calculus to computing power. As a *social* science, however, economics cannot be abstracted from its historical context, which puts into question the cumulative character of economic

knowledge. Economists usually address the problems of their time; theories which are valid in one context might not continue to be so in other settings. Likewise, ideas that went unnoticed in the past because of their inappropriateness to their context may be revived in the present or future. For all these reasons, the history of economic thought can offer lessons potentially contributing to knowledge production, acting as a lever for historicising the economic discipline. This has been true in all fields of economics, including environmental and ecological economics.

It is commonplace to argue that environmental issues first came to the attention of economists in the 1960s and 1970s, with the oil shocks and warnings such as the Club of Rome's *The Limits to Growth* (1972). Undoubtedly, this period fostered economic studies on resource scarcity and pollution. As a response, economic research centres dedicated to environmental and energy issues were set up. It is also at that moment that Kenneth Boulding (1966), Nicholas Georgescu-Roegen (1971), Herman Daly (1977), and René Passet (1979) ascended as pioneers of ecological economics.

This clichéd perception of the history of environmental and ecological economics, although true, is far too limited. Within the framework of modernity, natural resources and waste have appeared as recurrent topics since the emergence of political economy. Of course, such initiatives took other forms than those of today, if only because knowledge of the economy and of the natural world has changed considerably. Bearing that in mind, a history of the relationship between economics and the environment over a longer period of time can add substantially to accounts circumscribed to recent time frames.

Some work has already been done in this direction, starting with Erhun Kula's classic textbook *History of Environmental Economic Thought* (1998), which explored analyses of natural resources and externalities from 19th-century Classical political economy to the 1970s. Margaret Schabas (2005), Fredrik Albritton Jonsson (2013), and Paul Warde (2018) reached insightful conclusions on the evolving place of nature in economic thought in the 18th and 19th centuries. Nathaniel Wolloch (2016) offered his own point of view regarding the roots of the instrumental view of nature in economic thought even before the Classics. Philip Mirowski (1989) assessed the epistemological backdrop against which economists narrowed down their view of nature. Other works have investigated more specific areas of economic analysis, such as the history of exhaustible resource economics, the history of rent theories, and the history of nature pricing strategies (e.g. Guigou, 1982; Robinson, 1989; Missemer, 2017; Banzhaf, forthcoming).

Although these mentions are far from exhaustive, they all describe and analyse economic thought as applied to the right side of Cole's picture, i.e. in relation to the instrumental view of nature adopted by economists throughout history. At first, this seems quite logical. Economics is widely understood as intellectual efforts focusing on the satisfaction of human needs through the efficient use of available resources. Accordingly, the relationship between

humans and the natural world has mostly been apprehended in economic thought by means of an instrumental view. As a result, the history of nature in economic thought in a long-run perspective might seem restricted to finding old versions and roots of today's conventional environmental economics.

It should be now clear that this is only part of the story. Just as it is meaningful and worthwhile to write the history of environmental economics over longer periods of time—what can be referred to, following Kula (1998), as the history of *environmental economic thought*—it is also meaningful and worthwhile to do the same for the history of ecological economics, amounting to a history of *ecological economic thought*. It is indeed possible to redeem economic traditions, going at least as far back as the 18th century, which aligned themselves with the meaning of the left-hand side of Cole's painting, i.e. adopting a contemplative and respectful view of nature. With a few exceptions, including Joan Martinez-Alier's masterpiece *Ecological Economics: Energy, Environment and Society* (1987), this history has so far received little attention. This is what we strive to do here.

## Defining ecological economic thought

The expression 'ecological economic thought' appeared in the early 2000s (Edwards-Jones *et al*., 2000), although without a thorough qualification and notwithstanding the fact that it has until recently remained elusive in the literature. It has resurfaced in the past few years, thanks to a renewed interest in the origins of current debates on sustainability (e.g. Franco, 2018). Although it might at first be perceived as a broad intellectual history of ecological economics as we know it today, it would be misleading to argue that it can be limited to this definition. If we are convinced that ideas, theories, and concepts have a historicity, then the characteristics of contemporary ecological economics cannot be directly projected onto the past. Doing so would lead to anachronisms. Writing the history of ecological economic thought cannot, therefore, be a naïve search for the origins of today's ecological economics.

Providing ecological economic thought with an informative and historiographically accurate definition is not that easy. Even though the characteristics of contemporary ecological economics cannot serve as its definition, they are a good starting point. While other characterisations are possible, it seems that ecological economics has, broadly speaking, three main traits in its approach to the study of the economy in relation to the natural environment. First, as already mentioned, ecological economists consider that the economy is not above ground; it is embedded in society and in the natural world. There is no economic process or economic action disconnected from social relations and material constraints. All human activities take place in a social context and on planet Earth.

Second, the close relationships between economic processes, social relations, and the natural world imply a need for considering different sorts of knowledge; that is to say, a need for crossing disciplines in an ambitious way,

as in the case of strong interdisciplinarity (Max-Neef, 2005; Schmidt, 2008). The idea is not to unify all sciences as envisaged in 19th-century positivism. The goal is rather for social and natural scientists to build common tools, to have a common language, and to jointly produce knowledge about a complex world. In the gestation period of ecological economics, Georgescu-Roegen (1976, p. 54) did not hesitate to say that thermodynamics 'began as a physics of economic value' and that biology and economics had the same object of study, namely human evolution. In other words, Georgescu-Roegen not only had an integrative view of economic, social, and natural issues, but also of their corresponding scientific disciplines. The question of interdisciplinarity remains prevalent in today's reflections on the identity of ecological economics (e.g. Dube, 2021; Lundgren, 2022).

Third, the field of ecological economics is normatively characterised by a high level of pluralism, both thematically and methodologically. This feature has been the centre of discussions investigating whether pluralism is a strength or a weakness in counteracting conventional environmental economics (e.g. Norgaard, 1989; Tacconi, 1998; Gowdy, 2005; Baumgärtner *et al.*, 2008; Özkaynak *et al.*, 2012; Spash, 2012, 2013, 2020a; Spash and Ryan, 2012; Plumecocq, 2014; Söderbaum, 2015; Petit, 2018). Pluralism in ecological economics became the subject of a wide variety of articles published in the eponymous journal *Ecological Economics* since its creation in 1989.

Embeddedness, interdisciplinarity, and pluralism can be considered, therefore, as key characteristics of ecological economics. As expected, these characteristics are difficult to transpose as such into a long history of ideas. Embeddedness and disembeddedness processes, as derived from the work of Karl Polanyi (1944), suppose that the economic realm can be distinguished from other spheres of reality. This has not always been the case in history, especially outside Western thought. Interdisciplinarity, to be meaningful, requires the existence of separate scientific disciplines, which was not really the situation before the 19th century. Pluralism, understood as the plurality of methods and research topics, may be less problematic, insofar as we can assume that knowledge production in the past was at times as plural as in the present. Yet, the forms taken by pluralism, and their normative dimension, have not necessarily been constant over time.

In order to define ecological economic thought, we thus need to move up in generality to identify what may be behind those words—embeddedness, interdisciplinarity, and pluralism—independently of today's intellectual and scientific context. To this end, we note that embeddedness actually refers to the *ontological* conception of economic activities, society, and the natural world. When ecological economists talk about an embedded economy within social relations and material contingencies, they are, in fact, claiming that economic, social, and environmental phenomena take part in a shared reality and are inherently interdependent. In other words, behind the idea of embeddedness lies a more generic property, that of a *common ontology of the social and the natural worlds*. This is the first of two elements in our definition.

Likewise, interdisciplinarity refers to more than the mere juxtaposition of separate scientific disciplines. It is about the way we can jointly produce knowledge on the social and the natural worlds using shared tools, methods, and theories independently from disciplinary divides. When disciplines did not yet exist, what was at stake, therefore, was the integration of seemingly dissimilar forms of knowledge towards a common understanding of social and natural phenomena. In the same way that embeddedness refers to ontological assumptions, interdisciplinarity deals with *epistemological* stances. Behind the idea of ambitious forms of interdisciplinarity lies a more generic property: a *common epistemology of the social and natural worlds as objects of inquiry*. This is the second element.

Exploring the history of ecological economic thought, therefore, means searching for ideas of economic importance which are characterised by *common ontological and epistemological conceptions of the functioning of human societies and the natural world*. This definition can possibly cover a wide variety of subjects, methods, and approaches, thus allowing for pluralism, taken, if not in its normative sense, at least as the existence of plural approaches in such a history.

Past thinkers of the economy who sought to integrate knowledge on society and the natural world as deeply as possible are the best candidates to be part of our account. However, we must be careful about the types of knowledge integration that may have existed in history. Not all epistemological connections stem from shared ontological assumptions. For instance, many social scientists throughout history have used concepts imported from the natural sciences which did not imply a common ontology but served as logical arguments or figures of speech facilitating reasoning or communication. Economics is full of metaphors, homologies, and analogies, as best illustrated by the concepts imported from Newtonian mechanics, such as equilibrium or the forces of demand and supply.

When coming from biology and ecology, metaphors and analogies might pose as recourses fostering strong forms of interdisciplinarity, which is often not the case. For example, the evolutionary theory of the firm alludes to mutations by means of innovation and selection by competitive market forces as mechanisms operating on private companies (see Nelson and Winter, 1982). At a first glance, the connection with evolutionary biology seems strong. Yet, the natural environment and biophysical contingencies play a secondary role, if any. Darwinian biology is not applied as a tool for getting information on the evolution of a shared natural and social reality; it is only mobilised as a way for transferring a conceptual framework. The same could be said of expressions such as 'industrial ecosystems,' which do not suggest a shared reality of industrial complexes and ecosystems. Industrial ecosystems refer to a wide range of interdependencies between companies, providers, customers, and other agents on the same territory or in the same branch of business. The ecological functions of natural ecosystems do not play any role here. Expressions such as industrial ecosystems are mostly adopted for rhetorical reasons. Despite the fact that metaphors and analogies might lead to stronger forms of

interdisciplinarity, they do not present sufficient conditions to always comply with the definition of ecological economic thought. Hence, strictly logical and rhetorical interconnections fall outside our scope.

On more concrete terms, exploring the history of ecological economic thought means searching for intellectual contributions which investigated social and economic processes making substantial use of the tenets of natural sciences such as physics, thermodynamics, biology, ecology, chemistry, and physiology. Social energetics, agrarianism, resource flow accounting, and social metabolism are examples that have been already mentioned in the literature (e.g. Christensen, 1987; Martinez-Alier, 1987; Fischer-Kowalski, 1998; Røpke, 2004; Franco, 2018). Most of the time, these ideas and theories have remained in the background of intellectual history, while those related to industrialisation, economic development, and anthropocentrism dominated the scene, being hardly conducive to alternative visions of the relationship between humans and nature. By going off the beaten track, by exploring new bodies of work, it is actually possible to discover unsuspected but fitting intellectual episodes and traditions and then realise how this history is incredibly rich. Time has come to show that the history of environmental economic thought has a solid counterpart, which, far from being anecdotal, not only resisted but thrived at the fringes of mainstream scholarship.

## Exploring the history of ecological economic thought

When exploring the history of ecological economic thought, the question of temporal boundaries comes to mind. In the same way that production, consumption, and distribution of wealth appeared as issues before the advent of modern political economy in the 18th century, integrative views of human societies and nature also existed before the 18th century. The common Greek etymology of the words 'economics' (*oikos-nomos*) and 'ecology' (*oikos-logos*) is already a sign of that. We propose, however, to start our investigation at the Renaissance and the Enlightenment along the 16th, 17th, and 18th centuries, because it is at that moment that the modern ontological dualism between humans and nature crystallised. The fact that ecological economic thought has transcended this dualism and offered an alternative to the prevailing instrumental view of nature makes this period particularly fruitful as a starting point of our account.

Given that ecological economics was institutionalised in the end of the 1980s after the already mentioned intellectual advancements in the 1960s and 1970s—the early history of modern ecological economics (Røpke, 2004, 2005)—the history still to be done seems to naturally point towards periods before the 1950s. The account provided here is limited to the late 1940s because developments taking place after the Second World War were much closer to the early history of modern ecological economics than to previous advancements, which might have led to incomplete portrayals.

Exploring the history of ideas from the Renaissance to the 1940s opens up immense prospects. Further demarcation is needed, and a first choice is to reduce our scope to Western ideas, with few exceptions, such as Slavic bodies of thought. Of course, this choice entails losing intellectual diversity of all sorts. This decision, however, is due to the fact that the debate on human-nature dualism discussed here has been framed in a Western context, not to mention that today's environmental issues are primarily the responsibility of Western industrial societies, more precisely of the richer parts of these societies. We could, and certainly should, aim at further work looking for non-Western accounts. They would constitute *external* critiques of Western civilisation. The fact that ecological economic thought did exist in Western contexts constitutes, in this sense, a collection of *internal* critiques, nonetheless also inspiring in their attempts to rethink our ways of living. Even if limited in this regard, our inquiry gains in diversity in terms of language. In addition to English-speaking literature, we owe much to the work of French-, German-, and Russian-speaking historical figures.

Covering four centuries of intellectual history can hardly be done in an exhaustive way. Hence, our goal was to select moments, episodes, and controversies without expectation of completeness. Because of these distinct and freely chosen moments, episodes, and controversies, the account we offer does not consist in building a continuous and linear narrative. There are discontinuities in history, and it is not certain whether one can easily compare or connect the works of French botanists of the 18th century with the proposals of Russian utopians of the late 19th century or with the valuations of natural environments proposed by North American economists in the 1930s. Our historical account, therefore, takes the form of vignettes with stand-alone insights. These vignettes surely do not cover all possible episodes in the given period, and they cannot always dialogue directly or be compared with each other insofar as they correspond to ideas and theories caught in specific historical and cultural contexts.

Does this mean that we should give up striving for a general synthesis? Would the history of ecological economic thought be only a patchwork of scattered ideas? Fortunately not. It can be thought of as a series of independent paintings that together tell a common story. When Giuseppe Arcimboldo painted his *Four Seasons* in the 1560s–1570s, he portrayed four separate allegories, all having their specificities: *Spring* as a woman portrait with flowers and leaves; *Summer* as a woman portrait with fruits and vegetables; *Autumn* as a man portrait with branches, mushroom, and fruits; and *Winter* as a man portrait with dead wood and roots. All together, these paintings tell a story about the passage of time over the course of a year and about the diversity of states in the natural world. The same is true for the history of ecological economic thought—note how metaphors can sometimes lead to relevant intuitive results! Each episode is distinct from the others and bears specific

components. Put together, they carry a message about what ecological economic thought has been and about the lessons from the past that can be drawn for today.

In addition to offering an unprecedented journey into the history of ideas pertaining to ecological economics, the objective of this book is to identify, eventually, the most important themes, concerns, or proposals raised in the past for escaping the modern dualism and for imagining a more harmonious economic relationship between human beings and their natural environment. In other words, we aim both to enrich our knowledge of the history of ideas and to provide new sources of inspiration to contemporary researchers and students in ecological economics and, more generally, in sustainability studies.

In order to conduct a robust history of thought, a return to primary, original sources is essential. When secondary literature is available, we mobilised it, at least to situate our own analysis in comparison to others. The investigation we carried out has been, however, first based on primary materials in their original languages. Most of these materials were published essays, books, and articles, some of them available in digital version, others disseminated in libraries all over Europe. Archival material has played a modest role in our investigation, although the reader will find traces of them in some chapters. We made no use of oral sources, even if some may exist for the early and mid-20th-century chapters.

We tried to be as comprehensive as possible while examining each episode. Nonetheless, we should not forget that the sources available to historians are always fragmentary and subject to bias. The fact that the writings which have reached us were most often the works of authors in a favourable social position necessarily gives us a partial view of reality. It is no coincidence that, for instance, the history of ecological economic thought is dominated by male figures, not to mention issues of ethnicity. For a long time, women have had little access to writing, especially scientific writing. This does not mean that they did not develop relevant ideas in the 17th, 18th, or early 19th centuries but that these ideas were not as easily put on paper as those of male thinkers. Fortunately, this bias has tended to fade over time, so our account also includes female intellectuals from the late 19th century onwards.

As already stated, there is already some secondary literature on several authors who participated in the development of ecological economic thought. Thomas Hobbes, Hans Carl von Carlowitz, John Ruskin, Rudolph Clausius, Sergei Podolinsky, Patrick Geddes, Henry Adams, Vladimir Vernadsky, Frederick Soddy, Alfred Lotka, Lancelot Hogben, and a few others have benefited from judicious exegesis (e.g. Grinevald, 1976, 1990; Daly, 1980; Martinez-Alier, 1987; Christensen, 1989; Vivien, 1994; Du Pisani, 2006; Bobulescu, 2015; Warde, 2018). It did not seem necessary to go back to these authors in detail, even if they appear inescapable to a thorough assessment, except when renewed analysis led to innovative results.

Classical authors such as Thomas R. Malthus, David Ricardo, and John Stuart Mill constitute a particular case. The Malthus of the population principle (1803) and the Ricardo (1817) and Mill (1848) of the stationary state seem to have paid attention to the idiosyncratic dynamics of nature, but a detailed analysis of their contributions to ecological economic thought would be a research project of its own. A similar argument goes for Karl Marx. He paid some attention to environmental issues when he posed his conception of the exploitation of nature as a corollary of the exploitation of labour. He also mentioned natural scientists, especially the German chemist Justus von Liebig, as a source of inspiration regarding the notion of metabolism (Foster, 2000). Moreover, he did influence key figures in the history of ecological economic thought, especially Podolinsky, eventually leading to an eco-Marxist school of thought. We leave for future endeavours a careful treatment of his contributions.

Generally speaking, readers might be surprised not to find certain names, or, in contrast, to find some that they would have intuitively excluded. The choice of our contents has inevitably been motivated by our own backgrounds and the availability of materials. Nevertheless, it was driven by our definition of ecological economic thought, which might explain the results. That is to say that as soon as an episode involved *common ontological and epistemological conceptions of the functioning of human societies and the natural world*, we considered it as a candidate for examination, whatever the doctrinal orientation of the authors—liberal or socialist, for instance—and whatever the degree of radicalism of the proposals—from prudent reformism to sharp revolution. We do not claim that all our choices are indisputable and that the frontier between the history of environmental economic thought and our own has always been clear-cut. We hope, however, to have done justice to the diversity of past contributions and their heuristic power, in some cases still relevant today.

Although the following ten chapters have been conceived as vignettes, the general framework is more or less chronological: the first chapter deals with an episode in the 16th, 17th, and 18th centuries and the last one ends up in the 1940s. Cultural and geographical unity has been overlooked. The reader will move from Sweden and France to German territories, then back to France before reaching the Russian Empire, go back to Austria, travel to the United States, and so on. This has been done so as not to emphasise the existence of cultural or national traditions in the history of ecological economic thought. There was no clear connection between Buffon's political economy in the 18th century, Pierre Leroux's agronomy in the 19th century, and André Godard's economy of birds in the early 20th century. In contrast, there were probably more substantial links between Buffon and Carl Linnaeus in Sweden, Leroux and Edwin Chadwick in Britain, and Godard and Stephen A. Forbes in the United States. Our history should be read, therefore, less through the lens of national frameworks and more through those of distinct episodes transcending borders, requiring a certain amount of attention to the circulation of ideas.

Each chapter explores specific bodies of knowledge, at a particular moment, in a given context or around a defined set of controversies. This means that the chapters can be read separately, consecutively, or in any other order which suits the reader. However, overall lessons emerge more clearly once one goes through all chapters. As warned above more than once, the following contents have not been designed to cover all possible episodes. It constitutes *a* history of ecological economic thought among others, not *the* ultimate one. Therefore, we invite the reader to explore the results of our inquiry in addition to other works, in particular that of Martinez-Alier (1987), which has inspired us greatly and remains, after 35 years, a groundbreaking work paving the way for the establishment of a historiography of ecological economic thought.

Chapter 1 starts with the interlinkages between natural history and early modern political economy in the 16th, 17th, and 18th centuries. From Conrad Gessner's *Historia Animalium* to Linnaeus's economy of nature and representations of social and natural harmony at the *Jardin du Roi* in Paris, this episode shows how botanical and zoological works influenced the emergence of the science of economics and vice versa, at a time when disciplinary boundaries were not yet clearly defined.

Chapter 2 turns to the German context, analysing the articulation between economic policy and the emerging natural sciences in the works of Johann von Goethe and Alexander von Humboldt, which unfolded within the development of German natural philosophy. Goethe and Humboldt developed ideas about the role of energy and natural resources in the prosperity of nations, mixing the teachings of the natural sciences with those of modern political economy.

Chapter 3 moves beyond natural history, dealing with the role of chemistry in the organisation of society. From Antoine Lavoisier to Jean-Antoine Chaptal, from Leroux to Chadwick, it shows how liberal and social reformers shared ideas on how the agricultural and industrial economies could be based on chemical processes, leading them to innovative proposals for reforming economic institutions in various directions.

Chapter 4 shifts to a radically different context, Tsarist Russia. The *Narodnik* movement laid the theoretical foundations to a sort of ecological utopianism in response to the agrarian reforms promoted by Tsar Alexander II in the 1860s. Knowledge on agronomy, physiology, and ecology were combined in the works of Nikolai Gavrilovich Chernyshevsky, informing his views on political and economic matters.

Chapter 5 opens up the question of social energetics. As shown by Martinez-Alier (1987), social energetics—and its focus on energy flows as capable of explaining social and economic processes—has been a structuring thread in the history of ecological economic thought. While much has already been done in this regard, Chapter 5 covers lesser-known bodies of work dealing with social energetics in the 19th century, in particular the Austro-German context, especially by means of the works of Eduard Sacher

and the discussions that took place in the scientific journal of Wilhelm Ostwald, the *Annalen der Naturphilosophie*.

Chapter 6 crosses the Atlantic to search for the roots of North American environmentalism in the context of the emergence of the science of ecology at the turn of the 20th century. The Conservation movement of the Progressive Era is usually associated with a utilitarian conception of nature. A closer look at the movement shows, however, strong support for several initiatives promoting a quite integrative view of the social and the natural sciences. The example of economic ornithology, i.e. the study of birds from an economic point of view, is particularly relevant on the matter.

Chapter 7 assesses what has been called the 'Other Austrian Economics' of Joseph Popper-Lynkeus and Otto Neurath. Neurath's work on the incommensurability of nature has been quite documented. However, his broader *Naturalwirtschaft* and Popper-Lynkeus's proposals to conceive the satisfaction of basic needs in physical and physiological rather than monetary terms certainly deserve more recognition.

Chapter 8 investigates the articulation between evolutionary biology and economics in the late 19th and early 20th centuries, in particular in the writings of Thorstein Veblen and representatives of the home economics movement Ellen H. Richards and Hazel Kyrk. By insisting either on the role of biological instincts in shaping economic behaviour or that of the natural sciences and education in improving consumer expenditures, those thinkers proposed a deep integration between the life and social sciences beyond mere metaphorical imports from biology into economic theory.

Chapter 9 returns to the Russian and Soviet context in the early 20th century, this time to early Soviet ecologists such as Vladimir Vladimirovich Stanchinsky and Daniel Nikolaevich Kashkarov. Large natural reserves for scientific research were created in the 1920s, which served as instruments for designing ecologically sound economic planning programmes. Although early Soviet ecology suffered from the subsequent productivist biases in Soviet science policies, it demonstrated an original way of articulating ecology and economic planning.

Chapter 10 marks the end of the journey, back to the United States, around the articulation between ecology and economics in the land economics movement of the 1920s, 1930s, and 1940s. George Wehrwein and Aldo Leopold, in particular, developed important ideas on how to involve all economic actors, from farmers to consumers, in environmental policies. They considered that economists could not do without the science of ecology.

We wish the reader a joyful experience when reading our history of ecological economic thought. We ourselves did enjoy writing it. In the epilogue, we will turn to what we have learned, as authors, from this exploration. The reader might reach conclusions in addition to ours, which would be very welcome. This is, after all, still a very new field of research.

# 1 Natural History, Botanical Gardens, and Political Economy

As the chronicle of the long history of ecological economic thought begins, it must be admitted that the relationship between production and consumption activities, on the one hand, and the natural environment, on the other, predates by far the industrial period, which flourished in Europe in the late 18th century. However, to talk about economics, ecology, or the environment at a time when these terms did not exist may raise a few questions. Having defined ecological economic thought as a specific kind of cross-fertilisation between natural and social ideas, one might wonder whether it is reasonable to talk about it when scientific disciplines themselves were neither constituted nor well delimited. Certainly, the boundaries between the natural and the social spheres were not always clear in the pre-industrial era. Yet, it enables us to explore corpuses articulating natural and socio-economic issues in a more symbiotic manner, which is a relevant perspective for the history proposed here.

As is usually the case in the history of ideas, a starting point could be located in Antiquity, when Greeks and Romans began to forge the intellectual categories we inherited, including the multifarious concept of nature. One can just as well place the start of one of different possible stories in the 16th century, when the first discourses on modern science emerged, more specifically during the Renaissance and throughout the Enlightenment. Hence, we initiate our exploration of the articulation between a bourgeoning naturalist knowledge, in particular within natural history, agronomy, and physiology, and the newly established field of political economy from the 16th to the early 19th centuries, with a special focus on the 18th century.

A detour through Physiocracy and agronomy is unavoidable, and there are some familiar landmarks here on that matter. We lay focus on natural history in Linnaeus's economy of nature as well as French natural history, in the latter case in connection with the expansion of the *Jardin du Roi* in Paris. Public gardens, as will be shown, have indeed played a crucial role in the development of ecological economic thought in the 18th century. The works of cultural historian Emma C. Spary (2000, 2003) invite us to look at natural history as caught up in economic, political, and social issues, going far beyond species classification.

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## Early developments in natural history

Natural history as a field of knowledge appeared in the 15th and 16th centuries from various concerns about natural riches and their organisation in the world. Swiss naturalist and physician Conrad Gessner's *Historia Animalium* (1551) was one of the first books devoted to the subject. Gessner had a conception of natural history based on the collection of testimonials, without field experiments or observations. He did not limit himself to the description of natural attributes of species; he also listed the myths, symbols, and expressions associated with them (Ashworth, 1996). In retrospection, Gessner's early view of natural history, therefore, was different from more recent frameworks, which draw clear cuts between physical features and social representations.

The definition of natural history as the science describing the physical characteristics of species appeared in the mid-17th century. Symbols and expressions associated with animals and plants were taken out of the naturalists' agenda. Field experiments, which had first been developed in physics and medicine, became commonplace: to be true experts in botany, scientists had to work in gardens, as close to the observation grounds as possible. This methodological proximity with physics and medicine helped natural history become a reference in scientific circles at the turn of the 18th century. Any group claiming to be scientific would have to practise physics, medicine, *and* natural history to gain a reputation. With their transcontinental conquests, European settlers discovered, at the expense of indigenous populations, new worlds to explore, including unknown animal and plant species. Natural history soon became the best ally of these settlers to understand and nominate their surroundings. As made clear by Nicholas Jardine and Emma C. Spary (1996), natural history was located at the centre of the scientific as well as the political game.

As it became more and more popular, natural history turned into a potentially useful discipline not only for scientists, explorers, and conquerors, but also for the typical entrepreneur and merchant. The practical convenience of natural history was first related to botany and medicine: the discovery and study of valuable plants for the purposes of herbalism. In this sense, it is remarkable to note that the first French botanical garden in Montpellier was created in 1593 near the faculty of medicine (Mathis and Pépy, 2017). Throughout the 17th century, agricultural studies were also enriched by additional botanical knowledge aiming to improve the fertility of the soil.

The consolidation of this new discipline occurred in the 18th century, along with the appearance of new methods and tools. Detailed classification of species (in classes, orders, genera, species, etc.) appeared and became the norm. Until then, the organisation of specimens in the so-called 'curiosity cabinets' (*cabinets de curiosités*) did not follow these classifications. Natural and artificial objects were jointly presented, and geographical areas not respected. This was rarely due to clumsiness—catalogues were appropriate—but rather the consequence of a mode of exhibition which emphasised the contrasts

between distinct specimens (Whitaker, 1996). In the 18th century, even the most provincial amateur natural historian became aware of this new way of organising species and objects based on detailed classifications. This advancement was complemented by new quantitative methods to measure anatomical differences or to statistically enumerate populations in a specific place. Mathematics started to pervade most scientific domains; natural history was no exception.

With more sophistication and methodological tools, natural history progressively lost its general character to become a field composed by specific areas of expertise: mineralogy, botany, and zoology. What did not change, however, was the connection between natural historians and political and commercial power. When the first professorship of natural history was created at the University of Ferrara in 1543, Giuseppe Gabrieli had already insisted on the benefits of his field to the yeoman and above all to kings and princes (Findlen, 1996). In the 18th century, European political powers would push for further development in natural history.

This support was supplemented by a true interest from the bourgeoisie and local amateurs of scientific knowledge, especially in the early 18th century. In botanical gardens, although not all employees were scientists, they still participated in the creation of scientific knowledge through their daily operations (Cunningham, 1996). Local farmers also contributed to the constitution of practical experiences in relation to agricultural improvements (Lowry, 2003). In urban communities, objects of interest increased the appeal of natural history, as in the case of the obsession with shell collections (*conchyliomanie*) which made prices skyrocket all over Europe until the bubble bursts of the 1750s (Allen, 1996). Aristocrats and the bourgeois elites wished to impress their friends with large cabinets and ever more extravagant specimens.

## Linnaeus's economy of nature

Swedish scientist Carl Linnaeus played a decisive role in the development of natural history. Born in 1707, he essentially contributed to botany, even though some of his works in zoology also stand out (e.g. Linnaeus, 1751, 1761). He was aware of the pioneering studies that preceded his own work and he understood quite early the need for patrons to fund and publicise his research. He worked in close cooperation with his students, who, after training, were sent all over the world to collect specimens and make observations. Pehr Kalm, a famous 18th-century naturalist, was one of these disciples. He travelled through the American colonies between 1748 and 1751. His diary, translated into English in 1770–1771, would contribute to the recognition of Linnaean science across Europe (Albritton Jonsson, 2015).

Linnaeus's acknowledgement as a fundamental figure in the history of the natural sciences is due to his famous taxonomy of the natural world, divided into three kingdoms (animals, plants, and minerals) and organised in subgroups (class, order, genera, species, etc.). The taxonomical proposal

appeared early on in his career in his *Systema Naturæ* (1735), which was regularly re-edited until Linnaeus's death in 1778. His taxonomy had at least one important economic consequence. It was based on Latin denominations of species, with more systematic and neutral designations in comparison with previous attempts. As a result, natural objects became less imbued with symbols, and this standardisation favoured commercial exchanges (Müller-Wille, 2003).

Linnaeus's taxonomy has certainly been the most diffused and discussed way of arranging the natural world. Competing classifications would appear in the second part of the 18th century and in the early 19th century, when other scientists found the original taxonomy too complex and not adapted to certain areas. Linnaeus's proposal would also soon be deemed inaccurate for classifying species that could be found in different continents—in Linnaeus's system, some designations were geographically specific and hence misleading if individuals of the same species could be found all over the world. Nevertheless, Linnaeus's intuition, according to which universal classifications were the basis of natural history, remained as a cornerstone of subsequent studies in natural history. It is no coincidence that, one century later, Jules Verne would build a character for his novel *Vingt Mille Lieues sous les Mers* (1871), *Conseil*, who, alongside his master professor of natural history, was so overtly fond of classifications. Linnaeus and 18th-century taxonomies shaped the representations of the natural world in a broad cultural sense, moving beyond scientific circles.

To arrange the natural world was not an end in itself for Linnaeus; it was a way of understanding the complex natural order, the harmony between species, and the general balance of nature. In this context, he coined the famous expression 'economy of nature' in *Œconomia Naturæ* (1749), asserting that each species had a role to play in the general arrangement of nature designed by God. Plants, animals, and humans belonged to the same harmonious destiny, shaping the world as we know it.

Linnaeus's economy of nature was an encompassing concept, gathering humans and non-humans in a common conception of nature and recalling in retrospect the more recent concept of biosphere. The economy of nature was also a static concept, which did not provide a true framework to think about the evolution of species, which would come a century later in the writings of geologist Charles Lyell and biologist Charles Darwin (Schabas, 2005). By connecting God's will with the arrangement of the natural world, Linnaeus added a sort of spiritual dimension to his economy of nature contrasting with the purely scientific views of his classification (Rausing, 2003).

In fact, the expression 'economy of nature' can be found in writings predating Linnaeus's contributions, e.g. in Kenelm Digby's works from the 1650s (Worster, 1994; Deneault, 2019). Conceptually speaking, the idea of a great arrangement of the natural world with interdependencies between species goes back to Aristotle. As is well known, the word 'economy' etymologically comes from the Greek *oikos* and *nomos*, meaning the rules and practices for

the good management of the household. In the early 18th century, 'economy' was still associated with this ancient definition. Political economy and economics were still far from being established fields. Therefore, Linnaeus conceptualised the economy of nature in an Aristotelian fashion, meaning the good organisation of God's house, i.e. Earth's nature (DesRoches, 2015). Does it mean that talking about ecological economic thought at Linnaeus's time would be meaningless or misleading? Not insofar as Linnaeus's thought did not limit itself to describing the balances between animals, plants, and minerals, but also aimed at contributing to the development of the Swedish (human) economy.

From the early to the late 18th century, Swedish economic thought was different from the Scottish Classical thinking of David Hume and Adam Smith. German Cameralism, focused on the enrichment of political powers through commercial expansion, was the most influential doctrine in Sweden, with a small inclination to agricultural issues. Swedish scientific and political elites were particularly sensitive to the economic utility of science and to the question of making natural history beneficial to the whole country (Liedman, 1989; Rausing, 2003). Linnaeus had no problem with this position. He participated in the creation of the Swedish Academy of sciences in 1739, sharing its motto of enhancing national prosperity through scientific progress and agricultural improvement (Frängsmyr, 1989). Linnaeus surely considered natural history as a discipline devoted to practical issues, whereas economic studies were the most socially useful application of natural history. Throughout his writings, one can find information about the utility of species not only for the general balance of nature but also for specific human needs. In *Œconomia Naturæ* (1749), for instance, he described the circulation of organic matter and its critical role for maintaining the fertility of the soil (Warde, 2018).

Linnaeus, supported by his patrons and assisted by the observations of his students during colonial expeditions, tried both to improve knowledge on the Swedish territory and to find exotic plants for acclimatisation, what would contribute to the prosperity of his country (Albritton Jonsson, 2010, 2015). The acclimatisation of plants was one of the great fashions of the 18th century, professing that under certain conditions species might be successfully transposed from one point of the globe to the other. It could take time and demand intermediary steps, but its practise presented huge opportunities for Northern countries to strengthen and diversify their agricultural output. Linnaeus saw acclimatisation at first with strong optimism. Soon he had to moderate his enthusiasm, facing severe failures in attempting to tame exotic specimens. However, the general idea that species could be moved and adapted to new climatic environments was something that he constantly kept in mind. Acclimatisation was seen as an appropriate tool to reinforce Sweden's economic independence. In a sense, Linnaeus considered acclimatisation as a substitute for imports (Müller-Wille, 2003), which shows the close relationship between his natural history and his economics.

Because of the economic dimension of Linnaeus's work, some scholars have argued that Linnaeus could be considered as an early economist in the full meaning of the term (Schabas, 2005; DesRoches, 2018). One argument in favour of this interpretation is Linnaeus's role in the creation of many economics-related professorships in Sweden. These positions appeared either as a transformation of natural history courses into practical economic courses or as the direct creation of new chairs in 'economy' during the second part of the century (Liedman, 1989; Koerner, 1996). Linnaeus often appointed his own students to these new chairs—this is how, for example, Pehr Kalm obtained his professorship in Abo. With the exception of Anders Berch, who had been the first Swedish professor of *oeconomiae* at the University of Uppsala, Linnaeus controlled the early developments of the economic discipline in Scandinavia. The opposition between Berch and Linnaeus was not anecdotal; the former paid particular attention to the proto-industrial sectors, whereas the latter considered agriculture as the sole key sector in the economy. At the Academy of Sciences or University of Uppsala, the two men had regular occasions to confront their views on future Swedish prosperity. Berch admitted that natural history had a role to play in economic knowledge, although he also argued that law, political mechanisms, trade, and industry were topics needed in academic curricula (Liedman and Persson, 1992). This contrasted with Linnaeus's stance, who basically limited economic science to the practical side of natural history.

## Political economy at the *Jardin du Roi*

Linnaeus was not the sole natural historian in vogue in the 18th century. In France, Georges-Louis Leclerc de Buffon, born in 1707 (same year as Linnaeus), achieved similar fame. The first edition of the initial volumes of his masterly *Histoire Naturelle* (1749)—the full collection would contain 36 volumes published from 1749 to 1789—was sold in record time, showing Buffon's ability to reach a wide audience beyond scientific circles (Spary, 2000). Buffon was a declared opponent of Linnaeus, contesting his classification of specimens and showing a clear ambition to explore the dynamic evolution of the Earth in opposition to the latter's static balance of nature. Buffon even challenged the idea of a harmonious natural order designed by God. Instead, he favoured a constructivist view of natural arrangements, i.e. the natural scientist's task was not to reveal God's will and organisation, but to unveil our own understanding of the natural world as necessarily tied to intrinsically human cognitive capacities and conceptual categories (Maas, 2003).

As Linnaeus in Scandinavia, Buffon was the great architect of natural history in France. He was inclined to move the naturalist agenda beyond purely physical and botanic work to include philosophical, historical, and cultural discussions. For instance, his research on climatic conditions was related to their impact on culture and society. When he examined animals, he referred to social and ethical analogies in an old Gessner-like manner. Buffon's natural

history, however, was deeply modern in methodological terms. He considered experimentation and observation as critical for scientific research. This led him, early on in his career, to take after René-Antoine Ferchault de Réaumur in his empirical examination of optimal exploitation of woodlands in the long run—although he did not complete such experiments (Peyron, 2012). This occasion prompted Buffon to take part in the development of an important botanical garden in the heart of Paris, the 'King's Garden of Medicinal Plants' (*Jardin du Roi des Plantes Médicinales*).

The *Jardin du Roi* had been created in 1635 by a royal edict of Louis XIII. Botany, chemistry, and medicine were the sciences which occupied those in charge of the garden, despite a few clashes with competitors from the University of Paris. In the late 17th century, Jean-Baptiste Colbert started supervising the garden, whose team included future great names in French natural history such as Guy-Crescent Fagon and Bernard de Jussieu. In 1718, the *Jardin* lost its explicitly medicinal character to become the 'Royal Garden of Plants' (*Jardin Royal des Plantes*), offering an opportunity for natural historians to move beyond anatomy and medicine. Buffon was appointed *intendant* of the *Jardin* in 1739.

He quickly transformed the area in one of the most advanced research institutions in Europe. New buildings and cabinets were built, new trees and acclimatised specimens were planted, and acres of land were added to the grounds of the *Jardin*. Buffon had the ability to obtain strong financial support from the Court and other patrons who believed in the economic and educational benefits of natural history. Building and maintaining a great botanical garden were key for the development of new experiments and the overall advancement of the discipline. The *Jardin du Roi* became such an indisputably great scientific reference that it survived the French Revolution, turning into the 'National Museum of Natural History' (*Museum National d'Histoire Naturelle*) in 1793, a centre of attraction for eminent scientists of the early 19th century. The *Museum* is still today an important French research institution in the natural sciences.

Buffon developed natural history at a time when political economy was also emerging in France. The school of the Physiocrats, notably represented by François Quesnay (1758), was taking over old mercantilism. Although economists were not yet organised as an autonomous group of scholars, Physiocrats were already known as *les économistes*. They actually invented the expression 'economic science,' whereas they preferred 'political economy' as the designation of their research agenda (Faccarello, 1992). As Emma C. Spary (2000) has argued, 18th-century French natural history was closely related with the emerging science of political economy. In the lineage of Buffon (and Linnaeus), it encompassed topics of investigation which deeply interested the representatives of political and economic power (e.g. acclimatisation, climatic influence on society, agricultural improvement). The King did not only fund the *Jardin du Roi*; he also considered it as a place dedicated to his own empowerment. Many royal seedbeds spread across the French territory thus saw

their planting programmes guided more by economic and military concerns than by natural history as an end in itself (Mathis and Pépy, 2017). While the *Jardin du Roi* enjoyed a high level of scientific autonomy, it was also subject to the priorities of the Court.

Natural history was clearly perceived as a discipline providing useful knowledge to economic activity. All over Europe and particularly in France, agricultural improvement was seen as the main field of application of natural history. Supporters of this doctrine, consisting in rationalising husbandry and selecting the best seeds, would recurrently link political economy, rural economy (i.e. the examination of the riches of the countryside), and the economy of nature in a Linnean sense. Other sectors were also involved in the discussion. Geology, for instance, became increasingly appealing for mining companies: better knowledge of rocks and minerals was key to finding the richest deposits and to making extraction as efficient as possible (Guntau, 1996).

Political authorities, guilds' leaders, and entrepreneurs definitely pushed for enhancing the economic function of the natural sciences. This was also an initiative of natural historians themselves, starting with Buffon. When they looked for patrons, they did not hesitate to highlight the potential applications of their research for agriculture, mining, and conquest expeditions. This assumed link between natural history and economic studies would remain in vogue in the early 19th century, also beyond the French context (Larsen, 1996). In 1818, naturalist George Graves would open his *Naturalist's Pocket-Book* with these words:

> The advantages arising from the study of Natural History, being so important, we cease to wonder that men possessed of great mental discernment, should have devoted their time and attention to endeavour by promoting the knowledge of its different branches, to add to the comforts and happiness of their fellow men. To insist on the benefits derived from only a partial or superficial acquaintance with the subjects, must be esteemed unnecessary, as our food, clothing, and every domestic convenience, are all derived from one or other branch of this science.
>
> (Graves, 1818, p. 1)

As mentioned above, medicine undoubtedly was the first useful application of natural history, soon accompanied by agricultural studies. Louis Feuillée (1714) related the quest for medical plants to colonial expansion. He explained that the wealth which could be extracted from them could be larger than those from the mines (Spary, 2003). Useful plants were called 'economic plants' and the territorial expansion of European nations was intertwined with naturalist knowledge: the directions taken by conquerors oriented natural historians in their research and, conversely, conquerors could make detours and change their plans to search for new specimens as potential sources of wealth. The creation of the 'Committee of Agriculture' (*Comité d'Agriculture*) in 1785

reinforced the French authorities' interest in exotic plants, imported from colonial territories and contributing to the national prosperity (Spary, 2000).

At first glance, French natural history had the same characteristic as Linnaeus's economy of nature: its concrete, economic applications seemed limited to agriculture and mining, and pursued at the expense of industry. At the *Jardin du Roi*, however, industrial concerns were not absent. Public authorities regularly mandated French naturalists to investigate certain sectors (e.g. Louis Jean-Marie D'Aubenton for the wool industry). Research on new fibres for the textile industry was undertaken at the botanical garden, demonstrating capacity in fields of application beyond traditional agricultural sectors.

Notwithstanding the proximity between natural history and political economy, not all natural historians and political economists shared the same ideas and objectives. As Fredrik Albritton Jonsson (2010) reminds us, 'rival ecologies' existed in the 18th century, and some naturalists were not fond of economic applications, preferring to do science for its own sake. Opposing views to Graves's would also appear in the early 19th century, such as German naturalist Lorenz Oken's 1809 discourse promoting a discipline disconnected from commercial, medical, and agricultural applications (Jardine, 1996). While 18th-century natural history certainly belongs to the history of ecological economic thought, not all practitioners agreed with the connection forged between the natural and social sciences.

Another type of relation between French natural history and political economy can be found in the representation of the botanical garden as a utopian small world (Spary, 1996, 2000). The *Jardin du Roi* was not only an experimental station, but also a place full of symbols which could be extended to the whole of society. In a time when Voltaire (1759) made *Candide* say that we should 'take care of our garden,' the area of botanical gardens became more than just a planting site. The *Jardin du Roi* appeared as a place of good management, where natural riches were productively cultivated and visitors were invited to wander around according to specific rules, which still today manifest themselves in the typically Parisian practice of keeping pedestrians off the lawns of public parks. The economic discourse at the *Jardin du Roi*, being a mix of political and natural economy, touched upon nature, the individual, and society as a whole. During the French Revolution, naturalists implied that the regeneration of the nation could be informed by their expertise on the generation, degeneration, and regeneration of plants and animals. The garden was, in their minds, a model to emulate at the national level.

The activity of gardening conveyed a representation of nature imbued with human intervention and design. As in agriculture, the garden produced plants under human supervision and control, but with a wider scope than the production of food. To consider the garden as a prototype of the entire world led to a truly economic view of the relationship between humans and nature (DesRoches, 2015).

The last type of connection between natural history and political economy consists in the interpersonal relationships which existed between some

naturalists and early economists in the 18th century. From the 1760s to the 1780s, political figures and economists such as Anne Robert Jacques Turgot and Henri Léonard Jean Baptiste Bertin served as patrons of many naturalists. They were particularly interested in acclimatisation programmes and agricultural applications of natural history (Spary, 2000). Moreover, they shared views and opinions with their *protégés*, what contributed to the cross-fertilisation between natural history and political economy.

Members of the staff of the *Jardin du Roi* also participated in the links between naturalists and economists. André Thouin, who was in charge of the worldwide network of experts set up by the institution, soon became known as the chief economist of the *Jardin*, managing funds and detecting the most promising specimens for economic use in the many samples sent by his correspondents (Spary, 2000). Thouin had close friends in the emerging political economy circles. Mastering botanical economics, i.e. the trade of exotic plants, was a source of power in late 18th-century France. Thouin thus had his seat among the French commercial experts of his time, showing how natural history and political economy could merge in the context of the search for more national prosperity.

## Physiocracy, agronomy, and physiology

Political economy in 18th-century France had Physiocracy as the main intellectual current. Bearing in mind that the role of the Physiocrats in the history of ecological economic thought has already been addressed (e.g. Christensen, 1994), the purpose here is to establish in more detail the Physiocrats' interest in natural history and agronomy and the specific role played by physiology in the articulation between the natural and social sciences at the time.

The Physiocrats' intellectual framework consisted in locating the origins of the social order in the natural world. In the long history of ideas (e.g. Lockean republicanism), a natural order related to moral considerations has recurrently been advocated to justify certain institutions, as in the case of the link between personal merit and property rights (Charbonnier, 2020). The Physiocrats, however, did not exactly share this line of thought: to them, such an order was not anchored in moral or transcendental preoccupations, but rather in direct physical characteristics. The natural order for the Physiocrats was, before any ethical concern, a material order in the physical sense of the term. As a result, Quesnay and his colleagues sought to establish economic laws on the basis of natural dynamics. They put nature at the heart of the economic system.

The Physiocrats were particularly interested in phenomena occurring in the natural world, although they were not (or rarely so) natural scientists themselves. They insisted on the dependency of the economic system on biophysical flows; nevertheless, they were not experts in the examination of these flows. To gain knowledge about them, they referred, often implicitly, to studies in natural history.

It is well known that the Physiocrats claimed that agriculture was the sole true source of wealth, thanks to the natural self-generation of crops. They did not mean that the class of farmers was more talented or able than others to produce economic surplus, but simply that farmers were the only ones to benefit from the capacity of organic matter to grow and multiply. Although the historiography usually emphasises agriculture as the only key element in the Physiocratic system, a more accurate view should add all primary sectors, insofar as the Physiocrats also saw fishing and mining as productive activities in a material sense (Banzhaf, 2000). In the 18th century, agriculture and other extractive occupations undoubtedly constituted the core of the economy. Almost 70 per cent of economic efforts were devoted to the production or conservation of energy, especially in the form of food (Kander *et al*., 2013). It is then no surprise that the Physiocrats insisted on primary sectors as the mainstay of economic dynamics. It is likewise no surprise that they participated in the promotion of agricultural improvements by means of agronomy and associated branches of natural history, focusing not on the preservation of natural resources and landscapes but on their maximum exploitation and use (Wolloch, 2018).

Besides agronomy, another field deserves to be mentioned here as influential. Physiology, a subdiscipline hitherto associated with medicine and chemistry, made important progress from the 16th to the 18th centuries. While Galileo transformed astronomy, William Harvey revolutionised the conception of animal bodies with his examination of the circulation of blood (Cohen, 1994). This concept of circulation profoundly influenced the emerging social sciences in the 18th century, including Quesnay's Physiocratic view of the economy. Quesnay was a doctor before he became a political economist. He studied physiology early on in his career and would soon publish his *Essai Physique sur l'Œconomie Animale* (1736). Searching for the physical principles governing physiology, Quesnay explored various theories related to the circulation of blood.

Quesnay was not the only political economist interested in physiology. Boisguilbert had been particularly fond of Harvey's theories, which influenced his conception of production, circulation, and consumption of wealth (Christensen, 2003). Furthermore, Evelyn L. Forget (2003) has shown the continuity between Scottish physiology and David Hume's and Adam Smith's social theories. The articulation between the natural sciences and economics in the 18th century was thus not limited to agronomy or natural history. Physiology played a key role.

However, the relationship between physiology and political economy needs to be questioned with regard to its analogical or more substantial status. Quesnay's rapprochement between the circulation of blood in physiology and the circulation of riches in the economy was essentially analogical. His point was not that blood (or other natural fluids) actually circulated in the economy or directly exerted an influence over economic mechanisms. Moreover, his identification of different categories in the economic circuit

resembles different organs in a body, which also constitutes an analogical, or metaphorical, connection. At first sight, Quesnay's reference to physiology thus falls outside our scope.

Nevertheless, 18th-century political economy did refer to medicine or physiology in more substantial terms. In Quesnay's *Tableau économique* (1758), the circulation of wealth was possible thanks to an initial impulse provided by 'advances' which would be reconstituted throughout the entire process. What permitted the reconstitution of those advances in Quesnay's framework was the natural capacity of the agricultural and extractive sectors to produce material (and economic) surplus. In other words, the natural world allegedly played a critical role in the impulse to the whole circulation of wealth. Quesnay deduced this original impulse from his research in physiology, while finding that the heart was the human organ providing impulse to blood circulation (Banzhaf, 2000). The boundary between an analogical and a substantial rapprochement is narrow here. That Quesnay concluded from physiology that an impulse to the circulation of any (natural or artificial) riches must come from the natural world cannot be reduced to an analogy between the natural and social sciences. A biophysical basis is markedly present in his economic conceptions, bringing yet another discipline in addition to natural history and agronomy into the early history of ecological economic thought.

# 2 Economic Development in German *Naturphilosophie*

It is hard to underestimate the importance of German Idealism to modern intellectual history. Taken as a more general philosophical movement from the 1770s to the 1840s, it has been compared to 'the golden age of Athens in terms of its stature as a cultural phenomenon' (Ameriks, 2000, p. 1). Its contributions to the understanding of the relations between natural history and political economy have been given by means of the natural philosophies (*Naturphilosophie*)—the 'scientific branch of Idealism' (Watson, 2010, p. 228)—of thinkers such as Johann von Goethe and Alexander von Humboldt. In a broader context, such contributions can also be found—although to a lesser extent—in British Romanticism, particularly in the works of poets Samuel T. Coleridge and William Wordsworth (Levere, 1981; McKusick, 1996; Becker *et al*., 2005; Connell, 2005).

*Naturphilosophie* was actually an amalgamation between two main, often converging currents. On the one side, the Romanticism of Goethe, Hölderlin, Novalis and others amongst the so-called Jena Romantics, which opposed French Enlightenment in its approach to reason and objective reality in favour of the role of instinct, emotion, and creativity in an inward-looking transcendental world (see Becker, 2003; Becker and Manstetten, 2004). On the other, the idealist worldview stemming from Johann Gottlieb Fichte's rather subjective scientific doctrine (*Wissenschaftslehre*) and ultimately inspired by Immanuel Kant's critical philosophy, which conversely would morph into an absolutist type of idealism (peppered with elements of Spinozean realism and resembling Leibniz's concept of monads), best represented by Friedrich von Schelling (2004 [1799]). Inorganic, organic, and human consciousness would teleologically (i.e. in view of divine goals or ends) combine into a unity. When applied to the articulations between natural history and political economy, or when related to more theoretical issues such as those pertaining to the concept of energy, this *Naturphilosophie* would provide a long-standing holistic framework posing as a significant contribution to ecological economic thought.

Other influential thinkers who corroborated a holistic approach to philosophy and science were Gotthold Lessing and Moses Mendelssohn, who rejected Newtonian laws as a framework to assess living nature in favour of

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immediate experience and the teleological aspects of biological and social development. Johann Blumenbach, Johann Reil, and Carl Kielmeyer were also distinguished advocates for the need to address organic structures in terms of complex interdependencies and teleology as opposed to mechanical, linear causal relations. In addition, the German historicist tradition of Johann Herder and Leopold von Ranke would reinforce the primacy of contingency, organisation, and development over Enlightenment's eternal laws (Iggers, 1967). As the organic approach could best explain living nature, so would history be in the best position to address social processes. Thus, German historicism—and the notion of the unique historical development of Germany—was interconnected with the ascendance of this holistic worldview, which, in turn, would also appear in the German Historical School of economics and the organic view of the economy in the *Volkswirtschaft* of Karl Rau, Wilhelm Roscher, Karl Knies, and Gustav von Schmoller (Hutter, 1994; Watson, 2010).

Notwithstanding Goethe's acclaimed legacy as a literary writer and poet, he held a lifelong interest and substantial incursions in the natural sciences. He took courses in history, anatomy, chemistry, and political science at the University of Strasbourg, and his scientific works range from methodology to physics, botany, zoology, morphology, geology, and meteorology (Goethe, 1995; see also Heisenberg, 1968; Amrine *et al.*, 1987). Because of his acquired fame after the publication of *The Sorrows of the Young Werther*, Goethe became a friend and policy adviser of Karl August, Grand Duke of Sachsen-Weimar-Eisenach, when he had the opportunity to look into issues related to infrastructure, mining, forestry, parks, defence, taxation, and treasury. In turn, such duties would deepen his fondness for the natural sciences, which included the assembly of an astounding *cabinet de curiosités* and an avid appetite for Linnaeus's works, not to mention the epistolary exchange between them (Larson, 1967; Watson, 2010).

Goethe was the quintessential Romantic scientist. He was wary of Enlightenment's reliance on experimentation as a source of knowledge and the Cartesian paradigm, focusing instead on nature's constant change from primitive to more organised forms, which were perceptible not only by means of observation, but also through human imagination (Brady, 1977). Matter and mind would be different sides of the same force (*Lebenskraft* or *Bildungstrieb*); thus, reality would be intelligible for scientists and artists alike. The key issue was to unveil the causes of variations leading to organising processes in the natural world. In this context, 'biology was the paradigmatic discipline in Romantic science' (Watson, 2010, p. 199; see also Richards, 2002). From the classification of fundamental archetypes in living nature to the understanding of reality as a process subject to underlying evolutionary and developmental forces, this worldview, which traces back to Kant and oriental philosophy, rejected the Cartesian mechanical framework and prioritised the 'aesthetic comprehension of an entire organism' (Watson, 2010, p. 201) over the analysis of its respective parts.

## Goethe and the birth of German energetics

Before delving into Goethe's—and, after that, Humboldt's—contributions bridging natural history and political economy, it is worthwhile to introduce Goethe's worldviews regarding the concept of energy or, equivalently, of force (*Kraft*). The term energetics was coined by William Rankine in the 1850s and is to be understood as a synonym to the later widespread concept of thermodynamics, although the laws of energetics are broader in scope, in the sense that they address how energy is transformed or exchanged according to different methodologies. Social energeticists thus apply thermodynamic principles to social systems, assessing the flows and stocks of energy that shape and condition the functioning of human societies.

The consolidation of thermodynamics as a prosperous field of knowledge along the 19th century was at once cause and consequence of its implications to social and economic issues (Daggett, 2019). In the early 1880s, social energetics appeared as the systematic accounting of energy flows in agriculture undertaken by Ukrainian physician Sergei Podolinsky and Austrian professor Eduard Sacher. A few years later, Wilhelm Ostwald would stand out as one of the main advocates for social energetics, acting as the leading figure of Ernst Haeckel's Monist League and as founding editor of the acclaimed periodical *Annalen der Naturphilosophie*, a vehicle for key works on the philosophical repercussions of the then recent theoretical developments on energetics authored by figures such as Georg Helm, Oskar Nagel, Ernest Solvay, and Johann Žmavc.

During its existence (1902–1921; the 1913/1914 and 1914/1917 volumes were published as *Annalen der Natur- und Kulturphilosophie*, co-edited with Rudolf Goldscheid), the *Annalen* published several essays (e.g. Lucerna, 1911; Hirsch, 1912) and book reviews (mainly by Ostwald) on the relevance and legacy of Goethe as a natural philosopher, reflecting a broader intellectual interest at the time in the poet's scientific and philosophical works (e.g. Magnus, 1906; Boucke, 1907; Förster, 1909). In particular, although Goethe obviously preceded the formulation of the laws of thermodynamics (the first law was proposed in the 1840s by Julius Robert von Mayer and the second one in the 1850s by Rudolf Clausius) and hence did not engage in any sort of energetics *per se*—let alone social energetics—his insights about the role of energy in the development of physical, biological, and human phenomena inspired a rich intellectual tradition in the history of ecological economic thought.

One of Ostwald's book reviews in the *Annalen* illustrates Goethe's influence over German energeticists, in which he affirmed to have had himself held a lecture in Berlin on Goethe as an energeticist (Ostwald, 1917). Despite his very unfavourable view of Carl Horn's (1914) *Goethe als Energetiker*, especially regarding the latter's differentiation between an organic, on the one side, and a physical and mathematical energetics, on the other, Ostwald concurred with Horn on Goethe's monist view of nature and his forewarning of the energy conservation law. Ostwald (1918, 1932) not only called attention

to the poet's early scientific insights in the fields of chemistry, biology, and optics, but also to his prophetic views on energetics made explicit in *Faust*. Ostwald portrayed the role of Goethe's main character as a hydraulic engineer (*Wasserbauingenieur*) as the pinnacle of his existence, draining marshes and controlling floods, and above all claiming for the utilisation of the free energy provided by nature. Ostwald (1932, p. 37) sees his own energetic imperative—'do not waste energy, make use of it!' (*Vergeude keine Energie, verwerte sie!*)—being anticipated by Goethe, 'the prophet,' in the beginning of the previous century. Goethe would have not only predicted the role of energy for human development, but also hinted towards technical progress as a means leading to this bright future (for an account relating nature, technology, and endless economic growth in Goethe's Faust, see Binswanger *et al.*, 1990).

Notwithstanding Ostwald's unsavoury review of Horn's book—physicist Felix Auerbach (1914), another well-known thinker who contributed significantly to the development of energetics, was also not impressed by it—it brings further elements which qualify what could be dubbed as Goethe's 'protoenergetics.' Horn based his work on the views of the well-known German physicist and physician Hermann von Helmholtz, who succeeded Mayer in his contributions to the understanding of energy conservation and transformation into work. Helmholtz (1903) alluded to Goethe's Earth Spirit in *Faust* as a representative of organic life, characterised by processes which actually led him, and Mayer before him, to his assertions on the general law of energy conservation. Goethe would have been aware of the notion of a constant overall amount of energy or 'acting force' (*wirkunsfähiger Triebkraft*) (p. 360) in the world as well as of its different types and constant transformations between them (movement, heat, chemical bonds, etc.), intertwining the living and non-living realms.

Horn (1914, p. 6) linked Goethe's view on how energy transformation played a role in the development of living nature—he refers to Goethe also as a 'bioenergeticist' (*Bioenergetiker*)—to posterior work in physiology. Nevertheless, a physical, inorganic approach to energetic processes would have taken the lead at the end of the 19th century. This perceived separation of energetics into physics and physiology was a source of criticism from Ostwald, although Horn had not deviated from a monist view of nature. In fact, Horn stressed the all-encompassing reach of the concept of energy, including 'the meaning of energetics for economics' (*die Bedeutung der Energetik für die Nationalökonomie*; p. 21). Analogously, to Camilla Lucerna (1911), Goethe devised a dynamic, evolving, process-oriented 'organic whole' (*organisches Ganze*; p. 199) which extended to human (*sinnlich*) and cultural (*sittlich*) phenomena.

Horn draws even closer to the contemporary notion of social energetics when he depicts the connections between Goethe's, Mayer's, and Helmholtz's writings with respect to the energy flow from the sun to Earth, its transformation from light to heat and movement, how it can be stored, and how plants and animals make chemical use of it for their own development.

Horn (1914) added that, based on Goethe's belief in an eternal process of energy transformation, leading to more organised, 'differential' outcomes (*differenzphänomen*; p. 32), he would not have agreed with the 'senseless consequence of the heat death of the universe' (p. 34) as predicted by the entropy law.

From a more practical perspective, i.e. affecting the daily activities of living beings in their exchanges with the environment, Horn turns to Goethe's *Wilhelm Meister's Lehrjahren* to present the latter's call for physiological (or metabolic) balance and moderation, according to a budget (*Etat*)—Mayer also used this analogy between physical, biological, and economic phenomena—built around forces expressed as 'income' (*Einnahme*), 'savings' (*Ersparnis*), and 'expenditure' (*Ausgabe*) (pp. 38–39). In this context, 'high expenditures must be compensated by savings' and 'although nature has a certain budget from which it conveniently covers its expenses, income is not fully absorbed by expenditures so that something is not left for use as ornament' (Goethe, 1868 [1806], p. 259). The harmony between these forces would correspond to a healthy organism both at the individual and collective levels as well as to the prevalence of diversity in terms of the structures which weave it together. To Horn, Goethe's scientific thinking is marked above all by notions associated with 'the "budget," with constancy, integration and functional diagnostics, with the meaning of symptoms, and particularly with cycles' (1914, p. 35).

## Goethe's political economy

Circling back to how Goethe interconnected natural science and political economy, Myles W. Jackson (1992) addresses this interplay in 18th-century German Cameralism as the use of knowledge about nature to manage State affairs and expand the wealth of the nobility. The case of Goethe and Karl August would be representative in this regard, as the scientific understanding and achievements of the former served the economic, administrative, and political purposes of the latter, corroborating the Linnaean notion of 'economy of nature' (although not so much in the teleological sense, i.e. that nature's God-given purpose would be to serve the human economy). Inspired by the Physiocrats, Goethe transposed his views on nature (*Naturanschauungen*) onto the social world, construing economic and administrative theories and exercising his policy-related duties as they would be given by natural laws (Binswanger, 1994). To him, '[e]ven what is most unnatural is nature. The one who does not see her everywhere sees her nowhere clearly' (Goethe, 1995 [1783], p. 3). Consequently, investigations on nature, the State, regional management, and social life needed to take into account organising principles dictated by the tenets of *Naturphilosophie*.

Goethe's need for practical, managerial knowledge on the economy of nature involved analogical as well as deeper entanglements between the natural and social sciences. Often combining elements from Physiocracy and

German Cameralism, Goethe made extensive use of tools or concepts such as the above-mentioned budgets and balance sheets as a means to assess, bring order, or systematise natural and social phenomena: either physical processes (water systems, forest and crop management, mining techniques) or financial flows in monetary units, both in constant motion towards/from equilibrium and propelled by *Bildungstrieb*. The application of hydraulic principles for extracting minerals was referred to as the economy of water (*Wasserwirtschaft*), both in the sense of accounting for the distribution of water in the mine and for the financial implications of this technique to the wealth of the State. The economy of nature (*Ökonomie der Natur*) was thus ultimately a natural law which guided the improvement of human economies through the analysis of its organisation, flows, stocks, and balance. Such budgets and balance sheets epitomised Goethe's articulation between knowledge pertaining to the natural world and political economy, being prompted by his duties as policy advisor and grounded in his holistic *Naturphilosophie* (Jackson, 1992, 1994).

## Humboldt on natural wealth, economic prosperity, and institutions

While most Jena Romantics and natural philosophers neither pursued positions as civil servants nor focused on the state in their intellectual work, Goethe's interest in the relations between nature and political economy was shared by at least another prominent figure amongst German idealists, the well-known Prussian geographer, naturalist, and explorer Alexander von Humboldt. Alongside his older brother, linguist, statesman, and education reformer Wilhelm von Humboldt, he abided by the precepts of Schelling's *Naturphilosophie* and took to heart the latter's 'aesthetics of nature' (Richards, 2002, p. 134), ascribing an active and creative role to the natural world or *Kosmos* (Humboldt, 1811, 1858, 2014 [1807]).

Humboldt and Goethe were close friends and reciprocal admirers (Schmuck, 2018). The first of Humboldt's publications on his expeditions in America was dedicated to Goethe, who, in turn, called him a hero to be praised in prose and poetry. Although Humboldt agreed with Goethe's stance on the aesthetical aspects of science, he would confer a particularly high value on rigorous observations of nature—especially by means of instruments, maps, graphics, and other quantitative tools—and the consequent generalisation and verification of results. Humboldtian science sought to unveil universal laws and underlying causes of interconnected natural and social phenomena. His obsession with exploratory expeditions, which stemmed from an early fondness for natural history, mixed a Romantic approach towards the natural world and more practical outcomes, such as social prestige in the Court of Weimar and politically and economically useful findings, including 'issues of health and disease, racial diversity, tradable commodities as well as colonial administration' (Buttimer, 2001, p. 106).

Humboldt focused less on teleology and more on cross-influences between humans and their environment. Assessments on the geographical distribution of plants—whether a given plant species appeared dispersed or in large, continuous tracts of land—would provide valuable information related to human settlements, national borders, cultural differentiation, and the dynamics of war and land conquest, as vegetation posed obstacles to agriculture, communication, and commerce. In his mind, agriculture was the link between plants, politics, and the economy (Wulf, 2015). Human progress would be associated with a process of replacing traditional plant species with those more amenable to human life (e.g. the clearing of forests in Germany led to less humidity and bogs and thus to the replacement of moss with more useful species). In contrast, plant species were more scattered in dense tropical forests, where the ready supply of food, if not for other immediate dangers, would lead to very different types of social provisioning and cultural development. Climate and soil were key elements in human history; different environmental conditions could explain, notwithstanding the role played by cultural norms, exceptions to Lord Kames's stadial theory of social evolution (as in the case of the absence of a pastoralist age in the American continent) (Humboldt, 1805; see also Glacken, 1996). Nevertheless, Humboldt believed in social progress, being impressed by the ideals of the French and American Revolutions. He stood against colonialism, slavery, and Eurocentrism in favour of cultural relativism, exemplified by the differences and similarities between the greatest human civilisations in history (Buttimer, 2001).

In the same vein, Mauro Boianovsky (2013) discusses the connections between Humboldt and Classical economists in the context of natural resources, institutions, and growth. Some of the volumes of the travel reports prepared by Humboldt (1811) combined into his *Political Essay on the Kingdom of New Spain*, a compilation of biophysical data, demographic and socioeconomic information, public finance, and economic activity, as well as a sort of manual for the economic development of Mexico in the event of its independence from Spanish rule (Walls, 2009). Drawing from physical and social geography in what could be seen as an early form of regional science, Humboldt's ideas on the relation between natural wealth and economic prosperity were based on his observations in Mexican territory during the 1800s, amounting to 'an investigation of the causes which have had the greatest influence on the progress of the population and national industry' (1811, vol. 1, p. 1). To a lesser extent, he also studied Cuba and Venezuela in this perspective. Curiously, his discovery of extensive guano reserves in Peru and their potential use as fertiliser led to a more direct impact over economic activity, as the demand for this commodity boomed at the turn of the 19th century (Helferich, 2004).

Elaborating on Montesquieu's theory on the influence of the environment over human character, Humboldt deemed that the paradoxical negative relation between natural wealth and human development in the Spanish colonies, at least in comparison with the more advanced North American

economy, could be attributed not only to biophysical, but also to institutional factors (amongst the latter stimulus for land cultivation, taxation schemes, and trade monopolies):

> If the political force of two states depended solely on the space which they occupy on the globe, and on the number of their inhabitants; if the nature of the soil, the configuration of the coast; and if the climate, the energy of the nation, and above all the degree of perfection of its social institutions, were not the principal elements of this grand dynamical calculation, the kingdom of New Spain might, at present, be placed in opposition to the confederation of the American republics. Both labour under the inconvenience of an unequally distributed population; but that of the United States, though in a soil and climate less favoured by nature, augments with an infinitely greater rapidity.
>
> (Humboldt, 1811, vol. 1, pp. 13–14)

This view challenged the understanding of economic progress based on the availability of natural resources postulated by David Ricardo; on the other hand, the theories of renowned figures such as John Stuart Mill and Thomas R. Malthus would abide by Humboldt's observations and explanations. His findings on income inequality, land distribution, production conditions, and population growth in Mexico would support Malthus in his assertion that soil fertility was connected with underdevelopment in the absence of effective demand; Mill (and Adam Smith before him) conversely focused on the perverse effects of natural bounty over institutions and the associated 'supply of effort,' i.e. the meagre disposition of inhabitants to contribute to economic progress due to a poor institutional framework (Boianovsky, 2013, p. 60). In this respect, institutions inherited from a past of authoritarian rule did not help the Mexican population to escape its degraded condition. To Humboldt (1811, vol. 1, p. 14), the 'wise and humane' Spanish laws offered little assistance in this regard, as the kingdom of New Spain suffered 'from the great distance of the supreme authority.' Alternatively, Mexico had an advantage over the United States, namely the very low numbers of slaves. He saw it as 'an advantage which the European colonists have only begun rightly to appreciate,' as 'the fear of physical evils acts more powerfully than moral considerations on the true interests of society.'

Humboldt was also intrigued by the influence of a boom in the extraction of metals over agriculture and manufacture. Against the consensus view at the time and based on measurements having wheat as a common unit, he concluded that the main economic activity in Mexico was not gold and silver mining, but agriculture, regardless of the fact that the latter was yet far from what it could have been. Moreover, he saw no trade-off between these two undertakings, as mining was restricted to a small portion of the territory and actually fostered cultivation of land through its demand for food. Again, he blamed the misguided institutional arrangements and their ill-fated

impacts over individual behaviour, which prevented higher rates of population growth, wealth distribution, and transport infrastructure so as to create a reasonable aggregate demand for agricultural products:

> Notwithstanding the difference of climate and other local circumstances, Mexican agriculture is fettered by the same political causes, which have impeded the progress of industry in the Peninsula. All the vices of the feudal government have passed from the one hemisphere to the other (…). The property of New Spain, like that of Old Spain, is in a great measure in the hands of a few powerful families, who have gradually absorbed the smaller estates.
>
> (Humboldt, 1811, vol. 3, p. 101)

As far as the production of gold and silver goes, Humboldt saw the emphasis on money as an illusory praise for the 'nominal value of things' in opposition to the real, 'intrinsic worth of metals, their relative utility, and the influence which they possess on manufacturing industry' (p. 104). In this sense, precious metals were overrated; 'the general interest requires a preference to be given to those vegetables which supply nourishment to man over those which are merely objects of exchange with strangers' (p. 105). Although trade could supply what Mexico could produce internally, there was always the danger of interruption due to war and ensuing price spikes. Focus should lay on subsistence—i.e. agriculture and industry—as 'true wealth consists in the abundance of objects of consumption, in that of *things*, and not in the accumulation of the *sign* by which they are represented' (p. 106, italics in the original).

In short, the holistic approach to science of Goethe and Humboldt presented above, which relied on the *Naturphilosophie* of Schelling and others, constitute not only a clear instance in which knowledge from fields within the natural sciences were effectively applied to issues pertaining to political economy, but also a distinguished and long-standing view on human-nature relations which cannot go unnoticed in the history of ecological economic thought.

# 3 Chemistry and Agriculture Reconsidered

The 19th century was a moment of scientific revolution. As already discussed, natural history and botany were then at the peak of their development. Chemistry also experienced tremendous changes, particularly in the last decades of the 18th century. Residues of old alchemy and vitalist theories, according to which living organisms existed because of a mysterious vital force animating the circulation of basic elements, had been taught for a long time. There had been, in a sense, something magical in the understanding of chemical processes, something that could not be rationally explained.

At that juncture, a new generation of chemists, including Antoine Lavoisier, established new principles for the science of chemistry based on observation, facts, and experiments. At the same time, Classical political economists such as David Hume and Adam Smith followed with attention the development of chemistry, in particular for agricultural purposes (Argemí, 2002; Warde, 2018). They did not draw from it important lessons for their economic theories, although other thinkers with backgrounds in either chemistry or political economy did try to be more ambitious in the articulation between new knowledge about the conservation and circulation of elements and reflections about social provisioning.

These alternative proposals, from the late 18th to the mid-19th centuries, fit well in the history of ecological economic thought. We focus on episodes such as the implications of the law of conservation of matter for economic thinking, as understood by Lavoisier and the French industrialist Jean-Antoine Chaptal; the development of economic thought in the context of 19th-century agronomy, in particular the work of French socialist theoretician Pierre Leroux, who was inspired by agricultural chemists such as Jean-Baptiste Boussingault and Justus von Liebig; and the intersection between agricultural perspectives and the British sanitary movement in the 19th century in the work of Edwin Chadwick. After venturing into natural history, botany, physiology, and energetics, we turn to the intellectual universe of chemistry.

## Lavoisier, Chaptal, and the conservation of matter

Antoine Lavoisier published his treatise on chemistry in 1789. From the outset, he criticised the tendency of his colleagues to reduce all chemical bodies to

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the four basic components dear to ancient Greeks (i.e. fire, water, earth, and air). Science requires observation and facts rather than myths. There are many chemical elements, and their combination varies alongside natural conditions. In the historiography of science, Lavoisier is known for his famous principle 'nothing is lost, nothing is created, everything is transformed,' which refers to the law of conservation of matter. In fact, it is an apocryphal principle; Lavoisier never used these exact words. Yet, we can find passages in his treatise that show the same ideas, for instance, when Lavoisier writes about fermentation:

> [...] nothing is created, either in the operations of art, or in those of nature, and it can be acted as a principle that in any operation, there is an equal quantity of matter before and after the operation; that the quality and the quantity [...] is the same, and that there are only changes, modifications.
>
> (Lavoisier, 1789, pp. 140–141)

The conservation of matter (and energy) is an important idea in the history of ecological economic thought; it is interesting to note that it is with Lavoisier that it obtained scientific justification (Kern, 1990).

Lavoisier was a chemist, although he also undertook entrepreneurial activities and published essays and documents on administration and economic affairs. In his examination of Lavoisier's economic writings, René Dujarric de la Rivière (1949) mentions three categories of essays: the first focused on insurance funds for the poor, the second on fiscal issues related to the reimbursement of revolutionary public bonds (*assignats*), and the third on rural economy and the organisation of agricultural activities. As emphasised by Christopher Hamlin (2007), from the 1760s to the 1780s Lavoisier also wrote on urban management, especially water supply and lighting. His main contribution to economics is his unfinished book *De la Richesse Territoriale du Royaume de France* (1791), published in the context of the French revolution. *La Richesse Territoriale* was regularly re-edited throughout the 19th century; in 1893, it was supplemented by new fragments from Lavoisier's personal documents. *La Richesse Territoriale* can be retrospectively considered as an early attempt of national accounting: Lavoisier traced the circulation of wealth in the economy and described balances between production and consumption in various sectors (Perrot, 1988; Klotz, 1989; Arkhipoff, 1990). The data he used was not very reliable, but his reasoning was groundbreaking.

Lavoisier did not miss an occasion to acknowledge the role of the Physiocrats in shaping his own economic ideas, starting with Pierre Samuel Du Pont de Nemours. This influence can be observed in Lavoisier's fiscal proposals, based on the net product (*produit net*) for tax purposes along the lines of Quesnay. This has led some commentators to define *La Richesse Territoriale* as a 'Physiocratic book in political arithmetic' (Klotz, 1989). There is no doubt about the Physiocratic dimension of Lavoisier's ideas. It seems, however, that he went further than the Physiocrats in his understanding of the laws of nature in economics.

The law of conservation of matter implies that chemical elements circulate, combine, and are transformed, but never created or destroyed. It is striking to see that in his national accounting Lavoisier replicates a similar process for economic flows in terms of production and consumption: all that is produced is supposed to be consumed. It is tempting to consider Lavoisier's correspondence between production and consumption as consistent with his chemical law of conservation of matter (Bolado and Argemí, 2005), even if there is no textual evidence of such a connection. When he justifies his economic ideas, Lavoisier does not mention chemistry but rather confusing arguments about the circulation of riches inside the economy. We cannot, however, completely discard the idea of a common ontology between the economic and the natural worlds in Lavoisier. Unlike Goethe, who drew analogies between the notions of natural and economic budgets, there is in Lavoisier something stronger in the articulation between chemistry and economics. Because Lavoisier had Physiocratic inspirations, he conceived economic riches primarily as material and only secondarily as monetary flows. When he talked about the conservation of economic wealth in production and consumption, he had in mind material wealth. It is, therefore, reasonable to argue that Lavoisier transposed, even unwittingly, his chemical principles to economics when he built his national accounting framework. That would also make him a pioneering thinker of material flow accounting in economics and, in turn, of reflections in terms of economic metabolism, held dear by ecological economists.

Jean-Antoine Chaptal is essentially known for being the Minister of the Interior of Napoléon Bonaparte. He started his career as a student at the Montpellier faculty of medicine, where old ideas in chemistry, especially vitalism, were still taught (Pigeire, 1932; Bolado and Argemí, 2005). He became aware of Lavoisier's novelties quite early and soon adopted the new principles on the conservation of matter. Lavoisier's influence can be observed in Chaptal's own treatises on chemistry from the 1790s and 1800s, when the former is mentioned as a significant forerunner (Chaptal, 1790).

Chaptal was an applied chemist. He conceived his scientific work as directed towards industrial processes. When he became an administrator and a politician in the early 19th century, he widened his fields of interest, reading and writing about political economy and public regulation. Chaptal (1800, 1819) had liberal acquaintances, in the classical sense of the term; he promoted private enterprises and wished to limit the role of government. We should not, however, consider Chaptal as a strong promoter of free trade. Like Frederich List in German territories, he had a national conception of the economy, arguing for free competition inside the country and protection against foreign industry.

Regarding the natural environment, Chaptal helped to shape the 19th-century French regulatory framework for chemical industries. In 1810, he set up principles according to which pre-authorisations were needed to implement manufactures producing damages to the neighbourhood. This led some

chemical polluters to move away from dense areas, but it had almost no effect on the general level of pollution (Chappey and Vincent, 2019). In fact, it limited people's room for protest: once the pre-authorisation was given, appeals were virtually impossible. Although Chaptal (1819) argued that his approach to regulation was useful to limit the disturbances of chemical industries, reality was different. Chaptal's 1810 decree is now considered the cornerstone of the 19th-century alliance between regulators and entrepreneurs to foster industrial development at any price (Fressoz, 2013; Bonneuil and Fressoz, 2016).

Chaptal's work suggests that he considered chemistry not only as useful to industries, but also as an overarching discipline, governing the laws of matter and, in a sense, also economic laws. In other words, the question of the ontological unity between the natural and the social worlds arises in Chaptal. When he emphasised the role of chemistry in economic affairs, he did not only point to applications of chemical processes to industrial production such as the extraction of beet sugar, for what he became famous, but also insisted on the fact that all production processes are subject to chemical laws. Manufacturing cannot abstract from the law of conservation of matter, as it governs all material processes. Businesspeople and manufacturers would benefit from knowing more about chemistry to conduct their work:

> […] it may be possible to do mechanical work without being a mathematician, as it may be possible to make a nice scarlet colour without being a chemist; but the operations of the mechanic and of the dyer are not less based on invariable principles, whose knowledge would be infinitely useful […].
>
> (Chaptal, 1790, vol. 1, pp. xlix–l)

> So all operations of nature or art [*i.e.* manufacturing], which carry changes in the nature of the bodies, are within the scope of chemistry.
>
> (Chaptal, 1807, vol. 1, p. 2)

Chaptal went further by drawing a correspondence between chemical processes and wealth, even bearing upon the notion of economic utility. Because chemistry was able to set up new industrial processes, to extract new elements from the natural world, and to help manufacturers to recycle matter, it had the capacity to create economic value from scratch: 'chemistry, by expanding its domain, creates values and contributes to general utility' (Chaptal, 1819, vol. 2, p. 76). There is here a similarity with 18th-century natural history.

Chaptal did not only regard the laws of nature and natural constraints as critical for industrial processes, but also for the specialisation of territories. He argued that manufactures, like farms, had to be located in the right place, according to market conditions (e.g. distance from the market place) and, above all, according to natural conditions, especially the availability of raw materials. Although he was a liberal and an industrialist, Chaptal believed that

economic geography was first governed by nature. He considered this true within the borders of a country and at the international level, each nation having its own field of specialisation according to its natural endowments—a vision reminiscent of the Heckscher-Ohlin model of international trade, which would be developed over a century later. If trade can be mutually beneficial, it is because of the unequal distribution of natural riches all over the world, enabling each country to export products for which it has inherent advantages (Chaptal, 1819). In that context, according to Chaptal, France was a profitable place, benefiting from a wide variety of naturally occurring raw materials and hence having the capacity to produce many goods with its own natural resources.

In short, Chaptal was an ambiguous character in the history of ecological economic thought, promoting polluting chemical industries, but also considering natural laws as 'immutable and eternal' (Chaptal, 1823, vol. 1, p. vii) and, as a result, seeing economic processes as deeply connected with chemical ones. The law of conservation of matter, inherited from Lavoisier, was deeply structuring, from local manufacturing to international trade.

## Leroux and the *circulus* theory

After Lavoisier, Chaptal, and a few other innovative scientists, chemistry advanced sturdily throughout the 19th century, particularly in connection with modern agronomy, on the road to Justus von Liebig's seminal contributions on the role of mineral nutrients in sustaining soil fertility. As stated by Paul Warde (2018), Liebig had already presented his work to the European scientific community in the 1830s, insisting on the role of chemistry in modernising agriculture. In France, Jean-Baptiste Dumas (1835, 1846) and Jean-Baptiste Boussingault (1843) worked along these lines. They contested the traditional humus theory, according to which plants only received their nutrients from vegetal matter, and highlighted the importance of the circulation of mineral elements in living organisms and the soil.

Dumas, Boussingault, and their colleagues insisted on the perpetual recycling of nutrients and matter in the natural world. Chemical processes enabled flows of elements from one type of living organism to another (Dumas and Boussingault, 1844; see also Simmons, 2006). Liebig defended the same ideas, standing behind the law of conservation of matter and emphasising the constant circulation of elements (Mårald, 2002).

In this context, Pierre Leroux elaborated a theory on the circulation of nutrients—the *circulus* theory—which deserves here particular attention. Leroux is known for coining the French word *socialisme* in 1834, albeit doing so in a critical tone insofar as he considered it a notion in opposition to individualism but with its own limitations, providing an excessively holistic view of society (Viard, 2004; Frobert, 2010). Leroux was for some time a supporter of Saint-Simonism, having contributed to the journal *Le Globe* and collaborated with social reformer Prosper Enfantin. He finally left the movement to

devote his time to other projects such as the edition of the *Encyclopédie Nouvelle* and a French translation of Goethe's *Werther* (Carlisle, 1974; Simmons, 2006). Later on, Leroux came back to Christian thought as a basis for social reflection, considering that religion was necessary to human bonding (Viard, 1982; Le Bras-Chopard, 1993; Herland, 1996). Leroux (1849) also wrote on finance, making connections between banking circles, the spirit of lucrative gains, and the Jewish community (in a quite pernicious tone, which unfortunately echoes the mood of the times in 19th-century Europe).

The *circulus* theory was based on a simple intuition: if nutrients circulate in nature from one organism to another and if fertilisers from organic matter play an important role in agricultural productivity, what to make of substances released by the human body (urine, excrements)? Do they contribute in the same way to the circulation of nutrients? And could they be used to improve agricultural productivity? Leroux thought about using human manure in agriculture for the first time in the 1830s, when he read Charles Fourier's complaints about the short supply of fertilisers for his community projects and during informal discussions with agricultural experts about the self-sufficiency of animal manure to produce cattle feed. Leroux fully developed his theory in the 1840s and 1850s, explaining that by dumping wastewater in rivers, or dispersing it, a huge source of nitrogen fertiliser was lost (Leroux and Reynaud, 1843). The human body acts as a type of laboratory, transforming food into useful secretions for plants and other organisms. In economic terms, the circulation of nutrients corresponds to a natural *circulus* between the production and consumption of chemical elements:

> Do you produce something with all your wealth? No, it is Nature that produces everything; and when you get to the depths of your means of production, industry sends you back to agriculture, and agriculture to your dung. Nature has established a *circulus* between production and consumption. We do not create anything, we do not annihilate anything; we make changes. With seeds, air, earth, water, and manure, we produce food materials to feed ourselves; and in feeding ourselves we convert them into gases and manures that produce other food materials; this is what we call consuming. Consumption is the goal of production, but it is also the cause of it.
>
> (Leroux, 1846, p. 87, italics in the original)

In this passage, emphasising Lavoisier's law of conservation of matter and the circulation of nutrients, Leroux makes a strong connection between chemistry and economic thinking. The definitions of production and consumption are reshaped according to chemical processes: contrary to Physiocratic or Classical economic principles, wealth no longer circulates from one social class to another, but through living organisms. Economic cycles are chemical cycles.

In an essay referring to the State of Jersey, where he spent some time in exile, Leroux detailed the practical implications of his *circulus* theory. Implementing the *circulus* in Jersey would allow for 'a fivefold, if not more, increase in the country's agricultural production' (Leroux, 1853, p. 3). To do so, new infrastructure was needed. At the time, wastewater in Jersey was directed to the sea by means of a network of pipes. Leroux called for a system of pumps to bring wastewater up to higher ground in order to irrigate the fields of the island. He was convinced that the effect on agricultural productivity would be tremendous, based on the results of an experiment conducted in London in which he was able to produce food from a handful of soil, water, and his own excrement.

Leroux's writings are filled with references to French chemistry. In fact, the recycling of urban manure, in addition to its disposal, was widely discussed all over Europe and particularly in France from the 1820s onwards (Corbin, 1982; Reid, 1991; Mårald, 2002; Hamlin, 2007). Liebig (1840) played a critical role in developing and disseminating the notion that human manure could be profitably used in agriculture. He participated in the British public debates over adapting infrastructure to the recycling of wastewater (Sheail, 1996). Liebig explained that his inspiration came from Asian, especially Chinese, experiences. The recycling of human manure in agriculture was quite common prior to the 19th century in China, Japan, and India, contributing to the demographic expansion of those countries long before it happened in Europe (Ferguson, 2014). Hence, Liebig, like other Western chemists, did not come up with the idea of using human excrement; rather, he gave it support thanks to his modern chemistry.

In his writings, Leroux made explicit references to chemists such as Dumas, Boussingault, and Liebig. Their works were a source of inspiration to him: 'they say that human manure is the most fertile, that the quantity of this fertiliser […] would be sufficient to fertilise the land necessary to feed the whole humankind in cereals' (Leroux, 1846, p. 88). We can, however, observe an evolution in Leroux's confidence in chemistry. In the 1840s, he claimed that modern chemistry was particularly relevant for the *circulus* theory. In the 1850s, he became more critical towards the chemists who focused on mineral nutrients and artificial fertilisers. According to Leroux, only nature was capable of making nutrients circulate and giving life to organisms. Chemists, with their ambition to create ammonia salts and other artificial products, wrongly thought that they could do without nature. For Leroux, soil fertility was the result of a subtle equilibrium among various components that could not be mastered. By focusing on nitrogen, Liebig and his colleagues were going in the wrong direction, i.e. they were narrowly looking at a single chemical component, as did the previous generation of agricultural chemists that mistakenly focused on humus.

Leroux was not a chemist and part of his criticism was more the result of an act of faith, as he saw in nature the only source of vital force, than of reliable scientific knowledge. One might suspect that the reason for his criticism was

the lack of recognition for his *circulus* theory. Leroux (1853, p. 178) claimed precedence on the idea of recycling human manure in agriculture, arguing that, based on Chinese testimonials, he 'could have done without the chemists.' This dispute led by Leroux is worthy of attention when we consider the articulation between economic thought and the natural sciences in the case of the *circulus* theory. It means that, unlike in other episodes, in this instance ecological economic thought had its roots in the thinking of a social rather than natural scientist. Chemistry came later for Leroux, even if its role was probably more important than he admitted.

In fact, Leroux did get recognition for his *circulus* theory. His influence was particularly significant on French novelists, especially Victor Hugo. In *Les Misérables*, Hugo (1862) devotes a full chapter to the sewers of Paris as a reservoir of fertiliser for the rural surroundings (Lacassagne, 1970; Jarrige and Le Roux, 2016). Hugo spent some time with Leroux in Jersey. Their relationship quickly deteriorated, but there can be no doubt of Leroux's influence on Hugo's ideas about the recycling of wastewater (Mathias, 2018). It is true that Leroux was also mocked for his theory, many social thinkers considering that using human manure to solve the problem of hunger was at best far-fetched, at worst a heresy.

Looking at the economic and social implications of the *circulus* theory, we can fully perceive Leroux's place in our historical account. Amy Wickner (2017, p. 1) indicates that the *circulus* was a 'socioeconomic concept.' This definition makes explicit that Leroux conceived his theory as a lever for a broader social thought. On many occasions, he wanted to give a response to Malthusian positions, according to which nature was stingy and pauperism unavoidable. For him, because of the circulation of nutrients and the law of conservation of matter, nature had to be considered as full of riches. We are alive, so we must at the same time feed ourselves and fertilise the soil, which provides in return the food we need (Leroux, 1846). In that context, it would be absurd to affirm that nature does not provide sufficient means of subsistence. When nature is not hindered, these means reproduce themselves as predicted by the *circulus*.

In his criticism, Leroux denounced the inconsistency of Malthus's reasoning. Malthus suggested that living organisms, including humans, were naturally inclined to reproduce themselves without limits. The emerging social conundrum was, therefore, supposed to come from the confrontation between this uncontrolled population growth and limited means of subsistence. However, why should nature be infinitely fertile for other living organisms and ungenerous with the means of human subsistence? The *circulus* shows the opposite: as soon as population grows, the amount of available human manure increases, and so the fertility of the soil and finally the means of subsistence. For Leroux, if there was misery, it was not due to any given natural law, as advocated by Malthus, but to the ill-advised economic organisation of modern societies, which promoted the concentration of capital, prevented people to produce their own food, and thus disturbed the normal circulation of nutrients.

Leroux accused Classical political economists of being against the poor and solely defending the interests of the industrialists. The *circulus* theory was a solution to help the poor secure their means of subsistence. As Leroux (1853, p. 193) summarised in a parable, 'the problem of the proletariat envisaged as a problem of subsistence [is] only a convenient problem.' The end of hunger was considered by him as a way of emancipating the poor from the modern industrialist system. By unifying the production and consumption of food, the *circulus* could help the working class to satisfy its own needs. Workers would no longer be forced to accept low wages; they would even no longer have to enter the wage system. This shift would entail profound changes to the capitalist organisation of society.

In the same way that he proposed a redefinition of the concepts of production and consumption, Leroux promoted a new conception of wealth. In this sense, he talked about a kind of 'manure capital' (Leroux and Reynaud, 1843, p. 807; see also Simmons, 2006), more important than other forms of capital in economic processes. 'Nature [is] the source of all production' (Leroux, 1849, p. 32), so natural cycles are called upon to replace the circulation of wealth advocated by political economists. Here lies his ambition to subordinate all economic processes to natural, in his case especially chemical, processes.

Leroux was not the only social and utopian thinker of the 19th century to advocate for some sort of harmony between human beings and their natural environment. In France, Charles Fourier and Saint-Simonians such as Michel Chevalier wrote on different but related topics: the overexploitation of nature and the role of landscapes in economic geography (Roelofs, 1996; Drolet, 2018). In Britain, John Ruskin, to name just one of many emblematic authors, is known for having linked economic and environmental issues (MacDonald, 2012; Albritton and Albritton Jonsson, 2016). Apart from these other contributions, the above account on Leroux serves the purpose of redeeming a less documented episode regarding the interweaving of chemistry and economics in a long intellectual tradition spanning from the golden years of Lavoisier to the mid-19th century.

## Chadwick and the British sanitary movement

As already mentioned, the idea of recycling urban wastewater was widespread in Europe during the 19th century. One reason was to avoid the loss of valuable fertilisers for agriculture. Another reason was related to sanitary issues in the context of urban sprawl, especially in Britain from the late 18th century onwards. London was already a big city at the time, with an increasing population and high demand for more dwellings. Waste disposal infrastructure could barely keep up, which engendered insalubrity and health hazards. Many jobs were then devoted to handling waste in European cities (Barles, 2005). Concerning faeces, however, these professions, which were highly undervalued, did not succeed in maintaining satisfactory levels of urban health. The inner courtyards were filthy and epidemics spread rapidly (Hamlin, 1985; Ashton and Ubido, 1991).

The British sanitary movement gained a lot from the work of technocrat Edwin Chadwick (1800–1890). Such initiatives emerged all over Europe, but the British one was probably the most important and influential (Hamlin, 1998; Ramos Gorostiza, 2014). In France, Leroux did not use sanitary arguments to promote his idea of recycling human manure. In sharp contrast, Chadwick evoked the same argument in synch with his sanitary proposals. His stance on the use of wastewater recycling in agriculture was inspired by some practices he observed in Edinburgh while preparing his report on the sanitary conditions of Great Britain published in 1842. To him, the easiest way of making urban manure available to agriculture was to connect urban sewage systems with rural surroundings. This kind of infrastructure was the most efficient, secure, and reliable way to dispose of wastewater while aiding agricultural production:

> If […] the contents of the cesspools were carried by adequate supplies of water in drains from the houses into covered sewers, and thence in covered instead of open sewers to the lands at proper distances where it might be distributed as manure by irrigation, it would be […] the best means for removing quickly, and constantly, and the least injuriously, the matters which can only remain for removal by any other process at the expense of the public health; […] it would also be the most productive mode of distributing the manure.
>
> (Chadwick, 1842, p. 51)

Practically speaking, there was a close similarity between Leroux's *circulus* and Chadwick's recycling of human manure. We know that Leroux spent some time in London at the turn of the 1850s, although his ideas on the *circulus* predated that period. Chadwick could read French and sought inspiration from French sanitary science, especially from the works of Louis René Villermé and Jean-Baptiste Parent du Châtelet (La Berge, 1988). We do not know, however, if Chadwick knew about the *circulus* theory. Leroux (1853) once wrote that Charles Kingsley brought his own ideas to England; however, as far as we know, there is no evidence that Kingsley and Chadwick discussed Leroux's *circulus*.

In any case, Chadwick certainly did not share with Leroux the association between wastewater recycling and the end of industrial capitalism or the wage system. He was not a socialist, but rather a utilitarian reformer in close contact with political economists such as John Stuart Mill (Finer, 1952; Price III, 1984; Tynan, 2007). Chadwick's priority was to eliminate any waste of resources in order to improve the efficiency of the economic system. This need was applicable to all sectors of the economy; human manure was no exception. In addition, such a concern fitted well with sanitary issues.

Notwithstanding Chadwick's peculiarities, he had something else in common with Leroux, namely his references to chemistry and the circulation of nutrients. In his 1842 sanitary report, Chadwick explicitly mentioned Liebig, Boussingault, and Lyon Playfair, one of Liebig's students. In fact, Chadwick's

ideas on the links between wastewater recycling and agriculture also stemmed from his reading of Liebig (Mårald, 2002; Hamlin, 2007).

Pulling Chadwick into the history of ecological economic thought can be justified on the grounds that he drew general lessons—very different ones in relation to Leroux—from the circulation of nutrients for his reasoning on economic and social organisation. What mattered most for Chadwick was to think about the place of urban areas in the natural world and to assess the conditions for a harmonious relationship between those areas and rural landscapes. The circulation of nutrients from cities to farmlands, by means of the direct material link between wastewater and new foodstuffs, was perceived as the best way of warranting cohesion between these territories: urban population could get food from rural surroundings and farmers could obtain in return the fertilisers they needed to increase their production (Sheail, 1996; Rayner, 2009). While modernity started to create sharp asymmetries between urban and rural areas, with a concentration of wealth in the former, wastewater recycling was seen by Chadwick as a means to preserve the unity of society.

Enjoying a higher level of renown in British public expertise, Chadwick was able to go further than Leroux in the implementation of his proposals. As affirmed by Christopher Hamlin (1992, 2007), the perception of cities as chemical systems participating in the circulation of nutrients gained prominence in Britain from the 1840s onwards. Yet, after modernising the disposal of waste in London and encouraging a few companies to start recycling urban sludge, Chadwick eventually lost his influence in the mid-1850s because of disagreements with other experts and rulers. In addition, wastewater recycling rapidly appeared to be more costly for the State and less profitable for farmers than anticipated. Operational aspects took Chadwick by surprise, revealing him as a theoretician and architect of sewage systems without a penchant for practicality.

Moreover, in the last decades of the 19th century, the idea of recycling wastewater was superseded by other sanitary options, especially artificial filtration. As Sabine Barles (2005) indicates, the fight against the waste of resources also became less intense, with less scruples to throw away used goods. In this context, human manure was no longer seen as a potential source of value; it had now to be disposed of—preferably thrown into the sea. In the same way, knowledge on sanitation evolved, boosted by improvements in medical biology and a better understanding of the immune system and of the causes of disease (Ashton and Ubido, 1991). Finally, agronomy also moved on to a long-lived era of unbridled reliance on artificial fertilisers and the expansion of markets beyond the local or regional levels. All these changes challenged the role of wastewater recycling in agriculture. In the 1880s, only a few dozens of British farms persisted in irrigating their fields using a sewage system (Sheail, 1996).

At the end of this journey into the relationship between chemistry and economic thought from the 1780s to the 1880s, we can see how alternative

views of industrialisation and urbanisation emerged in parallel with the development of political economy, supported by the law of conservation of matter and the theory of circulation of nutrients. Chemists, technocrats, and social thinkers tried to construct a body of knowledge that was oftentimes very practical, despite its integrative or holistic ambitions typical of episodes in the history of ecological economic thought: Lavoisier and Chaptal used their chemistry to study national economies; Leroux's *circulus* aimed at solving pauperism and emancipating workers from the wage system; and Chadwick aimed at the economic, social, and metabolic cohesion of urban and rural territories.

# 4 *Narodnik* Ecological Utopianism

The revolutionary socialist movements seen in Russia and Ukraine in the 19th century, especially since the 1860s, were composed of political and intellectual groups of opposition to the Tsarist regime jointly called the Russian populists or *Narodniki* (the term *narod* refers to people or folk; 'Narodnism' is here given preference, given the multiple connotations of 'populism'). The emancipation of the serfs in 1861 and other reforms promoted by Tsar Alexander II marked the downfall of feudalism in Russia, being replaced by a new system which, according to the *Narodniki*, encouraged the exploitation of peasants by landlords and threatened the existence of the traditional system of rural communes (*obshchina*), which reflected the true essence and will of Russian peasants.

All of these groups were to some extent inspired by the works of Nikolai Gavrilovich Chernyshevsky, Aleksandr Ivanovich Herzen, and Nikolai Konstantinovich Mikhailovsky, although there is a much longer list of prominent *Narodnik* intellectuals then working in Russia or abroad (e.g. Vissarion Belinsky, Nikolai Nekrasov, Petr Lavrov, Nikolai Dobroliubov, etc.). The literary works of renowned Russian novelists also stirred these revolutionary movements in some sense, as in the case of Dostoevsky, Turgenev, and Tolstoy (Berlin, 1994 [1978]).

The importance given to the *obshchina* by the *Narodnik* would carry strong environmental implications. Paul Josephson et al. (2013, pp. 38–49) discuss the relations between peasant agriculture and environmental change in late imperial Russia, contending that 'the peasant commune had perhaps the greatest human influence on the environment before the industrial revolution and the rise of the city in Russia.' The complex social changes in peasants' attitudes towards agricultural science and the impacts of the communal system on land productivity were key elements in the analyses of the *Narodnik* intelligentsia.

The 'conquering of the steppe,' set forth since Ivan the Terrible in the 16th century and aiming to control and populate a vast expansion of land at the frontiers of the Russian empire through agriculture in grasslands, meant a profound change from earlier days in which peasants would live in the forest heartland, seeking subsistence from cereal and animal farming. By the late

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19th century, although peasants made use of the then available agricultural technology, they were still perceived by Tsarist policymakers as backward and feeble-minded, given the pressure to produce more for export markets. However, the communal system fared badly under market rules: it led peasant households to exhaust the soil, once they had only a temporary claim over it, and it induced the formation of narrow plots of land, inefficiently scattered around the village, which prevented the production of surplus for trading.

The reforms of Tsar Alexander II, despite conceding the emancipation of the serfs demanded by the intelligentsia, did not achieve its goal of improving agricultural output, once the social structures of rural areas barely changed, with serfs becoming tenants and more fertile lands remaining in the hands of the nobility. While liberals hoped that Western large-scale agricultural practices would be implemented in Russia, peasants were in general sceptical of the benefits of the market, remaining unconvinced by foreign views of success based on the creation of surplus and profit-making. The *Narodnik* intelligentsia praised such values and attitudes of the peasants, although it failed in its attempts of more direct forms of communication, as in the case of the 'going to the people' initiative of 1873–1874, when young revolutionaries living amongst peasants and seeking to mobilise them against the Tsar were received with suspicion, denounced, and persecuted.

The historical content, theories, visions, and ideals of the *Narodniki* were of utmost importance to the development of Russian political economy, even though the intelligentsia was mostly represented by literary and art critics, poets, novelists, and philosophers. Economic theory was regularly and inconspicuously inserted into their voluminous monthly periodicals and social novels. To Frederico Normano (1945, p. 8), despite its underground character and lack of immediate influence over economic policy, 'the intelligentsia was the bridge between public opinion and revolutionary economics,' establishing a deep and long-lasting intellectual influence over State bureaucrats, academics, and the reading public at large. Their political economy was comprehensive enough to combine elements of economic theory with social engineering and utopian thought. Theoretical arguments about the real world were complemented by ideals or visions for possible worlds and the corresponding social policy design (Akhabbar and Allisson, 2014).

As will be shown here, the economic thought of the *Narodnik* intelligentsia can be characterised as a form of socialism which is simultaneously scientific and utopian. If another specific trait is added, namely the rejection of the Promethean view of the eternal abundance of natural resources and the call for wealth distribution as a moral imperative, then these thinkers can also be regarded as ecological utopians within the frame of ecological economic thought. Their emphasis on the role of the *obshchina* is the cornerstone of such a claim, figuring as an element of the real world, subject to social policy, and serving as a constitutive basis of an ecologically and economically viable social organisation. Chernyshevsky's main philosophical and economic ideas can be used to illustrate these arguments.

## The revolutionary political economy of Chernyshevsky

Chernyshevsky studied at the History and Philology Faculty of the Saint Petersburg University in the 1840s, when he first had contact with the works of French utopian socialists. In 1854, he started to work for and quickly thereafter became the chief editor of the periodical *Sovremennik*, which had been founded by the great poet Aleksandr Sergeevich Pushkin and, during the 1850s and 1860s, became the main outlet of figures such as Turgenev and Tolstoy. Chernyshevsky's literary reviews and essays on philosophy and political economy focused mainly on the peasant question and its importance to the future of socialism in Russia, being the reason behind his arrest in 1862. He spent most of his life in prison or exile.

His philosophy mixes materialism with elements of German romanticism, English utilitarianism, French Enlightenment, revolutionary political activism, and Slavophile ideology. He shared the atheism and materialism of philosophers Claude Adrian Helvétius and Baron d'Holbach, a view in which reality was nothing more than matter moving according to cause-and-effect laws. Such a naturalistic view of the world was based on the acknowledgement that the senses were the source of all knowledge and common to all humans. Moral and political phenomena could also be explained by empirical observation. Such an outlook would be in accordance with his purpose to use philosophy and science as instruments to alter social and political reality, to enforce revolutionary-democratic goals, and to fight tsarism and serfdom (Frank, 1990).

The 'anthropological principle in philosophy' of Chernyshevsky (1953b [1860]) resembles Helvétius's and Holbach's psychological egoism or, even more blatantly, Jeremy Bentham's and John Stuart Mill's rational egoism. The tricky part is that Chernyshevsky distorted such propositions to state that the altruistic conduct is, in fact, the ultimate way to serve one's own purposes. His rational egoism is based on the integrality of human beings (mind and body as a single organism which expresses lower and higher forms of organised matter), as well as on their natural requirements and conditions for happiness. He addresses individuals who freely seek to protect their own interests—not abstract ideas, but interests affecting their reality—as egoists, and contrasts them with submissive and obedient individuals. His ethical view on rational egoism opposed a narrow interpretation of self-interest, as the common good would be inherently embedded in one's egoistic actions. When that is not the case, the mode of social organisation was to blame, since individual requirements for happiness are contingent on social life. If the norms of the prevailing social system harmonised individual and collective interests, then people would be naturally able to reach a higher moral ground. Egoism and altruism would become aligned through rational motivation in an egalitarian manner. Therefore, Chernyshevsky's reinterpretation of English utilitarianism corresponds to an understanding of rational egoism which would promote utopian socialism, in the same manner as, for Ludwig Feuerbach (1845), egoism would lead to communism.

Chernyshevsky (1987 [1888], vol. 2, pp. 70–145) gave special attention to Mill's *Principles of Political Economy* (1848), having translated and added lengthy notes to it in 1860. He criticised Mill's preference for a psychology of the middle classes, neglecting the historical formation of the poor, and deemed his approach unsatisfactory in the context of the real causes of production, human requirements for happiness, and the toils of labourers to create the means of subsistence. Wealth could only be assessed in connection with the purchasing power of the people. To him, labour was the sole agent of production and, therefore, its proceedings (including capital, which he regarded as the product of labour aimed at augmenting future production) should be divided among those who take part in it. As an inherent feature of Western economic systems, competition would more properly apply to a system based on the exchange of goods, and not to one in which the product is distributed among labourers; in fact, the need to lower prices in competitive economies led to a push towards lower wages. In his alternative system, production costs replaced prices as the key economic variable, avoiding the trade-off between wages, profits, and rent—as income becomes a sole category—as well as the contradiction posed by gains in labour productivity and diminishing well-being of labourers (Turin, 1930).

Chernyshevsky's philosophy, political economy, and revolutionary activism were cunningly embodied in his epoch-making novel *What is to Be Done?* (1989 [1863]), a bedside book for the younger generations of revolutionaries. The main character, a young woman named Vera Pavlovna, seeks to escape from the traditional ways of her family and arranges a forged marriage to obtain economic independence and freedom. She ventures into a sewing cooperative, inspired by the social ideals of French utopian socialists and, even closer to the core of the plot, by the theories of the intellectuals of the new generation, i.e. the *Narodnik* intelligentsia.

Through the worldviews of the main characters of the book, the author continuously praises the materialism, rational egoism, and egalitarianism of the new generation, for whom it is personally aggravating to see others in adverse situations, including labourers and women forced into submission. Thus, egoism and altruism are again claimed to share the same outcome: strengthened community values and social equity, if only unhindered by the economic circumstances imposed by the prevailing mode of social organisation.

While describing one of Vera Pavlovna's dreams, Chernyshevsky depicts the future and ideal society as a result of scientific progress and social reform. It is shaped by tight social bonds and the communal character of the main aspects of life, stretching beyond the sphere of labour relations. Enjoyment of life is only achievable by means of shared love, beauty, and wealth. Technical progress leads to greater agricultural productivity, advanced architecture, and the replacement of harsh labour duties by the use of heavy machinery. In such conditions, humans would be able to express their integral personalities, with the demise of the conflict between common and personal interests.

Vera's dream brings as main principle the equality of rights, without which there is no real freedom or joy. This is also applicable to the relationship between humans and nature. There is no dominance, no master and mastered, only their integration into a whole which transcends the sum of its parts. An ideal socialist society is thus also ecologically sound, to use a more recent term. Basic human needs are promptly satisfied by nature through labour. Luxurious whims are treated as such and are therefore costly; there is no perpetual abundance of natural wealth. People abide by the offerings of the seasons, and yearly migrations are deemed as a part of life. Cities are no longer the basic form of human settlement, being used mainly as centres of communication and transportation. Most people live in rural areas, organised in ways which resemble the traditional Russian *obshchina* (Stites, 1989).

## Chernyshevsky's physiological outlook on energy and life

It would be hard to overestimate the importance of the natural sciences to Chernyshevsky. Many of his essays containing his views on the nature and progress of the natural sciences point unequivocally to how subjects such as chemistry, biology, geology, botany, astronomy, and geography were highly esteemed by him. Science would be the language in which nature reveals itself. Albeit humans were still not able to explain every natural phenomenon, it was only a matter of time, and to resort to other forms of gaining knowledge was not the right path. The systematic application of inductive logic would be the only way to determine the general elements, forces, and laws governing nature. Observation and experimentation—even more so after the technical progress of scientific instruments—would be an important aid in this pursuit to unveil the truth by means of reason (Chernyshevsky, 1953b [1860]).

The moral sciences, on the other hand, such as psychology and metaphysics, would hitherto display a disputable character, being usually unable to provide definitive answers. However, as the scientific reasoning of the natural sciences started to be applied to the moral sciences, the latter would soon rise up to the level of the former, becoming able to find truth and shed light on the old obscurantist ways.

In Chernyshevsky's eyes, the natural sciences and its mode of investigation would be crucial to validate moral views and social ideals. As seen above, a form of social organisation which promotes the common good was, to him, objectively rational, even from the perspective of the individual. His utopia was scientific. The ideal society would be the result of the combination of technological progress and social transformation, with feedback mechanisms between them.

There is evidence, however, that his scientific utopianism is of a particular sort. To Chernyshevsky, matter and movement are the sources of all creation, and the diversity seen in the world is a question of varying qualitative properties. Different chemical combinations lead to different structures, with different and sometimes incommensurable qualities. Bearing these principles in mind, Chernyshevsky would discover in physiology the quintessence of natural science.

At first, physiology is merely a subject derived from chemistry and consisting in the study of plant and animal organisms. Nevertheless, he takes it to heart when he realises that it ultimately deals with the qualitative properties of matter, the constant dialectical change and development of these organisms, propelled by struggle, opposing tendencies, divergent forces, and inherent contradictions which are part of a circumstantial and objective reality, not abstractions or metaphysical entities. Chernyshevsky, in this respect, uses dialectics as a form of escaping the crude mechanicism of older forms of materialism (Grigorian, 1953).

The concept of energy appears to Chernyshevsky as a synonym of 'force' (1953a [1884], p. 507). It would be an intrinsic feature of matter, once 'an acting force is the acting object itself; and the energy of an object is the object itself.' Energy was thus within the realm of physiology, another term for his notion of movement as the origin of reality and the source of life. Matter and energy were the basic building blocks to the study of the functioning of living organisms, with focus on processes, relationships, and connections between them. Analogously, flows and stocks of matter and energy are now the basic units of analysis in modern ecological science.

Energy was also the ability to do work. The comparison was to him irresistible: in many passages of his novel, he praises labour as another manifestation of this force, movement, or energy which shapes reality, and the revolution would be an inevitable consequence of such force (references to French physiologist Claude Bernard abound). This is clear in another one of Vera Pavlovna's dreams. She is taken aback by how solar energy induces transformations in the structure of living matter, resulting in compounds of higher complexity. Although it would be troublesome to attribute to Chernyshevsky a role as precursor of social energetics, his philosophy of science and praise for physiology certainly influenced his views on social issues.

Chernyshevsky's faith in the potential of the natural sciences was accompanied by normative statements about their purposes. In his novel, he recurrently asserts that the natural sciences should make it possible for men and women to have their basic needs fulfilled, to develop their true potentialities, and to live in joy and freedom, protected against a coarse, subsisting existence without meaning. These goals were to him a requirement to the preservation and expansion of human rights, which would lie at the core of the concept of justice. Every individual was obligated to prevent injustice within their capacity. Analogously, the State should intervene in the economy whenever justice needed to be served (Chernyshevsky, 1859a).

Although there is not a Promethean tone in his view of the benefits of science (the subjugation of external nature is never mentioned), he is overly optimistic in relation to the boundaries of technological progress:

> [E]xternal nature creates no obstacles to supplying the entire population of every civilized country with an abundance of food; the only task that remains is to make people conscious of the possibility and necessity of energetically striving towards this goal.
>
> (Chernyshevsky, 1953b [1860], p. 102)

He moves on to affirm that in England land could feed at least 150 million people, if modern agricultural techniques were to be implemented in each field. The neglect for any acknowledgement that there are limits to nature's bounty is not a particular trait of Chernyshevsky, as technological progress and growing reserves of natural resources seemed quite promising to most thinkers of the 19th century. Land is quite representative in this regard. It was still seen as the main natural resource available; it was the means by which the *obshchina* either thrived or perished; and its distribution was one of the motives behind the impetus for revolution.

Therefore, while Chernyshevsky's ecological utopianism (i) is rooted in the natural sciences, (ii) takes into account matter and energy as determinants to cultural development, and (iii) calls for moral views and social ideals based on a rational egoism which promotes egalitarianism, it is necessary to investigate to what extent he deemed land as a limited natural resource and how he thought it should be distributed to serve the purposes of human emancipation.

## Land and rural communes

A few of Chernyshevsky's essays, written between 1857 and 1861 and published in the *Sovremennik*, focus on issues related to land ownership and the peasantry. They present his main arguments against Russian political economists who opposed the cause of the serfs and against those who favoured a type of agrarian reform which would maintain the most fertile lands in the hands of the nobility, precluding any significant improvement in the life of poor peasants. In these writings, land is treated as a limited natural resource which should be distributed according to the precepts of justice.

Chernyshevsky proposed a radical transformation in the structure of the Russian peasant economy. In the first of such essays (1857), he stressed the need to preserve and expand communal ownership in Russia. In a very harsh tone, he attacked the scepticism of political economist Ivan Vasilevich Vernadsky (father of ecologist Vladimir Vernadsky) towards the benefits of communal property. Vernadsky would have completely failed to grasp the consequences of the empirical findings of the field research of German agricultural economist August von Haxthausen on rural communal institutions in Russia, published a few years before. Haxthausen had argued that such rural communes had to their advantage the capacity to act as mediators between individual peasants and society at large, therefore allowing for a process of social integration based on customs and traditions instead of relying on top-down legal schemes. Chernyshevsky mentioned how Haxthausen deemed as successful the way land was divided in the *obshchina*. Either each household received a plot and worked on it or, in more evolved communities, plots were collectively worked and the harvest was divided among households; in any

case, free will and entrepreneurship were seen as active principles in communal rural life, balancing external forces pushing for centralisation and the maintenance of bureaucracy.

Chernyshevsky also challenged the claim in which private ownership of land would lead to higher productivity, despite common sense based on the most developed agricultural lands in Western Europe. In his analysis of Haxthausen's data, he did not see any significant differences in the agricultural techniques employed in fields owned either privately or collectively. Land use under both ownership systems applied the same expedients to cut down forests (with deleterious effects on the soil, such as erosion) and gradually replaced the three-field system by crop rotation practices. The promise of greater agricultural yields would be actually linked to the prevailing institutions and social conditions, such as the legal system, size and density of population, and communication and transportation infrastructure, and not so much to the type of ownership of land. Moreover, given the right social circumstances, improvements could be made more easily and quickly in communally owned fields.

Chernyshevsky compared the regimes of land ownership present in Russia with those in Western countries such as Austria, England, and France, arguing that in all of them the evidence pointed to a general observation: higher monetary gross incomes in privately owned lands contrasted with better lives to a higher number of households in communally owned lands, mainly as a consequence of the access to a higher share of the product. Hence, most of the rural population would benefit from the establishment of more rural communes. Land use policy should aim at the satisfaction of the basic needs of the greatest number of people, not to maximise yields and profits for purposes of wealth accumulation. He was obviously not against productivity gains or higher gross incomes; however, such parameters were not the main goal but a means towards human emancipation through a more prosperous life for the masses of miserable peasants.

Chernyshevsky did not stand by an immediate elimination of all private ownership of land, given the likely resistance of a substantial part of the population that clung to the old ways and customs. People should decide their own fate; also, he who considered himself uniquely laborious or ingenious should be allowed to privately own and cultivate his land. Conversely, the *obshchina* would always be open to those in need and willing to farm the land.

The transformation would be gradual. After communal ownership was established, rural communal labour would be the next step. While the former only prevented peasants from becoming urban proletarians, the latter would more effectively contribute to augmenting agricultural production. Nonetheless, an 'agreement on communal production is much more difficult than agreement on communal ownership' (Chernyshevsky, 1857, p. 461), since it would be difficult to control the diligence of work (i.e. less productive peasants free-riding on more productive ones, in contemporary economic jargon) and thus require a higher level of trust. Communal consumption would be

the last stage in this process, being even more difficult to achieve in wider social circles. Hence, such schemes would have to be instilled in the peasantry by the intelligentsia.

Chernyshevsky (1859b) demanded the end of serfdom and the nationalisation of lands in which serfs lived and worked without any form of indemnification for the landowning nobility. In fact, he argued that, in addition to the redemption of land in favour of former serfs, landowners also needed to forfeit extra tracts of land as compensation for their previous misconduct towards peasants. After such schemes had been enforced, the distribution of land allotments among the emancipated serfs would follow the customs already in place in existing rural communes. The biased projects formulated by bureaucrats and put forth by the tsarist provincial committees would have no place in the structure of a reinvigorated peasant economy.

## Anti-Malthus: land improvement and social reform

Chernyshevsky (1857, p. 445) despised Malthus's political economy, a 'murderous system' which sought to preserve 'the need for vice and poverty in the mass for the happiness of the chosen ones of fate.' His rebuttal of Malthus's stance on land and population might shed light on his understanding of the interplay between nature and humans or, more specifically, between natural laws and cultural development.

In his notes to his Russian translation of Mill's *Principles of Political Economy*, Chernyshevsky (1949a, 1949b [1860–1861]) made use of demographic and agricultural data to challenge Malthus's theories on poverty, population growth, and declines in per capita agricultural output. He agreed that an increasing population might lead to decreasing agrarian productivity; however, Malthus would not have pursued in depth the empirics needed to truly understand the phenomena and their implications.

To Chernyshevsky, Malthus neglected that land improvements are perfectly able to offset the poorer quality of the soil of newly cultivated fields. Malthus did not bother to provide any contrary evidence in this regard. So, as time passes, improvements would need to keep up with such a marginal loss of soil fertility and with population growth to maintain a certain level of productivity. These two main opposing forces, land improvements and population growth, would regulate the level of productivity in agriculture.

Chernyshevsky delved deeper into the potential of improvements to compensate for population growth. He realised that the first step was to assess how strong the latter was. If the rate of population growth is known, he argued, then the necessary rate of progress in land improvements to feed the masses is also known. Chernyshevsky reprimanded Malthus for never proposing this simple exercise, preferring 'to show that

human disasters stem most fundamentally not from the shortcomings of the economic system, but from the laws of nature itself' (Chernyshevsky, 1949a [1860–1861], p. 751). Furthermore, if land improvements were important to sustain the basic requirements of the population, the question economists needed to answer was how to attract capital to implement such improvements. If the premise that capital is a special kind of labour is accepted, then the necessary capital for the implementation of the required improvements could be obtained by turning more people to farming; devising new ways to organise cultivation; introducing crop rotation and other advanced agricultural techniques, such as greenhouses; making better use of livestock; applying fertilisers; and so on. While fixed capital was the most important form of agricultural improvement, the current economic system did not stimulate such a vital endeavour, as the shares of income corresponding to profits and rent did not flow into rural areas due to lower financial yields.

Going back to the determinants of the rate of population growth, Chernyshevsky sought to establish the rules governing this phenomenon. He believed there was a natural rate of human reproduction determined by the physiological qualities of human beings. If the actual rate of reproduction was different than such a natural rate, then the conditions of life allowed by the current mode of social organisation would be unsatisfactory, and such a mode of social organisation was to blame. Abnormally low or high reproduction rates were a consequence of a social system which is prejudicial to human development, since they aggravated misery and grief for the poor, provoked unnecessary distress for women, and prevented the attainment of a healthy balance between human populations and the means to meet the basic needs of all.

Whereas more recent social circumstances in industrialised Western countries often led to diminished reproduction rates, as factory workers were prevented from getting married and the urban middle classes increasingly refrained from giving birth to many children, the conditions in rural or urban areas of poorer Eastern European countries were quite different. Therefore, Chernyshevsky claimed that poverty and coarse morals tend to increase the number of births and place the reproduction rate above the natural one, which would be in effect if all classes enjoyed high levels of well-being and freedom to pursue their natural drives. This means that the geometrical growth of population put forward by Malthus was not a natural law and that humanity was not doomed to suffer under the yoke of population checks. Social reform (i.e. revolution) would provide the requirements to lower the rate of reproduction so as to verge on the natural rate, which is to be understood not as a law of nature, but a rate at which people were free to pursue their real desires and purposes in life. Hence, such a natural rate of reproduction was, in fact, the result of favourable social conditions and norms which varied between countries, classes, ethnicities, and religions.

To reach such a state of affairs, human development was crucial. Proper education was necessary to set people free from the old social norms and public opinion and to let them follow their natural volitions in a new light. Chernyshevsky (1949b [1860–1861], pp. 308–309) believed that:

> if the present rudeness of family relations is eliminated by the action of pervasive enlightenment, reproduction will cease and population numbers will increase only as a result of social need; when there is no need for it, there will be no reproduction.

Thus, enlightened populations would naturally feel the need to extend their numbers only if it were socially necessary. Population growth could stop altogether if people reached a level of rational consciousness in which their wants matched social needs.

But what was the required degree of mass enlightenment to induce a birth rate which maintains the desired rate of population growth? Chernyshevsky did not provide an answer to this question. In any case, land improvements would have such a great potential to augment food production that mass enlightenment could be postponed for centuries before the lack thereof could be blamed for the current situation of the poor.

## Struggle for existence and mutual aid in Russian thought

The contrast between Malthus's principle of the struggle for existence between humans and Chernyshevsky's ones of communality, cooperation, and improved social relations was the subject of heated discussions among revolutionary Russian thinkers in the second half of the 19th century.

On the one hand, Russians either summarily rejected Malthus for its dreadful individualism or never paid too much attention to him. The idea of overpopulation seemed distant to them due to socio-historical conditions in post-1800 Russia (Grigorian, 2016). The country had low population density and rate of population growth; its vast territory had a great untapped potential for food production; and social cohesion was particularly valued among Russians as a defence mechanism against the harsh climate. On the other hand, when in the late 1860s Darwin mentioned Malthus's concept of struggle for existence as a source of inspiration for the development of his theory of evolution—he had read his *Essay* in 1838 (Barlow, 1958)—revolutionary thinkers had to make a statement, either against Darwin or somehow realigning the theory of evolution with the principles of communal property and cooperation.

The way to reconcile Darwin with such principles was to break competition into three different types: intraspecific (within one species), interspecific (between different species), and against the external environment. To *Narodnik* Petr Alekseevich Bibikov, Malthus's theory only considered the first type,

namely the competition between humans. However, intraspecific competition was only a determinant force if the other types of competition did not pose an imminent threat to the competing organisms. He added that, most of the time, interspecific competition was the one of greatest importance. Most population checks were caused by disease stemming from germs or bad harvests due to plagues, droughts, floods, storms, and so on. Humans could minimise these checks, provoked by interspecific competition or by competition against the external environment, by means of technical progress and social reform. Thus, there would be a lot of room for population growth and general welfare gains before intraspecific competition started to take effect. This would solve the age-old contradiction of political economy in which competition simultaneously augments productivity and poverty.

In the example given by Bibikov in his comments to his own translation of Malthus's *Essays*, he considered, in a rather analogical fashion, capitalists and workers as two distinct species. If capitalists excessively oppressed the workers, the competition among the latter would not have significant impacts. Interspecific competition was the key driver: productivity would be hindered and poverty induced. In a scenario of lighter oppression, workers would start competing among themselves for better jobs and positions, increasing productivity and alleviating poverty. Hence, the implications drawn by Malthus were fallacious; one must properly understand how and when each type of competition acts before devising a social system which maximises production and minimises poverty.

The separation between interspecific and intraspecific competition would dissociate Darwin's theory of evolution from Malthus's struggle for existence between humans. Private property and market-based competition could again be contested and compared to communal property and cooperative social relations as institutions which fostered the common good and abided by Darwinian evolution theory. Biologist Nikolai Dmitrievich Nozhin, one of the first Russian intellectuals to accept the precept of natural selection, argued that 'intraspecific relations were normally characterized not by competition, but by mutual aid' (Todes, 1989, p. 31). Consequently, an increased population would mean more labour capacity and a higher level of general welfare.

The realignment of Darwinism and the principles of communal property and cooperation was an important achievement for the *Narodnik* intellectual movement. Nozhin's views would wield influence over the revolutionaries of the following decades. By the turn of the century, these ideas would constitute the cornerstone of Petr Alekseevich Kropotkin's influential book *Mutual Aid: A Factor of Evolution* (1902). Like Nozhin, Kropotkin agreed with the mechanism of natural selection underlying the evolution of species but attributed a major role to intraspecific cooperation as a force behind the adaptation of successful communities. He also agreed with Chernyshevsky that if interspecific competition was a heavy burden to a species, then intraspecific

competition would weaken the individuals of this species to the point at which evolutionary progress came to a halt.

In a time of high interest in and debates about Darwinian theory, *Narodnik* thinkers made use of key insights taken from evolutionary biology, in addition to those mentioned on physiology, agronomy, and energetics, to develop their economic ideas within a utopian socialist framework—an original episode in the history of ecological economic thought.

# 5 Early Austro-German Social Energetics

From the proto-energetics of Goethe to the crucial developments of Mayer, Clausius, Helmholtz, and Ludwig Boltzmann (alongside the works of their French and British counterparts, such as Sadi Carnot, James P. Joule, and Lord Kelvin), expanding the bulk of knowledge on energetics constitutes one of the main contributions of German-speaking scientists of the 19th century (for a history of energetics, see Helm, 2000; Müller, 2007). Energy-based theoretical frameworks and empirical data applied to social systems, i.e. social energetics, were another important part of the research interests of many distinguished Austro-Hungarian and German scholars working in thermodynamics and other subfields of physics, chemistry, and biology. In addition to the eventual incursions of Clausius (1885), Helmholtz (1896), and Boltzmann (1905) into the social implications of their own fields, theories, and discoveries, the appearance of a—here referred as—'Austro-German social energetics' was also the result of the work of other natural scientists such as Eduard Sacher, Leopold Pfaundler (Boltzmann's successor as physics professor at the University of Graz), Slovenian-Czech librarian Johann Žmavc, and above all Wilhelm Ostwald (Martinez-Alier, 1987).

Austro-German social energetics was by then also promoted by social scientists such as Rudolf Goldscheid and other sociologists who have at some point contributed to Ostwald's journal *Annalen der Naturphilosophie*. In fact, at the turn of the 20th century, Austro-Hungarian social scientists pushed forward the emerging sociological discipline on many different fronts. The Viennese Sociological Association counted with social ethicist, socialist, liberal, and conservative currents (included in the spectrum were Austro-Marxists such as Max Adler, Wilhelm Jerusalem, and Karl Renner and individualist-liberal thinkers such as Carl Menger, Eugen von Böhm-Bawerk, and Friedrich von Wieser). Although social energeticists formed only one of such currents, they stood amongst a significant share of Austrian sociologists, social reformers, and socialists who were influenced by an Austrian type of philosophical tradition—circling back to Leibniz and the reception of his philosophical ideas in the beginning of that century by Bohemian mathematician and philosopher Bernard Bolzano—which was based on the quest for a scientifically grounded ethics. In the end of the 19th century, this tradition would

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be above all influenced by Ernst Mach's naturalistic-monistic view of science and of a scientific method based on logic and empirics, capable to explain and act upon not only natural, but also social phenomena of political and economic interest. Such a naturalistic approach to the social sciences would offer a long-lasting legacy to social energeticists, also thanks to Goldscheid's (and Ostwald's) intellectual and organisational skills (he was involved not only in the foundation of the Viennese Sociological Association, but also of the German one; he served as president of the Austrian Monist League between 1912 and 1917). Being himself an ethical socialist abiding by Mach's and Ostwald's monism, Goldscheid's openness to diverging views on how to improve the human condition contributed to the co-existence of very unlike-minded scholars within the same professional associations (Mikl-Horke, 2019).

In the broader context of the development of sociology, this early Austro-German social energetics fits as part of a then emerging so-called mechanistic school of sociology, which also included social mechanics, social physics, and mathematical sociology, featuring names such as Léon Winiarski, Thomas N. Carver, and Vilfredo Pareto (Sorokin, 1928). Moreover, when seen as the foundation of a specific understanding of ecological economic thought—i.e. as the study of flows and stocks of energy and matter as well as of their economic implications for the processes of social provisioning and cultural development—approaches to social energetics can be classified according to (i) their level of reductionism vis-à-vis energy as a determinant of cultural development and (ii) their stance on moral and policy issues associated with social provisioning processes and their related social ideals. In this sense, social energeticists have been divided into those depicted as left-wing ecological utopians, who argued in favour of more egalitarian forms of social organisation while living within given biophysical boundaries; technocrats, whose faith in technological development suppressed any concern for such boundaries; and social Darwinists, seen as advocates for the survival of the fittest principle of natural selection in the competition among human groups for energy use maximisation (Martinez-Alier, 1987; Franco, 2018).

Notwithstanding the usefulness of these distinctions, we focus on less known episodes pertaining to this early Austro-German social energetics, taking stock of the intellectual landscape of this extended scholarly community. Special attention will be given to works framed as or contributing to political economy, spanning from Eduard Sacher's 1881 *Grundzüge einer Mechanik der Gesellschaft* to articles published in the *Annalen* up to the beginning of the 1920s.

## Eduard Sacher's social mechanics as political economy

Sacher, who is not to be confounded with the homonymous Viennese gastronome and hotelier, was a mathematics, physics, and chemistry professor at the Imperial-Royal Teacher's Training Institute (*Kaiserlich-Königliche Lehrerbildungsanstalt*) in Salzburg between 1869 and 1883, when he was

promoted to the position of director of a similar institution in Krems until his retirement in 1895. Author of a few publications on physics, flora conservation in the Alps, and urban planning and climate, it was Sacher's contributions to the development of a social science grounded in the latest discoveries of the natural sciences that granted him a modest reputation within academic circles.

His two main books on what he called 'social mechanics' (*Mechanik der Gesellschaft*; 1881, 1899), which were written as treatises on political economy and structured around fundamental economic concepts expressed in energy units (e.g. production, consumption, value, wealth, labour, and capital), were reviewed in a disapproving light by prominent political economists such as the social-democratic politician and Marxist revisionist scholar Eduard Bernstein (1900) and the lead representative of the younger German Historical School of Economics, Gustav von Schmoller (1882). His immediate influence over sociologists (e.g. Zenker, 1903) and even over social energeticists was also very limited (e.g. Žmavc, 1926).

Nevertheless, Sacher remains an important figure in this Austro-German scholarly tradition due to the innovative character of his energy-based approach to social and economic research. Having devised most of his ideas already in 1881, he seems to have been a thinker ahead of his time, despite the fact that similar approaches to social science, which were less formal but similarly grounded on how human labour is a form of energy that constitutes the material base of social systems, had already been independently developed by Hermann Gossen (1854), Frédéric Le Play (1855), and Sergei Podolinsky (2004 [1881]; see also Scott, 2011). Although Sacher did not succeed in impressing his contemporary scholarly community, it is worthwhile to redeem his legacy and properly place his contributions to social energetics in the context of the history of ecological economic thought.

Karl H. Müller (2019) draws a distinction between a Machian approach to social mechanics, i.e. based on abstract analogical constructs and deductive reasoning having the natural world as a reference, and Sacher's own way of building bridges between the natural and social sciences: posing questions on the validity scope of the applicability of the energy conservation law to the human economy and heuristically pointing to the advantages of research on social issues adhering to knowledge stemming from energetics. These epistemological differences might partly explain the absence of mentions to Sacher in the works of Mach and Ostwald.

Martinez-Alier (1987) attributes to Sacher some of the first assessments of energy flows in agriculture and the ensuing development of regional accounts incorporating sources such as coal, wood, and food- and feedstuffs. Sacher's social energetics was based on assumptions such as minimum energy requirements per person per year and a corresponding minimum energy productivity of labour, inferring connections between human development and energy use per capita from an evolutionary perspective in the same way as posterior works in the *Annalen*.

In contrast, the focus here lies on the level of energetic reductionism and morally grounded policy-relevant propositions espoused by Sacher as a political economist. Regarding the former, he undoubtedly attempted to build an overly reductionist economic science, for which he was reprimanded by Bernstein and Schmoller. He set out from an energy theory of value that differentiated between exchange values as the amount of energy required by human labour to produce a given good, and use values as the serviceable amount of energy provided by that good after losses and according to the efficiency of the necessary energy conversion processes (the total amount of energy embedded in that good would correspond to its absolute value). He posited the economic principle of labour (and of society as a whole) as seizing the maximum possible amount of energy from nature.

However, even though wealth as a whole was largely determined by the energy returns of labour, Sacher was well aware of the limits of such a view. Labour's ability to seize energy also depended on environmental conditions and individual skills, and thus certain human activities (as well as the wages related to them) did not have their value considerably influenced by energy flows, such as art and other more creative undertakings. Although labour is defined in terms of energy, Sacher's theory of value actually amounts to what can be referred to as an energetic labour theory of value, in which value is not reducible to all forms of energy even though human labour can be converted into these other forms and vice versa. Sacher (1897, p. 10) makes it very clear that 'only labour creates economic value.'

In *Gesellschaftskunde als Naturwissenschaft* (1899), Sacher explicitly stated how the main failure of economic science and organisation at the time related to the issue of distribution, 'the most difficult and currently very unsatisfactorily solved duty of contemporary society' (p. 18). He was deeply concerned about how energy surpluses were appropriated by certain social groups, which led to a moral reproach to rent and profit as accepted practices of a healthy economy. Sacher's energetic anti-capitalist approach—for him, nature is the only true capitalist, if one defines capital as a good that augments its own energy content, as in the case of fertile soil and the accrued interest in the form of sunlight (1881)—places him close to the utopian stance on moral and policy issues in connection with processes of social provisioning and related social ideals. As a matter of fact, his rebuke seems to bring him closer to the socialist approach to political economy he had presented and distinguished as an intermediary position between individualists (the Classical school) and communists (or altruists), defined as the advocacy for some level of collective participation, supervision, and guidance to production and distribution. As a remedy, he called for a new economic order based on the maximisation of the total product and the regulation of distribution according to the amount of dispended labour, in addition to a revamped economic science abiding by his own understanding of the economic organism.

Sacher's criticism of the then current mode of distribution of goods was also a key element in his booklet titled *Vier Denkfehler der heutigen civilisirten*

*Menschheit* (1897). To him, mass poverty was the most pressing issue of his time, not least because in modern societies it was caused by overproduction (even if granted the possibility of exports) and not a widespread shortage of goods, as illustrated by the then still unfolding long depression. Concurrent material abundance and destitution amounted to a historically unique economic conundrum: 'producers want to sell but find no buyers. The poor want to buy but find either no work or such low wages that their needs cannot be met' (p. 5). The underlying cause, according to a rough comparison between countries, could not be attributed to type of government, level of political freedom (from which Sacher concludes that revolutions are the wrong way to address the issue), protective tariffs, lack of technical progress, or population and army size.

The root cause of this conundrum or apparent paradox was given by four 'thinking errors' (*Denkfehler*) in connection with labour. To consider time (i.e. rent) and space (land or, more generally, matter) as sources of value in the process of wealth accumulation amounted to two of these errors, although they constitute necessary means of subsistence or absolute conditions for the creation of value (as such, land did not possess an exchange value, and doing otherwise, in fact, prevented the realisation of a greater total product). A new legal framework was needed to correct the injustice of having 'pure human labour, which creates everything, coming out empty-handed in the distribution process' (1897, p. 14). The third error had been the inheritance of Roman law in modern labour contracts, retaining aspects of the slavery system such as the objectification of human labour. Finally, the fourth error regarded the disappearance or weakening—for the sake of economic freedom and competition and not without incurring both amelioration in production and wasteful practices, such as advertising—of a State-led compensatory or equalising social institution (*Ausgleichsorgan der Gesellschaft*) in the process of division of labour, responsible above all for securing that prices and wages allowed people to meet their needs.

Therefore, overcoming poverty needs a reassessment of labour itself. To Sacher, in the then current organisation of the economy, labour actually worsened living conditions, as interest-based reinforcing feedbacks between low wages and overproduction prevented the satisfaction of basic needs. The social reforms necessary to solve this conundrum were the focus of his last book *Die Massenarmut* (1901), which were basically already present in *Gesellschaftskunde*. His critique of the prevailing economic system was primarily targeted against rent as a cause of overproduction and high prices. In addition to the creation of an *Ausgleichsorgan* that made sure prices aimed at the satisfaction of basic needs and the maximisation of the total product by means of securing the availability of the means of production for workers, his reform propositions included public ownership of land and State-led production whenever necessary.

In a single reference to Marx, Sacher calls him 'a great economist' (1901, p. 51) while alluding to his notion of historical forces of change and how he

could sense the germ of a new mode of social organisation. Yet, by that, Sacher meant a reform of the economic system—not revolution—based on the rejection of the 'English way of doing economics' and aided by the creation of a 'general savings cooperative' (pp. 65–66), in which he seemed ready to partake to the point of sketching himself the statutes of the organisation and providing his own address on a footnote so that interested readers could contact him directly.

## Ostwald's monist approach to energetics

In an introductory piece to the inaugural volume of the *Annalen*, Ostwald (1902, p. 2) states the purpose of the journal as the 'maintenance and development of common ground between philosophy and individual scientific fields,' which he deemed had been drifting apart during the 19th century. This rift called into question the ability to integrate and systematise the growing number of scientific breakthroughs into general philosophical frameworks while avoiding speculative—i.e. not based on experimentation—ways of doing science. The laws of thermodynamics (*Energiegesetze*), 'the biggest scientific discovery of the 19th century' (p. 3), were to Ostwald the embodiment of the need to bring philosophical depth back into scientific research for the sake of a common, overarching knowledge. His monist stance imprinted onto many contributions to the *Annalen*, especially those concerning the application of energetics to a broad spectrum of human, social, and cultural issues, from organic and psychic phenomena to economic, moral, and aesthetic implications (Stekeler-Weithofer *et al.*, 2009, 2011).

Ostwald was one of the few natural scientists whose take on social energetics exerted a clear influence over social scientists, especially cultural anthropologists. His incursions into debates on social issues, which were from an epistemological viewpoint informed by a Comtean, positivistic view of science as a pyramid topped by the social sciences or, in his own terms, 'culturology' (*Kulturologie*), aimed at the formulation of an empirical and objective (i.e. based on the natural sciences) ethics, extractable from natural social laws and acting as a driving force of changes in modes of social organisation. These changes could be explained and were ultimately caused by processes of generating, converting, and storing energy for human use (Ostwald, 1909), which amounted to reductionist correlations between cultural development and energy availability that were fiercely criticised by Max Weber (1909).

Focus on discourses in the *Annalen* on topics related to an energy-based political economy can shed light not only on the history of Austro-German social energetics, but also point to a more nuanced landscape in terms of reductionism and morally grounded policy issues pertaining to the conceptualisation of social provisioning processes. Ostwald himself wrote short pieces in the *Annalen* in response to criticism from social scientists in relation to these topics. For instance, he asserted it was a misconception to attribute to him the view according to which energy was 'an absolutely general and sufficient

principle for the conception of the whole world' (Ostwald, 1911b, p. 1). The laws of thermodynamics were to him capable of explaining a large set of phenomena, especially in physics and chemistry, but other general concepts were needed, such as order (i.e. time, space, rules of logic, mathematics) and life. In fact, energy would rather constitute an auxiliary concept in fields associated with the general concept of life, such as physiology, psychology, and the social sciences broadly defined (*Kulturwissenschaften*). Energy would be necessary but not sufficient to address biological and social phenomena, although such claims remain reductionist, in the sense that no general or central concepts emerged from the social realm itself.

Ostwald's moral stance towards the social and economic implications of the 'energetic imperative' (1911a) sets out from an ethical principle based on energetics: 'act in such a way that you transform, with the best efficiency relation [*Güteverhältnis*], raw energies into higher ones [i.e. more useful for human purposes]' (p. 114); behaving in this manner would favour human collectives in their attempt to counter the entropic nature of social provisioning processes. In turn, associating with others would be energetically rational for individuals. Ostwald compares humans and bees as parts of a collective (*Gesamtorganismus*) and, therefore, human rationality should dictate that we act in favour of general welfare, as our individual well-being largely depends on the whole. Therefore, despite the fact that he believed natural selection, understood as a struggle to appropriate and make use of free energy, would be an important element of cultural development, it did not make him a social-Darwinist in the sense of being an advocate for the survival of the fittest in an intra-species context (he also openly rejected any associated race-based claims, as one can infer from his many book reviews in the *Annalen* on that topic). Even if his energetic cost-benefit imperative contributed to spread a certain utilitarian economic logic into all areas of social life, his ethical stance was more in line with those of social-Lamarckist reformers, who argued in favour of planning and progressive social policies (education, housing, women's and workers' rights, etc.) as a way to improve the human condition. The practical implications he drew from monism and social energetics translated into an appeal for a science-based social reform and collective emancipation, pacifism, and internationalism (see Neef, 2012). Ostwald (1910, p. 185) stated that, in the context of social progress, he was living in a time 'when the social organization therefore demands and strives for as thorough an equalization as possible on the conditions of existence of all men.'

Although the contents of the *Annalen* correlated with Ostwald's evolving scientific interests and worldview, it cannot be seen merely as a flagship of positivism, social energetics, or monist philosophy. It actually entailed a quite diverse assortment of disciplines, topics, methods, and positions. Nevertheless, in her analyses of the sociological discourses in the *Annalen*, Katharina Neef (2011a, 2011b) identifies an increasing focus on social questions in detriment to epistemology and natural science from 1913 onwards—although social energetics was a recurrent topic since 1905—which not by coincidence

came with the appearance of Goldscheid as a co-editor (who, alongside Ferdinand Tönnies, had a decisive influence on Ostwald's *Kulturologie*), as well as a gradual move towards contributions signed by non-academic authors engaged with social reform and mostly belonging to either Freudian or socialist intellectual circles.

## Political economy in the *Annalen*

Focus on specific contributions to the *Annalen* bearing upon political economy from the standpoint of social energetics corroborates such a level of diversity of approaches, which is also the case for other topics covered by the journal, from linguistics and education to psychology and chemistry (Neef, 2011a). Articles on social energetics spanned from isolated and inane forms of social Darwinism calling for thriftiness and entrepreneurship (Nordenholz, 1912) and energetically and biologically reductionist, technocratic, and productivist approaches (Fulda, 1909; Barkowski, 1921), which were less critical or in some cases supportive of capitalism, to more elaborate outlooks mixing such reductionist and technocratic features with overtly socialist perspectives. Nevertheless, they all shared a positivistic and interventionist view of science which is clearly associated with the term 'social engineering,' as used in a derogatory way by Friedrich von Hayek (see Martinez-Alier, 1987). Two main arguments commonly set forth in the latter group of contributions are (i) the need to reform existing capitalist economic systems, in its then current form seen as a cause of misery, cultural degeneration, and social unrest, as opposed to giving in to revolutionary socialism; and (ii) the energetic nature of economic value, bearing different but similar meanings and eventually amounting to unambiguous formulations of an energetic labour theory of value. Both positions are strikingly in line with Sacher's work, although no direct mention to him is to be found in the *Annalen*.

### *Rudolph Goldscheid*

The economic reforms proposed by Goldscheid (1913) focus on the amelioration of the human condition in a material, psychological, and cultural sense as well as on the acknowledgement of the economic gains of purposefully increasing standards of living for all. Goldscheid (1908, 1911) draws from Paul Kammerer's neo-Lamarckist social biology, according to which the process of active adaptation in humans would lead to changes in environmental conditions and, in turn, shape our own development trajectory; Marx's notion of the living forces of purposeful change and progress; and Ostwald's energetic imperative as a key economic concept. His article in the *Annalen* calls for an economy of and centred on human beings (*Menschenökonomie*) as means to foster a socially cohesive cultural development without room for ruthless egoism at the individual and collective levels, which wasted the biological

and economic value of human life and constituted the norm under the rapacity of a commodity-based, capitalist, and Taylorist economy (*Warenökonomie*; Fleischhacker, 2000; Exner, 2004; Neef, 2012).

Providing people with all that was needed for a full life (including not only the energy requirements for subsistence but also leisure and intellectual or artistic activities) would lead to higher labour productivity, an argument which the Viennese sociologist thought was more convincing to get elites to think about workers as 'organic capital' (1908, p. 54), assets to be efficiently managed and maintained just like machines or land. Although seemingly discriminatory, this rhetoric was deemed as useful in order to set in motion reforms which would unleash the full potential of the evolutionary process of 'higher development' (*Höherentwicklung*) based on human willpower, autonomous conscience, and collective action (Mikl-Horke, 2011). Opposed to Malthusianism and social Darwinism, although not without incursions into eugenics, he also expected to compensate for declining birth rates with a population of higher quality as a result of social policies. It was targeted not only at workers, but covering the whole human life cycle and giving special attention to women, given their special character as organic capital, i.e. their economic value as employees in the branch of human reproduction of the *Menschenökonomie*. Moreover, his axiological appraisal of a *Höherentwicklung* was based on a slightly different conceptualisation of theory of value, i.e. the existence of a surplus value as the difference between the value produced by a working individual over its life cycle and the costs of raising, caring for, and sustaining the needs of that individual, which is not strictly reducible to energetics (Goldscheid, 1908).

Whereas the market still played a role in the *Menschenökonomie*, Goldscheid, without going into details, argued in favour of nationalising those means of production which were directly related to the fulfilment of the basic needs of the masses; attacked exploitative social relations of production which kept nationalist elites in power and created wars in the context of international competition, thus preventing development in all countries; and affirmed the need for a strong democratic State, even if private corporations should be the ones bearing the costs for sustaining the organic capital they employed. While holding a strong social democratic standpoint in political settings—he was a member of the socialist party with close ties to union movements—Goldscheid believed that the inadequacies of capitalism could be overcome within that same economic system by means of a radical, transformative reform based on the concept of *Menschenökonomie*, since market economies would not necessarily prevent the achievement of higher stages of human development (Neef, 2018; Witrisal, 2019).

### *Franz Oppenheimer*

Another proponent of reforming capitalism along socialist lines was physician and social scientist Franz Oppenheimer, who in the 1910s studied in

Berlin with Schmoller (as did Goldscheid) and was strongly influenced by Adolf Wagner. He became a private professor and lecturer of political economy, securing a position at the Goethe-Universität in Frankfurt in 1919, and eventually immigrating to the United States in 1940 after short stays in the Palestine, Japan, and China. In line with his medical background and under the influence of the German Historical School, Oppenheimer (1913, p. 335) adopted a holistic view of the economy as an organism and emphasised the role of the social scientist as the 'doctor of the social body' (*Arzt des Gesellschaftskörpers*), in charge of diagnosing its problems and offering alternative modes of socio-economic organisation as treatment.

In his article in the *Annalen*, he focuses on the concept of 'practical economics' (*praktische Ökonomik*) as the application of economic theory aimed at the 'common good' (*Gemeinnutzen*)—and, therefore, dissociated from the economics of private interests—understood as the ability to maintain population levels and meet basic human needs for all (described in biological and cultural terms). The associated art of formulating economic policies (*Volkswirtschaftspolitik*), on the other hand, must take into account non-economic political forces which act upon economic processes. In a capitalist setting, such forces act according to specific class interests and power relations, resulting in monopolies and ultimately in an unfair distribution of wealth which prevents higher stages of social and economic development. Hence, the common good must take precedence over private (or class) interests; the role of a practical economics and related economic policies is to remove the conditions that make competitive markets harmful to the common good. However, these conditions are not easily ascertained. Oppenheimer identifies above all the need for an agrarian reform, since the prevailing system led to class-based monopolies which extracted a surplus seen by him as the main problem of capitalism. Other functions of a State working for the common good were taxation, enforcement of workers' rights, and the promotion of education, health, technological innovation, and infrastructure. Yet, economic regulation should be undertaken parsimoniously, as most of the time State interventions in the economy were, in fact, corrections of past wrongdoings—markets would after all function well on their own if protected from the political forces of private and class interests.

In his attempt to scientifically ground practical economics, Oppenheimer calls for justice as a Kantian categorical imperative for the existence of society itself. An ethics-based set of norms and standards served as objective coordinates for the deduction of pure economic theory as well as the formulation of policies aimed at the common good. Furthermore, despite the fact that energetics does not appear in his article, it did so in his book *Theorie der reinen und politischen Ökonomie* (1911), which was reviewed by Ostwald (1913) and praised for its monist stance and assertions that the expenditure of bodily energy—also from an entropic perspective—for the acquisition of goods is a fundamental economic phenomenon and that labour, in a physical and human sense, is the only value-creating economic factor.

### *Zygmunt Heryng*

A more energetically reductionist standpoint than those of Goldscheid and Oppenheimer can be seen in the article of Polish socialist economist and publicist Zygmunt Heryng, who studied at the Commercial Academy in Vienna and later, while studying in the Mining Academy of Saint Petersburg, joined the *Narodnik* movement. In the 1890s, he turned his focus to economics and finance, having published several books on economic theory and history. He corresponded with Ostwald and was an enthusiast of social energetics. His contribution to the *Annalen*, 'Die Logik der sozialen Ökonomie' (1911), was a shorter version of a homonymous book published in 1896 and meant to give more visibility to his work on the application of social energetics to political economy. It also aimed to get him acquainted, via Ostwald, with Mach and other prominent scholars in Vienna who could endorse his application to a professorship in social economics (*Sozialökonomik*) at the Lemberg Polytechnikum, since at the time his reputation as an engaged socialist did him no favours with the Viennese administration (Neef, 2012).

Heryng's article attempts to build a theoretical framework for economic science based on social phenomena as regular (although contingent and uncertain) causal relations empirically explained in terms of purposeful transformations of energy. Economic processes are ultimately the conversion of physical or natural energy into social energy, notwithstanding the subjectivity entailed in social relations and ethical requirements, which arise from the common will (*Gesamtwillen*) in a given point in time. Social energy is defined as the energy produced within an economic system or structure (taken in a broad sense, corresponding to either firms, the proletariat, farms, etc.) or appropriated from the environment for the sake of the maintenance and development of that system; the maximisation of the availability of social energy at the aggregate level is then presented as the main goal of every form of economic organisation and hence also of social economics.

The most original part of Heryng's article concerns the development of his own energetic theory of value, which differs from Sacher's energetic labour theory of value. While supply and demand, as expressions of the quest for appropriation of social energy, determine relative values in the processes of circulation and exchange, the absolute value of goods and services is given by means of the energy used in their production, which is also reflected in prices. Heryng combines the labour and utility theories of value, arguing to have successfully built a bridge between them. From the viewpoint of supply, the energy expended in the process of production (which is not limited to labour) determines the value of a good; from the viewpoint of demand, the energy to be gained by the buyer does so, despite the fact that it varies according to its intended use. Profit arises mainly when there are arbitrage opportunities, which are created by dependence-based social relations (between peasants and landlords, producers and suppliers, lenders and debtors, more and less skilled labour, etc.). In this context, wage labour is reduced to

the loan of the biological energy of those who do not own large stocks of social energy (i.e. capital) and thus dependent on those who do. Heryng sees these dependencies as exploitation of weaker parts of the economy and the reason for such an unequal distribution of social energy.

### *Oskar Nagel*

A less theoretically structured contribution to the issue of economic value was given by Oskar Nagel, a Viennese chemist, writer, and scientific journalist who immigrated to the United States at the turn of the 20th century for a career as researcher in industrial chemistry (Neef, 2011a). Few authors had such a strong and permanent presence in the *Annalen*, where Nagel published eight articles between 1908 and 1921 on subjects ranging from animal and human evolution, ethics, and philosophy of history to energetics and political economy. Most of them also figured as chapters in his book *Die Welt als Arbeit* (1909b), a declared attempt to bring together Darwinists, vitalists, and physicists, and to forge a new, monist worldview inspired by the works of Mach, Ostwald, and Goethe. In this sense, Nagel's teleological and quite reductionist account of human evolution is based on the notion of energetic capital (*Energiekapital*), which is the ability of human beings to harness increasing amounts of high-quality or noble (*edel*) energy, which also translates into the flourishing of rationality, ingenuity, morals, and feelings, and, in turn, of art, science, and economic prosperity, posing as the basis of cultural development (Nagel, 1908a).

In his discussion on economic value, Nagel (1908b) grounds his arguments on practical experience rather than on axiological theorisation. Rejecting Marx's labour theory of value and adopting a technocratic tone, he states that the value of a good comes primarily from the quality and only secondarily from the quantity of energy (which bears no relation to labour time) used in the production process. Even more importantly, value must be determined by the extent to which a given good supports human life and development, i.e. by its ability to add to the consumer's *Energiekapital*, in which case it can also be either zero or negative if it wastefully does not contribute to those ends or leads to the degeneration of the *Energiekapital* of consumers, respectively. Hence, drawing from Ostwald, with whom Nagel was well aligned in intellectual matters, he called for an 'ethics of evolutionary energetics' (1909a, p. 145).

The notion of value also had implications for the assessment of the alienated lives of workers forced to perform degrading and meaningless work in factories. To Nagel, society should give more room for creativity and freedom at work, even to the loss of some productivity; extreme forms of division of labour also divided human beings themselves, and widespread physical and mental degradation would be the real price to pay in exchange for us being able to purchase cheap pins—an implicit allusion to Adam Smith. As a conclusion, he claims the assaults of capitalism must be neutralised so that all

can find meaningful work and have their basic needs met; yet, the true social question refers to how labour and leisure are performed in terms of accruing *Energiekapital* and not to goods (1908b). Taking after the work of Ruskin, Nagel (1909a) praises workers and advocates for better living standards for them, while the 'social question remains primarily an energetic one, and not of wages or labour time' (pp. 427–428). The goal of political economy would be to find out which types of work and leisure foster this type of cultural development, including which goods should be produced.

### *Ernest Solvay*

A more prominent figure amongst the social reformers writing in the *Annalen* was chemist and wealthy industrialist Ernest Solvay, who also served as a patron of research in social science (being thus of great use to Ostwald, whom he met in 1907, and other scholars who shared his scientific predilections). Solvay led his own institute of sociology in Brussels, dedicated to providing scientific solutions to social questions, especially by means of social energetics as a combination of ethical and practical propositions which aimed at improving workers' lives (Vatin, 1993; Neef, 2012).

Solvay's reductionist approach entails the notion of humans and animals as 'energetic apparatuses' (Solvay, 1910, p. 106), made of self-organising physical-chemical reactions in constant energy exchange with their environment. Sociology is defined as the search for objective principles, which underlie modes of social organisation based on collective and reciprocal duties to set these apparatuses in motion for the sake of augmenting aggregate production. Moreover, he stands by a highly technocratic stance, according to which intellectual prowess is a driving force of a so-called energetic-productivist kind of development. Hence, his bid for social reform focuses on education and inheritance taxes (all other taxes would be barriers between production and consumption, and thus should be avoided) as a means to create equality of opportunities early in life. This, in turn, would lead to more technological progress through higher averages of intellectual abilities in the population, increasing production and social welfare.

Such a technocratic worldview also shaped Solvay's (1917) formulation of economic value. Emphasising the role of knowledge to cultural development, he classified it into two categories: the 'special knowledge' (*Spezialwissen*; p. 91) of exceptional individuals, who are responsible for technical progress and expanding production in accordance with an inherent dynamics of scientific development, and the 'general knowledge' (*Allgemeinwissen*; p. 92) of the average individual, who must be subjected to education and training in order to reduce social inequality and support production and welfare. Increasing the intellectual ability of the population would boost 'social energy' (p. 94)—the energy that is converted into welfare. Therefore, Solvay argues for the creation of a unit of knowledge (*Wissenseinheit*) to be energetically equalled to a given unitary amount of a typically intelligent, mechanical

labour force in a given unit of time, assuming intellectual and physical powers are interchangeable and that the welfare which can be obtained by this unit of labour force corresponds to an amount of food that can physiologically produce energy in the form of heat which is, in turn, equal to the mechanical energy expended by the worker. Thus, the value of knowledge can be given in energy units, which means that the average values of *Allgemeinwissen* and *Spezialwissen*, which determine the stages of social development, can be given in terms of energy. Solvay's energetic labour theory of value lays emphasis on intellectual faculties as the mainstay of labour-based and energy-oriented creation of economic value.

While capital is the direct result of the accumulation of labour or ultimately of energy, labour arises from the use of intellectual and physical powers over time. It is seen as drudgery and thus to be minimised for a given amount of produced welfare or capital. The ratio between capital gains and labour wages is of utmost importance. Assuming capital and labour have the same value and that all people have the same knowledge (special and general), then the employment of capital and labour for the same amount of time would yield the same gains. However, the average value of special knowledge is always higher than that of general knowledge; therefore, the ratio between capital gains and labour wages corresponds to that between the energetic average values of special and general knowledge. He calls for a type of management focused on equality in terms of knowledge and consequently of welfare, therefore claiming for equal opportunities so that inequality levels would accrue only from differences in the actual economic output of individuals as contributions to society (Solvay, 1911, 1917).

Apart from his energetic-productivist approach to value and welfare, Solvay argued in favour of free markets, open ports, and international cooperation as ways in which reciprocity leads to development. He calls for a system of 'free socialization' (1910, p. 114) as a means to regulate productive forces, which would be composed of State investments in businesses—especially those tending to the satisfaction of basic human needs—paid by voluntary loans from all social sectors and conditioned to increasing wages in relation to capital gains.

### *Johann Žmavc*

Last, there is Slovenian-born Czech scholar Johann (born Ivan) Žmavc, who earned his doctorate in philosophy from the University of Prague in 1898 and worked at its library until his retirement in 1934. In addition to his work on the modernisation of librarianship, he wrote extensively on the need for a scientific approach to economic and cultural issues, catching Ostwald's (also Solvay's) attention and praise when reviewing his 1906 book *Elemente einer allgemeinen Arbeitstheorie* (1908). After 1918, Žmavc enjoyed some notoriety: he was appointed professor of political economy at the University of Ljubljana, without taking the position; founded and led academic associations

in Prague; became an active member of the socialist party; and had close ties with philosopher and first president of the newly formed Czechoslovak Republic, Tomáš G. Masaryk.

The theoretical contributions of Žmavc to the making of an energetic political economy are perhaps the most thorough amongst those in the *Annalen*. He sets out from the role of thermodynamics, especially the concepts of work and energy, in economic reasoning and postulates the economic principle as one of energetic efficiency, i.e. providing for oneself while minimising expenditures and maximising intake from nature's stock of energy. Furthermore, humans are able to build energy reserves over time in the form of goods like infrastructure, which is due to accumulated manifestations of knowledge inherited from earlier generations (Žmavc, 1905b). Thus, energetics bridged physics and the laws of organic and social development, including causal links which would explain psychic phenomena such as freewill and motivation. Žmavc (1905a) gives the typical ecological description—including a very crude and simple attempt at accounting—of social energetics in the context of ecological economic thought: energy flows from the sun to plants, animals, and humans as a basis for the maintenance of social systems.

Žmavc's theory of value is grounded in the energy of labour which sustains society, despite the fact that it does not create energy but only acts upon the environment to convert it for human purposes at the cost of the worker's own energy. While value ultimately stems from nature, economic value entails energy inputs in the form of labour—according to his own examples, air does not have economic value whereas cultivated food does. In his own words, 'economic value is ultimately the useful energy taken from nature and adapted to human needs by means of purposeful labour' (1905a, p. 236). Labour is also the only factor of production—seeing land or industrial capital as such, which amounted only to previously accumulated energy as conditions for the further creation of economic value, would serve only to justify property laws. In addition, value also depends on final use, i.e. the ability of goods and services to meet basic human needs. In any case, an objective assessment of value is needed to counter the harm to social progress inflicted by the price-based, subjective, and skewed views on value promoted by *laissez faire* liberalism.

In an article devoted to ethics, Žmavc (1909) emphasises the satisfaction of basic needs (food, housing, clothing, health, education) and communal life as cornerstones of an ethics-based set of social laws yet to be developed and implemented. More specifically, determining human needs would be the main object of social ethics and hygiene-related knowledge (*Hygienik*), the latter defined as the field responsible for objective, qualitative, and quantitative assessments of human physiological and psychological needs. The next step would be to calculate the necessary labour to fulfil those needs. Combined, these two efforts would allow to measure and distribute economic values in practice (Žmavc, 1910). Distribution would be based on

the energetic output of labour (granted all the advantages of intellectual over muscle-based work), although all would be entitled to subsistence (*Existenzminimum*). In fact, needs were already more homogeneous in modern societies, thanks to reduction in temporal and spatial scales occasioned by technical progress (Žmavc, 1905a).

Hence, to Žmavc, labour and ethics jointly shape an ideal of cultural development that must guide the discussion on values away from the ethically vicious character of Manchesterism and its biased deduction of natural laws based on profit, supply, and demand, and towards a sense of justice based on collective self-preservation. The liberal elites hindered the principle of the highest welfare for the highest number, indulging in luxuries while the majority is deprived of the most basic needs. Given the then current levels of production, this state-of-affairs was no longer caused by scarcity but by prevailing property laws—a point similar to Sacher's claim on overproduction. Unequal power relations allowed undue energy appropriation to be turned into law and social norm. It was the duty of ethics to place the interest of the collectivity above and as the objective of the individual. Instead of engaging with class struggle, people should agree on distributing the immense reserves of energy offered by nature.

In another line of argumentation expounded two decades before by Sacher, Žmavc (1906a) criticises how the European economic and legal systems were still based on the barbaric economic customs of Roman times, when property, profit, and rent were given priority over meeting human needs or even balancing demand and supply. Wages in the context of division of labour was a concept grounded on Roman economic law and its exploitative social norms, impervious to moral claims regarding the injustice of practices related to property, inheritance, and leonine labour contracts. The greater part of production was seized by a few—who create no economic value but live lavishly—in the form of rent on land and other forms of capital in the name of property rights. While the overindulgence of these few would not be objectionable given the vast stocks of useful energy in nature, the problem lies in the appropriation of the income of workers: production could grow indefinitely and there would still be excess on the one side and misery on the other. Previously created values are held hostage; workers cannot create further value without them and thus are subject to allegedly 'free' labour contracts.

This conflict between production and distribution and the ensuing detachment between production and consumption called for new labour laws in the context of an energy-based political economy. The means of production must be readily available to workers so that the barriers imposed between production and consumption by personal interests, so typical of market economies, are removed. Also, prices must be scientifically determined (as in Sacher's *Ausgleichsorgan*) based on quantity and quality of labour; money must act as a social, ethical, and legal representation of the value of 'concentrated social labour' (1905a, p. 237); the social function of credit must be performed

by labour organisations as transfers of knowledge and goods. For achieving these goals, Žmavc proposes the articulation of a 'science of human labour' (*Menschenarbeitswissenschaft*; *ibid.*).

Žmavc seems to have come closest to Sacher's social energetics, a finding that is at odds with the lack of mention to the latter's work in the *Annalen* or with little praise elsewhere (Žmavc, 1906b), an issue deserving further historical research. More broadly, overlaps between Sacher's social mechanics and the propositions from authors combining social energetics and political economy in the *Annalen* are clearly not negligible. Even without explicit mentions, such a result increases Sacher's relevance as one of the first social energeticists in the context of the history of ecological economic thought.

# 6 Conservation and Economic Ornithology

A few decades after independence, people in the United States viewed their country as an immense land to conquer, in particular westward. The myth of the *frontier* was part of their identity and relationship with the environment: on the one side, the Jeffersonian ideal associating democratic values with the extension of land property to all citizens; on the other, a proximity with wilderness and a contemplative view of the aesthetics of nature.

In this context, replicating the old European opposition between Arcadian versus instrumental views of nature, American environmentalism emerged through the writings of a few unconventional characters, starting with Ralph W. Emerson (1836), Henry D. Thoreau (1854), and George P. Marsh (1874). They provided early warnings about the destruction of pristine landscapes and extinction of species, a trend they considered to be in conflict with American values.

In the late 19th century, this nascent environmentalist movement echoed the end of the *frontier*, i.e. the conquest of all available territories, from the Atlantic to the Pacific ocean. Natural limits became a reality. The articulation between the concept of American *wilderness* and the emergence of clear geographical boundaries required the structuring of new discourses and the design of environmental policy programmes. This need led to the development of two distinct currents within American environmentalism in the last decades of the 19th century: the preservation current of John Muir and the conservation current of Gifford Pinchot.

Hence, we turn now to American environmentalism in the early 20th century and the associated role of natural science in shaping public policy. Its articulation with social science implied the cooperation between scholars who identified themselves as part of specific disciplines and no longer as encyclopaedic thinkers. In that context, research thrived with the emergence of interdisciplinary fields. A fitting example is economic ornithology, i.e. the study of birds from an economic standpoint.

## Conservation *versus* preservation in the Progressive Era

John Muir and Gifford Pinchot were not exactly of the same generation. Muir was older. In the 1860s, a health accident led him to dedicate his life to the

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protection of nature. His work would later contribute to the creation of Yosemite and other national parks. He also co-founded the Sierra Club, a well-known environmental organisation which conveyed his views to a broader audience. Muir's conception of environmental action was based on clear-cut borders between areas not to be touched by humans and those whence natural resources could be drawn. He claimed that the intrinsic beauty of nature was sufficient to legitimate protective action. Creating natural parks was, to him, one of the best environmental policies.

Conversely, Pinchot grew up in the 1870s and 1880s. He was trained at the *École Nationale des Eaux et Forêts* in Nancy (France) and rapidly became a pre-eminent American forester at the turn of the 20th century. He developed a real concern for environmental degradation and the overuse of resources, although he deemed that the best approach was not strict preservation but wise use. He believed that improvements in the management of natural resources were in line with the public interest. Pinchot defined conservation as 'the greatest good to the greatest number […] for the longest time' (1910, p. 48), which showed close proximity to utilitarianism. He divided his doctrine into three main principles: 'development' (p. 43), 'prevention of waste' (p. 44), and action 'for the benefit of the many, and not merely for the profit of a few' (p. 46). This last point explains why Pinchot's conservation succeeded in the Progressive Era, i.e. the period of Theodore Roosevelt's presidency, which was directed towards the revitalisation of public interest (Mowry, 1958).

Pinchot's conservationism was influenced by Marsh and other early writers of American environmentalism. Some pioneering economists were also able to exert influence, as in the case of Grover P. Osborne, whose *Principles of Economics* (1893) is often deemed as the first textbook in natural resource economics published in the United States (Vaughn, 2006). Osborne included reflections on the definition of land, a detailed nomenclature of resources, prospective statements on energy sources, concerns about intergenerational equity, proposals for the distribution of property rights, and other topics familiar to conservationists. Forester and economist Bernhard E. Fernow, a figure close to the Conservation movement, praised Osborne's book in his *Economics of Forestry* (1902).

Many authors have emphasised the main characteristics of conservationism in the context of the Progressive Era. Efficiency was definitely the buzzword of the movement (Bates, 1957; Hays, 1959). To Pinchot, all renewable resources could be exploited in the same way as conventional crops. This included forestry, wildlife, and hydropower potential. This explains the resemblance with utilitarianism, albeit intergenerational equity played an important role (Ramos Gorostiza, 2003).

Muir's preservationism, in turn, saw its audience dwindle in the early 20th century after enjoying some success in the last decades of the 19th century. In 1898–1899, before Roosevelt's accession to the Presidency, Muir and Pinchot had a few occasions to meet and collaborate. Their relationship was cordial, although it would soon deteriorate. The famous episode which led to the

final break between preservationism and conservationism occurred in the fall of 1905, following a strong disagreement over the building of a dam in the Hetch Hetchy Valley, California. The development of San Francisco in the previous decades demanded securing water access to the city. The idea of making water reserves by flooding the Hetch Hetchy Valley soon came to the engineers' minds. From Pinchot's standpoint, this was consistent with the use of natural resources for the benefit of the people. To Muir, it was unacceptable due to two reasons. First, Hetch Hetchy was considered at the time as a remarkable natural landscape, both aesthetically and in terms of what we now call biodiversity. Second, Hetch Hetchy was located inside the Yosemite national park. It made no sense to build a dam in a protected area. Roosevelt was close to both Muir and Pinchot. He had taken mountain hikes with Muir and had Pinchot in his experts' team. In late 1905, Roosevelt gave his support to the construction of the dam, which was subsequently built. He appointed Pinchot as the head of the new US Forest Service, consolidating the triumph of conservationism over preservationism.

## Expertise and the natural sciences in conservation governance

In *The Economic Significance of Forestry* (1921), Pinchot remembered his years as a student in Nancy, referring to 'the scientific thought' (p. 157) of the time. Although it became a political movement, conservationism was clearly rooted in scientific knowledge, especially engineering and the applied natural sciences. In a later essay, Pinchot (1937) still considered that forestry as a natural science was at the very origin of conservation practices. The scaling up of his movement occurred through the junction of forestry concerns with water management, represented by hydrologists such as Frederick H. Newell (Hays, 1959).

In the 1900s–1910s, conservationists were primarily experts and technicians. They hoped to reach a larger audience—this was the goal of the creation of the National Conservation Association in 1909—but they also wished to focus on technical and economic issues. In economics, the few academics who took part in the movement, such as Lewis C. Gray (1913, 1914) and John Ise (1920, 1925), considered that their role was limited to scientific contributions, excluding militant discourses. They recognised conservation as a field deeply rooted in the natural sciences and called for complementary insights from other disciplines:

> It is the purpose of this paper [...] to point out the economic possibilities of conservation. This is all the more important in view of the fact that in America the possibilities of conservation have been considered largely from the standpoint of natural science, while the economic limitations have been but little appreciated.
>
> (Gray, 1913, p. 499)

Acknowledging Pinchot's conservationism as part of the history of ecological economic thought is also motivated by the emergence of ecology as a new scientific field or discipline at the turn of the 20th century. Whereas the Conservation movement developed in parallel to this new field, it had an impact over the way conservation was scientifically conceived.

Ecologists insisted on the systemic, holistic dimension of the natural world, which goes beyond the individual analysis of species, spaces, and resources. In the 1910s, Victor E. Shelford defined ecology as the science of communities: 'that branch of general physiology which deals with the organism as a whole' (1912, p. 1). This conception had been under development for a few years and was shared by conservationists. Pinchot constantly repeated that natural resources had to be jointly considered and managed: 'this is a time to consider not one resource but all resources together' (1908, p. 11); 'all these natural resources which we had been dealing with [...] actually constituted one united problem' (1937, p. 262). We can also find scattered references to 'ecology' and 'communities' in writings related to conservation (e.g. Fernow, 1902). Moreover, the interrelation between minerals, biological organisms, and water was specifically examined for issues such as soil erosion (Van Hise, 1910). Unlike compartmentalised subfields of the emerging natural resource and environmental economics of that time, conservationism adopted a systemic, holistic approach.

## The National Conservation Commission (1908–1909)

The Conservation movement of the Progressive Era reached its climax in 1908–1909, when a newly founded national commission was in charge of preparing the first extensive report on American natural resources. Roosevelt invited hundreds of attendees, including political representatives, scientists, experts, engineers, and social activists, to assess the resource endowments of the United States and to collectively think about the good management of the American natural wealth. The final report, chaired by Pinchot himself, was published in three volumes, showcasing the variety of the debates and collecting contributions of experts involved in specific working groups (land use, water, forest, etc.).

The wide scope of the report and the diversity of the arguments presented are impressive. In retrospection, what is particularly significant is the assortment of disciplines invited to participate in the discussion. Not only foresters, engineers, hydrologists, geologists, economists, and lawyers participated in the working groups, but also physicists and chemists—a good interdisciplinary mix. Marston Taylor Bogert, the president of the American Chemistry Association, expressed his satisfaction to see his profession represented in the commission, seeing his role as crucial for understanding the transformation of materials in the extraction, production, and consumption of resources, not to mention soil nutrient and erosion issues (National Conservation Commission, 1909). The high level of specialisation of experts might have led to the

lack of dialogue between disciplines; probably not all debates were characterised by holism and cross-fertilisation; and it seems that some fields and topics, such as forestry and water management, have cast a shadow over others. Yet, many participants recalled the importance of dealing with conservation in its entirety, at the expense of particular approaches. Leading economist Irving Fisher, who was invited to write a section about human resources in the context of conservation, made this point clear:

> The problem of the conservation of our natural resources is therefore not a series of independent problems, but a coherent all-embracing whole.
> (Fisher, 1909, p. 748)

This assertion exemplifies the intellectual milieu in which conservationism unfolded, as different scientific fields collaborated to devise an integral view of the natural world. The rise of ecology was certainly not a coincidence or isolated development in this regard.

The National Conservation Commission deserves special attention because it participated in the definition and characterisation of what is now called nature's services or ecosystem services. The notion of ecosystem services was allegedly coined in the 1970s (Gómez-Baggethun *et al.*, 2010; Méral, 2012; Boisvert, 2015). Obviously, the idea that nature provides services to humans can be considered as particularly old, consubstantial even with the human consciousness of its environment (Costanza *et al.*, 2017). A more precise period of emergence can however be pinpointed as soon as one recognises that defining the interaction between humans and nature as *services* mirrors a wider conception of the environment as *capital*, precisely as *natural capital*. Natural capital and ecosystem services are twin concepts, analogous to the distinction between human-made capital and productive services: we define a flow of ecosystem services obtained from a stock of natural capital as we define a flow of productive services obtained from a stock of human-made capital.

It is also usually believed that the concept of natural capital emerged in the 1970s, being later made popular by David Pearce (1988) and other ecological economists in the early 1990s (Akerman, 2003; Nadal, 2016). The concept gave birth to controversies over its relevance for the new field of ecological economics (Victor, 1991). It has been shown that traces of the concept can be found in previous periods, either only as the same underlying idea (Des-Roches, 2015; Franco, 2020; Wolloch, 2020) or including the use of the expression 'natural capital' itself, in particular from the mid-19th century onwards (Missemer, 2018).

Interestingly, the first historical occurrence of natural capital in the modern sense can be traced back to the 1900s in the context of the Conservation movement. Alvin S. Johnson was a young economist at that moment, trained by John Bates Clark and influenced by Fisher. He was not yet a leading figure of the future New School for Social Research, to be founded only in 1919.

In his *Introduction to Economics* (1909), Johnson argued that productive agents could be classified into two categories, artificial capital and natural capital:

> In everyday language men speak of investing capital in land, as of investing capital in buildings or machinery. This usage will be followed in this book; wherever it is necessary to distinguish between the two classes of productive wealth, we shall call the one *artificial capital*, the other *natural capital*.
>
> (Johnson, 1909, p. 197, our emphasis)

Johnson continued his analysis emphasising the varying value of natural capital, and he insisted on intergenerational equity concerns, as the stock of natural capital could deteriorate.

This old history of the emergence of the natural capital concept sheds light on the way some participants in the Conservation movement viewed natural resources. Capitalistic metaphors were usual, as several contributions published in the report of the National Conservation Commission attest. For instance, G. Morris Homans (1909, p. 192), from the Forest Service, stated that federal forests represented 'a capital of $1,122,150,000.' Carl S. Scofield (1909), from the Department of Agriculture, defined 'agricultural production as a natural asset.'

Forest was a typical case. Participants in the National Conservation Commission repeatedly insisted on the necessity to conceive forest areas as delivering more than lumber to be sold at the market. In their introductory statement, the coordinators listed a series of attributes of forests which were useful for the regulation of soil and streams and more generally for human beings:

> Forests not only grow timber, but they hold the soil and they conserve the streams. They abate the wind and give protection from excessive heat and cold. Woodlands make for the fiber, health, and happiness of the citizen and the nation.
>
> (Pinchot *et al.*, 1909, p. 19)

Other participants embraced the same idea (e.g. Leighton, 1909; Willis, 1909). Some even extended the reflection to the aesthetic and moral values associated with forests. Filibert Roth, from the University of Michigan, did not refer to ecosystem services—the expression was not used at the time—but to the 'economic functions' of forests (1909, p. 725). He also proposed to assign monetary figures to these functions, including more subjective benefits: 'the aesthetic value of the wood lots of Michigan is worth many millions of dollars' (1909, p. 728). Obviously, the estimate was a guess, but the fact that it existed is significant.

Other participants in the National Conservation Commission agreed that the natural world provided services not only in terms of resources, but also of

amenities, recreation, and scientific interest. Andrew Delmar Hopkins (1909, p. 479), an entomologist, argued that taking into account 'attractiveness' and 'pleasure resorts' would lead to a skyrocketing of the monetary value of forests and other natural areas. Walter T. Swingle (1909, p. 244) from the Department of Agriculture pushed for the inclusion of a scientific value—the 'intellectual interest'—of a given territory in the value of land property.

Neither all concepts and tools that we know today in the valuation of ecosystem services existed at that time nor all participants in the Conservation movement of the Progressive Era shared a complex and enriched view of nature's interdependencies. Nonetheless, it appears that concerns about nature's services to humans were not alien to conservationists and that the emergence of ecology at that moment, highlighting the systemic dimension of the natural world, played a role in this development.

Among the participants in the National Conservation Commission, experts of the Biological Survey constituted a distinguished group. This bureau of investigation deserves a closer assessment because, at the turn of the 20th century and in connection with the Conservation movement, it represented the dawn of a new discipline emerging in American agricultural departments: economic ornithology. This field pushed forward the cross-fertilisation between economics and the natural sciences as well as the notion of nature's services.

## The origins of economic ornithology

Economic ornithology was a pioneering movement of more recent studies on the biological control of invasive species in agroecology (Evenden, 1995). Work undertaken at the time still seems familiar to today's researchers involved in the definition of ecosystem services (Kronenberg, 2014; Levrel and Missemer, 2019). Economic ornithologists, mammalogists, and entomologists devised studies at the crossroads of agricultural expertise, economics, and the natural sciences. Participants defined their field as the observation of animals, especially birds, in their relation to 'man and his interests' (Murray, 1877, p. 3), 'from an agricultural point of view' (Cathcart, 1892, p. 325) or, in more straightforward terms, 'from the standpoint of dollars and cents' (Palmer, 1899, p. 259). The main subject of investigation was the food diets of birds and their capacity to reduce populations of invasive insects and small mammals in agricultural areas. Some pre-eminent figures, such as Stephen A. Forbes, who also contributed to the emerging science of ecology, used the expression 'economic biology' (1880a, p. 16) to extend the investigation to a broader set of species. There is something reminiscent of Linnaeus's economy of nature in this definition. Forbes, however, was more specific about the economic purpose of his understanding of 'the laws of oscillation in plants and animals' (1880a, p. 16) and their relation to human activities. He aimed at determining precisely the role of birds and other animals in the regulation of the environment and the benefits which farmers and citizens could draw from them—Linnaeus did not go that far.

Economic ornithology was not a consequence of Pinchot's impulse for conservation. It had existed before, and it developed in parallel with the structuring of the Conservation movement. The connecting points were nevertheless numerous. Economic ornithologists occasionally made clear references to conservation (e.g. Weed and Dearborn, 1916). And conservationists did not hesitate to mobilise the work of economic ornithologists to promote their own cause. In his opening of the report of the National Conservation Commission, Theodore Roosevelt (1909, p. 7) mentioned the damages of insects on agricultural crops and praised the work conducted at the Department of Agriculture to better manage this threat. Pinchot, McGee, Price, Woodruff, and Holmes (1909, p. 18) mentioned the role of birds in controlling harmful species, not to mention scattered contributions directly related to this issue (e.g. Merriam, 1909; Olmsted, 1909).

The origins of economic ornithology can be traced back to the early 19th century, when Alexander von Humboldt underlined the role of birds in the production of guano. The idea that birds could reduce populations of insects had surely been formulated long before, all the way back to Antiquity. However, only in the 19th century would more precise assessments be developed. Early achievements appeared in Europe in the middle of that century.

In France, during the Second Empire, Florent Prévost tried to determine the usefulness or harmfulness of certain species based on their food diets. He had the ambition to be 'useful both to ornithology and agriculture' (1858, p. 263) and reached the conclusion that 'generally speaking, birds are more useful than harmful to our crops, […] the harm done to us at certain times is largely offset by the consumption of insects they do at other times' (1858, p. 267). In Switzerland, Frédéric de Tschudi explained that listing all useful bird species had little interest, as there were too many of them. What was essential to him was to shed light on the most useful species 'without which no agriculture […] would be possible. They do a job that millions of men's hands would not do half as well and as completely' (1860, p. 25). In Britain, the work of Charles O. Groom Napier (1865) was right at the frontier of the field. He proposed an exhaustive classification of birds by means of the attribution of a letter (A, B, or C) to each species according to its economic value. No monetary figures were added to these letters, but an ordinal valuation which helped to categorise species in a synthetic manner. He used the same method to order the aesthetic attributes of species, assuming a 'utilitarian point of view' (1865, p. 13) which shows, once again, the character of conservation as it would later develop in the United States.

An American economic ornithology would appear in the 1860s with the studies conducted by Wilson Flagg in connection with the Agricultural Societies of Massachusetts. Flagg addressed the role of birds in the economy of nature—an affiliation with ideas of the 18th century—and contributed to discussions on the 'services of birds' (1862, p. 50) for agriculture, concluding that 'if the birds were exterminated, mankind could not subsist upon the face of the earth.' Flagg would later be acknowledged as a major forerunner of economic ornithology. The fact that he used the expression 'services of birds'

points to the originality of his approach. Entomologist Benjamin D. Walsh was yet another pioneer with even stronger references to economic concepts and tools. He saw the study of birds in relation to agriculture as a sort of cost-benefit analysis, with credits and debits amounting to a final opinion on the usefulness of species:

> […] to find out whether each [species] is to be considered, upon the whole, as a friend or as an enemy to the Farmer, we must draw up a careful Debtor and Creditor account, and ascertain on which side the balance lies.
>
> (Walsh, 1867, p. 44)

The expression 'economic ornithology' would first appear in writings from the early 1880s (e.g. King, 1883). What had consisted in studies spread over isolated agricultural societies became a true discipline when a subdivision of economic ornithology was created in the division of entomology at the US Department of Agriculture on July 1, 1885. Its institutionalisation, reinforced by the autonomy of the new subdivision from entomological research obtained one year later, helped the new field to gain financial support and public recognition (Merriam, 1887).

The new group of experts started to examine the efficiency of biological control policies. Pennsylvania was one of the first states to be blamed for having promoted the elimination of birds, which led to the proliferation of invasive species on farming lands. The gains from extirpating birds came at a high price, and repairing the subsequent damage done by insects was even more expensive—sound *ex ante* analysis was now required before destroying or promoting this or that species.

With increasing interest in economic ornithology, in 1896 public authorities decided to create a fully independent division of research within the Department of Agriculture: the Biological Survey. It became the main centre for the advancement of the discipline in the United States and a model for foreign countries. A worldwide institutionalisation trend was confirmed by the creation of the International Convention for the Protection of Birds (1902), which established a list of useful species to be protected based on work done by agricultural societies.

## In the stomachs of birds

One important issue in economic ornithology was that crop damages by birds were easier to quantify than the benefits arising from their control of insect populations. This tended to intuitively skew the cost-benefit analysis towards the harmfulness of species (Archibald, 1892; Beal, 1897). At least four direct services required to be accounted for: the fact that birds eat 'harmful insects, their eggs and larvæ,' 'the seeds of noxious weeds,' the 'field mice and

other small mammals which injure crops,' and their actions 'as scavengers' (Chapman, 1903, p. 6). Assessing these services would help to more precisely classify bird species as useful, harmful, or neutral (Forbes, 1880b). However, these attributes only made sense in relation to inhabited areas. Economic ornithologists did not intend to attribute value to birds *per se*, but only in relation to human activities, especially agriculture.

To acquire detailed knowledge on the eating habits of birds, economic ornithologists devoted time and effort to field research: observation, experiments, and capture. Basically, the main activity was to study the content of birds' stomachs, looking for the presence of either harmful or useful insects to humans and thus concluding on their global utility. Several methods were in use: diets could be determined based on volume, weight, or variety of ingested insects. In the late 1860s, Walsh had already tried to set a standard to conclude whether a species was useful: 'the number of Noxious Species of Insects is to that of Beneficial Species as three to one' (1867, p. 46). This criterion was arbitrary, with no clear scientific justification. It would soon be rejected by the next generation of economic ornithologists, who failed to reach a consensus on which method to adopt. The reason for these disagreements was that food diets were not easy to understand. First, they constantly varied from one bird to the other, even within the same species, because of varying environmental constraints, such as the availability of prey. Second, the relation between birds, insects, and crops was not straightforward. Studying the diet of birds was not sufficient; researchers also had to examine the diet of the ingested insects. The whole food chain needed to be analysed, reducing practicality and increasing uncertainty on the final conclusion regarding the usefulness or harmfulness of different species. All this, however, did not prevent some economic ornithologists from going quite far in their valuation of the services provided by birds.

## Valuing the services provided by birds

As Jakub Kronenberg (2014) rightly demonstrated, the resemblance between economic ornithology and today's studies on ecosystem services can be illustrated by the lists of services provided by birds which were established by scientists from the early 20th century. Birds were primarily seen as providing commercial value as mere commodities (i.e. game) or producers of derivatives (e.g. eggs, guano). This direct utility was sometimes called 'intrinsic value' (Forbush, 1905, p. 84), though the term certainly did not have the same meaning as the one conveyed by a preservationist view of wildlife. Robert E. Coker (1920), for instance, valued a pair of cormorants at USD 15 for the guano they produced (reported by Forbush, 1922, p. 79).

The main service provided by birds was the ingestion of insects, weeds, and noxious small mammals. That was the reason for the creation of the Biological Survey, and most studies in the field dealt with this issue, including

those of the head of the bureau, C. Hart Merriam. Other members specialised in different areas, assessing the services provided by birds either for crop fields, forests, or orchard nurseries (Forbush, 1905; Kellogg and Doane, 1915).

In the context of forestry—a central topic of conservation—birds were deemed to contribute to plant health by transporting seeds and hence spreading plants and trees over tens of miles. The rhetoric of the economy of nature was not absent in these studies. A service more directly linked to humans was the control of diseases performed by birds while eating pernicious flying insects, such as mosquitos in wetlands. Calculating the monetary value of the damages resulting from disease was seen as impossible, as 'it is not conceivable that we can make any estimate in dollars and cents of the great bodily and mental suffering entailed as a result of some of the diseases that are carried by insects' (Kellogg and Doane, 1915, p. 404). This service, however, needed to be accounted for in the examination of the utility of species (Forbush, 1922).

In the same way as the participants in the National Conservation Commission, economic ornithologists paid attention to the amenities, recreation, and other benefits provided by the natural world. Birds were frequently presented as essential for their 'scientific, educational and aesthetic value' (King, 1883, p. 461). Most researchers listed aesthetic services provided by birds separately from direct material or economic interests. The junction between amenities and direct economic value was made in one particular case: sport, which, at the time, meant hunting. The valuation of the services provided by birds to sportspeople was facilitated by the revenues derived from side activities such as tourism, equipment, and transport. These activities were seen as indirect beneficiaries of the existence of birds.

While listing different types of services, including birds as game, producers of commodities, insect eaters, singers, source of natural beauty, scientific subjects, and source of indirect revenues through recreation, economic ornithologists were finally confronted with the complementarity or rivalry between services. As in the case of conservation policies and probably also under the influence of the nascent science of ecology, they were sensitive to the need for a holistic approach to the study of birds. The main goal was to reach a final judgement on the utility of this or that species, encompassing all services (Theobald, 1907; Godard, 1916). This led to efforts in comparing and balancing the costs and benefits of rival services. Henry W. Henshaw, a member of the Biological Survey, worked on this issue from the standpoint of farmers:

> [I]t is questionable if the value of game birds to the farmer, especially the quail, as weed and insect destroyers be not greater than their value as a source of revenue from sportsmen or as food.
>
> (Henshaw, 1908, p. 172)

This suggests that trade-offs between birds' services were envisaged or at least discussed at the time. Once again, it shows the similarities between this early economic ornithology and today's research on ecosystem services, in which synergies and trade-offs are key subjects of investigation (Vallet *et al.*, 2018).

Once services were identified, the next step for economic ornithologists was to proceed with valuation by means of quantitative cost-benefit analyses. The economic rhetoric used in this regard was explicit: authors talked about the 'cash value of birds' (Forbush, 1922, p. 60), their consideration as 'valuable assets' (Wenninger, 1909, p. 109), and the due 'insurance premiums' (Godard, 1916, p. 162). As the head of the Biological Survey, Merriam was sceptical about the possibility of making full monetary valuations of the services provided by birds. In his contribution to the report of the National Conservation Commission, he stated that it was 'impossible to represent by figures the value of our insectivorous and predatory birds, or to present in the form of statistical tables the number of millions saved annually by their labors' (1909, p. 316). Other researchers, however, took their chances in this endeavour.

Economic ornithologists devised several methods to obtain the monetary values of birds' services, in particular in association with the ingestion of harmful insects and mammals. The first of these methods would be now called the *damage costs* method: experts looked at the losses provoked by insect invasions and then deduced the value of birds through the costs saved by their presence. Stephen A. Forbes wrote:

> [...] birds [are] an insect police, [...] in increasing the efficiency of birds five per cent, we should thereby add eight and one-fourth million dollars to the permanent wealth of the State.
>
> (Forbes, 1880b, pp. 87–88)

Estimates based on saved costs varied dramatically in form and content among economic ornithologists: USD 8.25 million (Chapman, 1900, p. 79); USD 20–30 per bird (Chapman, 1903, p. 18); FRF 40 million (Godard, as reported by Forbush, 1922, p. 38); USD 100 per owl per year (Saunders, 1938, p. 120), and so on. Valuation was usually limited to a particular area or species. Aggregation was conceived as misleading due to the heterogeneity of costs and the same methodological difficulties encountered in the characterisation of their food diets.

What is today called *replacement costs* was also applied. From the mid-19th century onwards, the role of chemistry in agriculture grew constantly, at first due to artificial fertilisers and progressively due to pesticides. At an early stage, Forbes (1880b) considered that birds were able to control harmful species at lower costs than alternative means (however, without mentioning chemical products). Merriam (1909) backed that same idea. André Godard (1916) pointed to the 'irreplaceable services of birds' but

also addressed chemicals and artificial means of biological control. Taking the example of vineyards—he was, after all, French—he explained that starlings' avoided damages, costing FRF 20 per hectare, were much lower than the costs of chemical treatments, which amounted to FRF 150–200 per hectare (1916, pp. 313–314). Therefore, the service of starlings could be deduced by measuring the difference between these two costs. Obviously, starlings provided only a few direct services to winegrowers, eating small quantities of vineyard parasites. Godard stood by his method of calculation, as starlings would help neighbouring farmers in even greater proportions, whose actions in favour of the protection of ortolans could help the winegrower in return. This example of cross-reasoning shows how replacement costs could lead to complex schemes of analysis in economic ornithology.

For the valuation of amenities and recreation, a first methodological direction was to account for all indirect activities that benefited from the existence of birds. We already mentioned the activities related to hunting and tourism, which were regularly mentioned by experts (Forbes, 1887; Theobald, 1907; Merriam, 1909). Yet, even for sportspeople, the pleasure and benefits obtained by listening to birds or shooting them could not be reduced to the value of equipment and transport. 'A day with dog and gun, rod or rifle may bring small return from a pecuniary point of view, but who can calculate the amount of physical good and pure enjoyment it has afforded?' wrote Frank M. Chapman (1903, p. 20), from the American Museum of Natural History.

To assess the valuation of recreation in all its dimensions, some economic ornithologists went as far as suggesting that the value of land could be influenced by the presence of birds and environmental amenities. The Massachusetts ornithologist Edward H. Forbush argued that 'with the growing interest in birds, towns or localities where birds are plentiful will have an added value as places of residence' (1905, p. 89). Forbush and others, however, did not provide figures to illustrate this kind of *hedonist approach* to the valuation of birds' services.

## The decline of economic ornithology

In the 1920s, economic ornithology started to lose influence over agricultural studies and policies. The reasons are diverse. Intuitively, the development of artificial, chemical means of biological control seems to have played a role. More flexible, sometimes cheaper, and easier to manipulate, chemical pesticides became popular among American farmers alongside machinery use. Our inquiry into economic ornithology suggests however that pesticides were already well known in the early 20th century. The fact that replacement costs were used as a method of valuation is a clear testimony of that (Godard, 1916). Statements on the harmful effects of pesticides on

birds and the environment as a whole are another indication (Forbush, 1905; Henderson, 1913). The development of artificial means of biological control cannot, therefore, be a sufficient explanation for the decline of economic ornithology.

Monetary valuation and its perverse effects were not welcomed by part of the audience of economic ornithologists. First, considering the services provided by birds from the standpoint of dollars and cents made a wide range of preservationists sceptical about the work of the Biological Survey. According to them, birds had to be protected for themselves, not for the services they provided to humans. That was an old argument of bird protectors, who had been around for centuries. This counter-current gained momentum in the 1920s. Second, monetary valuation revealed itself as a limited approach for determining the value of birds. The calculated benefits often seemed low when compared to the cost of protection. Birds could surely ingest large quantities of harmful insects in certain periods, depending on a reasonable balance between the numbers of predators and prey. However, as soon as unexpected events occurred, such as a sudden swarm of insects for climatic reasons, birds got overwhelmed. These events were seen as the costliest for farmers. If birds could not be a true insurance in these cases, their utility had to be questioned and reassessed (Ainslie, 1930).

These criticisms were complemented by persistent methodological difficulties. Several decades after the institutionalisation of their field, economic ornithologists still debated about the accurate method to define the diets of birds. Moreover, entomologists constantly updated knowledge on the detrimental or beneficial effects of particular species of insects. One ingested species could quickly and unexpectedly become more or less useful, which made synthetic results in economic ornithology more complicated to establish. In the late 1920s, many economic ornithologists shifted their focus to other dimensions of their research, relinquishing the question of the utility or disutility of birds.

The perception of the discourse of economic ornithologists as biased in favour of the protection of birds also made their position more fragile in the 1920s. They claimed to conduct cost-benefit analyses with robust methods and without preconceptions about their results, and many of them indeed took this path. Yet, some studies in economic ornithology appeared as pro-wildlife statements despite conflicting results. Universal observations such as 'birds generally do more good than harm' (Cathcart, 1892, p. 337) or 'nearly all native species of birds should be protected' (Henderson, 1913, p. 18) cast suspicion on their objectivity. Walsh (1867, p. 44), partly in vain, had warned his colleagues about the necessity to avoid such general statements. This situation certainly contributed to the slowdown of economic ornithology in the 1920s, as those against bird protection saw pro-conservation results as activism rather than science and vice versa.

The golden age of economic ornithology only lasted for a couple of decades. In the context of the Conservation movement, however, it drew the attention of the public to the need for cross-disciplinary expertise to deal with human activities in relation to natural species. Interestingly, the study of birds from an economic standpoint offered the possibility to consider natural means of regulation of human activities, which is reminiscent, in a sense, of what is today known as nature-based solutions to environmental issues.

# 7 The Other Austrian Economics

Concurrently with and independently from the appearance of an Austro-German social energetics—although not without some cross-influences—another relevant intellectual current in the context of ecological economic thought was the so-called 'Other Austrian Economics' (Nemeth, 2013; Vianna Franco, 2020). Its main representatives were Austrian thinkers Josef Popper-Lynkeus and Otto Neurath, whose works in the course of the 1910s and 1920s posed as a heterodox, biophysical approach in opposition to that of the more traditional Austrian School of Economics. Their propositions as social reformers revolved around economic planning based on calculation in kind as a means to regulate production and distribution processes, aiming above all to alleviate poverty.

Popper-Lynkeus, uncle of the well-known philosopher of science Karl Popper (he adopted *Lynkeus* as pseudonym symbolising the extraordinary eyesight of the lookout of the Argo in Greek mythology or of the tower keeper in Goethe's *Faust*), was a natural scientist and engineer born in Bohemia and based in Vienna, who later in life dedicated himself to moral philosophy and the conceptualisation of a social programme able to ensure the subsistence of all humans. He was a highly regarded public intellectual in German-speaking countries at the turn of the 20th century, being in contact with or praised by prominent figures such as Ernst Mach, Albert Einstein, Julius Robert von Mayer, Wilhelm Ostwald, Stefan Zweig, Sigmund Freud, and Arthur Schnitzler. Yet, his writings have not been translated to English and his influence remains restricted to German-speaking scholarly circles as well as most of the secondary literature on his life and work (e.g. Belke, 1978; Hellin and Plank, 1978; Brezina, 2013; exceptions include Bühl, 1952; Wachtel, 1955).

Popper-Lynkeus's (1912) assessment of national economies focused on the availability of natural resources and the aggregate demand for livelihoods, described in terms of material and energy balances which served as inputs for a thorough planning of social provisioning. Such an approach to economic planning was also favoured by his friend Neurath, the renowned political economist and philosopher of science involved in the socialist calculation debate (Uebel, 2005, 2008). In fact, Neurath (2004b [1925]) went beyond

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Popper-Lynkeus in his argument for the feasibility of a planned socialist economy according to a rational process of calculation in physical units. Different hypothetical calculations would lead to alternative plans, whereas the choice among them would be a political one, in any case informed by physical limitations such as the availability of materials, energy, and labour.

Martinez-Alier (1987) characterised Popper-Lynkeus and Neurath as left-wing social energeticists, and they have indeed acknowledged the implications of thermodynamics to social science and, more broadly, argued for some form of unified science. Yet, they were not active members of the Austro-German social energetics community; energy did not constitute an epistemological unit of analysis in their work, revealing a certain aversion to more energetically reductionist stances; and an energetic labour theory of value was not part of their theoretical framework.

Conversely, their focus lay on economic planning schemes and social provisioning systems capable of satisfying human needs. They held a so-called ecological utopian worldview, in which knowledge stemming from the natural sciences led to the rejection of cornucopian outlooks on the future of humanity and fostered more egalitarian forms of social organisation as means not to exceed given biophysical boundaries (Franco, 2018). For this, and notwithstanding his opposition to totalitarian agendas, Neurath was derogatorily characterised as a Saint-Simonian social engineer by Hayek (1979 [1952]), whereas Neurath (1973b [1919]) himself referred to economic planning proposals as utopian social engineering constructions, i.e. the exploration of alternative socio-technical possibilities based on historical and theoretical research. The Other Austrian Economics, therefore, constitutes a stand-alone episode in the history of ecological economic thought.

## In-kind calculation and economy

At the turn of the 20th century, Neurath and Popper-Lynkeus gravitated towards a Machian philosophy of science (Mach, 1919 [1893]), based on which they sought to describe social phenomena in accordance with methods employed by the natural sciences, which were themselves conditioned by physiological and social subjectivity. Mach opposed Kantian aprioristic idealism in favour of the role of experience in processes of knowledge construction; experimentation is fallible, but if taken critically in terms of pursuing an acceptable level of neutrality of the scientific method, it could unveil reality based on what empirical evidence suggests.

Moreover, Neurath's and Popper-Lynkeus's flow accounting method took after a holistic component of Mach's philosophy of science, namely a need to understand physical and psychical phenomena as a set of organised and ordered experiences, as opposed to a sum of particulars. Such a presentation of the world would come in the form of physical or physiological flows or processes from which one is supposed to draw systematic observation-bound correlations, not imaginative hypotheses or dogmatic certainties (Cohen,

1968). Resource flow accounting in the Other Austrian Economics constitutes an instance in which representation of reality is given in terms of such integrated physical and physiological elements: facts experienced through the senses which can be used not only to theorise, but above all to instrumentally understand and control the natural world. In their approach to economic science, production and labour were historically determined phenomena depicted by the experience of the social organisation of human life, to be systematised as commensurate and interconnected facts based on sensorial experience.

While Neurath sought to 'modernize the holistic conception of economics he had inherited from the Historical School by re-formulating it from a Machian point of view' (Nemeth, 2013, p. 346), Popper-Lynkeus was less concerned with the theoretical character of his social reform proposals, notwithstanding his positivistic-empiricist approach supported by an extensive use of statistics. Their calculation in kind called for a flow accounting that could enlighten decisions about alternative uses for resources according to the needs of a given society.

## Otto Neurath's *Naturalwirtschaft*

Neurath's (2004b [1925]) economic theories sought middle ground between subjective theories of value associated with Austrian economics and the empirical approach of advocates of the German Historical School. He attempted to broaden the subject of economics by shifting focus away from markets and price formation mechanisms as its sole concern and towards the study of economic behaviour and welfare (i.e. real income) also in non-market settings. His calculation in kind emphasised the satisfaction of needs rather than prices, wages, or any other monetary variable. He saw economic categories such as wealth, labour, or welfare as composed of irreducibly heterogeneous elements which were, therefore, not subject to value aggregation in terms of prices, labour time, or even pleasure.

His earlier theoretical views on economics would gradually evolve into an alternative conceptual structure of economic science and eventually into a framework for the planning of a socialist economy in the 1920s and 1930s. Neurath's course of action would be aided by his empirical studies on war economies (e.g. the Balkan wars and the First World War), whose central planning schemes, peculiar production and distribution arrangements, and priority given to real needs over monetary variables meant that calculation and economies in kind were workable, even if imperfect (Neurath, 2004c [1916]). Such a universal economic accounting would be composed of estimates of social demand and available supply generated through reports by producers and governmental agencies. A directive planning would entail a political decision for the actual determination of a desired plan; an indicative planning, on the other hand, would point to the possibilities given by empirical evidence. In the latter case, planning agencies would have full autonomy,

as an indicative planning is more strictly related to operational issues of in-kind economic accounting (Uebel, 2004).

As a result of the theoretical backlash prompted by his *Economic Plan and Calculation in Kind* (Neurath, 2004b [1925]), which stemmed from Austrian and Marxist economists alike, Neurath would later argue in favour of a conceptual and programmatic separation between economy in kind (*Naturalwirtschaft*) and calculation in kind (*Naturalrechnung*). There would be a need for the latter even if the former remained only as a theoretical possibility, as in the case of environmental concerns and incommensurable values involving the physical basis of the supply of energy and raw materials, an issue that served as one of Neurath's main arguments against Ludwig von Mises and Friedrich von Hayek in the socialist calculation debate (O'Neill, 2004; Uebel, 2005, 2008).

Moreover, calculation in kind would allow for the acknowledgement of material and energy losses during economic activities, which might impact the qualities of life of present and future generations and thus to be weighed in decisions among alternative economic plans: 'Savings in coal, trees, etc., beyond amounting to savings in the displeasure of work, mean the preservation of future pleasure, a positive quantity.' Conversely, 'capitalism cuts down the forests even if the consequence may be karstification in a hundred years. In the tropics, and elsewhere, capitalism engages in over-exploitation without any care' (Neurath, 2004d [1925], pp. 470–471).

According to Neurath (2004e [1917], p. 316), calculation in kind is necessary for assessing the 'external conditions' (*Sachlage*) of life (e.g. food, housing, clothing, heating), which, combined with an appraisal of social variables based on household surveys (education, health, personal relationships), amount to an inventory of the 'conditions of life' (*Lebenslagenkataster*; p. 326). Limits were given by the 'bases of life' (*Lebensboden*; p. 314), which refer to the actual state of the world enabling the actualisation of subjective experiences of human beings he alluded to as 'qualities of life' (*Lebensstimmungen*; p. 313). However, in the context of calculation in kind, 'the relief map of qualities of life is therefore replaced by an inventory of conditions of life' (2004b [1925], p. 420).

The transformation of raw materials into end products or of the bases of life into conditions of life—'food into human body, other things into machines, etc.' (2004e [1917], p. 327)—consists in flows not only of material and energy, but also of other external conditions, such as climate and disease. Hence, a unit of account is not to think of from the outset; Neurath's calculation is far too encompassing to allow for a common denominator. Broad, practical, and relevant categories for the determination of the conditions of life such as energy are necessary and helpful, but not sufficient. There would be 'no "universal unit" of calculation, but only specific units: kilogrammes, days of labour, acres of fields, etc.' (2004a [1931], p. 486), which necessarily call for a multi-criteria representation that 'takes its start from the given fields, swamps, forests, waste land, machines, stores of all kind, people, etc.'

(2004e [1917], p. 337) and is confronted with subjective variables assessed in terms of ordinal rankings of 'pleasantness' (2004b [1925], p. 416).

The statistical accounting of production and consumption must be naturally intertwined and detailed according to sector, product, and population, as Neurath makes it clear in a report written to the eighth plenary session of the Munich Workers' Council in January 1919:

> It is not enough to know the possibilities of production and consumption as a whole, one must be able to follow the movement and fate of all raw materials and energies, of men and machines throughout the economy. Alongside the balance for raw materials and energy which deals with production, transformation (consumption), stockpiling, import and export for the whole country, and will be set out according to individual raw materials such as copper, iron and so on, we must also have the balance for individual branches of industry, agriculture, etc.
>
> (Neurath, 1973a [1919], p. 140)

Once this assessment became available, distribution issues could be tackled within the context of a politically selected economic plan (Neurath, 2004f [1917]). Yet, although Neurath offered a social justification, a detailed theoretical conceptualisation, and a programmatic outline for calculation in kind, he did not pursue the necessary statistical work, relying on empirical efforts of figures such as Popper-Lynkeus and Karl Ballod-Atlanticus, whose 'impressive sketches' amounted to evidence that in-kind economic plans were, in fact, feasible (Neurath, 2004b [1925], pp. 445–446). Finally, even though Neurath's immediate impact on the economic discipline as a whole was limited, his ideas remained relevant in the context of the history of ecological economic thought, not least due to his influence over other conceptualisations of in-kind calculation, as in the case of Soviet economic planners (Magnin and Nenovsky, 2021) and works of post-war precursors of a modern ecological economics such as the German economist K. William Kapp (1950; see Uebel, 2018).

## Josef Popper-Lynkeus's *Nährpflicht*

The *Allgemeine Nährpflicht als Lösung der sozialen Frage* (1912) is commonly held as Popper-Lynkeus's main contribution to social science and the embodiment of his social programme. However, the development of his social ethics and first insights into a corresponding ideal of economic organisation had started more than 30 years before its first appearance with the publication of *Das Recht zu Leben und die Pflicht zu Sterben* (1903 [1878]). Theoretical elements were successively added in *Voltaire* (1905b), *Fundament eines neuen Staatrechts* (1905a), and *Das Individuum und die Bewertung menschlicher Existenzen* (1910) (where he approvingly mentions Rudolf Goldscheid's *Menschenökonomie*), which were then laid out in detail with accompanying data in *Allgemeine Nährpflicht*.

Popper-Lynkeus sets out from a moral imperative to preserve the existence of each individual, satisfying basic human needs according to the principles of physiology and hygiene. For that effect, he championed a kind of social reform which, stemming from the ethical principles of enlightened social reformers and capable of gradually building common understanding, could pragmatically promote an institutional change focused on the amelioration of individual rights and more specifically on the issues of hunger and war. Opposed to compulsory military conscription, as he deemed it immoral to force individuals to forfeit their lives in exchange for any sort of conquest (except for defending human lives, in each case there would not be a shortage of volunteers faced with their own deaths), Popper-Lynkeus proposed instead to channel those human resources into the production of all that was needed to placate the other greatest menace to human existence, namely an economic one: he devised a program of social conscription for guaranteeing the satisfaction of the basic needs of everyone within a given territory, which he termed *Nährpflicht* (an expression conveying the notion of 'the duty towards nourishment').

His social programme was then based on the collective production and distribution of the necessaries of life *in natura*, evading the problems posed by money as a unit of account. In this sense, Popper-Lynkeus's *Nährpflicht* has been alluded to as an early proposal of universal basic income (Parijs and Vanderborght, 2017). Furthermore, he argued that luxuries, defined as goods and services unrelated to basic human needs, should be privately produced and traded in free markets. Therefore, while *Naturalrechnung* made it possible to secure a minimum living standard, the theoretical problems associated with the concept of *Naturalwirtschaft*—which would become a heated topic in the socialist calculation debate (e.g. how to account for production factors, such as manufacturing capital)—were to a large extent not applicable to his programme, not to mention the fact that Popper-Lynkeus had very little patience for the abstractions of political economists and their perceived inability to offer practical recommendations for a feasible social reform.

Thus, to him, there would ideally be two economies functioning in parallel: a planned one, managed by a central economic accounting institution and circumscribed to the satisfaction of basic human needs, and a market one for the allocation of non-vital goods. Once an individual fulfils his duty towards the supply of basic goods and services in the form of labour, he would be free to take part in the market economy.

Popper-Lynkeus's social programme depended on the ability to calculate, plan, and match supply and demand for labour and natural resources, with special attention to non-renewables and the constraints imposed by their exhaustibility. Hence, in *Allgemeine Nährpflicht* he set out to show the feasibility of his proposal, presenting data based on actual stocks and potential flows of energy and raw materials which could match the physiological needs of the German population. He did not demand empirical

'absolute exactness and completeness' (1912, p. 493), with data serving rather as an illustration of the validity and workability of his programme and, more broadly, of a planned large-scale economy. He divided his calculations by sector: food, housing, housing infrastructure (e.g. lighting and heating), clothing, health care, public services, and transportation, all that he deemed necessary for 'a physiologically and hygienically comfortable life standard' (p. 333). In sum, his calculations called for a 'nutrition army' (*Nährarmee*) of 7.2 million men and 4.64 million women working in these sectors, respectively, for 13 and 8 years of their lives, between 7 and 7.5 hours a day, in order to provide for all the predicted 70 million Germans by 1916 or 1917 (p. 643).

On the demand side, Popper-Lynkeus's physiological approach to human needs delves into nutrition in terms of subsisting levels of food intake—necessary quantities of water, minerals, protein, fat, and carbohydrates—according to gender and age. However, he also acknowledges cultural aspects, such as eating habits and taste, suggesting a diet based on meat, bread, potato, butter, cheese, milk, and sugar in the case of Germany. Even items without nutritional value, such as coffee and tea, could be included in the programme as a basic need if people demanded it as such. Estimates analogous to food per person per day were also performed for the other sectors, using different physical units (housing floor area, cubic metres of gas, tonnes of coal, pieces of clothing, number of transport vehicles, etc.).

In terms of supply, he presents data on national production and imports which are to be contrasted with the basic needs of the German population. Productivity and technological gains are mentioned as a promise to ease the burden over the *Nährarmee*. In this context, Popper-Lynkeus asks whether Germany could become an energetically independent country, focusing on potential new energy sources and the relationship between energy consumption and production. The exhaustible character of coal is a central concern, and therefore he discusses the possibilities and advantages of replacing coal with peat, petroleum, and especially renewables such as biofuels, hydro, wind, and tidal power. His results were in general pessimistic, which led him to call for an increasing independence from exhaustible resources and eventually for population control.

While Neurath's indicative planning proposed to first assess supply in terms of resources potentially available for use and then to move onto distribution, Popper-Lynkeus set out from individual and aggregate demands for basic goods and services before establishing how resources are to be attained so as to meet demand. Notwithstanding these differences, the cultural and thus subjective character of demand is not neglected by them; an objective scheme of calculation in kind did not prevent acknowledging the role of values in economic planning. Value-based judgements are political decisions, and the more information there is about alternative economic plans, the better these decisions would be, especially in terms of a materially and energetically rational relationship between nature and society. On the other hand, the lack

of such information would lead to an economic order in which social values cannot be fully exercised, as possible combinations of resource availability and human needs remain unknown (Vianna Franco, 2020).

## Utopian socialists and other reformers

The Other Austrian Economics was not an isolated intellectual development. Popper-Lynkeus engaged with several social reformers who sought to devise programmes targeted at solving the social question. On the one side, Neurath and Popper-Lynkeus can be placed in the context of the Viennese Late Enlightenment, loosely referred to as liberal, social, and educational movements in the capital of the Austro-Hungarian Empire at the turn of the 20th century (Uebel, 1995; Stadler, 2015). On the other side, this set of ideas was to a large extent shared with utopian socialists, Marxists, and other social reformers whose influence crossed several national borders and oceans.

Popper-Lynkeus took his time to review previous proposals of social reform, above all in his *Allgemeine Nährpflicht*. While he acknowledged their intent and purpose, his criticism lay, apart from diverging statistical methods and findings amongst their calculations, mainly in four different topics. First, the use, for the construction of a practical social programme, of abstract, deductive theories related to economic value, labour time, or the appropriation of the fruits of labour, which were to him necessarily arbitrary and subjective, not to mention beside the point, as human existence itself justifies the right to a minimum standard of living and thus a universal and equal distribution of the necessaries of life. Second, the adoption of monetary wages in such programmes in lieu of in-kind provisioning, which is also related to a class-based underlying framework. Third, the lack of a proper differentiation between necessaries and luxuries. And last, the neglect for the role of free markets and entrepreneurship, which would ease the burden of the programme as far as the production of luxuries was concerned and foster technical and cultural progress.

Above all, Popper-Lynkeus disavowed the stance of several French, German, Russian, and American utopian socialists pertaining to their insistence on measuring the yields of labour and other to him only ancillary or tangential issues to the task at hand, such as the role of land, the formation of cooperatives, and class struggle. All these notions reflected only a partial picture of the social system and could be fully bypassed by his universal programme and a strong underlying social ethics. The above notwithstanding, Popper-Lynkeus praised their positivistic, experimental, and scientific approach to the social question, which did not deserve the label of utopian if it implied the unfeasibility of their proposals.

Some of the social programmes discussed by Popper-Lynkeus fit especially well as part of the Other Austrian Economics, although only one of their authors was, in fact, Austrian: jurist and social theoretician Anton Menger. In *Neue Staatslehre*, Menger (1903) favoured a more practical kind of socialism

and the need to advance its organisational aspects and methods for transitioning towards a State based on labour and collective values (*volkstümlicher Arbeitsstaat*). His social programme entailed non-durable consumption goods (e.g. food) as the only form of private property and durable consumption goods (e.g. furniture) as State property but available for private use, while means of production remained solely as property and use of the State or State-led cooperatives. Distribution was to be undertaken by the State according to individual needs, although the right to a minimum standard of living would be considered a priority over luxuries. He also argued for the idea of a maximal living standard as a matter of justice, which Popper-Lynkeus deemed as peripheral for securing a livelihood for all and actually harmful in terms of technical and cultural progress.

However, Menger's proposal did not take advantage of calculation in kind. It adhered to a compulsory wage labour system in which wages varied according to the line of work, reinserting class-based inequality in a manner seen by Popper-Lynkeus as arbitrary and authoritarian. Workers were free to combine their labour duties towards the production of necessaries with additional activities pertaining to luxuries in different ways, and a central organisation would regulate supply and demand.

Such a combination was also possible in an early social programme advanced by German communist revolutionary Wilhelm Weitling (1842), according to which individuals could choose any line of work connected to necessaries, labouring daily for six hours in order to be entitled to all that was needed for a decent living. Demands for luxuries would call for extra working hours, whose prices would be set by the State according to their scarcity and labour costs and, in turn, be offered in terms of these extra hours. Each individual would have an official notebook (*Kommerzbuch*) to account for one's own balance. Although his ideas resembled those of Popper-Lynkeus, particular criticisms of the latter pointed to Weitling's dismissal of the potential contributions to be gained almost exclusively in the context of a freely competitive and private economy—even though he did allow for a differentiated treatment of extraordinary intellectual accomplishments—as well as to his attempt to take into account the scarcity of luxuries and the relative demand for them, which made it all much less practical.

*Looking Backward*, a utopian novel by American journalist and author Edward Bellamy (1888), also presented elements strikingly in line with Popper-Lynkeus's *Sozialprogramm*, and apparently their development happened quite independently. Despite its literary character, the book brings a rather detailed programme, with State ownership of industry along the lines of an all-encompassing cooperative in which all individuals take part. It amounts to a form of social conscription directed towards ensuring the subsistence of all, for which Bellamy calculates a working span of 24 years for each individual, who can decide where to work in exchange for equal in-kind compensation per unit of time. However, money remains as an abstraction to make different goods and services commensurable during consumption,

while distribution is regulated through a central administration in charge of the process of calculation in kind. Amongst the shortcomings or loopholes in Bellamy's programmes, Popper-Lynkeus (1912) mentions the lack of statistical basis and ensuring faulty calculations as well as the inclusion of luxuries in the programme to the detriment of a functioning free market.

The author whom Popper-Lynkeus sees as coming closest to proposing a workable social programme and explaining it in detail was Latvian economist, statistician, and demographist Karl Ballod-Atlanticus, whose book *Der Zukunftstaat* (1919 [1898]) became the object of a dedicated section in *Allgemeine Nährpflicht* and also exerted influence over Neurath (Uebel, 2008). Ballod-Atlanticus employed calculation in kind to explain the role of technical progress and material efficiency for the satisfaction of basic needs of present and future human generations. Similar to Popper-Lynkeus, his social reform did not entail the elimination of markets, anticipating a mixed economy in which human existence was to be guaranteed by the State and operationalised by calculation in kind in physical units, whereas more superfluous needs were to be met through market transactions.

Popper-Lynkeus (1912, p. 499) argued that Ballod-Atlanticus was the 'first to have devised a solid formulation and calculation of a social programme,' especially concerning land use, and whose assumptions and results he acknowledged were partly useful for his own work. He called attention to the level of qualitative and quantitative detail, which was necessary for demonstrating its practical applicability and value. His *Nährarmee* was not very different from Popper-Lynkeus's: nine to ten years of labour for men, six to eight years for women. But there were also significant differences which they would debate in the following years. In a somewhat more liberal stance, Ballod-Atlanticus adopts a monetary system of distribution, argues for different wages between manual and intellectual labour, and does not make his programme universally compulsory (exempting the children of wealthy families or those being trained for special activities). In this respect, his proposal reminds one of right-to-work laws as a consequence of the right to a minimum living standard for all. Moreover, the separation between necessaries and luxuries was less clear in his work, with housing being excluded while travel, culture, and art were mentioned as part of his programme.

# 8 Evolutionary Biology and the Science of Consumption

When addressing the links between the social and the natural sciences in the history of ecological economic thought, it is almost impossible to overlook biology, especially evolutionary biology, as one of the disciplines which exerted a deep influence on social thinkers, including economists. Alfred Marshall's famous call for considering economics as closer to biology than to physics—'The Mecca of the economist lies in economic biology rather than in economic dynamics' (1920, p. xiv)—has echoed throughout the 20th century. The success of expressions such as 'economic growth' rather than economic increase or expansion might also be related to the influence of biology on economic representations, although in a metaphorical way. Yet, while economists are still fascinated with biological science, it does not mean that it was fully successful in shaping 20th-century mainstream economic theories.

Evolutionary biology picked up momentum at the turn of the 19th century through the works of the French naturalist Jean-Baptiste de Lamarck, who argued that species change over time through the increasing complexity of organisms and thanks to adaptation to their environment. With the publication of *On the Origin of Species* (1859), which was partly inspired by Malthus's political economy, Charles Darwin opened a new, systematic perspective with four important principles: (i) the variation of biological traits, (ii) their heredity, (iii) their natural selection by the environment, and (iv) the struggle for life (Gordon, 1989; Schabas, 1990; Hodgson, 1992). In contrast to Lamarck's, Darwin's evolutionary thinking devoted little space to adaptation, which suggests that species were meant to have little control over their fate. Soon after publication, Darwin's argument was extended to the social sphere with the development of the so-called social Darwinism, even though Darwin did not consider his theory applicable to human societies as such. Almost at the same moment, Herbert Spencer developed his own conception of evolution specifically applied to society. By popularising the expression 'survival of the fittest,' which he explicitly related to Darwin's natural selection, Spencer (1864, pp. 144–145) launched a full research programme with which social scientists would soon engage. Social Darwinism or, as it should be more properly called, Spencerism, took a dark turn and became a source of

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inspiration for eugenicists and advocates for racist political ideologies, moving far away from its initial biological sources.

As mentioned in the introduction, the influence of evolutionary biology over economic thought, especially after Marshall, manifested itself mainly by means of analogies and metaphors, as illustrated by the evolutionary theory of the firm, and therefore lies beyond our scope. There are however examples of articulations between biology and economics which occurred at a more substantial level. Relevant thinkers such as John Ruskin and Henry Adams made use of evolutionary biology to construct their conceptions of social provisioning (Martinez-Alier, 1987). Alfred Lotka's economic theories also owed much to biology (Kingsland, 1994). More recently, Nicholas Georgescu-Roegen (1978) referred to evolutionary biology as one of the foundations of his theoretical framework. Back in the late 1960s, Herman Daly (1968, p. 392) sought to 'bring together some of the more salient similarities between biology and economics.'

In these research programmes, evolutionary biology has frequently been presented as giving two main lessons to economic theory: changes in the natural world are mainly qualitative and not quantitative; and most of them are stochastic, not subject to precise predictions. The consequences for economic analysis are twofold. First, economic processes have to be characterised and discussed in qualitative terms, thus moving beyond aggregate monetary measurements into assessments in kind. Second, uncertainty should play a central role in economic theories and models. This double dimension inherited from evolutionary biology has already been discussed in the literature (e.g. Norgaard, 1985; Mesner and Gowdy, 1999; Heinzel, 2013; Missemer, 2013; Bobulescu, 2015).

The objective here is to turn to a third one. At the micro level, evolutionary biology can provide insights into traits of the human species which allowed human beings to survive. Here lies the question of instincts, natural predispositions, and habits which have played a critical role in shaping human behaviour and which may have conditioned economic behaviour as well.

At the turn of the 20th century, this implication of evolutionary biology was addressed by social thinkers, most notably by pragmatist philosophers such as Charles Sanders Peirce, William James, and John Dewey, who were interested in the determinants and the description of human action (Hédoin, 2013; Raymer, 2013). In the field of economics, Thorstein Veblen has devoted effort and time to biology in order to forge a new way of dealing with economic behaviour focused on instincts. In our historical account, Veblen deserves, therefore, specific attention when looking into how biology and economics have been articulated in the context of the development of Darwinian ideas in Western science.

Roughly at the same time and partly influenced by Veblen, another American intellectual current developed original theories about economic behaviour, in particular the behavioural attributes of consumers, based on biological knowledge stemming from fields such as physiology and social

hygiene: the home economics movement. Mainly driven by women such as Ellen H. Richards and Hazel Kyrk in the first half of the 20th century, home economics had a more indirect relationship with evolutionary biology in particular; nevertheless, its criticism towards the neglect of mainstream economists in relation to how preferences are shaped ranged from the domains of physiological needs and health-related issues to the more social aspects of human behaviour. Its quest for the establishment of a science of consumption rooted in biological concerns about sanitation and nutrition undeniably grants it a place in the history of ecological economic thought. In this context, the distinction between physiological needs and subjective preferences poses as a structuring thread.

## Thorstein Veblen: instincts, institutions, and behaviour

Veblen's contribution to the articulation between biology and economic analysis is first to be found in his article 'Why is Economics not an Evolutionary Science?' (1898), in which he tried to explain why the discipline missed the boat when faced with the rise of evolutionary biology, which was not the case of anthropology and psychology. To him, this turn was unavoidable and soon economists would have to consider economic development as an evolutionary, not a mechanical process. Looking back in history, Veblen argued that economic life was the result of cumulative causation: any change is produced by the combination of past and present events, which implies that the march of history is not linear or easy to read; distant and recent pasts always play a role in today's emerging processes, and this combination cannot be explained by simple, teleological economic theories (Lawson, 2002; Brette, 2003). Veblen explicitly referred to biologists. In his books *The Theory of the Leisure Class* (1899) and *The Instinct of Workmanship* (1914), he sought inspiration in Darwin and Spencer and made direct references to Darwinian scientists working on heredity. At the University of Chicago, from 1891 to 1906, he was in close contact with Darwinian scholars such as physiologist Jacques Loeb, psychologist George Herbert Mead, and zoologist Charles Otis Whitman (Raymer, 2013). Veblen also benefited from a Lamarckian perspective when admitting that some adaptive traits acquired by one generation could possibly be transmitted to the next generation under certain circumstances (Hodgson, 1992). Darwin remained, however, as his main reference.

Institutions, defined as consolidated social practices and habits, played a central role in Veblen's conception of social and economic evolution. He explained that human beings have to struggle for their existence, institutions being both the results and the factors of the selection process:

> The life of man in society, just like the life of other species, is a struggle for existence, and therefore it is a process of selective adaptation. The evolution of social structure has been a process of natural selection of institutions. The progress which has been and is being made in human

> institutions and in human character may be set down, broadly, to a natural selection of the fittest habits of thought and to a process of enforced adaptation of individuals to an environment which has progressively changed with the growth of the community and with the changing institutions under which men have lived. Institutions are not only themselves the result of a selective and adaptive process […]; they are at the same time special methods of life and of human relations, and are therefore in their turn efficient factors of selection.
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> (Veblen, 1899, p. 188)

In contrast to Spencer, Veblen did not limit his assessment to the level of individuals in society. In fact, institutions were his main unit of analysis, situated at the core of social and economic change. It is easy to understand, therefore, why Veblen has been a key source for the American Institutionalist movement in the 20th century (Rutherford, 2011).

Drawing from biology to postulate institutional change might seem more metaphorical than substantial. When Veblen mentions 'struggle for existence,' it is not that clear whether he means biological life or social reputation, especially in the case of the leisure class. This ambiguity led to challenges against Veblen's engagement with evolutionary biology and above all Darwinism (Jennings and Waller, 1998). It would be excessive, however, to accuse Veblen of having only a superficial view of biological issues. This statement can be assessed in more detail if one moves upstream from his theory of institutions to his theory of instincts.

Veblen's representation of society consists in several blocks. Institutions are at the core of the edifice. Taken together, they constitute a cultural scheme, valid in a particular society at a particular moment. Basically, institutions are defined as *collective* practices and habits that progressively consolidate from *individual* practices and habits, which are the result of specific actions taking place under specific material and technical conditions and driven by instincts. In other words, in Veblen's framework, instincts are the starting point for individual and social behaviour and ultimately for institutions and cultural schemes. Veblen did not provide a precise definition of instincts, which were broadly identified as 'innate and persistent propensities of human nature' (1914, p. 2). They had to be distinguished from tropisms, in the sense that they were not intended to imply behavioural reactions such as those resulting from hunger or fear, but they were nonetheless seen as conditioners of human action (Brette, 2004).

On several occasions, Veblen mentioned two main instincts particularly influential in driving human actions and, in turn, habits and institutions: workmanship and the parental bent. The instinct of workmanship corresponds to the accomplishment felt by human beings when they do or see properly conducted well-crafted work in the sense of an efficient use of means (resources, etc.) to reach specific ends. The parental bent, which is not limited to the parental instinct towards offspring, refers to a form of social

sympathy directed to all fellow human creatures. What is particularly interesting is that Veblen gave strong biological foundations to those two instincts, explaining that both have been critical for the survival of the human species right from its origins:

> Chief among those instinctive dispositions that conduce directly to the material well-being of the race, and therefore to its biological success, is perhaps the instinctive bias here spoken of as the sense of workmanship. The only other instinctive factor of human nature that could with any likelihood dispute this primacy would be the parental bent.
>
> (Veblen, 1914, p. 25)

Veblen reasoned as follows: the human species had no physical advantage in comparison to other animal species to survive in a competitive environment. Struggling for its own existence, it had to rely on other strengths. Workmanship helped human beings to make the best use of their resources and the parental bent acted as a gregarious tendency towards group solidarity to combat surrounding dangers. Hence, both instincts have played an essential role in human survival and evolution, thus constituting the foundations of human behaviour.

As mentioned above, Darwinian evolution was not only about variation and selection, but also heredity. Veblen deepened his analysis of instincts in this direction, arguing that instincts are in general hereditary, i.e. they are transmitted intergenerationally, and immutable (Brette, 2003, 2004). This means that instincts are biological traits which do not depend on cultural and historical contexts. Contexts matter in the *activation* of instincts, but they do not condition their existence: all human beings continue to be equipped with those original predispositions, whatever the place and the time in which they live.

Instincts, combined with specific material and technical environments, are 'prime movers in human behaviour' (Veblen, 1914, p. 1). Sometimes, particular actions can be driven by some urgencies or constraints that make biological instincts less influential. However, behaviour is mostly conditioned by the expression of instincts. This is particularly visible in economic life. The fact that waste is usually undervalued in economic activity and that economic actors look for high efficiency can be considered as 'an outcropping of the instinct of workmanship' (Veblen, 1899, p. 98). Other instincts, according to Veblen, which appeared later on in biological evolution, also shape economic behaviour: 'the propensity for emulation is probably the strongest and most alert and persistent of the economic motives proper' (p. 110). Contradiction may appear between instincts or between instincts and more established habits. In the case of the leisure class, the fact that conspicuous consumption and idleness become socially valued habits goes against the instinct of workmanship. Individuals may try to circumvent contradictions through institutional arrangements (e.g. the distinction between a leisure and an industrious class)

or by deluding themselves about the aims of their actions (e.g. by considering decorum as an expression of workmanship); in any case, cognitive tensions are unavoidable (Veblen, 1899).

The same instincts are present in all human beings, although they manifest themselves in varying intensities among individuals and also ethnicities—Veblen spoke of 'races' but at no point was his discourse racist in the sense of a hierarchy between them (Brette, 2003). Because human ethnicities developed on different continents and natural environments, some instincts may have advanced in certain ethnic communities more than others by means of natural selection, e.g. the instinct of workmanship in the communities living in places where resources were scarce. According to Veblen, whenever economic behaviour varied geographically, it could be partly explained by varying weights of biological instincts. However, his take on cumulative causation prevented cruder forms of geographical determinism. The case of Europeans and European immigrants in the United States would be specific insofar as they are ethnically mixed and hence the distribution of instincts among them would be quite homogeneous.

The link between biology and economics is quite straightforward here. Original biological instincts, partly ethnically specific, appear as the foundation of economic behaviour. It would be excessive, however, to consider that Veblen had a reductionist view of economic action as limited to biological determinants. As mentioned, in Veblen's framework human action is the result of habits coming from the combination of instincts and material conditions under specific institutional and cultural circumstances. Instincts are predispositions; they are not stimuli mechanically provoking determined types of action. This is why the immediate environment of individuals matters and why there is still room for free will in human behaviour. Instincts condition behaviour, but they do not dictate it.

All this is true for economic behaviour in general and for consumption as a particular type of behaviour. Veblen (1899) studied consumers' choices in industrial societies. He observed that conspicuous consumption was a phenomenon of advanced societies despite the fact that it countered workmanship by making inefficient and potentially reprehensible use of resources. As undertaken by the leisure class, consumption thus became more about expressing predatory and idle instincts than satisfying physiological needs. As John Kenneth Galbraith (1958) would argue half a century later, Veblen questioned the meaning of 'needs' construed by a society centred on technological progress, showing that the acquisition of certain goods could be driven more by social or cultural reasons than by an actual individual need:

> It is beyond dispute that such mechanical contrivances, for instance, as the telephone, the typewriter, and the automobile are not only great and creditable technological achievements, but they are also of substantial service. At the same time it is at least doubtful if these inventions have not wasted more effort and substance than they have saved, —that they are to

> be credited with an appreciable net loss. They are designed to facilitate travel and communication, and such is doubtless their first and obvious effect. But the net result of their introduction need by no means be the same. […] The largest secure result of these various modern contrivances designed to facilitate and abridge travel and communication appears to be an increase of the volume of traffic per unit of outcome, acceleration of the pace and heightening of the tension at which the traffic is carried on, and a consequent increase of nervous disorders and shortening of the effective working life of those engaged in this traffic. But in these matters invention is the mother of necessity, and within the scope of these contrivances for facilitating and abridging labour there is no alternative, and life is not offered on any other terms.
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> (Veblen, 1914, pp. 315–316)

Veblen also mobilised his theory of instincts to challenge the basic principles established by the economic discipline. Economists usually have strong assumptions regarding human behaviour. Economic agents would be hedonistic and mostly egoistic, optimising their personal interests, monetary gains, and leisure with time preferences strongly biased towards the present. In Veblen, the original biological instincts of the human species tell a radically different story. The parental bent, for instance, states that in their struggle for existence human beings need a strong sense of solidarity and empathy, which is clearly in opposition to an individualistic and hedonistic conception of human nature (Brette, 2004). It favours caring for future generations, so it is also a counter-force to the so-called present bias of economic agents. Future generations might be privileged in certain circumstances, something that would be considered irrational by economists despite clear instinctive explanation:

> In the simplest and unsophisticated terms, [the parental bent's] functional content appears to be an unselfish solicitude for the well-being of the incoming generation—a bias for the highest efficiency and fullest volume of life in the group, with particular drift to the future; so that, under its rule, contrary to the dictum of the economic theorists, future goods are preferred to present goods and the filial generation is given the preference over the parental generation in all that touches their material welfare.
>
> (Veblen, 1914, pp. 46–47)

The instinct of workmanship also provides counterpoints to the usual assumptions of economists. Ordinary economic agents are supposed to be averse to labour, seeking the maximum amount of rest and leisure. The disutility of labour thus plays a central role in microeconomic theories. By explaining the survival of the human species in terms of workmanship, Veblen argued that men and women were naturally inclined towards work and effort. Otherwise, they would have been extinct. The reason for work aversion so blatantly

manifest in modern societies is to be found in more recent predispositions, reinforced by cultural trends (e.g. the increasing prominence of the leisure class), not natural penchants (Brette, 2004; Raymer, 2013).

Apart from the question of instincts, Veblen (1898, 1899) did mention the natural world on a few other occasions, in particular when dealing with the selection environment of institutions. In early times, material and climatic conditions weighted upon the range of human actions and technologies. This is still true for communities located in adverse environments, such as the Eskimo (Veblen, 1914). In technologically advanced societies, natural conditions, counterbalanced by cultural development, nonetheless remain relevant for social and economic phenomena.

At the end of this brief exploration of Veblen's theory of instincts, what appears is a deep articulation between evolutionary biology and economic thought. If we limit ourselves to his conception of institutional change, we may have the feeling of a purely analogical use of biological reasoning. The question of instincts opens up a new horizon, back to the origins of the human species and to the role of our natural predispositions in shaping our daily behaviour. Veblen's call to consider economic agents as biological agents was barely heard by economists in the 20th century, with some relevant exceptions such as John Maynard Keynes's use of the expression 'animal spirits' (1936, ch. 12).

## Ellen H. Richards and the first generation of home economists

Home economics emerged as an established scientific field in the United States at the dawn of the 20th century as a result of efforts, mainly from women, to foster research and teaching focused on material and social aspects of the household. It set out from health-related issues such as hygiene and nutrition to gradually encompassing economic knowledge pertaining to the management of daily domestic activities, thus combining the natural and social sciences in a quite substantial manner (Le Tollec, 2020). The goal of home economists was to procure and disseminate knowledge which improved standards of living and, more broadly, human development. This also meant securing a cleaner environment at and beyond the level of the household, a shared concern with advocates for healthy urban environments practicing a so-called 'municipal housekeeping' (e.g. Chadsey, 1915) as well as with members of the American Conservation movement, especially women such as Mary Lydia Adams-Williams and Mira Loyd Dock (Rimby, 2012). Such views entailed a complex mixture of conservative, urban middle-class identity and a rational approach to resource use, appreciation for the beauty of nature, and intergenerational equity principles (Merchant, 1984).

The home economics movement had grown slowly but steadily since the first decades of the 19th century, with distinguished early contributors such as Lydia Maria Child (1828) and Catharine Beecher (1841). The field was

first known as 'domestic science' or 'domestic economy' and reminiscent of the term *oikonomia* in Greek philosophy as the management of the household (Biester, 1950). The growing interest and advancements of its practitioners in economic issues eventually led to a broader and formal recognition of the field by the early 20th century as a stand-alone academic discipline (Weigley, 1974). It was officially branded 'home economics' and placed as a subsection of 'economics of consumption' and under 'political economy and sociology' during the Lake Placid Conferences (1899–1908), organised by librarian Melvil Dewey, inventor of the Dewey Decimal Classification and one of the founders of the American Library Association back in 1876, and spearheaded by its most preeminent advocate, Ellen H. Richards, born Swallow. By then, home economists started to more openly reclaim consumption as a research object belonging to their field of expertise, as household production, until then such a crucial component of domestic science, quickly lost ground to the market as the main form of provisioning, especially in urban settings (Dyball and Carlsson, 2017; Le Tollec, 2020; Philippy, 2021). In Richards's own words:

> Housekeeping no longer means washing dishes, scrubbing floors, making soap and candles; it means spending a given amount of money for a great variety of ready-prepared articles and so using the commodities as to produce the greatest satisfaction and the best possible mental, moral, and physical results. The very variety of choice is a danger unless knowledge comes with liberty.
>
> (Richards, 1910b [1899], p. 135)

Richards was a chemist and the first woman allowed to attend classes at the Massachusetts Institute of Technology (under a special student classification), where she graduated in 1873 and would work for decades as an instructor in sanitary chemistry. Her work spans from chemistry and the role of sanitation, hygiene, and nutrition as parts of domestic science to a broad approach to human ecology and finally the strengthening of home economics. Her accomplishments in these fields and efforts to improve standards of living, which she saw as objectively intertwined with aspects concerning the family, the household, and the environment, have given rise to several historiographical accounts of her intellectual legacy (e.g. Hunt, 1912; Clarke, 1973; Swallow, 2014; Sutherland, 2017).

Richards's scientific trajectory has from the outset been marked by an ethical and pragmatic concern for the implications of science to well-being at the family and community levels. It combined emphasis on educating those responsible for household affairs (and, even more importantly, their children) and demanding policies leading to a healthy environment and rational processes of social provisioning, in the attempt to counteract the visible pernicious effects of widespread industrialisation over the well-being of working people, such as low food and water quality (Dyball and Carlsson, 2017). From

sewage treatment standards to food inspection in factories, Richards offered an array of subsequently implemented health policy recommendations mainly at the municipal level (Richards and Woodman, 1904 [1900]; Richards, 1906 [1885], 1911a). Conversely, from a demand point of view, she addressed standards of living in terms of how households could provide for themselves in a more efficient way, i.e. how to follow rational guidelines for improving well-being within the family budget. Well-being was seen as the adequate consumption of goods and services fulfilling basic human needs, such as food, shelter, and cleanliness (Richards, 1905, 1911b [1908], 1913 [1901]). Richards (1910b [1899]) referred to this question as the 'cost of living.'

Furthermore, regaining economic control at the household level meant not only being able to provide for one's own family in an efficient way, but also living in harmony with the natural world across scales. In *The Art of Right Living* (1907b [1904], p. 10), she calls 'attention to certain points in practical, every-day living which make for such improved conditions in environment as will permit a higher moral and intellectual development.' To that effect, Richards (1910a) also adopted the term 'euthenics' as 'the science of the controllable environment.' Her first word choice as an embodiment of her ideas had, in fact, been Haeckel's *oekology*—Richards visited his laboratory back in the 1870s and apparently was the first to use the term in the United States—deemed as 'neatly capturing her broad concerns for human-created environmental conditions and the health consequences for people living in those conditions' (Dyball and Carlsson, 2017, p. 22; see also Clarke, 1973). However, as her at once social and ecological holistic notion of *oekology* was overshadowed by the narrower and now reigning meaning of the term (i.e. the relations between organisms and their natural environments), Richards, seeing some room to produce a meaningful impact during the Lake Placid Conferences, settled for domestic science, then reborn as home economics. Her proposed use of euthenics overlapped with the latter when it came to practical problems and public policy, even though, from a theoretical standpoint, it transcended home economics to encompass human ecology as 'the study of the surroundings of human beings in the effects they produce on the lives of men' (Richards, 1907a, p. v). It amounted to an integral view of human-environment interactions and the role of consumption in them still in vogue today (Christensen, 2014).

Richards (1910a, p. vii) explained her understanding of euthenics—*Euthenia* was the Greek female spirit of prosperity—as 'the betterment of living conditions, through conscious endeavour, for the purpose of securing efficient human beings.' Again, this could be accomplished by means of education and science as well as their power to foster habits leading to well-being, more productive lifestyles, and consequently an increasing national wealth. Studying consumption and enhancing consumption patterns is, therefore, crucial:

> The economics of consumption, including as it does the ethics of spending, must have a place in our higher education, preceded in earlier grades

> by manual dexterity and scientific information, which will lead to true economy in the use of time, energy, and money in the home life of the land.
>
> (Richards, 1910a, pp. 158–159)

Euthenics stands in contrast to eugenics in Richards's work, as the former deals with human development through environmental and social factors, while the latter does so through heredity in an intergenerational perspective. She was not, however, opposed to eugenic approaches to improving humankind. In fact, she had high hopes for it, pending further scientific investigation. Eugenicists themselves also acknowledged the role of the environment in perfecting human beings (Cooke, 1998). Euthenics was, in this sense and according to Richards herself, a preliminary step: she called for 'developing better men now, and thus inevitably creating a better race of men in the future' (1910a, p. viii). These darker links between eugenics and euthenics might also be extended to domestic science in relation to their shared ideals pertaining to human efficiency and a pure American identity (Egan, 2011; True, 2011).

Richards became president of the American Home Economics Association in 1908 and founded the *Journal of Home Economics* in 1909; even though she died shortly thereafter, in 1911, the groundwork necessary for establishing the field had been laid. She was the leading figure of a first generation of home economists who exceled in drawing from the sanitary and nutrition sciences to formulate health and education policies, especially those related to rationalising consumption patterns, as a means of ensuring well-being levels despite the social and environmental harm caused by industrialisation (Goldstein, 2012; Philippy, 2021). More specifically, she charged against the 'environmental costs of capitalist technology' (Richardson, 2002, p. 46) and based her solutions on hopes for a 'rationally "enlightened" capitalist economy, tempered by active intervention of a democratic government' (p. 45).

Whether through domestic science, later revamped as home economics, which turned knowledge stemming from the natural sciences into environmental policies and educational programmes aimed at increasing the well-being of consumers, or through her theorisation on euthenics and human ecology, Richards's work successfully conjoined natural and social phenomena into a single framework. Even if not directly drawing from evolutionary biology, her visions of a healthier society—from the household to the municipal level—led her into a groundbreaking academic trajectory encompassing large swathes of knowledge on issues concerning the life sciences as well as economics.

## Hazel Kyrk and the second generation of home economists

In the 1920s, a second generation emerged as home economists narrowed and deepened their focus on consumption both in empirical and theoretical terms, which implied a quest for better understanding the drivers

of consumption. This new moment in the development of the discipline had two distinct milestones, both taking place in 1923: the creation of the Bureau of Home Economics at the US Department of Agriculture, in support of empirical research related to the notion of 'rational consumption,' and the publication of Hazel Kyrk's *A Theory of Consumption* (1923), a landmark book laying the foundations of an 'economics of consumption' (Philippy, 2021, p. 2). This renewed outlook prompted the question of how to theorise consumption, and as a result, led to the intensification of previous more general criticisms of home economists, including Richards's, now explicitly aimed at neoclassical economists who seemed to deliberatively neglect consumption as an economic phenomenon worthy of closer attention.

Home economists adopted a radically different view of consumption in comparison with the one traditionally adopted in the field, which was based on consumer preferences and fell short of explaining the multiple processes which create them and condition their manifestation. The issue of consumption had received some consideration a few decades before by figures such as Simon Patten, Richard T. Ely, Henry R. Seager, and Veblen himself, whose specific contributions to this matter have exerted strong influence over home economists, particularly those of the second generation. Nevertheless, it remained relatively underdeveloped, which had been the case since Classical political economy, as the dissemination of the marginalist analytical framework, while placing demand at the centre of economic theory, did not move beyond the postulation of fixed or given preferences, as if abiding by the principle to be known as 'consumer sovereignty' (Matherly, 1942; Desmarais-Tremblay, 2020; Philippy, 2021).

On the one hand, the Bureau of Home Economics pushed for an empirical research agenda assessing consumption patterns and ultimately aimed at promoting a more efficient or wiser consumption. It followed as a consequence not only of the social context of rationalisation of resources demanded during the First World War, but also of 'the bewildering variety of goods from which to make selections, high pressure selling and advertising, the difficulty of judging quality and of comparing prices, the necessity of buying in small quantities, [and] the distance between producers and consumers' (Matherly, 1942, p. 60). On the other hand, Kyrk, who was affiliated with the Department of Economics and the Department of Home Economics at the University of Chicago and whose accomplishments also relate to a pragmatist ethics of consumption and relevant empirical studies on indexes and budgets, stood at the forefront of a new wave of theoretical scrutiny on consumer expenditures (Kiss and Beller, 2000; van Velzen, 2003). Combined, they paved the way for the consolidation of a science of consumption.

Kyrk criticised the use of hedonist psychology and utility maximisation by her mainstream colleagues, seen as overly simplistic categories to assess the subjective character of social and cognitive factors involved in consumption as well as how consumers value concrete goods. Circling back to Veblen, she

highlighted habits, impulses, and instincts as important categories for understanding economic behaviour, therefore implicitly referring to biology. She focused on innate but environmentally and socially conditioned instincts, including self-preservation, which would directly influence standards of living by means of processes of valuation and decision-making:

> It seems quite clear that our attitudes toward goods for consumption purposes, that is, our consumption standards and values, are made of the same stuff and by the same process as our other attitudes and standards. This stuff from which all our attitudes, values, or sentiments are made, their basic raw material, consists of the inborn tendencies of man attempting to realize themselves in ways afforded by the environment. All activity, all behavior, goes back to these native tendencies or dispositions to feel and to act in certain ways as the external world provides an outlet. (Kyrk, 1923, p. 194)

Somewhat sticking to the progressive, reformist tradition of the first generation of home economists, Kyrk asked herself how to raise standards of living based on such considerations. Formulating a theory of consumption, for her, served the purpose of dealing with 'the problem of choice—of values and of valuation' and that of 'human welfare as a function of wealth,' but above all of 'the control and guidance of economic activity' (p. 7). Seen as efforts which 'exist only because they are ways of fulfilling social purposes' (p. 8), Kyrk applied her theorisation to guiding behaviour in a quest towards the 'rational consumer' (Le Tollec, 2020, p. 62). Her book had a broad impact over economists interested in consumption, and within home economics she made way for other key contributions. These would include the works of her mentee and, later, colleague Margaret G. Reid (e.g. 1934, 1938; see also Forget, 1996; Yi, 1996; Bankovsky, 2020) and of Elizabeth E. Hoyt (e.g. 1928, 1938; see also Parsons, 2013; Bankovsky, 2020), who added elements from cultural anthropology to better understanding consumption as a social practice.

Discussions about how preferences are subject to the influence of a wide range of factors, from biological traits, physiological needs, and psychological drives to environmental, social, and cultural determinants as well as how they shape actual behaviour, reveal another key issue with which home economists engaged and which lies at the core of a science of consumption: the distinction between basic human needs and luxuries. This question has been addressed in different episodes of the history of ecological economic thought in connection with critiques towards the economic mainstream, as in the case of British social biologist Lancelot Hogben (1936) and his proposed differentiation between the biophysical aspects of basic needs and the subjective, social-historical character of ostentation-driven preferences, implying the necessity to integrate the natural and social sciences for understanding consumption patterns (Martinez-Alier, 1987).

The intention of home economists to forge a rational consumer was, to a large extent, focused on the satisfaction of basic needs (food, shelter, clothing, etc.). Conversely, they were also concerned with how consumers were being manipulated by corporations—again, by means of lax regulations, advertising, or lack of proper information—which sought to shape their preferences on a subjective level, thus breaking away from any claims connected with the principle of consumer sovereignty.

Richards had clearly attempted to merge a sociological approach with that of the natural sciences (physiology, sanitation, nutrition, etc.) for these purposes, although she emphasised the satisfaction of needs as what leads to a productive or efficient individual. For example, she contrasted the importance of quantitatively and qualitatively securing the 'three essentials of human existence,' namely '*clean air, safe water,* and *good food*' (Richards and Woodman, 1904, p. 2), with the detrimental effects of 'over-indulgence,' which would be motivated by the difficulty to 'choose from the bewildering variety offered that which shall best promote the health and develop the powers of the human being' (p. 9). As pointed out by Philippy (2021, p. 9), in Richards's 'distinction between "productive" and "unproductive" consumption,' the latter is associated with luxuries, while the former poses as basic human needs leading to more productive or efficient individuals and, in turn, to an increase in national wealth—a distinction reminiscent of the 18th-century controversies over the role of luxuries in the society and the economy (Provost, 2014; Pavy-Guilbert and Poulet, 2021). These would be measured 'not by units of satisfaction or by inner feelings of completeness but by the efficiency of production' (Matherly, 1942, p. 54).

Kyrk (1923) also addressed basic needs and luxuries as 'essentials' and 'non-essentials,' associating them, however, with a more elaborate notion of standard of living:

> The point seems to be that a standard of living is a psychical fact. It is an attitude toward, a way of regarding, or of judging, a given mode of living. It is a subjective view of certain objective facts. A standard implies a measurement, an evaluation, a judgment according to some accepted model. It is that 'scale of preferences,' that 'hierarchy of interests,' that code or plan for material living which directs our expenditure into certain channels and satisfies our sense of propriety and decency as to a mode of living. It is our standard of living which places goods as essentials or non-essentials, and which determines whether we are tolerably well-content or acutely dissatisfied with our material status.
>
> (Kyrk, 1923, p. 175)

Even though standards of living are subjectively assessed and socially situated, sometimes framed in relation to 'a recognized superior group,' behaviour is based on one's existing standards, and the inability to maintain them 'causes a feeling of insufficiency and of privation' (p. 176). Hence, wise consumption

serves the purpose of upholding a perceived standard of living. Along the same lines, when discussing the consumer's freedom of choice, Kyrk makes the differences between needs and preferences clearly distinguishable:

> […] we do know our primary and fundamental requirements quite well. […] It might be argued that experts, with a view to service rather than to profits, could rationalize and standardize consumption; could define necessities, luxuries, and waste; could experiment with new values, and provide for change and improvements.
>
> (Kyrk, 1923, p. 39)

Differentiating between needs and preferences is, therefore, above all a matter of public policy. Even if there is no necessity to precise the character of standards of living in terms of general welfare, acknowledging the possibility to agree upon 'minimum consumption requirements' (p. 40) based on scientific research and formulating policies to guarantee that all would have their needs met was the crux of the matter (see also van Velzen, 2003). The suggested budgets of home economists aimed to help in this regard, being 'geared towards satisfying basic needs with current income' (Le Tollec, 2020, p. 68). Nevertheless, defining what these essentials would be did not prove to be an easy task, varying a lot within social groups, over time, and amongst different branches, such as housing, clothing, or recreation; in any case, their budgets remained useful as models for comparatively improving expenditures, especially during the economic hardships of the late 1920s and early 1930s.

# 9 Early Soviet Ecology

Advancements in ecological science and policies for conservation proposed by Soviet thinkers in the 1920s and 1930s showcase an initiative in which economic planning took environmental issues into account. It amounted to a scientific movement characterised by a combination of rationalist and romanticist views towards nature, a strong intellectual influence of contemporary Soviet left-wing Marxists, and an emphasis on energetics and complementary empirical methods as evidence-based support for a conservationist economic planning programme.

Soviet ecological science can be divided into three distinct, consecutive phases throughout the 20th century: early, middle, and late Soviet ecology (Foster, 2015). Early Soviet ecology stretches from the 1917 revolution up to the tightening of Stalin's control over Soviet science in the mid-1930s. The body of new knowledge produced during this period on theory and application of community ecology was then unmatched by similar developments in Western countries (Weiner, 1988; Gare, 2002). The creation of large natural reserves for scientific research—the *zapovedniki*—served as instrument for a comprehensive nature conservation plan as part of an ecologically sound economic planning programme. In a wider context, by 1927, Soviet protected areas extended for almost seven million hectares, a result of one decade of growing pressure from conservationist movements (Weiner, 1982).

The rise of Stalin's repressive State meant a drastic change in Soviet ecology, with an aggressive politicisation and bureaucratisation of science, from the mid-1930s until his death in 1953. The political ascension of Trofim Denisovich Lysenko, a dominant figure in Soviet biology responsible for the suppression of studies on community ecology in favour of a more utilitarian approach to the management of Soviet natural resources, culminated with the elimination or ostracising of dissenting ecologists. Lysenko's research agenda was centred on acclimatisation studies, aiming to improve agricultural productivity by means of the artificial transformation of nature, above all by removing species from their original habitats and inserting them into new ones. Ecologists previously working on community ecology who wanted to continue their work had no choice but to abide by the acclimatisation agenda (Foster, 2015).

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Finally, in the second half of the 20th century, anthropogenic impacts over increasingly larger natural processes stemming from rapid industrial development became more apparent (e.g. air and water pollution, soil contamination, biogeochemical cycles imbalances), with unexpected and non-linear effects over the stability of ecosystems. As a consequence, the focus of late Soviet ecologists turned to interdisciplinary studies in an attempt to explain, predict, and act upon worldscale phenomena as a means to preserve or improve interactions between the environment and living organisms for economic purposes (Budyko, 1980).

## Soviet environmental thought in 1917

Douglas Weiner (1988) identified three main groups within Soviet environmental thought by the time of the 1917 revolution: nihilists, neo-romantic conservationists, and rationalist romantics. Nihilists valued nature according to its potential for economic use, and therefore, conservation was to be guided by the maximisation of material gains to humans. Only the more useful aspects of the mineral, animal, and plant domains should be conserved. The domination of science over nature was an important aspect of this utilitarian current of Soviet environmental thought. This approach 'for transforming nature *ex nihilo*' has been termed 'Michurinism' due to the accomplishments of Ivan Vladimirovich Michurin, a horticulturist and dedicated practitioner of biological selection and hybridisation who created different varieties of crop plants (Weiner, 1985, p. 245).

The roots of Soviet nihilist environmental thought can be traced back to 19th-century Russian science. French empiricism was an inspiration to Russian thinkers with Westernising tendencies, i.e. those who looked westward to modernise Russian society and economy. Within environmental thought, renowned nihilists were zoologists Karl Frantsevich Rule and Anatoly Petrovich Bogdanov, who had close ties to Jean-Baptiste de Lamarck and Étienne Geoffroy Saint-Hilaire and favoured their inductionist theories of heredity. In the 1860s, the idea of acclimatising species for practical purposes matched the interest of Russian scientists in empirical research with direct implications for social life. The modernisation of agriculture as a means to an increased grain output was one of the top priorities among Russian policymakers, who then faced the problem of unchecked urban population growth. Thus, by the 1920s, acclimatisation had already appeared as a priority for most ecologists, among them Anatoly Bogdanov's disciples and Michurinist biologists Dimitry Konstantinovich Solovev and Boris Mikhailovich Zhitkov.

The second group, the neo-romantic conservationists, opposed a utilitarian view of nature and adopted an anti-industry, anti-modernisation stance in line with the acknowledgement of nature's intrinsic value and the rights of non-human species. They denounced the perils of industrial development for nature and culture alike, as the engendered disequilibria made life devoid of meaning. Their inspiration in German idealism was complemented by more

traditional elements of Russian culture and even a particular interpretation of the notion of patriotic duty. Their views regarding the natural world have also been associated with those of American transcendentalists, such as Emerson and Thoreau (Gare, 1996).

Their most prominent representatives were botanist Ivan Parfenevich Borodin, who drew many insights from German conservationist Hugo Conwentz and envisioned the creation of vast national parks according to the American model, and entomologist Andrei Petrovich Semenov-Tian-Shansky, son of Petr Petrovich Semenov-Tian-Shansky, a prominent Russian geographer, explorer, and statistician, also a disciple of Alexander von Humboldt with ties to Russian revolutionary movements. He wrote extensively during the 1910s on nature conservation, appealing to scientists and laymen to 'save the "last refuges of Russian nature"' (Shtilmark, 2003, p. 16). Amid the social turmoil of the first post-revolution years, Semenov-Tian-Shansky stressed the need for an aesthetic approach to nature conservation and cultural development in lieu of a materialist and productivist drive based on self-interest as a principle. Every species should have the right to live and develop to its full potential, and humans had a duty to safeguard nature (Weiner, 1982).

The third group, embodied by the aforementioned early Soviet ecologists, stood in the middle ground between neo-romantic conservationists and nihilists: their approach mixed romantic, rationalist, and anti-mechanistic elements. They were also influenced by Western thought, from German idealism and realism to French and English utilitarianism, although there is an undeniable link to earlier Russian intellectual movements associated with 'the traditional Russian value of community feeling' (Weiner, 1988, p. 12) and 'rich practical traditions in agronomy, forestry and meadow management' (Gare, 2002, p. 58). There were clear ties between Narodnism and Bogdanovism (Kelly, 1981; Gare, 2000a), not least pertaining to their shared holistic worldview and stress on social praxis. In addition, both the *Narodniki* and early Soviet ecologists had a penchant for assessments based on energy flows, applied respectively to peasant economies and biological communities (in the former case, see Tvardovskaia, 1978). A third uniting element was the integral approach to the study of a determined location, embodied in the concept of *kraevedenie*—the equivalent of the modern notion of regional studies–which was used by the *Narodniki* (to explain the importance of the rural communes) and by the acclaimed Soviet ecologist Vladimir Vladimirovich Stanchinsky (1923a, 1923b).

The research of early Soviet ecologists revolved around fieldwork in the *zapovedniki*, partly inspired by the recent creation of natural reserves in North America and Western Europe (Shtilmark, 2003), whose protection would allow them to advance our understanding of integral ecological communities and consequently recommend appropriate economic uses of natural resources according to the ecological carrying capacity of a specific area or community (Weiner, 1988). They appreciated the value and complexity of the natural world, refraining from an excessively utilitarian and deterministic stance.

The balance and efficiency of natural processes served as inspiration for their work; the task at hand was to learn from nature, marvel at its grand feats, and preserve it as much as possible rather than arbitrarily interfere with it according to one's interest.

Conversely, they also favoured and had often practised a nihilist scientific approach. The traditional notion of acclimatisation carried with itself a conservationist element, as its promises of a more rational management of natural resources meant preventing a wasteful use of plant and animal stocks. However, as such stocks dwindled in Russia, especially between the late 19th and early 20th centuries, the nihilist and conservationist agendas seemed too divergent to remain aligned, making room for the rise of community ecology (Weiner, 1982). This spat was evident after Grigory Aleksandrovich Kozhevnikov, an entomologist working at Moscow University and pupil of Anatoly Petrovich Bogdanov, was elected president of the Acclimatization Society. He used his position to undermine the utilitarian and interventionist ethos of the organisation, prompting his fellow ecologists to support his views on conservationism and the need for the creation of the *zapovedniki*. After that, the Society fell into oblivion and Kozhevnikov embraced an ethical and aesthetical approach to conservation, calling for 'the right of primitive nature to existence' (Kozhevnikov, 1960 [1909], p. 90).

Early Soviet ecology was marked by new goals, methods, and contents, having little in common with pre-First World War Russian ecological studies. Nineteenth-century Russian ecology was mainly botanical; at the turn of the 20th century, plant ecology studies flourished in the wake of surveys commissioned by the Ministry of Agriculture to support the planned emigration of peasants to Siberia and the Far East; the same happened with animal ecology, which only thrived in the 1910s as a response to the locust threat to agriculture. Most works were still restricted to autecology, focusing on the interactions of individual organisms with their environment rather than on interconnected biotic communities: 'the development of the community concept [in ecology] has everywhere been largely post-war' (Carpenter, 1939, p. 355). 'Biocenology,' a term coined by German zoologist Karl August Möbius in 1877 to refer to a biological community and a synonym to 'community ecology' or 'synecology,' was the word of choice of most Russian authors (*biotsenologiia*).

Nihilist and rationalist-romantic variants of Soviet community ecology flourished in the 1920s, while the latter gradually moved from acclimatisation to conservation as a foundation for their work on the interconnectedness of biotic communities and its implications for economic planning. Their numbers grew steadily under the auspices of *Narkompros*—the People's Commissariat for Education. The most prominent scholarly figures, in addition to Stanchinsky and Kozhevnikov, were Vladimir Ivanovich Vernadsky and Vladimir Nikolaevich Sukachev. J. Richard Carpenter (1939, p. 367) listed 517 noteworthy Soviet publications on the theory and method of community ecology between 1917 and 1937, not to mention a large literature on 'special economic biological and epidemiological problems.'

## Left-wing Marxism and *Narkompros*

This early Soviet ecology, as every other field of Soviet science, did not escape the imprint of Marxist philosophy, as received by Russian Marxist theorists. The way in which Marxist thought was interpreted by leading Soviet theoreticians was, however, far from unanimous. In the context of ecology and nature conservation, Marxism would be another topic of dissent between nihilists and rationalist romantics.

Georgy Valentinovich Plekhanov, one of the founding fathers of Russian orthodox Marxism, saw nature as the means by which a historically determined proletarian revolution would unleash productive forces. His utilitarian view of Marxism matched the attitude of the nihilists towards nature. Contrary to Plekhanov, the so-called left-wing Russian Marxists favoured the anti-mechanistic science of early Soviet ecologists, providing political and financial support for their research. Anatoly Vasilevich Lunacharsky and Aleksandr Aleksandrovich Bogdanov were amongst the most important left-wing figures in terms of intellectual and political power during the 1920s, arguing for a democratic community without deep fissures between those who governed and those who were governed, which could be accomplished by the assimilation of a proletarian culture (*Proletkult*). This new culture would demand a different approach to science, one inspired in the German natural philosophy, in which nature constitutes a live and integrated organism with self-organising properties, attributes potentially applicable to the proletariat. This assumption implied people had the ability to organise themselves democratically for the sake of a revolutionary transition into communism (Gare, 2002).

By the end of the 19th century, debates on the application of Marxian ideas to the semi-feudal Russian economy were part of wider efforts to foster economic development in the country. From the perspective of political economy, Vincent Barnett (2005) divides Russian revisionist Marxism into two main currents. Neo-Kantian revisionists, among them the young legal Marxists Mikhail Ivanovich Tugan-Baranovsky, Petr Berngardovich Struve, and Sergei Nikolaevich Bulgakov, advanced an ethics-based economic methodology in which moral issues transcended class interests (see also Allisson, 2015). Conversely, Nietzschean or Machist revisionists, led by Lunacharsky and Bogdanov, saw social phenomena through the lens of the scientific method of the natural sciences. They rejected Kantian aprioristic idealism in favour of the role of experience in processes of knowledge construction, also realising that they were conditioned by the subjective nature of social relations: one could only 'fill out the gaps in experience by the ideas that experience suggests' (Mattick, 2007 [1978], p. 171).

The revisionist character of the theories of Bogdanov (2016 [1923]) relates to his efforts to draw elements from dialectical materialism and empiriocriticism, aiming however to surpass, respectively, Marx and Mach in their capacity to answer contemporary philosophical problems (Jensen, 1944). He

called for a more sensuous view of the concept of matter and argued against Mach's separation between action and contemplation for the sake of a proper understanding of causal relations and their explanatory power (Boll, 1981). The Marxian notion of class fitted well into Bogdanov's philosophy of science, featuring as an objective phenomenon of a socially constructed reality useful to reveal causal relations and to understand the social character of knowledge.

Bogdanov found the dialectics of Marx and Engels unsatisfactory, especially when applied to mechanical phenomena, often confusing dialectical concepts with reality, and in that capacity resembling Hegelian dialectics. In contrast, Bogdanov (2016 [1923], p. 182, italics in the original) viewed dialectics as an 'organising process, occurring through the struggle of opposing tendencies,' while 'for Marx, the question is about *development* and not an organising process […] in the sense of the strengthening and increasing complexity of certain complexes, whether real or abstract.'

For Bogdanov, transformation is the underlying element of an otherwise continuously changing world. Mind and matter are causally linked through energy transformations. The conscious application of the collective forces of the proletariat against external nature consists 'in the systematic and deliberate *transformation of forces* or, to be more scientific and exact, in the *transformation of energy*' (2016 [1923], p. 201, italics in the original). This is how 'contemporary production "changes the world."' Thus, Bogdanov acknowledged the centrality of the concept of energy for understanding a changing reality, to a large extent influenced by the Monist League of Ernst Haeckel and Wilhelm Ostwald (Boll, 1981; Gare, 2000b).

However, Bogdanov's use of the concept of energy to overcome the dualism between mind and matter does not lead to an argument in favour of energetic reductionism, as he overtly emphasised the social character of organisational processes related to mental and physical complexes (i.e. mind and matter). Social phenomena are an integral part of nature allowing for the possibility of emergent properties of purely social character—e.g. knowledge attainment—which require higher levels of complex organisational forms. Whereas technology is the result of more primitive organisational levels of human activity, ideology relates to more complex ways in which cognition is employed to strengthen social bonds, such as laws, customs, and concepts. Culture would be the combination of technology and ideology as forces driving the advancement of society.

Bogdanov's stance led to a different approach to science, one which stresses and universalises the epistemological importance of organisational aspects of natural and mental elements. It proposes a systematic method to reveal and generalise modes of organisation, thereby exposing tendencies and regularities able to predict future advancements of these modes of organisation and to demonstrate their role in natural and mental processes alike (Bogdanov, 1996 [1913]). Bogdanov's universal science of organisation, tektology, takes into consideration the ability of self-organising natural and social systems to act

as a resistance or countertendency to the inescapable disorganising principle imposed by the entropy law. If a system performs better against resistances in comparison to the sum of its isolated elements, it is deemed organised by Bogdanov. Organised systems are described in terms of traits like levels of interdependency, stability, and plasticity; they are regulated by tektological mechanisms acting through a selection process which determines what will be preserved, transformed, or destroyed. The development of cybernetics, general systems theory, and praxeology were all influenced by these early insights (Gare, 1994, 2000a, 2000b).

Bogdanov's philosophy was meant to be the foundation of a new culture and science. According to his post-capitalistic utopia, the natural and social sciences would come together as a universal organisational science. In the long term, this new science would be capable of democratically fostering the creation of a socialist society, a much more effective revolutionary endeavour towards the socialist ideal than seizing power overnight and maintaining a Taylorist production system, which would most likely lead to State capitalism. A different culture would emerge out of the conscious creation of new ways to organise experience, aided by the ideological labour provided by art, literature, and philosophy. Once the cognitive barrier imposed on the proletariat by class society was lifted, this new socialist culture would allow for new ideas and actions, including the propensity of workers to 'appreciate both the limitations and the significance of their environments and other forms of life' (Gare, 2000a, p. 346). If old fetishes and dualisms were removed, it would be possible to acknowledge nature as a self-organising system.

The intrinsic value of nature asserted by Bogdanov was also present in his utopian novel *Red Star* (1984 [1908]). His predictions of future scientific and social developments entailed a genuine concern related to the natural limits of economic activity. Upon imminent environmental catastrophe, the advanced socialist Martian society debates about the possibility of conquering Earth and annihilating humans. The argument in favour of the significance of other forms of life—in this case human life—reflects Bogdanov's philosophical appreciation for the diversity and interdependence of organisational complexes. The overt rationalist-romantic stance of Bogdanov thus justifies the claim that he had created an intellectual framework based on which those concerned about the environment could develop their own theories.

Bogdanov's views were fiercely opposed by Lenin, who could never let go of a certain level of conscious (i.e. party) control. He sided with Plekhanov in his orthodox interpretation of Marxist theory and condemned Bogdanov's proposal for a new culture and science (Lenin, 1972 [1909]). Lenin was also disappointed by how Nikolai Ivanovich Bukharin, one of the leading theoreticians of Soviet Marxism, sympathised with systems theory and the notion of a social dynamic equilibrium. Bukharin supported *Proletkult*, for what he was labelled as a Machist revisionist by his enemies and targeted as a menace by

Stalin. Standing in the middle ground between Lenin and Bogdanov, he saw the need for some level of party control, while supporting the idea of shaping a new proletarian culture, of which the peasantry would be an important part. In the transition to a socialist society, cultural change would be a more important concept than class struggle; cultural hegemony more relevant than political power (Sochor, 1988).

Bukharin (1925) also shared Bogdanov's view in relation to the dialectical relations between humans and nature. He attempted to couple breakthroughs in ecology of the early 20th century with historical materialism, a challenge also faced by renowned ecologist Sukachev, for whom the interconnections between natural phenomena were a premise of the materialistic dialectics of Marx and Engels. Not by coincidence, Sukachev had been influenced by Georgy Fedorovich Morozov, a Russian precursor of scientific forestry using systems theory and pioneer in the use of the concept of biocenosis in ecological science (Foster, 2015).

Whereas the philosophical foundations of early Soviet ecology were given by Bogdanov, his brother-in-law, literary critic and art theoretician Lunacharsky (1918), who envisaged a wide cultural transformation as key to the Soviet socialist ideal, was the main figure responsible for making possible the progress of empirical studies on community ecology and for conveying their results and recommendations to government (Gare, 1994). As head of *Narkompros*, he not only provided the political support for the creation of the *zapovedniki*, but also for a new intellectual approach to the relations between humans and nature which combined the empirical character of community ecology with a utopian worldview seeking to transform reality without incurring in a totalitarian, technocratic agenda. It allowed the pioneering ideas of ecologists such as Vernadsky, Stanchinsky, Kozhevnikov, and Sukachev to thrive and build a legacy for posterity, even if, by the late 1930s, the careers of most of them were cut short. Early Soviet ecology and the whole Soviet conservation movement of the 1920s would become the epitome of *Proletkult*, probably the main reason why they fell prey to the enemies of Bogdanovism. To Arran Gare (2002, p. 71), the conservation movement was the 'ghost of authentic communism.'

It is worth asking why Lenin supported Lunacharsky's *Narkompros* and, more specifically, the scientific advances of early Soviet ecologists. Despite his more orthodox views on conscious control, Lenin did not agree with the more radical determinism of Plekhanov, which would later constitute a hallmark of orthodox Marxism. Lenin's dialectical materialism gradually assimilated the notion of spontaneity in contrast to consciousness, which meant that the proletariat and the peasantry would spontaneously rebel against capitalistic social relations. Notwithstanding his political and philosophical controversies with Bogdanov, by 1919 Lenin would take the time to support an anti-mechanistic approach to the conservation of nature, a theme close to his heart which was entrusted to the respected intellectual figure of Lunacharsky.

## Energetics and conservation ecology

Sergei Podolinsky's work on social energetics was familiar at least to one of the most distinguished ecologists of the time, being mentioned by Vernadsky (1924). By then, ecological energetics was already a concern among ecologists, as developments on the transformations of solar energy in the biosphere were under way in Russia since 1884, when climatologist and geographer Aleksandr Ivanovich Voeikov acknowledged the need for an energetic accounting of the solar heat received by Earth. Contemporary works with those of early Soviet ecologists had been undertaken by Sergei Ivanovich Savinov and Nikolai Nikolaevich Kalitin long before studies on Earth's heat balance started to be more systematically pursued in the 1940s (Budyko, 1980).

The implications of energetics for social and particularly to economic systems would be an innovation quite characteristic of early Soviet ecology. Nevertheless, their achievements in this area do not fit exactly into the description of social energetics, as they did not apply thermodynamic principles to social systems but limited themselves to the assessment of flows and stocks of energy in the biocenosis. Their originality consisted mostly in recommending that these results be used to inform economic planning programmes. Once the energetic accounting of a set of biological communities was attained, they hoped to be able to use this information to plan economic activity without disrupting the biocenosis. Economic planners would be responsible for adjusting the energetic demand of a given economy, translatable into biomass units, to the supply provided by the biocenosis.

Stanchinsky, an ecology professor at the Smolensk University and later on at Kharkov State University, was at the forefront of research on ecological energetics or 'trophic dynamics' (Weiner, 1988). He described how flows of energy (and, analogously, of biomass) decreased along biological trophic levels and how it conditioned the existence of a dynamic equilibrium in a determined community. The inter-species distribution of energy would serve as a means to identify the boundaries of the biocenosis. Solar energy enters the biocenosis and is fixed by autotrophic plants, therefrom partially flowing to higher levels of the food web until it is completely exhausted in the cyclical biological processes inherent to that community. The emerging dynamic equilibrium would correspond to the observed stability of the system, in which population ratios between different species remained remarkably constant over long periods of time. Furthermore, the entropy law would dictate that energy must be dissipated while flowing along trophic levels, which could explain the gradually decreasing biomasses from vegetation to herbivores and finally to carnivores (Gare, 1993, 2002).

The empirical approach to ecological energetics of Stanchinsky was based on a mathematical model which describes, in energy units, the dynamic equilibrium of a theoretical biocenosis. The annual energy budget of a given community was calculated using measurements of the biomass of each component species (Stanchinsky, 1931b, 1931a). His analysis of trophic dynamics

was groundbreaking, preceding Raymond L. Lindeman's (1942) work in ecosystem ecology by a decade. Stanchinsky's approach to energetics provided a common denominator, i.e. energy, to understand inter-species transformations and interconnections in different biocenoses and in the biosphere.

His theory and methods assumed that biocenoses were comprised of continuous exchanges of matter and energy. The biocenosis would be subject to a proper analysis by means of dialectical concepts which could explain the biological phenomenon of collective adaptation, a crucial research question to him (Stanchinsky and Kashkarov, 1931). Bearing in mind that Stanchinsky earned his doctoral degree from Heidelberg University in 1906, which hints towards some level of exposure to the influence of Ostwald's *Energetik*, his innovative approach to community ecology can be regarded as the amalgamation of Marxism, Bogdanovism, the energeticism of Ostwald, and Vernadsky's well-known work in ecological science.

The economic implications drawn by Stanchinsky from his ecological energetics were closely related to his leading role in the political promotion of the creation of the *zapovedniki*. Although he never developed an empirical method to assess the economic demand for the energy or biomass of a biocenosis, Stanchinsky thought it would be possible to plan this demand according to what the biocenosis could offer and in such a way that its stability would not be permanently ruined. Protected areas could serve as a standard or reference (*etalon*) whose detailed ecological assessment could provide the necessary information for planning the use of natural resources of similar areas.

Energetics, along with the bulk of the then ongoing research on the level of disturbance that biocenoses could tolerate without a major disruption, was used so as not to oppose conservation and the political urge to modernise and expand the Soviet economy, as endorsed by Lenin's New Economic Policy. The kind of conservationism practiced by early Soviet ecologists did not prevent economic development, albeit it aimed at the same time to preserve large tracts of pristine nature. In the face of relentless political pressure for economic expansion, they managed to find support through the discourse that preservation was essential for scientific progress and consequently to economic development itself. Such a stance also served to shield them from vilification and personal attacks promoted by the establishment against dissenters of official policy.

## Biocenology in planning programmes

The development of conservationist ideas and their implications for economic policies unfolded while economic theory itself was going through radical changes. The Bolshevik political platform was based on the transformation of the current social and economic system, and economic analysis would be instrumental for the revolution to reach its goals. Even if the Bolshevik ascension to power did not entail an immediate replacement of

the economic system, theoretical debates would extend from the period of War Communism well into the 1920s, during the deployment of the New Economic Policy. Given the possibilities created by non-market forms of social control, Soviet economists pursued more original approaches to economic planning with varying degrees of comprehensiveness and flexibility in planning methodology. As the decade approached its end, the pluralism of economic ideas would be attacked and eliminated, putting an end to a surge in economic theory especially in relation to the agricultural sector, non-monetary accounting, and economic planning programmes.

Despite the Bolshevik emphasis on the social and economic possibilities of a State-run, collectively owned industrial sector, the accommodation of the peasant economy was the most important Soviet economic issue during the 1920s, receiving attention from the most prominent economists of the time. Feeding a growing population was a constant challenge, which spurred innovative contributions to agricultural economics. There were at least four different currents of Soviet agricultural economics in the 1920s, with strong disagreements on the role of modernising agricultural entrepreneurs (Barnett, 2005). Nikolai Dimitrievich Kondratiev focused on agricultural markets and their impacts over farmers' decisions; Marxist agrarianist Lev Natanovich Kritsman stressed the role of class structure in rural areas, especially the relations between wage labour and landowners; Aleksandr Vasilevich Chayanov proposed a behavioural analysis of peasant farms as households whose production depended on a balance between consumption and the drudgery of labour; and finally, right-wing agrarianist Lev Nikolaevich Litoshenko opposed the latter as far as such households in a modern monetary economy would rather maximise the difference between earnings and expenditures.

At the fringes of these debates were early Soviet ecologists and their attempts to contribute to the specific, although highly controversial and relevant, issue of the planning of the agricultural or peasant economy. Their competitors over the chance to wield influence over agricultural policy were mainly affiliated with the People's Commissariat for Agriculture (*Narkomzem*), whose goal was to assess and improve land productivity. Hence, a political dispute ensued between *Narkomzem* and *Narkompros* over control of the *zapovedniki*, even though there was hardly any intellectual interaction between ecologists and agricultural economists. While *Narkompros* resisted, the reserves were protected and proved to be key for the advancement of community ecology. Contributions included ways to deal with locust and other plagues, warnings on diminishing populations of plants and animals with economic value, and analyses on the productivity of forests, pastures, lakes, and seas.

The precautionary approach of early Soviet ecologists to the use and management of natural resources, and above all the acknowledgement of ecological thresholds as sensible limits to economic activity, led to objections against the productivist bias of the first Five-Year Plan, which included the damming of rivers, large-scale agro-industrial projects, and acclimatisation

of exotic fauna. Economic policy should abide by their theories and empirical research, a topic of heated debates during the First All-Russian Congress for the Conservation of Nature held in 1929, when Stanchinsky took the lead in affirming that 'conservation organizations must be able to review plan targets and monitor plan fulfilment' (Gare, 1993, p. 124).

The ecological energetics of Stanchinsky was meant to serve as basis for the calculation of the productive capacity of each biocenosis. The results obtained could be used by planners to estimate the provisioning potential of a given territory, a precious input for ascertaining economic possibilities. Different parameters or indicators pertaining to biological activity and trophic dynamics could be created for these purposes (e.g. reproduction rates of useful species and biomass yields), in addition to finding optimal conditions under which productivity can be maximised. To Stanchinsky, 'such potentialities determine the role of organisms in nature and in the human economy' (Stanchinsky, 1931b, p. 43). When tackling the issue of low agricultural productivity in the steppes of southern Ukraine, Stanchinsky proposed a multidisciplinary ecological study (i.e. involving not only different subfields of biology, but also climatology, geology, soil science, etc.) in order to find a course of action leading to higher agricultural yields. Using the *zapovednik* of Askania-Nova as an *etalon*, he hoped to be able to increase the productivity of crops in similar biocenoses (Stanchinsky, 1930).

Notwithstanding the theoretical underpinnings and the academic strength of Stanchinsky, Daniel Nikolaevich Kashkarov was probably the early Soviet ecologist who went furthest in the matter of economic planning. The fact that he managed to do so and keep his academic position until his death in 1941, during the siege of Leningrad, hints towards his ability to adapt his discourse to official policy. Kashkarov taught at the Central Asian State University, in Tashkent, being later transferred to the Leningrad State University. He worked on comparative anatomy, zoopsychology, and zoogeography before turning his attention to community ecology. In the end of the 1930s, he started to prepare a textbook, *Osnovy Ekologii Zhivotnykh*, with a subsection on the application of ecology to the construction of a socialist economy (Kashkarov, 1944, pp. 21–30). Back in 1933, he had co-authored an article with phytogeographer Evgeny Petrovich Korovin whose aim was to point to the economic role and tasks of ecology in a planned economy (Kashkarov and Korovin, 1933).

In *Osnovy*, Kashkarov attributes the burgeoning development of ecological science in the USSR to the challenge of establishing a rational and planned use of natural resources in a socialist economy. He welcomes Bogdanov's tektology as an integrated, process-oriented worldview capable of not only understanding nature but also making use of it for such purposes. He is specific about how this integrated approach can be applied to different areas of the Soviet peasant economy: fishing, agriculture, forestry, hunting, animal husbandry, and even public health are deemed as sectors which could economically benefit from policies informed by community ecology.

As a planning tool, recommendations of ecologists could expand production while observing minimum requirements, in terms of the health of the biological community, for the maintenance of the integrity of a given biocenosis. These requirements should be treated as fixed capital, and only the accruing interest, seen as a surplus provided by nature, could be extracted for economic use. The task of community ecology was to provide a detailed assessment of such requirements and, in turn, recommend limits for determinate economic activities. In this sense, the work of ecologists was crucial to 'a truly planned, scientifically grounded socialist economy' (Kashkarov, 1944, p. 22) which does not deplete the fixed capital from which society earns a profit. On the yield of fisheries and the health of the associated biocenoses—Kashkarov brings different examples of the applicability of this type of research, including crop productivity, fur trade, and pheasant hunting (see Franco, 2020)—he states:

> [w]e are reconstructing our fishing economy, applying new, more advanced, collective forms of fishing organization, better techniques, increasing fish production; we must find new fishing sites, expand fisheries to places where they did not exist before. However, we must do this in a way that does not violate the integrity of "fixed capital"–fish stocks; we should use only the "interest," according to a strictly developed plan based on accounting. […] It is impossible to solve these problems without using the methods of synecological study. Synecology should play an outstanding role in this regard. We can consider the pond, the river, the lake, the sea as a complex, the components of which are in an intricate dependence on each other and on environmental factors.
>
> (Kashkarov, 1944, p. 21)

Once a thorough system of ecological accounting was in place, it could start providing economic planners with relevant information about determinate sectors and proposals in terms of productive structures and optimal extraction paths. For this to be possible, community ecology had to be given proper assistance, above all by means of the creation of the *zapovedniki*. However, the political support given to early Soviet ecologists has never really moved beyond the establishment of these natural reserves. Their conservationist economic planning programmes did not entail a ready-to-go, short-term policy for economic recovery. What they offered was a long-term, balanced solution for a sustained co-existence of humans and nature, a promise of yield maximisation in the peasant economy subject to ecological limits. Their research was only beginning; many rounds of trial and error would still be necessary before results could be used for the progress of a socialist economy in the USSR. Not meeting the expectations of official policy and rivalled by the followers of Lysenko, early Soviet ecologists never got actually close to implementing a conservationist economic planning programme, and soon the *zapovedniki* would be out of reach for their scientific research.

# 10 Land Economics and Land Ethic

Most of the traditions previously covered paid attention to land, its role in providing sustenance to human beings, in maintaining the circulation of chemical elements, and more generally in concatenating the elements of the natural world. They did not merely depict land as the locus of economic or social activities, but also as a living space, essential in the interactions between humans and nature.

In the first decades of the 20th century, a new research field emerged in the United States within the discipline of economics, at first in close connection with the Conservation movement and progressively creating its own academic niche. Research in 'land economics' explicitly aimed to focus on land as a key element in economic production and business affairs. Land economics had ties with agricultural economics, real estate economics, and public policy. Some of its adepts had interest in land limited to property issues, not going as far as others in considering land in its entire complexity. A specific group of researchers at the University of Wisconsin, however, came to develop a holistic approach to land economics, inspired by several fields in the social and natural sciences, especially ecology.

Meanwhile, on the other side of the corridor at the University of Wisconsin, the famous ecologist and ethicist Aldo Leopold developed his own ideas on 'conservation economics' (1934a) imbued with the clear mission to inculcate into farmers, consumers, and public authorities a more careful consideration of the environment pertaining to economic matters.

As our journey through the history of ecological economic thought draws to a close, this stage in land economics in the pre-Second World War United States offers an insightful take on interdisciplinarity at a time when the Great Depression made it particularly hard to lay emphasis on the sustainability of socio-ecological systems.

## From institutionalism to land economics

In the early 20th century, agricultural economists—who focused on the optimisation of processes and business organisation in the agricultural sector—worked mainly on land use and the dynamics of crops using quantitative

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methods. They touched upon conservation issues in connection with erosion and wildlife (with ties to ornithology and entomology), even though these subjects constituted a secondary concern in curricula and research.

At the University of Wisconsin, agricultural economics appeared in junction with the rise of pioneering figures of what would soon become the American Institutionalist movement (Rutherford, 2011). Institutionalism became a recognised field of economic research in the 1910s. At the time, it was perceived as an attractive, modern field, mobilising interdisciplinary frameworks to deal with economic problems based on a down-to-earth approach, contrasting with reliance on unsound abstractions. This attractiveness led to academic support: new institutions were created such as the Brookings Institution in Washington and funding was abundant.

The Conservation movement, on the other hand, was born outside the sphere of influence of institutionalism. Pinchot had been trained as a forester and not as an economist or lawyer, remaining oblivious to this new trend. Nevertheless, conservationism and institutionalism—even before these labels existed—found opportunities for mutual support, not least because participants in both movements often coincided. Richard T. Ely, one of the main figures of agricultural economics and shortly thereafter of land economics, was one of the founding fathers of institutionalism and a contributor to the landmark book on conservation *The Foundations of National Prosperity: Studies in the Conservation of Permanent National Resources* (1918).

Proximity between conservationism and institutionalism was also present in terms of common topics. All institutionalists were preoccupied with social control, i.e. regulation, norms, economic policies, and planning. This was exactly one of the *raisons d'être* of the Conservation movement. Discussions over the right tools to direct economic actors towards the wise use of natural resources were commonplace (e.g. Leith, 1918), as were reflections on the role of public utilities in the economy. Another shared concern between institutionalists and conservationists was the role of property rights. Conservationists devoted energy and effort to establish clear conservation policies on public land and they regularly emphasised the need for adequate incentives to foster conservationist behaviour on private lands. Seemingly, property rights were crucial to the institutionalist discourse, as illustrated by John R. Commons's notion of 'bundle of rights' (1893, p. 92). Commons also mentioned issues related to the depletion of natural resources, although this was not his main research subject.

Although the Conservation movement started to wane in the 1910s–1920s, some late contributors persevered in their work on natural resources and intergenerational equity. John Ise (1920, 1926), for instance, contributed to conservation issues through research on the economic aspects of forestry and oil with a clear institutionalist bias: he focused on public policies, property rights, and operational tools rather than on abstract theoretical principles. He was trained at Harvard, where Frank W. Taussig (1911) had set a research

agenda not particularly keen on institutionalism. However, the strength of this movement in the 1920s would seduce Ise and many others: George W. Stocking (1925) examined the oil industry, while works conducted at the Brookings Institution on the role of energy in economic development could also be seen as part of the same project (Tryon, 1927; see Missemer and Nadaud, 2020).

Economists at the forefront of conservationism in the 1900s–1910s would gradually leave the scene in the 1920s. Lewis C. Gray (1925) turned back to his agricultural research. More generally speaking, early conservation economists shifted towards rural, agricultural, and land studies throughout the 1920s–1930s. At this moment, Ely established the new field of land economics. In a sense, it was the continuation of these conservationist concerns within the Institutionalist movement.

Remarkably, the natural sciences remained as a central source of knowledge for land economists, at least between the 1920s and the 1940s. To Ely, inductive methods based on statements supported by evidence were crucial to maintaining dialogue with natural scientists, especially in the context of agricultural studies. Bernhard E. Fernow had since the 1890s encouraged his students and colleagues to foster 'intercourse with the workers in other biological sciences' (1895, p. 253), and some of them took part in land economics research.

## George S. Wehrwein's approach to ecology

At the University of Wisconsin, Ely was joined by a few students who soon became the main references in the new field of land economics. George S. Wehrwein stood out among them. In 1922, he co-authored with Ely and Mary L. Shine the first textbook in the field, *Outlines of Land Economics*. His *Land Economics* (1940), also co-authored with Ely, remained as a key reference for years. Wehrwein had been trained in agricultural studies and extended his research interests to other land use issues throughout the 1920s and 1930s. His approach was particularly marked by institutionalism, full of case studies, statistics, and ideas on public regulation (e.g. Wehrwein and Spilman, 1933).

Wehrwein paid more attention to conservation than most land economists (Vaughn, 1995). It was to him a key subject, not least because it weighed on the value of land. With mentions to George P. Marsh, Wehrwein (1939) displayed a broad knowledge of American environmentalism, noticing how fossil fuels altered the impact of human beings on their environment and insisting on the discrepancy between the short-term horizon of individuals and the long-term requirements of sound conservation. Wehrwein embraced economic principles, constantly trying to find the best incentive frameworks to encourage landowners to adopt conservation practices. However, not all economic principles would be necessarily valid in the field of conservation.

His main criticism towards *laissez-faire* and Adam Smith's invisible hand is quite illustrative:

> Adam Smith stated the consoling doctrine that, in the main, whenever each person pursues his own self-interest he is automatically also acting in the best interests of society as a whole. […] Whatever may have been the validity of this philosophy in commerce and industry it fails when applied to the conservational utilization of natural resources.
>
> (Wehrwein, 1939, p. 432)

Wehrwein's main argument was that countries which allowed for full private property rights on land incurred in detrimental effects for conservation. To protect natural resources, public regulation was needed.

Wehrwein also contributed to the rise of a new concern in the context of conservation, namely pollution, which was hitherto only a secondary issue in the conservationist literature. In his land economics, pollution, especially water pollution, influenced the quality of a given space and, in turn, land prices. In Northern Atlantic American states, the consequences of oil extraction, which were often poorly monitored by producers, included major hydrocarbon leaks spanning several kilometres away from wells (Jones, 2014). Wehrwein was sensitive to this issue due to the destruction of natural habitats and the associated recreation opportunities: 'bathing beaches […] being polluted along streams and lakes […] by city wastes and oil' (1927, p. 167).

Recreation was then an emerging topic for economists. At the turn of the 1920s, the Forest Service reinforced the investigation on recreation in forest areas (Banzhaf, 2019). The National Conservation Commission (1909) had already pointed to the need of new infrastructure leading to more open spaces for recreational wise use. In the 1920s and the 1930s, land economists worked extensively on methods to assess the value of recreational services and to better circumscribe the role of these services in terms of land use and property. Recreation was perceived as providing two kinds of benefits: explicit revenues through direct and indirect activities (e.g. tourism, equipment, transport) and non-monetary gains through individual satisfaction and collective well-being. The challenge was to find a way of valuing the second type of benefit. Several alternatives were conceived after the Second World War. In the 1930s, however, methods remained rudimentary and dependent on the availability of proxies to estimate the non-monetary value associated with recreational services. For instance, to calculate the aesthetic value of some areas, the entrance fee to the Yellowstone National Park (USD 1.25/day/person) could be used as a benchmark, as this was the price which individuals accepted to pay for entry into the most beautiful landscapes of the country. One could then infer the aesthetic value of different areas according to their beauty in comparison with Yellowstone (Martin and Norcross, 1932).

Wehrwein (1927) did not work on such detailed valuation attempts. Nonetheless, he paid special attention to recreational services in addition to his above-mentioned concern for pollution. He viewed recreation as a new social demand not only for sport (i.e. hunting) but also for leisure in a broader sense. Furthermore, it provided a new possibility for land use in territories unsuitable for agriculture and forestry (Wehrwein and Spilman, 1933). Wehrwein perceived infrastructure as a critical issue to help people access recreational areas as well as to create conditions for the enjoyment of entertaining activities which respected the aesthetic value of land. He regretted that engineers were the only voice heard in public debates about recreation at the expense of both economists and ecologists. To him, an alliance between economists and ecologists had to be forged as an alternative approach to landscape planning.

Wehrwein also wrote on general issues related to valuation methods. He agreed that direct and indirect activities served for estimating the benefits from recreation. That included, for instance, 'the gasoline needed to drive motor cars' to recreational land (1927, p. 171). In the late 1930s, he tackled the issue of valuing the aesthetic and pleasure dimensions of recreational areas using arguments which remind us of more recent developments in contingent valuation and estimates on willingness to pay:

> I think we are witnessing a growing appreciation of the aesthetic values of our landscape and people are more and more willing to pay taxes to maintain land for the sole purpose of affording pleasure and *re*-creation of mind and body so sorely needed in a modern high tension civilization.
> (Wehrwein, 1938, p. 245, italics in the original)

Such contributions seem to belong as much to the history of environmental economic thought as to that of ecological economic thought. Obviously, the valuation of recreational services became, in the post-war era, an important line of research in the emerging field of environmental economics (Banzhaf, 2017, 2019). Wehrwein nonetheless also leaned towards the other side when articulating the social and natural sciences. His 'Economist's Approach to Ecology' (1939), published in the *Journal of Forestry*, is worthy of mention in this regard.

Wehrwein asserted that economists could not by themselves solve conservation problems. They could possibly play a role through the examination of individual behaviour such as reactions to price signals. However, the natural sciences were an inescapable path to obtain a good understanding of land dynamics and to plan land use in harmony with 'physical and socio-economic laws' (1939, p. 734). He sought to create a research interface between economics and ecology: economists had to take a step towards ecologists and the latter to include economic concepts in their reasoning. Wehrwein alluded to space as an example of concept from land economics which perfectly illustrates such an interface. 'Space […] is a mere physical concept' (1941, p. 163) and, at the same time, its understanding in the context of conservation

of natural resources or wildlife depends on institutions, especially property rights. The spatial division between soil and underground resources, for instance, is a legal rather than a physical issue; it depends 'on constitutions, statutes and the courts' (1941, p. 163).

Wehrwein's invitation to merge economic and ecological approaches, most notably applied to land economics, was to him justified by the complexity of the natural environment. Agricultural areas were his primary focus, but he was aware that recreation and other services provided by nature could only be properly understood under the condition that all ecological aspects were taken into account. This was true for conservation purposes as well as for studying human interactions:

> The land economist must not only consider human institutions but also have some understanding of biotic, ecological relationships and the impact of man on his environment in so far as these affect the relationship of man to man in the efforts of men to live collectively.
>
> (Wehrwein, 1941, p. 169)

Institutionalists interested in conservation were not that much attached to such an ambitious programme for the economic discipline. Ecology was by then still a young scientific field. In any case, Wehrwein saw at a very early stage how it was crucial for designing adequate conservation policies in line with the evolution of the natural world.

## Aldo Leopold's third way between conservation and preservation

Aldo Leopold started his career as a forester drawn to conservation issues. After his arrival at the University of Wisconsin in the early 1930s, he was influenced by institutionalists and land economists, becoming close to Commons and Wehrwein (Goodwin, 2008). Leopold took an interest in economic ornithology as a useful endeavour for his work on game management (1933a, 1939, 1947b).

As a child, Leopold was already in close contact with the natural environment, joining his father in hunting incursions and being a keen observer of his surroundings. Born in 1887, he was a young man when Pinchot ascended as the leader of American environmental policy. As soon as 1904, he penned an essay on the protection of forests, noticing that 'useless destruction […] has been solved by some of the European nations, and [it] can be solved by the United States at will' (1904, p. 38). Both the subject of forests and the rhetoric of waste prevention were reminiscent of the Conservation movement. Leopold (1921) quoted Pinchot in later writings, especially when he became an employee of the Forest Service right after graduating in forestry from Yale University. He was, however, more sensitive to the diversity and complexity involved in the science of ecology than many of his conservationist

peers. J. Baird Callicott (2002) reports that Leopold may have read Frederic Clements's *Research Methods in Ecology* (1905) as an undergraduate student. His diaries contained collections of citations from a wide range of renowned figures, including Roosevelt and more contemplative observers such as Thoreau and Muir (Meine, 1988; Lorbiecki, 2016). Early on in his career, he was a man of multiple and eclectic inclinations, working at the fringes of broader debates on conservation and preservation.

Leopold (1913) shared the opinion of conservationists of the National Conservation Commission who insisted on a global rather than segmented consideration of natural resources. Forest administration would not only be responsible for woods, but also for their surroundings, including rivers and agricultural fields, and for their aesthetic dimensions. Even before land economics was instituted as a field, he had paid attention to natural areas as useful for sport and 'as a source of democratic recreation, a human source, a social asset' (1919, p. 63). The amenities of the environment, therefore, were essential to him for understanding the relationship between humans and nature.

In the 1920s, Leopold became more and more sceptical about Pinchot's principles of wise use, above all within the Forest Service. His encounter with Arthur Carhart, who also worked for the Forest Service at the time and supported a preservationist perspective in the management of natural areas, definitely contributed to his increasing awareness of environmental issues.

Leopold's writings during the 1920s were filled with systematic references to the complex articulation between species and natural landscapes as well as to the holistic dimension of nature: 'the term *irrigable land* actually represents a combination of natural resources' (1923b, p. 87, italics in the original); 'we [now] realize the indivisibility of the earth' (1923b, p. 95); and 'natural resources are interdependent' (1924a, p. 112). Yet, in the late 1920s, what occupied Leopold's mind was mainly game management. His textbook (1933a) became a classic reference in the 1930s. Traces of his early interest in Pinchot's conservationism can be found throughout the book, dealing with crops and artificial means of production with a clear focus on the economic dimensions of nature. Leopold was a hunter, which must be taken into account when trying to comprehend his ambivalent view of wildlife. On the one hand, he perceived game as a source of enjoyment with his dog and rifle. On the other hand, he considered hunting as key to his understanding of the dynamics between species and their environment (Mech, 2002). The opposition which we assume today between environmental activists and hunters was far less valid in the 1920s and 1930s. Thus, Leopold's ecological ideas need to be put into context, even though it does not preclude a critical assessment of a position which now may seem paradoxical or at least culturally determined (Mallory, 2001).

Leopold's work on game management helped him secure a position at the University of Wisconsin in 1933. He deepened his interest in ecology, given

the usefulness of its insights for game management and more broadly for understanding natural dynamics. His conviction that the holistic approach to conservation was the right path gradually found more echo in his writings, with explicit references to ecology:

> For twenty centuries and longer, all civilized thought has rested upon one basic premise: that it is the destiny of man to exploit and enslave the earth. […] During the past few decades, however, a new science called ecology has been unobtrusively spreading a film of doubt over this heretofore unchallenged "world view". Ecology tells us that no animal—not even man—can be regarded as independent of his environment. Plants, animals, men, and soil are a community of interdependent parts, an organism. No organism can survive the decadence of a member.
>
> (Leopold, 1934b, p. 209)

The tension in Leopold's thought between utilitarian and contemplative stances might point to paradoxes, ambiguities, or a tug of war between two hardly compatible positions (Hickman, 2007). This, however, comes from a retrospective bias. In the 1930s, Leopold allowed himself to simultaneously be a conservationist, hunter, game manager, ecologist, and keen observer of the beauty of nature. Nevertheless, this combination made him an atypical character, which led several scholars to assert that Leopold actually opened a *third way* between conservationism and preservationism (e.g. Meine, 1987; Vaughn and Meine, 1996; Flannery, 1998; Kellert, 2002).

Leopold himself argued that reconciling utilitarian and aesthetic values of nature was at the heart of his project: 'economic and aesthetic land uses can and must be integrated' (1935, p. 213). To do so, scientists had to broaden their views and transcend disciplinary boundaries. The purposes of conservation required 'a combination of economic, aesthetic, and biological competence' (1933a, p. 422). This notion of a third way seems to have appeared to him a few years before when he still worked at the Forest Service. Writing on recreation, he noticed 'the old conflict between preservation and use' (1921, p. 79), and considered that it was 'the fundamental function of foresters to reconcile these conflicts' (1921, p. 79). As a forester, he applied this prerogative to himself.

The combination of utilitarian and aesthetic concerns in Leopold's work finally resulted in his famous 'land ethic.' This concept rested upon an individual ecological conscience regarding the place of humans in the natural world. It consisted in establishing normative principles based on the respect for ecological balances composed of interacting species (Leopold, 1947a, 1949). The idea of a moral community was central, including humans and other biological species. Today, Leopold's land ethic remains as a source of inspiration for environmental philosophers. Leopold's thinking undeniably built a long-lasting legacy, although it must be further investigated with respect to its place in the history of ecological economic thought.

## Beyond utilitarian values

Leopold's acquaintance with economics started when he was a student at Yale. He did not attend courses in political economy, although the widespread teachings of Arthur T. Hadley might have influenced him (Goodwin, 2008). Discussions on utilitarianism and the articulation between private interests and the public good abound in Hadley's work. This certainly influenced the training of the young Leopold. Generally speaking, he held a negative opinion of economics as a discipline and as a set of practices. He felt that market-based values were the sole focus of economists at the expense of other more essential values (Snow, 1999). However, he never lost interest in economics and its instruments to formulate conservation policies. He sought instead to get rid of old economic structures, institutions, and practices which promoted the destruction of nature, and to devise new ones more in line with ecological dynamics. In his essay entitled 'Conservation Economics' (1934a), he made this point quite clear, especially in the environmental and social context of the United States:

> Our legal and economic structure was evolved on a terrain (central and western Europe) inherently more resistant to abuse than any other part of the earth's surface, and at a time when our engines for subjugating the soil were still too weak to ruin it. We have transplanted that structure to a new terrain, at least half of which is set on a hair-trigger of ecological balance. We have invented engines of unprecedented coarseness and power, and placed them freely in the hands of ignorant men. […] I assert we should be surprised, not that the pre-existing structure needs widening, but that it will serve at all.
>
> (Leopold, 1934a, p. 202)

When Leopold used the word 'economics,' he was, in fact, hardly addressing the discipline of economics, but the realm of markets and utilitarian conceptions of the natural world. The non-observance of this distinction would make his discourse often confusing regarding the role of economists in conservation policies: he denounced short-sighted and market-centred practices in land management, but not general principles such as competition, rationality, price mechanisms, and so forth.

It would be unfair nonetheless to assert that Leopold did not act himself as an economist. He did so when reflecting upon the inability of 'the free play of economic forces [to] automatically [adjust] supply to demand' in the case of game production (1930, p. 150). He also devoted time and effort to the role of incentives in influencing economic behaviour, preferring *ex ante* reinforcements than *ex post* fines and sanctions when establishing conservation policies (1933a, 1934a).

Leopold's conservation economics resonates with preoccupations of early conservationists, economic ornithologists, and land economists, sharing a

focus on the issue of valuing the services provided by nature. Leopold repeatedly wrote on what is called today the intrinsic value of nature. This approach was compatible with his land ethic insofar as extending the moral community to wildlife implied attributing innate value to other species and areas. Leopold's definition of intrinsic value was not perfectly clear, mixing non-anthropocentric (i.e. non-utilitarian) and non-anthropogenic (i.e. independent from human intervention) considerations (Banzhaf, 2019). At the same time, this ambiguity showed the flexibility of the concept of value proposed by Leopold, which moved beyond the economist's usual meaning.

At the turn of the 1920s, Leopold (1918) had already associated the valuation of a natural area, sometimes even in monetary terms, with multidimensional accounting, including the value of direct resources (e.g. wood) and of indirect recreational services (e.g. game availability). He started to expand his conception of valuation when he convinced himself that conservation of wilderness 'would not subtract even a fraction of one per cent from our economic wealth, but would preserve a fraction of what has […] been wealth to the human spirit' (1924b, p. 125). In the 1930s, in accordance with the latest developments in land economics and his exchanges with Wehrwein, he would increasingly pay more attention to the non-monetary benefits of recreation, highlighting, for example, the aesthetic and scientific values of birds (1936). He fully embraced the idea of non-economic value: 'some components of the land community are inherently of economic importance (soil, forests, water) while others cannot possibly be, except in a very indirect sense (wildflowers, songbirds, scenery, wilderness areas)' (1944, p. 316). Leopold (1946) was not thinking about methodological difficulties to value the indirect services provided by nature—these were debates which occupied the minds of land economists—but about an epistemological obstacle implying that some components of nature simply could not, for metaphysical reasons, be economically measured. Nature was, at least in part, composed of incommensurable categories. The connection with the philosophical realm of ethics was essential in this matter, as he made clear in his definition of value: 'By value, I of course mean something far broader than mere economic value; I mean value in the philosophical sense' (Leopold, 1949, p. 223).

On a more practical side of his conservation economics, Leopold insisted on the importance of qualitative determinants of value in addition to overly simplistic quantitative economic studies. This was especially true for game management. Wildlife could not be considered as a mere number of animals to be produced either naturally or artificially. Leopold (1931a, p. 158) raised this point to the rank of a 'theorem,' according to which 'the recreational value of a head of game is inverse to the artificiality of its origin.' This statement would be valid for game management and more general recreational services. Parks and other protected areas for entertainment purposes were a means to make people more sensitive to the pleasures provided by natural environments. However, attracting too many people to these areas at once made individual experience less pleasant—a natural area is not so natural

when it is overcrowded—and potentially harmful for the preservation of ecological balances (1934a, 1937).

In his famous *A Sand County Almanac and Sketches Here and There* (1949), Leopold translated this observation into a problem of 'scarcity-value' (p. 171): wilderness had some recreational value as long as it remained scarce. Interestingly, Leopold offered here quite advanced reflections on rivalry and exclusion in consumption, set forth at a time when the concept of public goods as known today was in its infancy (Desmarais-Tremblay, 2017). He argued that some components of wilderness, such as 'fresh-air' and 'change-of-scene,' could withstand 'mass-use without damage' (1949, p. 173)—we would now call them pure public goods. In contrast, components related to the above-mentioned scarcity-value were subject to rivalry constraints, as 'mass-use involves a direct dilution of the opportunity for solitude' (1949, p. 172). Leopold also had his moments as an economist.

His main criticism towards utilitarian champions was that, while focusing exclusively on monetary values, economic development opportunities would be overestimated without awareness of the true value of the protection of wilderness (1923a, 1925). Like Wehrwein, Leopold (1933a) denounced the pollution resulting from oil extraction. He regretted that his fellow citizens were then almost exclusively interested in material wealth at the expense of a sound relationship with nature.

Although Leopold constantly called for the emergence of an environmentalist conscience in line with his land ethic, he knew that in the short run economic motives were insurmountable. This is why he remained interested in incentive mechanisms for conservation policies, even though it was for him fallacious to think that, as a general rule, conservation measures could provide individual monetary profits (1944).

Leopold was a fierce critic of contemporary mainstream economic structures and thinking. His intellectual legacy as an economist nonetheless should not be limited to this. He also sketched a future in which new economic behaviour would put in practice his land ethic. He emphasised the relevance of consumption patterns and consumers' preferences. Unlike many economists, then and now, Leopold did not deem preferences as immutable (Goodwin, 2008). He thought consumers had a key role in influencing the production of goods and that it was possible to persuade these consumers to adopt more responsible actions. In an essay dealing with home building and wooden materials, he gave an example of the need for 'intelligent consumption':

> By refusing to buy white fir for the purposes for which it is suited, the average consumer unconsciously contributes to the huge waste of so-called "inferior species," and hastens the day when lumber will soar out of reach of the average citizen's pocketbook. […] The long and short of the matter is that forest conservation depends in part on intelligent consumption, as well as intelligent production of lumber.
>
> (Leopold, 1928, p. 145)

According to Leopold (1928, 1942), it would not suffice to have citizens adopting conservationist attitudes when voting or paying taxes. They had to change their habits as daily consumers. Economic laws, especially those related to price mechanisms, were difficult to circumvent, so the easiest way of implementing conservation would be to encourage consumers to include environmental criteria in their buying patterns, as they had already accepted to take into account other extra-economic motives in their choices:

> Economic laws may be permanent, but their impact reflects what people want, which in turn reflects what they know and what they are. […] some people discriminate against manufactured goods produced by child-labor or other anti-social processes. […] Social pressures have also been exerted to modify ecological processes which happened to be simple enough for people to understand—witness the very effective boycott of birdskins for millinery ornament. We need postulate only a little further advance in ecological education to visualize the application of like pressures to other conservation problems. […] Government may some day busy itself with legitimacy of labels used by land-industries to distinguish conservation products, rather than with the attempt to operate their lands for them.
>
> (Leopold, 1933b, pp. 191–192)

This quote shows how advanced was Leopold's approach to conservation economics, stressing the responsibility of consumers, education leading to sustainable behaviour, and the role of labels as signals to provide ecological information on industrial goods. At the same time, it reveals our long-run inability to effectively use demand to change our economic structures.

## Fieldwork, natural sciences, and 'ecological economics'

Leopold constantly tried to root science and expertise in real life. His colleagues saw him as a forester among engineers, preferring field experiments than lab calculations. His interest in nature was not only professional and scientific, it was also a personal practise and passionate hobby. In the 1930s, he bought a piece of land to be restored in the region of Madison, Wisconsin. It was his own experimental field and an educational tool for his children (Lannoo, 2010). Leopold's experience with the restoration of natural areas is less known than his land ethic. However, it contributed to his attachment to fieldwork at the countryside. His observation that 'a society rooted in the soil is more stable than one rooted in pavements' (1941, p. 286) certainly resulted from the feeling of fulfilment he and his family experienced during their time at the shack.

Field experimentation was not only his preferred method of investigation. It was a necessity for any robust scientific project in conservation issues. He explained that 'when it comes to actual work on the ground, the objects of conservation are never axiomatic or obvious, but always complex and usually conflicting' (1922, p. 83). The science of ecology, so useful to conservationists, needed above all direct observations. When he turned to game management and other topics in ecological research in the 1930s, his conviction was even stronger: 'experiment, not doctrine or prophecy, is the key to an American Game Policy' (1930, p. 151); 'we are getting nowhere with game management until we begin to practice it' (1931b, p. 29); and 'conservation [needs] to grow from the bottom up, instead of from the top down' (1942, p. 300). Leopold regretted that so many conservationists stayed in their offices instead of testing their proposals against reality. As a teacher, he would regularly take his students on field trips to raise their awareness of the importance of observation and reasoning when in direct contact with the natural environment—this was the best place for him to express his passion for ecology.

Leopold's ambition to conceive conservation as a bottom-up philosophy echoed his proposed incentive mechanisms to encourage private landowners to adopt ecological practices. Involving private actors in conservation issues went from the individual piece of land to aggregate results at the society level. In accordance with Wehrwein and his colleagues in land economics at the University of Wisconsin, Leopold searched for the best articulation between public land management and incentives for private landowners in the context of conservation policies. Although evocative of previous conservation concerns (e.g. Van Hise, 1910), it carried a different perspective from those of conservationists who were sceptical about the ability of private actors to promote conservation (e.g. Ise, 1926).

In the 1930s and 1940s, Leopold promoted an integrated approach to conservation, mixing economics and ecology and emphasising the holistic character of nature. This implied the development of close collaborations between academic disciplines. Leopold thus coined a few neologisms to show the necessity of adopting new integrated scientific approaches in lieu of compartmentalised bodies of knowledge. The expressions 'bio-economic laws' (1931a, p. 160) and 'biotic capital' (1939, p. 270) illustrate this undertaking.

The climax of Leopold's project to integrate economics and ecology was his unfinished plan to create a professorship of 'ecological economics' at the University of Wisconsin in the late 1940s. The analysis of his archives helped to ascertain his intention to create a truly new academic field. In late 1947, Leopold prepared a memo entitled 'Professor Ecological Economics' (reported by Lin, 2014, p. 110) addressing the administration of the University of Wisconsin. He proposed the name of William Vogt to hold the new chair, who was a renowned scholar for his work on population, resources, and industrialisation. The aim of the professorship was to have someone at that institution

able to address the 'worldwide conflict between economics and conservation (ecology)', establishing a link with 'other university departments, including especially wildlife management, geography, botany, zoology, agronomy, and engineering' (Leopold, in Lin, 2014, p. 110).

Leopold's conception of ecological economics entailed a multidisciplinary approach to the interface between economic and ecological issues. It is not usual to find such strong and clear calls for the emergence of 'ecological economics' such a long time before the institutionalisation of the field.

# Epilogue

As we reach the end of our journey into the history of ecological economic thought, some final remarks are in order. As briefly discussed in the Introduction, the beginning of the early history of modern ecological economics, a new stage in the development of such ideas, started to gradually take shape in the post-war era, followed by the institutionalisation of ecological economics as a scientific community and academic discipline in the late 1980s. From the 1950s to the 1980s, key contributions have been made in different directions and in addition to the previously cited landmark works of Boulding, Georgescu-Roegen, Daly, and Passet (Mayumi, 2001; Bobulescu, 2013; Missemer, 2013; Scott, 2015; Couix, 2019; Debref and Vivien, 2021; Ferrari, 2021; Victor, 2021). These included institutionalist perspectives (Kapp, 1950; Galbraith, 1958; see Spash, 2020b; Chirat, 2022), biological and ecological outlooks (Carson, 1968; Odum, 1971; see Hall, 1995; Røpke, 2004), and energy-based frameworks (Cottrell, 1955; Hannon, 1975; see Fischer-Kowalski, 1998), among others.

After the end of the 1980s, the creation of the International Society for Ecological Economics also meant an attempt to bring closer together a plural but rather scattered community. By doing so, its pluralism gained more normative colours and would inaugurate a protracted debate on the benefits and limits of methodological pluralism in ecological economics. Notwithstanding such discussions on the aims and subject matter of the discipline and arguments pertaining to how to foster its relevance and coherence, its sustained plural stance allowed for ample exchange with several disciplines in the natural and social sciences. In fact, akin intellectual currents and groups profited from such interactions in their own process of formation, sometimes intimately tied to the consolidation of ecological economics itself, as in the case of the emergence and spread of industrial ecology, sustainability science, political ecology, post-growth, and degrowth studies (Cleveland, 1999; Martinez-Alier, 1999; Jackson, 2009; Martinez-Alier *et al.*, 2010; Bonaiuti, 2011; Raworth, 2017; Kallis, 2018; Latouche, 2019; Parrique, 2019; Victor, 2019). Nonetheless, this same trend could be used to argue for the fragmentation of ecological economics and the ensuing appearance of subfields, according not only to emphasis—social, political, evolutionary, coevolutionary, institutional, post-Keynesian, feminist, radical, etc. (Remig, 2017)—but

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also leading to conflicting theoretical frameworks, worldviews, and policies (Spash, 2012). In this respect, ecological economists have struggled with their own position regarding agreement with the use of theories and tools developed within the framework of mainstream environmental economics.

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Looking back at our historical account, the challenge is to take stock of emerging ideas or questions cutting across chapters which are capable of inspiring further research on the many topics and tasks with which ecological economists—alongside the larger community of sustainability scholars—are faced. While an astonishing diversity of types of interconnections is undeniable, not to mention the presence of several different fields of knowledge interacting amongst themselves in different historical contexts, a few recurrent elements can be distinctly noted—even though they have not been anticipated. Embeddedness and interdisciplinarity, translated as *common ontological and epistemological conceptions of the functioning of human societies and the natural world*, were premises adopted for defining ecological economic thought and, therefore, guiding the task of content selection. The transversal, structuring topics or concerns which emerged here as more foundational or essential aspects of ecological economic thought are (i) definitions of wealth and value; (ii) proposals for reforming the prevailing economic system, especially capitalism; (iii) a surprising stance transcending views of scarcity and abundance in nature; (iv) an organicist standpoint as opposed to reductionism; and (v) questions about the form and scope of economic theory. Let us take a closer look into these structuring themes.

## Wealth and value

From Aristotle's chrematistics to the paradox of water and diamond, value and theories of value have been the focus of never-ending debates in the history of economics. Economic science has itself been to a large extent shaped by theorisation on value: doing economics would amount to defining and measuring it and vice versa. The 19th century was filled with controversies about use and exchange values as well as labour and utility theories of value. In the 20th century, leading economists continued to address the question of value, either directly (e.g. Debreu, 1959) or by more implicit ways (see Kurz, 2013). It is, therefore, not surprising to find recurrent hints to the definition and measurement of value and to theories of value themselves in the history of ecological economic thought. Interestingly, other important topics in the general history of economics, such as the rationality of economic agents, do not seem to have played the same role here.

Important figures of ecological economic thought have addressed the question of value in different ways. Many of them have wondered about the general definition of wealth, i.e. the definition of what could be considered as—and how much—valuable. From Linnaeus's depiction of the wide spectrum of natural riches to Leroux's characterisation of manure and chemical nutrients

as true wealth, many works developed an extensive conception of economic value, giving special status to natural endowments. The reference of American conservationists to the services of nature and to the existence of natural capital is another indication of the breadth of some of these conceptions.

However, not everyone tried to include natural riches in measurements of value, in particular because of challenges posed by the so-called incommensurability of values towards nature. This is the second aspect of such debates in the history of ecological economic thought. Neurath held a strong position over this matter. Popper-Lynkeus's insistence on in-kind calculation and the satisfaction of basic human needs amount to a conception of social provisioning disconnected from monetary variables and value aggregation. Early Soviet ecologists treated the economic use-values of natural resources as inputs for planning programmes instead of relying on market-based conceptualisations. In ecological economic thought, therefore, one can notice a strong claim to limit the validity of narrow economic measurements of value in the case of natural bounty. This is in line with its contemplative stance: the relationship between humans and nature cannot be solely instrumental, implying that natural riches cannot be limited to anthropocentric assessments. This acknowledgement also explains the presence of reflections upon the *intrinsic* value of nature, as illustrated by Leopold's land ethic.

The formulation of theoretical frameworks for measuring the value of ordinary goods and services constitutes another aspect of this debate. As mentioned, labour and utility theories of value have been a central development in political economy since the late 18th century. They have been used in modern ecological economics to draw lessons from history regarding the way value should be addressed in the 21st century (Douai, 2009; Harribey, 2013). In our history of ecological economic thought, there have been contrasting views on the measurement of value. Some of them, as in the case of a few 19th-century social energeticists, drew heavily from labour theories of value; others, in particular in the 20th century (e.g. land economists), were keener on the utility theory of value.

One specific trait of ecological economic thought stands in contrast with economic thought in general: the quest for integrating energy in theories of value. From German *Naturphilosophie* to early Soviet ecology, the rise of social energetics was characterised by a strong emphasis on the role of energy flows as a unit of analysis to assess economic value and think about the organisation of society. This led to the elaboration of energy theories of value, in which the value of goods and services is assessed in energy rather than monetary units. Yet, our inquiry shows that many initiatives in this direction were actually firmly based on labour theories of value. In Austro-German social energetics, for instance, Sacher, Žmavc, and others developed versions of what we call *energetic labour theories of value*. While labour remains as the ultimate source of value, it operates by means of energy conversion and according to a minimum energy productivity level that allows for energy surpluses flowing into the economy. On the other hand, energy can also be harvested directly from nature; in this case, many of these authors referred to value instead of

economic value. Moreover, the role of human-made capital in energy appropriation, as in the case of machines, was often perceived as the result of the accumulation of labour over time (including intellectual labour) and not a different source of economic value. In this sense, energetic labour theories of value can be seen as a particular category of labour theories of value, taking into account the development of thermodynamics.

Finally, a broader reflection about the idea of value can be detected in our history of ecological economic thought beyond material and natural wealth or theoretical formulations. Value as an ethical conceptualisation seems to have played a central role. Some instances are obvious, starting with Leopold's land ethic. Others also stand out, such as Leroux's and *Narodnik* formulations on social justice, and statements about human values and the dignity of human beings appearing in the context of sanitation in the writings of Chadwick, Richards, and Kyrk. Popper-Lynkeus's call for a universal right to live shares the same logic, i.e. a dignified human existence should prevail over any economic rationale. Ecological economic thought has been, therefore, more than a set of ideas on social provisioning and towards ecological sustainability. It has been sensitive to the question of human values generally speaking, as if the harmony between humans and nature had for corollary the harmony between human beings themselves.

## Social reform and capitalism

Economists do not always engage with policy or reflect upon the adequacy of economic systems as a whole. First, because they often claim to contribute to a *positive* rather than a *normative* science; second, because they do not want to be trapped in policy debates which are out of their control. Be that as it may, supposedly positive contents of economic theories also entail underlying normative contents (Hands, 2012). In addition, as well documented by sociologists of science, the extent of the connection between economists and politicians differs according to contexts (Fourcade, 2009).

This was not the case here. Authors were open and eager to engage with normative proposals and policy recommendations. Many of them came to their conclusions with the intention to apply knowledge for the sake of improving social provisioning processes, modes of social organisation, and particularly the prevailing economic system at a given time. These attempts were based on normative aspects involving resource distribution, social ideals, and policymaking frequently associated with utopian stances. The Austrian, German, and Russian traditions presented here attest to that. However, their utopian character relates not so much to the feasibility of the proposals, but to their idealist stance. This acknowledgement is certainly to be understood in the larger context of scientific development within Enlightenment and subsequent reactions to it, which by the 19th century had culminated in the common practice of applying science to practical matters. This was the case not only of technological progress for solving immediate problems of a rather technical nature, but also for concrete questions bearing an ethical content,

such as social, political, and economic affairs. In this respect, ethics was usually deemed as complementary to science in the process of formulating rational alternatives to the shortcomings of the current social and economic system. Together, ethics and science were capable of improving well-being at the individual and collective levels. This assumption stretched to different spheres of social and economic life, from promoting education as crucial for human development (as in the home economics movement) to adopting a wider scientific worldview conducive to prosperity both as material wealth and welfare as a moral end in itself (as in the Other Austrian Economics).

The realisation of the potential of science for changing reality seems to have been even more pronounced for those combining at first disparate findings related to apparently unconnected phenomena. While every chapter offered examples of that in the case of political economy, some go further as depicting instances in which foundational aspects of the economic system are challenged, with propositions for its reform always at hand as a result of this broader, more integrative view of the economy. This is clear, for example, for Chernyshevsky, Richards, or Sacher. The Western industrial capitalist system was thus assessed in detail by such thinkers and made subject of transformation towards socially or environmentally superior alternatives, including other possible versions of itself, according to their self-appraisals as conveyors of objective, scientifically grounded views.

There were varying levels of criticism in this regard, from the more specific incursions of Chaptal, Chadwick, and American conservationists to the more encompassing reform proposals of *Narodnik* thinkers and some German-speaking social energeticists. Moreover, the deep entanglement of social and environmental concerns is strikingly clear and occasionally handled as symptoms bearing the same causes to be found in industrialism and capitalism. Yet, most of them did not mean to overthrow the social and economic order, holding on to the belief that a rational, scientific take, even if laden by values which can themselves be objectively assessed, could achieve the end result of a better way to provide for humans while conserving nature. Here, the boundaries between reform and revolution, i.e. a reconceptualisation of the foundations of the economic system, were often blurred.

Furthermore, these critiques and propositions are not to be examined as a continuum between ideological capitalist and socialist stances, even if it might at times make it easier to qualify or classify them. There is too much nuance and this simplification would cost dearly in terms of historiographical understanding. For example, Leroux did not consider himself a socialist, despite his fierce reproach to the capitalist system (and even though he is allegedly who coined the word 'socialism' in French); Leopold challenged affluence as a social phenomenon, but did not take an issue with capitalism as a whole.

## Beyond scarcity and abundance

The question of scarcity lies at the core of the science of economics. When Lionel Robbins (1932, p. 15) identified economics as 'the science which studies

human behaviour as a relationship between ends and scarce means which have alternative uses,' he paved the way for applications of the economic rationale in domains beyond the production, consumption, and distribution of goods and services. Long before that, scarcity had already drawn the attention of economists because of the limited character of resources available for economic activity—land for the Classics and capital in 20th-century scholarship.

Mirroring scarcity, abundance has likewise been a Holy Grail for economists, from Adam Smith's *Inquiry into the Nature and Causes of the Wealth of Nations* (1776) to the unfettered promotion of economic growth after the Second World War. The 20th century has shown the dark side of affluent modern societies, from social inequality and the alienating effects of mass consumption to the environmental damages engendered by the predation of nature and the generation of waste. Scarcity and abundance thus seem to have been two sides of the same coin—the pursuit of economic goals.

Regarding natural resources and the environment, the diptych scarcity-abundance has manifested itself in the form of continuous debates framed according to the myths of Cassandra and Cornucopia. Nature's parsimony has often caused fear, from Malthus's early 19th-century population principle and W. Stanley Jevons's coal question (1865) to the *Limits to Growth* report (1972). Others have preferred to believe in an unlimited, freely available nature ready to provide all the resources needed and to receive all waste. The roots of this intellectual current go back as far as the 18th century (Albritton Jonsson, 2014). We can trace its evolution until today, starting with the exclusion of most of the components of nature from the field of economics by Jean-Baptiste Say—'natural riches are inexhaustible […]. As we cannot multiply nor deplete them, they are not part of economic science' (1828, vol. 1, p. 137)—all the way into the 1970s and growth theorists' deep trust in technical progress as a means to bypass resource scarcity in the long run.

In the face of this dual approach to nature's contributions to the economy, either as a limiting factor or as a reservoir of opportunities, one would intuitively situate ecological economic thought in the first camp. Today's ecological economists acknowledge the existence of 'planetary boundaries' (Rockström *et al.*, 2009) as a ceiling on economic activity. The notion of sustainability itself entails limits: a sustainable path of development is one that is constrained by social imperatives and biophysical limits.

Surprising as it may be, however, the diagnosis that emerges from the exploration of three centuries of ecological economic thought is not one-sided. Expressions of concern about the limits of nature tie back to calls for moderation regarding the balances between incomes and expenditures in Goethe or the advocacy of conservationists for the wise use of resources, in particular exhaustible ones and associated issues of intergenerational justice. Leopold insisted on the fragility of ecosystems and the disturbing forces of human beings. Yet, many thinkers espoused views of nature as bountiful. Physiocrats in the 18th century insisted on the role of agriculture in the economy because of the exceptional fertility of the soil. Chaptal saw opportunities for economic

advancement in chemical processes. Leroux considered the generosity of nature as a cornerstone of his economic theory and social reforms, devoting his best efforts to counter Malthus's stance. *Narodnik* thinkers searched for inspiration in the wealth of nature to design their utopian futures.

As a result, the history of ecological economic thought cannot be well read through this dichotomy. Contributors to the field have implicitly opened a *third way* between Malthus's dismal science and naive cornucopianism. The anthropomorphic concept of 'generosity of nature,' which implies the conditioning of provisioning for humans to respect and care for the natural environment, may be a good way of qualifying their worldviews. In economic terms, it is not that far from a transactional conception of nature, i.e. getting more from her if we do not overplay our hand. Harmony with nature, as harmony within society, is not a matter of scarcity or abundance, but rather of mutual respect.

## Levels of reductionism

The integrative approach which has been ascertained here as a foundation of ecological economic thought as well as its epistemological implications, namely the attainment of a general understanding of the relationship between humans and nature, seems to give rise to a holistic trend in views of the economy as an organism, irreducible to its parts. Typical of process-oriented philosophies of science (e.g. in Mach and Bogdanov) and bodies of knowledge such as ecology and physiology, it circles back to questions of embeddedness and emergence. The *ex post* recognition of low levels of reductionism in ecological economic thought might seem like circular reasoning, being to a certain extent entailed in or emanating from its definition. However, the links are neither straightforward nor linear. Reductionism can take different forms as we overlook emerging properties of complex systems. It can be, for example, mechanicist, energetic, or even biological (e.g. social Darwinism or Spencerism). It might not relate to natural science at all, but rather to a determinate conceptualisation within the social sciences, as, for instance, how mainstream economics portrays human behaviour according to a partial and highly simplified, fixed, model-friendly set of premises based on given preferences and utility maximisation.

The apparent anti-Cartesian embrace of complexity and allowance for multilevel emergence in natural, social, and economic processes, which can be perceived as an underlying trait of ecological economic thought, is easily detectable in several chapters. From Goethe to Chernyshevsky, Neurath and Leopold, it was at times an outright statement. On other occasions, it surfaced more and less implicitly in the frameworks of German social energeticists inspired by the German Historical School and their view of the economy as an organism; in the home economics movement and the focus on the household as a unit of analysis for the life sciences as well as for the economics of consumption; and in the approach of Soviet scholars to community ecology as the scientific basis of a rational process of economic planning.

However, there have also been instances when reductionism has shown its teeth. The increasing emphasis given to energy along the 19th century, as the laws of thermodynamics established themselves in academic circles across the board, motivated accounts in which energy flows and stocks constituted the cornerstone of whole systems of political economy, as could be so evidently witnessed in the works of Sacher and contributors to Ostwald's *Annalen*. Nonetheless, as has been mentioned, there was a high level of diversity in this regard, with more elaborate constructions acknowledging emergence and qualitative processes in social systems, not to mention some cases (e.g. Neurath) in which energy was overtly avoided as a universal unit of analysis and calculation in favour of a more sophisticated and sensible stance taking the issue of incommensurability into account.

Different levels of reductionism are, therefore, presented here as a question worth asking as a means to inform one's understanding of what ecological economic thought is and how it has been developed in history. In general, an organicist, comprehensive view of what were undoubtedly complex, integrated phenomena prevailed, from early takes on the economy of nature to ecologically sound economic planning programmes in Soviet ecology and institutionalist perspectives in American land economics. This observation gains even more meaning when we recall that ecological economic thought is associated with a biophysical approach to economic science in contrast with those allegedly more firmly grounded in human subjectivity. Attempting to do so and averting the pitfalls of reductionism is no small feat.

## Economic theory

The discussion over reductionism in the history of ecological economic thought spurs a whole series of more specific questions about how these thinkers related to economic theory from a methodological standpoint, which were not always explicitly summarised, but rather scattered around their argumentation. Generally speaking, many scholars belonging to the history of ecological economic thought criticised mainstream economics for neglecting the idiosyncrasies of nature or for reading natural laws in an inaccurate or partial way. Leroux made sharp statements against the Classics, contesting their claims on the restrictions imposed by natural endowments as an explanation for poverty; capitalist institutions would, in fact, be responsible for this. *Narodnik* thinkers were opposed to agrarian reforms inspired by Western agricultural productivism. Promoters of social energetics resented the fact that most established subfields of economics ignored the tenets of thermodynamics. Veblen said the same regarding evolutionary biology.

More precisely, two main criticisms seem to have emerged along the course of this history. First, towards abstract, deductive, sometimes too mechanistic theoretical frameworks. Popper-Lynkeus, for instance, made it clear how these approaches to value and labour were futile to solve practical social and economic issues. Leopold was sceptical about reductive theories isolating microeconomic issues as opposed to the ability of systemic approaches to account

for the complexity of the world. The whole institutionalist trend, from Veblen to home and land economics, was also anti-reductionist in terms of economic theory, using institutions rather than individuals as unit of economic analysis.

Conversely, theoretical approaches making use of mathematical formalism were not systematically rejected (e.g. in early Soviet ecology or land economics). It would otherwise have been somewhat contradictory as most thinkers were inspired by natural scientists—many of them were natural scientists themselves—who were comfortable with such tools. In any case, mathematics probably appealed less to them than to mainstream economists.

Second, a frequent questioning of the standard assumptions of economic theory, both in terms of human behaviour and market mechanisms. The allegory of *homo œconomicus* as depicting the rationality of economic agents has been largely contested in the history of ecological economic thought, from Chadwick's call for paternalistic sanitary policies to Veblen's and Kyrk's insistence on the role of instincts in human behaviour. Likewise, what was then perceived as an economic law was challenged in the context of conservation: Wehrwein explicitly argued that Smith's invisible hand could be an interesting principle in general but not applicable to environmental issues. Leroux's statement against the capitalist economy, the stance of Soviet ecologists in relation to planning, or Sacher's disapproval of rent and profit were hints towards the need for undermining the primacy of market mechanisms in economics. It should be noted, however, that markets retained some roles in most of such accounts.

There is one final structuring theoretical point which transcended several contributions, namely the distinction between needs and preferences. In economics, at least since the marginalist revolution beginning in the 1870s, it is usually assumed that all demands or end uses are legitimate; basic human needs are merged with individual preferences, the latter being treated as given. What precedes the arrival of economic agents on the market place (education, formation of preferences, psychological proclivities, etc.) remains out of the scope of economic theory. In ecological economic thought, there is a different take. Special attention has been paid to education and the formation of preferences (e.g. in Chernyshevsky, Richards, Kyrk, and Leopold). Physiological needs were seen as distinguishable from economic preferences. While needs relate to processes of securing energy and matter as required to lead a decent life, preferences involve a mix of cultural interests, including demands for luxuries. The definition of needs can be guided by social aspects, as argued by Popper-Lynkeus or Kyrk; however, they seem to be more closely related to basic physiological requirements in terms of energy and material flows (food, shelter, clothing, etc.), while preferences are more subjectively determined, even though they often imply larger amounts of energy and material consumption.

The lesson to be learned from this distinction concerning sustainability challenges—some progress has already been made in this direction (e.g. Vatn, 2005)—is that needs and preferences should not to be treated in the same way in economic analysis: the satisfaction of needs amounts to a social imperative, while preferences should be regulated according to their levels of consumption

of resources or waste generation. Again, the definition of needs can be socially grounded, i.e. not limited to basic physiological needs. The idea is not to produce a fixed list of needs; the distinction should be the subject of collective, democratic deliberation. In an ecological economic thought perspective, economists should not, however, hide behind consumer sovereignty to refuse any discussion on the formation of preferences or the prioritisation of needs. Faced with a generous nature, not all preferences are equal, and *ex ante* education is just as important as *ex post* incentives in driving economic behaviour.

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Having presented our five structuring themes, we arrive at a quite comprehensive view of what characterised ecological economic thought throughout history. It is noteworthy to realise that these subjects are also present in current debates within ecological economics. Critiques of basic assumptions underlying mainstream environmental economics, such as time consistency or the efficiency of markets, endure to this day. The same goes for reproaches against reductionism and instrumental values often leading to money-based approaches to valuing nature. In these respects, ecological economics does appear as the continuation of a long-run history of ecological economic thought.

Other topics seem less central in contemporary ecological economics. Systemic reflections upon capitalism exist but are not widespread, especially in the applied literature. Ecological economists seem often caught in the scarcity versus abundance debate, oblivious to the possibility of a third way opened up by former thinkers and leading to a conception of a 'generous nature.' Insisting on scarcity and natural limits is not the only response to advocates for a technology-based cornucopian view of nature. Finally, the distinction between needs and preferences opens up crucial research avenues today. While economics generally neglects the formation of preferences—or adopts partial views stemming from psychology—and disavows the prioritisation of needs, there is plenty of room for ecological economists to collectively embrace such a promising research lead.

Almost two centuries after Thomas Cole painted *The Oxbow*, we are living in a world that is very different from that of the beginning of the 19th century. The natural environment is now fully transformed by human activity—there is virtually no more pristine nature—and actual or upcoming threats are manifold, from climate change to biodiversity loss, pollution, and resource depletion. We are no longer sitting on the left-hand side of the painting, where Cole placed himself, gazing at the advancement of civilisation and domestication of nature. Surrounded by an overly domesticated nature, we are now sitting on the right-hand side of the painting, looking in the opposite direction, trying to regain a contemplative view of nature. However, what we seek is not paradise lost in exchange for civilisation. We aspire a future of generosity in which we can live and let nature live. With so much to draw from the history of ecological economic thought, this is clearly not uncharted territory.

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