



Conservation, economic planning and natural capital in early Soviet ecology

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ABSTRACT

The advancements in ecological science and policies for conservation proposed by Soviet thinkers of the 1920s/1930s are the result of pioneering research on community ecology, i.e. the study of the relations between living organisms and between them and their non-living environment. The creation of large natural reserves for scientific research – the *zapovedniki* – put in practice an unprecedented nature conservation plan, based on the theoretical framework of community ecology and resulting in policy recommendations on what would be an ecologically acceptable economic planning programme. Bearing these elements in mind, the paper aims to unveil the intellectual contributions of early Soviet ecology, particularly in relation to their quest toward conservationist economic planning programmes and the associated notions of natural capital and ecosystem services.

1. Introduction

The Soviet political emphasis on industrial production, the turbulent and often opposed views between Bolsheviks and nature conservationists, and the alleged frustrated dialog between Marxism and ecological economics (Burkett, 2009) are factors that could explain a misguided historical view in Western countries which assumes that there is little to learn from Soviet history to the progress of ecological thought. However, advancements in ecological science and policies for conservation proposed by Soviet thinkers in the 1920s and 1930s were ground-breaking, especially given their attempts to influence economic policies. The link between ecology and economics forged by such thinkers is in synch with the concept of ecological economic thought, a body of knowledge based on the analysis of the flows and stocks of energy and matter, and their implications for the processes of social provisioning and cultural development (Franco, 2018).

Soviet ecological science can be divided into three distinct, consecutive phases throughout the 20th century: early, middle and late Soviet ecology (Foster, 2015). The first phase, early Soviet ecology, stretches from the 1917 revolution up to the tightening of Stalin's control over Soviet science in the mid-1930s. Soviet studies on the intertwining between ecology and economics during the 1920s and 1930s were part of a wider effort of the People's Commissariat for Education – *Narkompros* – under the leadership of Bolshevik Anatolii Lunacharskii (1875–1933), with Lenin's support, to foster culture and science in

Soviet Russia. The knowledge produced during this period focused on theory and application of community ecology. It was by far unmatched by similar developments in Western countries (Batou, 1992; Gare, 2002; Weiner, 1988). The creation of large natural reserves for scientific research – the *zapovedniki* – put in practice an unprecedented nature conservation plan and promoted the theoretical advancement of ecology, including policy recommendations in terms of an ecologically sound (i.e., conservationist) economic planning programme.²

The rise of Stalin's repressive state meant a drastic change in the course of Soviet ecology. This led either to the elimination or ostracizing of many of the leading ecologists who disagreed with Trofim Lysenko (1898–1976), a dominant figure in Soviet biology until the late 1950s, who dismissed studies on community ecology in favor of a more utilitarian approach to the management of Soviet natural resources (Gare, 2002). The power of Lysenko to enforce theory and policy on environmental issues, accompanied by rapid industrialization rates fostered by the material demands of the Second World War and the ensuing Cold War, would lead to the widespread Western view of the USSR as a foe of the environment. According to Batou (1992), the political offensive against the “bourgeois” ecologists intensified during the first 5-year plan, as they denounced the environmental havoc and ensuing famine caused by excessive agricultural production targets, unbridled mechanization and collectivization of farms, and standardization of previously diverse ecological systems. By the end of the 1930s, Soviet community ecology waned even as a scientific discipline.

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² By 1927, the total protected area in the Soviet Union (including *zapovedniki* and other types of reserves, such as gaming preserves, the *zakazniki*, and “monuments of nature”, *pamiatniki prirody*) totaled almost seven million hectares (Weiner, 1982, p.48).

In the second half of the 20th century, anthropogenic impacts over increasingly larger natural processes became more apparent, with unexpected and non-linear effects over the stability of ecosystems. In consequence, the focus of the so-called late Soviet ecology turned to interdisciplinary studies which sought to explain or predict world-scale phenomena in terms of the interactions between living organisms and the environment, as well as to make recommendations on how humans could best preserve or improve the environment for their own benefit. [Budyko \(1980\)](#) acknowledges how this late Soviet ecology, wary of global environmental perils, was only possible due to scientific breakthroughs that took place in the first three decades of the 20th century.³

Early Soviet ecology did not only make possible the development of late Soviet ecology, but also gave a lasting contribution to ecological science as a whole. However, the role of early Soviet ecology has not been properly acknowledged by ecological economists. [Martinez-Alier \(1987\)](#) is one of the few to have praised early Soviet ecologists as innovative contributors to the development of an ecological economic thought.

A closer look into the conceptual initiatives of early Soviet ecologists also reveals additional insights deemed relevant for ongoing academic debates among ecological and environmental economists. For example, the central role played by the concepts of natural productive forces and biocenosis in early Soviet ecology is quite telling. What did they mean when applying these terms to the process of economic policy formulation? How do these terms respectively compare to the currently widespread concepts of natural capital and ecosystem services in an economic sense? Answering these questions might help to better understand, in retrospection, the ecological economic thought of early Soviet ecologists, as well as to put into perspective the present meaning of the latter two terms.

[Åkerman \(2003\)](#) investigated how the introduction of the concept of natural capital in the 1980s, acknowledged as a powerful metaphor, was appropriated by the discourses of different disciplinary traditions, each one aiming to consolidate a worldview or steer research priorities related to a growing demand for policies that would lead to sustainable development in a broad sense. The neoclassical interpretation of the concept, championed by [Pearce \(1988\)](#), would be of a “stock of natural assets serving economic functions” ([Åkerman, 2003, p. 434](#)). Although Pearce's objective was to increase environmental concern among mainstream economists, fostering new theories and methods that truly account for nature's particularities, the term natural capital legitimized nature as an abstract economic category, paving the way to narrow monetary valuations of the environment.

Within ecological economics, the term has been intensively debated and disputed in the last thirty years, although a more common view of natural capital would refer to the set of ecosystemic elements which allow for flows of energy and matter which, in turn, enable social provisioning processes by means of ecosystem services and availability of natural resources (e.g., [Costanza, 1991](#)). Natural capital would be more accurately characterized in a relationship of complementarity – as opposed to substitutability – to other types of capital. A biophysical limit to economic activity would be given by the need to maintain these ecosystemic elements functioning at a minimum level. However, ecological economists themselves still do not agree on the policy implications of such a view of natural capital, with the use of monetary valuation and cost-benefit analysis being a key point of dissent among them. [Åkerman \(2003, p. 439\)](#) distinguishes and counters two main approaches to the meaning of natural capital: the “financial asset” and “ecosystem” interpretations, respectively of neoclassical and ecological economists.

[Missemer \(2018\)](#) performed a meticulous search of the concept of

natural capital in the history of economic ideas, going back as far as the 18th century. His research aimed to find appearances of the expression “natural capital” whose meaning corresponded to either the “financial asset” or “ecosystem” version of the concept. His findings suggest that the first author to use the term bearing a similar meaning as intended by Pearce – as a set of productive environmental assets – was Alvin S. Johnson (1874–1971), an American economist working in the beginning of the 20th century. Hence, he would have been a precursor of the “financial asset” approach to the concept of natural capital.

Bearing these elements in mind, this paper is divided into the following sections, which aim to unveil the intellectual contributions of early Soviet ecology, particularly in relation to their quest toward conservationist economic planning programmes and the associated notions of natural capital and ecosystem services. Firstly, the different currents of Soviet ecological thought present by the time of the Russian Revolution are presented. In [Section 3](#), the link between conservationism and economic planning in the works of early Soviet ecologists is contemplated. [Section 4](#) addresses early notions related to the concepts of natural capital and ecosystem services in early Soviet ecology. [Section 5](#) brings some final remarks.

2. Currents of Soviet ecological thought in 1917

[Weiner \(1988\)](#) identified three main groups within Soviet ecological thought by the time of the 1917 revolution: the nihilists, neo-romantic conservationists and rationalist romantics. The nihilists valued nature according to its potential for economic use and, therefore, conservation was to be guided by the maximization of material gains to humans. The idea of acclimatizing species for practical purposes matched the interest of Russian scientists of the time for empirical research with direct implications for social life. The modernization of agriculture as means to an increased grain output was one of the top priorities among Russian policy makers. Thus, acclimatization quickly became a priority for nihilist ecologists such as [Dimitrii Solovov \(1886–1931\)](#) and [Boris Zhitkov \(1872–1943\)](#).

The second group opposed such a utilitarian view of nature. The neo-romantic conservationists were anti-industry, anti-modernization, and acknowledged the intrinsic value of nature and the rights of non-human living organisms. According to them, industrial society was interfering with nature's harmony, resulting in a disequilibrium that would, in turn, negatively affect cultural development. Without nature's inspiration, man would be doomed to a life devoid of meaning. Neo-romantic conservationists were undoubtedly influenced by German idealism and American transcendentalism, although their ideas were also founded on more traditional elements of Russian culture, and even on the notion of patriotic duty. Their most prominent representatives were [Andrei Semenov-Tian-Shanskii \(1866–1942\)](#) and [Ivan Borodin \(1847–1930\)](#).

The third current of Russian ecological thought stood in middle ground between nihilists and neo-romantic conservationists. Their views entailed anti-mechanistic, rationalist, and romantic elements, which together would lead to the formation of an intellectual movement that is here referred to as early Soviet ecology. Their aim was the long-term protection and study of integral ecological communities, incorporated in natural reserves. Research based on observations of the *zapovedniki* would allow scientists to improve ecological science and, consequently, recommend appropriate economic uses of natural resources according to the ecological carrying capacity of a specific area or community ([Weiner, 1988](#)). Like the nihilists, they favored a scientific approach to environmental issues, and many of them had been practicing acclimatization for decades. Concurrently, like the neo-romantic conservationists, they appreciated the value and complexity of the natural world, rejecting a purely utilitarian and deterministic worldview. Nature was a model to emulate due to its harmony and efficiency, not something to be conquered and altered according to man's self-interest. On the contrary, humans needed to respect nature's

³ Mikhail Budyko (1920–2001) was himself a renowned figure of late Soviet ecology. His energetic accounting of the Earth's surface granted him the Lenin Prize.

grand feats and care for the environment for their own sake.

According to [Weiner \(1982\)](#), early Soviet ecologists had been, up to the appearance of community ecology, nihilists themselves. Originally, the idea of acclimatization had a conservationist element, as it promised to make the use of natural resources more efficient, thereby preventing the irrational use of plant and animal stocks. As the levels of Russian biodiversity deteriorated throughout the late 19th and early 20th centuries, with declining populations of plants and animals, the nihilist and conservationist agendas seemed sufficiently divergent to cause a spat and the consequent flourishing of community ecology.

Within the academic arena of ecological science, early Soviet ecology was marked by new goals, methods, and contents. Its focus on community ecology had little in common with pre-war Russian ecological studies. According to [Carpenter \(1939, p. 355\)](#), “the development of the community concept [in ecology] has everywhere been largely post-war”. 19th-century ecological studies in Russia were mainly botanical. By the turn of the century, plant ecology studies flourished, as the Ministry of Agriculture commissioned surveys to support the planned emigration of peasants to Siberia and the Far East. A more profuse number of publications on animal ecology would only appear in the 1910s, in response to the locust problem faced by Russian agriculture at the time. Previous works were often restricted to autecology, which focused on the interactions of individual organisms with their environment rather than on interconnected biotic communities. Community ecology, synecology, or biocenology, the latter being the word of choice of most Russian authors (*biotsenologiya*), were often used as synonyms to describe this burgeoning field of ecological science in the 1920s and 1930s.

The term [community ecology] is not used in the restricted sense of studies of whole communities only, but to cover various aspects of synecology: the dynamics, structure, organization and functioning of biotic communities or parts of them, the interactions of the constituent species among themselves and with the habitat, and methods for their investigation ([Carpenter, 1939, p. 354](#)).

Studies in community ecology boomed during the 1920s, in its nihilist and rationalist-romantic variants. The content of the latter progressively shifted from acclimatization to the necessity of conservation. Their purpose was to understand the interconnections present in biotic communities, as well as its practical implications in terms of ecologically sound economic planning programmes. The number of ecologists interested in the rationalist-romantic approach to community ecology grew steadily under the auspices of *Narkompros*. Prominent scholarly figures included Vladimir Vernadskii (1863–1945), Vladimir Sukachev (1880–1967), Grigorii Kozhevnikov (1866–1933), Vladimir Stanchinskii (1882–1942), and Daniil Kashkarov (1878–1941). [Carpenter \(1939\)](#) listed 517 noteworthy Soviet publications on the theory and method of community ecology between 1917 and 1937, not to mention the “very large literature on special economic biological and epidemiological problems” (p. 367).

Early Soviet ecologists combined empirical methods and their objective results with a conservationist worldview that opposed the Promethean attitude of the nihilists. Their rationalist-romantic approach argued in favor of the existence of biophysical boundaries to economic activity, which needed to be taken into account for the sake of development itself. They believed ecology would be instrumental for a successful economic planning programme in revolutionary Russia.

Soviet ecological thought, 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 nature conservation, Marxism would be a topic of dissent between nihilists and rationalist romantics. Georgii Plekhanov (1856–1918), 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. Contrarily to Plekhanov,

the so-called left-wing Marxists favored the anti-mechanistic science of the rationalist romantics, providing political and financial support for their research. Anatolii Lunacharskii and Aleksandr Bogdanov (1873–1928) were among the most important left-wing Marxist figures in terms of intellectual and political power during the 1920s. They argued for a democratic social reality in which a new culture – *Proletkult* – would emancipate from the degenerate social norms tied to capitalism. They viewed nature as a live and integrated organism, with self-organizing properties, attributes that would also be valid for the proletariat. Hence, people would have the ability to organize themselves democratically and effectuate a revolutionary transition into communism ([Gare, 2002](#)).

Within the confines of economic thought, [Barnett \(2005\)](#) divides Russian revisionist Marxism into two main currents. Neo-Kantian revisionists, such as Mikhail Tugan-Baranovskii (1865–1919) and Petr Struve (1870–1944), strived to develop an ethics-based economic methodology in which moral issues were of universal significance and, therefore, irreducible to class interests. Conversely, Nietzschean or Machist revisionists, led by Lunacharskii and Bogdanov, attempted to describe social phenomena based on the scientific method of the natural sciences, which would be itself conditioned by subjective social relations. They opposed Kantian aprioristic idealism in favor of the role of experience in processes of knowledge construction; nevertheless, it would be impossible to make objective statements about reality through human sensory lenses. It would only be possible to “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 relates to his efforts to combine elements from dialectical materialism and Mach's empiriocriticism ([Jensen, 1944](#)). He argued against Mach's separation between mental and natural complexes, as it hindered the formation of an “adequate notion of causality as the explanatory connection between various elements of experience” ([Boll, 1981, p. 45](#)). Interconnections among the mental and physical complexes, mediated by man's social nature and described by means of causal relations in a historical setting, would correspond to the unending “practical interaction of man and nature” ([Boll, 1981, p. 47](#)).

[Bogdanov \(2016 \[1923\], p.182\)](#) viewed dialectics as an “organising process, occurring through the struggle of opposing tendencies.” Energy transformations would be the underlying element of changing and interconnecting mental and physical complexes, even though he acknowledges the possibility of emergent properties of purely social character (e.g. knowledge attainment) which require more complex levels of organizational forms. Hence, Bogdanov stressed the epistemological importance of organizational aspects of experience. His universal science of organization, Tektology, was part of the onset of the development of cybernetics, general systems theory and praxeology ([Gare, 1994, 2000a,b](#)). It takes into consideration the prowess of self-organizing natural and social systems, a resistance or countertendency to the unescapable disorganizing principle imposed by the entropy law. Organizational complexes are described in terms of their interdependencies, interlinkages, stability, plasticity, and boundaries; technological mechanisms act upon or regulate them through a selection process that determines which complexes will be preserved, transformed or destructed.

Bogdanov's philosophy was meant to be the foundation of a new culture and science in which nature is acknowledged as comprised of self-organizing activities with their own significance and diversity. His predictions of future scientific and social developments entailed a genuine concern related to the natural limits of economic growth. The rationalist-romantic stance of Bogdanov, thus, justifies the claim that he “offered the basic philosophical direction required for the conservationists to flourish” ([Gare, 1994, p. 69](#)). Moreover, if the philosophical foundations of early Soviet ecology were given by Bogdanov, Lunacharskii, Bogdanov's brother-in-law, was the main 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*, Lunacharskii not only provided the political support for the creation of the *zapovedniki*, but also for the development of the pioneering ideas of rationalist-romantic ecologists, even if, by the late 1930s, the careers of most of them were cut short by Stalin's purges.

3. Economic planning and conservationism

The 1920s witnessed a surge in economic theory, especially in relation to the agricultural sector, non-monetary accounting and economic planning programmes. Even if the Bolshevik ascension to power did not entail an immediate replacement of the economic system, the debate on economic ideas would extend from the period of War Communism well into the late 1920s, during the deployment of the New Economic Policy.

Despite the Bolshevik emphasis on the social and economic possibilities of a state-run, collectively owned industrial sector, the agricultural development was the most important Soviet economic issue during the 1920s. Feeding a growing population was a constant challenge, which spurred innovative contributions to agricultural economics.

"Together with agriculture, planning was the other 'great theme' of the decade" (Barnett, 2005, p. 106). Given the theoretical possibilities created by non-market forms of social control, Soviet economists pursued more original approaches to state planning. *Gosplan*, the State Planning Committee, opted for a comprehensive, imperative planning programme led by left-wing Marxist Vladimir Groman (1874–1940), who proposed methods of numerical calculation of industrial production indicators and agricultural yields in the form of raw material balances (Barnett, 2005). Nevertheless, "in the late twenties, planning of the national economy implemented through compulsion replaced planning by methods which, with certain exceptions, would have been acceptable in democratic countries" (Jasny, 1954, p. 54).

This was the setting in which early Soviet ecologists attempted to contribute to the specific, although highly controversial and relevant, issue of the economic planning of the agricultural sector. Either during War Communism or during the transition into the New Economic Policy, the political conjuncture meant that environmental concerns would not become a state priority; supporting the creation of the *zapovedniki* was one thing, conditioning economic goals to ecological constraints was a whole different subject. Additionally, intense disputes in the academic scene between competing economic theories over policymaking forced the ecological economic approach to the fringes. Yet, despite all the political and academic barriers that prevented the implementation of a conservationist economic planning programme, the recommendations of early Soviet ecologists on economic policy undoubtedly figured as extremely original.

3.1. Early Soviet ecologists as conservationist economic planners

The technical challenges faced by agricultural producers were tackled by natural scientists working for the People's Commissariat for Agriculture – *Narkomzem* – in response to political pressures to improve land productivity. Barnett (2005) mentions at least four different currents of Soviet agricultural economics in the 1920s, which strongly disagreed on the economic advantages brought by modernizing agricultural entrepreneurs.⁴ Nikolai Dimitrievich Kondratiev (1892–1938) studied agricultural markets and their impacts over farmers' decisions. The group led by Marxist agrarianist Lev Natanovich Kritsman

(1890–1938) stressed the role of class structure in rural areas, taking into account the roles of wage labor and landowners. The organization-production school of Aleksandr Vasilevich Chaianov (1888–1937), Nikolai Pavlovich Makarov (1887–1980) and Aleksandr Nikolaevich Chelintsev (1874–1962) proposed a behavioral analysis of peasant farms, interpreted as households in which production was determined by the balance between consumption and the correspondent amount of toil. Right-wing agrarianist Lev Nikolaevich Litoshenko (1886–1943) opposed the organization-production school, arguing that, in a modern monetary economy, households composed by peasant farms would maximize the difference between earnings and expenditures, denying the labor-consumer balance suggested by Chaianov.

Conversely, early Soviet ecologists were mainly working for *Narkompros* – whence public funding became available for the creation of scientific committees, expeditions, and the actual preservation initiatives – and a political dispute ensued between these organizations over control of the *zapovedniki*, despite the fact that there was hardly any intellectual interaction between ecologists and agricultural economists. While *Narkompros* resisted, the reserves were protected and proved to be instrumental for the advancement of community ecology, which included ecological methods for controlling the locust problem and other plagues, censitary data on species, warnings on diminishing populations of plants and animals with economic value, and analyses on the productivity of forests, pastures, lakes, and seas (Carpenter, 1939).

Thus, the role of community ecologists as economic planners started with their empirical research on the dynamic of the biocenoses of the *zapovedniki*, which they believed could lead to the formation of a body of knowledge capable of recommending ecologically sound economic planning programmes. The *zapovedniki* would serve as standards of biological communities in natural harmony, resulting from hundreds of years of environmental adaptation. Hence, comparative ecological studies would be able to assess how disruptive was human-induced change in analogous tracts of land, as well as to restore them.

Early Soviet ecologists believed there were empirically quantifiable limits to how much economic activity could draw from each biocenosis. Overshooting such limits would lead to the disruption of the biocenosis and, consequently, of the flows of natural resources necessary for economic activity. Therefore, they deemed conservation as a practice that favored the maintenance of the provisioning systems which ultimately enabled cultural development. In this sense, it was a utilitarian, anthropocentric approach. The romantic aspect stemmed from the acknowledgement that acclimatization cannot profoundly alter a biocenosis or artificially create a new one without jeopardizing the existence of human life. Man cannot surpass nature's ability to provide for him; he can only be inspired by nature to find ways to improve his life within limits imposed by nature. Plant and animal productivity can only be augmented within these limits. The economic planning programmes proposed by them reflected this simultaneously rationalist and idealist approach.

The precautionary stance of early Soviet ecologists regarding the ecological limits of economic activity led to objections against the productivist bias of the first Five-Year Plan. They "called for a central role for ecology in formulating the Five-Year Plans" (Gare, 1994, p. 91). Resource use and economic policy should be based on their scientific expertise, which "could ensure that growth would remain within the possibilities afforded by healthy nature" (Weiner, 1988, p. 230). These claims gained momentum during the First All-Russian Congress for the Conservation of Nature, held in 1929, when ecologists realized that they needed to be part of the formulation of the Five-Year Plans, with Stanchinskii arguing that "conservation organizations must be able to review plan targets and monitor plan fulfillment" (Gare, 1993, p. 124). In this sense, the ideas and recommendations put forth by Stanchinskii, Vernadskii, and Kashkarov, among others, are representative of a conservationist alternative to more conventional economic planning programmes.

Stanchinskii was trained as a zoologist. He earned his doctoral

⁴ These discussions were at the center of agricultural policy-making until 1929, when it was decided to eliminate the *kulaks* (rich landowning peasants who employed wage labor) as a class.

degree from Heidelberg University in 1906, when he was very likely introduced to Wilhelm Ostwald's ideas on social energetics. After his return to Russia, he managed to establish ecology as a curricular discipline at Smolensk University and, later on, at Kharkov State University (Weiner, 1988). The trophic dynamics or "ecological energetics" of Stanchinskii would serve as basis for the calculation of the productive capacity of each biocenosis. He strived to describe how the flows of energy (and, analogously, of biomass) decreased along biological trophic levels, and how it conditioned the existence of a dynamic equilibrium. The annual energy budget of a given biological community could be calculated using methods and tools which measure the biomass of each component species (Stanchinskii, 1931, 1931b). His analysis of ecological trophic dynamics was highly original, preceding the work of Lindeman (1942) in ecosystem ecology by approximately a decade.

The results obtained from such an assessment would inform economic planners about the aggregated provisioning potential of a certain region and the ensuing economic possibilities. Several parameters or indicators pertaining to biological activity and energy transformation could be created for that purpose, in addition to finding optimal conditions under which productivity can be maximized. 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. For instance, when addressing the problem of the naturally low agricultural productivity of the steppes of southern Ukraine, Stanchinskii called for a thorough, multidisciplinary ecological study as the only path toward higher agricultural yields. To accomplish that goal, he proposed the use of the *zapovednik* of Askania-Nova as an *etalon*, based on which the productivity of crops in similar biocenoses could be improved (Stanchinskii, 1930).

Vernadskii, a renowned geochemist and mineralogist, former member of the Imperial Academy of Sciences, and public figure (especially after establishing the concept of biosphere in the 1920s) reached similar conclusions regarding the economic implications of ecology. Although his contributions focused on the productive use of natural resources, the recognition of ecological limits to economic activity was also present. On the more specific issue of economic planning, Vernadskii expanded Stanchinskii's energy accounting of biological communities to biogeochemical processes, adding a geological component to produce an integrated assessment of how living matter appropriates available energy and, thus, shapes the biosphere (Ponomarev, 1989). He believed that the necessary planning of a socialist economy could be based on physical units, and energy would be such a common denominator for the economic appraisal of natural wealth. Given the increasing demand for resources in modern economies, Vernadskii warned about their finite character, especially of mineral reserves, and called for more creative scientific breakthroughs to deal with the issue (Vernadskii, 1926).

Notwithstanding the political strength and theoretical contributions of Stanchinskii and Vernadskii, Kashkarov was probably the most representative figure among early Soviet ecologists addressing the question of economic planning. He was a professor at Central Asian State University, in Tashkent, and later transferred to Leningrad State University. He worked on comparative anatomy, zoopsychology, and zoogeography, before turning attention to community ecology.⁵ In the end of the 1930s, Kashkarov started to prepare a textbook entitled *Osnovy Ekologii Zhivotnykh* [Fundamentals of Animal Ecology], in which

he dedicated a subsection to the practical importance of ecology to the construction of a socialist economy (Kashkarov, 1944, p. 21–30).⁶

In the *Osnovy*, Kashkarov states that the rapid development of ecological science is also due to the need for a rational and planned use of natural resources in a socialist economy. He embraces Bogdanov's Tektology, stating that only through an integrated, process-oriented worldview, aware of the complex interconnections between natural phenomena, would humans understand nature and put it to use for their own benefit. He tried to demonstrate how such an integrated approach can be applied to the different areas of the Soviet peasant economy. He cites fishing, agriculture, forestry, hunting, animal husbandry, and public health as sectors which would economically benefit from the application of ecological tenets, both in terms of expanding production and of rationally planning economic activities.

As an example, Kashkarov discusses how ecological research could improve the yield of fisheries without disrupting the respective biocenoses. There would be minimum requirements, in terms of resources, for the maintenance of the integrity of a given biocenosis; these requirements are characterized as fixed capital. Normally, only the accruing interest, a surplus provided by nature, can be appropriated by humans. The goal of community ecology would be to perform quantitative and qualitative assessments of such requirements and, thus, determine what can be drawn from nature. Therefore, ecological theories, methods, and accounting are essential to "a truly planned, scientifically grounded socialist economy" (Kashkarov, 1944), which does not deplete the fixed capital from which society earns a profit.

We 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. Furthermore, we must increase the size of "fixed capital", increase the fish stocks in our fisheries, improve their quality, and repopulate exhausted commercial fishponds. Temporarily, due to necessity, it is possible to spend part of this "capital". However, this should be only temporary. 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 (p.21).⁷

Another example would be ecological research for the improvement of crop yields. In this respect, agricultural zoning would be a crucial point, which should also be analyzed in accordance with the precepts of ecology, and not solely as a consequence of demands authoritatively imposed by economic planners. Although "social and economic factors play a leading role in zoning, (...) it is quite obvious that one cannot give a culture to an area with conditions where this culture cannot flourish" (p.22). Natural and historical conditions would be determinant to the success of agricultural policies, which, to a large extent, impact the ability to forecast and plan economic activity.

Kashkarov also addresses the important historical role of the domestic and foreign trade of fur, arguing that, after the "Great October Socialist Revolution", this activity was a target of economic planning. The contribution of community ecology would entail the pursuit of "accurate data on the geographical distribution of fur-bearing and other commercial species" (p.27), as well as data on their habitat and density.

⁵ Kashkarov was among the early Soviet ecologists who adapted their discourse according to the political atmosphere, reason why he managed to keep his academic position until his death in 1941, during the siege of Leningrad. Weiner (1988) uses the term "protective coloration" to explain how Soviet conservationists tried to soften their discourse in the face of the vilification promoted by the establishment against dissenters of official policy.

⁶ The ideas put forth by Kashkarov in the *Osnovy* were briefly presented in an article coauthored with phytogeographer Evgenii Korovin (1891–1963), which discussed the economic role and tasks of ecology in a planned economy (Kashkarov & Korovin, 1933).

⁷ All primary references in the Russian language have been freely translated by the author.

More broadly, Kashkarov called for a detailed ecological accounting of stocks and flows of natural resources, which would serve as basis for a dynamic, long-term economic plan. The example of the accounting of the pheasant for economic planning purposes is quite illustrative of his argument:

Pheasant in Central Asia is a highly important object of the hunting economy, an export item. The pheasant reserves, apparently, are great. However, no one can say how many pheasants there are in Central Asia. It must be taken into account, as without this it is impossible to draw up a procurement plan, an export plan.

In order to make the right plan, not for one year, but a real economic plan, it is necessary to take into account the annual offspring, the number of young animals that survive under normal conditions, and the fluctuations of the survival rate, which depends on fluctuations in climatic and other factors. Only the ecologist can answer questions on the causes of periodic variations in population (p. 27–28).

Once a thorough system of ecological accounting was in place, it would be possible to develop tailored planning solutions to each economic activity and, ultimately, to restructure these activities accordingly. However, before all of this could be done, community ecology had to be given proper support through the creation of the *zapovedniki*. This means that the recommendations of early Soviet ecologists did not provide a ready-to-go, short-term policy for economic development. What they offered was a permanent solution, in which man and nature would coevolve, balancing needs and limits. Their research was only beginning; many rounds of trial and error would be necessary before they could actually produce meaningful data and propositions. Having failed to respond to immediate political demands, and being tagged as followers of left-wing Marxists, their chances of influencing economic policy fell from slim to none.

4. Early notions of natural capital and ecosystem services

According to the notions of natural capital provided in Section 1, and based on the contents of the following sections, it could be argued that early Soviet ecologists were among the precursors of the “ecosystem” approach to the concept of natural capital, mirroring Johnson’s stance in relation to the “financial asset” perspective. Although the term does not explicitly appear in the appraised works of Stanchinskii, Vernadskii, or Kashkarov, an assessment of the context, content, and intent of their work reveals the use of notions that are strikingly similar to the modern use of the concept of natural capital as a set of ecosystemic elements. Nevertheless, there is no evidence and odds are that the modern use of the term bears no causal relationship to the intellectual developments of early Soviet ecology.

The expression of choice of Vernadskii (1926, 1988 [1921–1922]) was “natural productive forces”. It does not constitute an extension of the Marxist labor-centered notion of productive forces, which was used by Nikolai Bukharin (1888–1938), one of the leading intellectual and political figures in the revolutionary Russia of the 1920s, to discuss the dependence of man on nature. Citing Marx’s *Capital*, Bukharin explained that “nature’s material” (an expression used by Marx), such as soil, would provide the means of subsistence that exists independently from man and are the subject of human labor. Nature would be “the immediate object of labor in the acquisitive industries” (Bukharin, 1925, p. 105).

Unlike Bukharin, Vernadskii was against the philosophical dominance of dialectical materialism in Soviet science, defining himself as a philosophical skeptic. For him, the practical implications of scientific knowledge were the best hope for humanity, and the civilizatory process would be determined by “peaceful evolutionary change” (Bailes, 1981, p. 290). Such a process would be conditioned and enabled by “natural productive forces”. Labor is absent in this formulation:

The wealth of a country or a people can be decomposed into two interrelated, but largely independent, parts: 1) the forces of nature of the territory which is at the disposal of the country, and 2) the forces of

the people who occupy this territory (Vernadskii, 1988 [1921–1922], p.337).⁸

Vernadskii’s natural productive forces included the biogeochemical elements and processes of ecosystems, namely “underground wealth, the wealth of soils, the products of the animal and plant kingdoms, and the sources of mechanical energy”. Such elements needed to be scientifically explored, their economic value understood and “translated into forms that are accessible to human life” (pp. 337–338).

Kashkarov (1944), on the other hand, used the term “capital” in a very specific context, giving a small margin of error for the statement that he anticipated the “ecosystem” approach of ecological economists to the modern concept of natural capital. His passage on fisheries explicits his view of ecosystemic elements (fish stocks, ponds, rivers, lakes, or seas) as “fixed capital” (p. 21). The integrity of such a “fixed capital” must not be violated, hinting toward the need for limits to the employment of such capital and its monetary valuation, as well as the precariousness of its substitutability for labor or man-made capital. The “interest” accruing from this “fixed capital” would ideally constitute a limit to the human use of natural resources and ecosystem services. Whereas Johnson did not include ecosystem services in his definition of natural capital (Missemmer, 2018), Kashkarov certainly did, although using the terminology proper to biocenology.

The concept of biocenosis – and, later, of biogeocenosis – was embraced by most Soviet ecologists of the 1920s as the basic unit of ecological study.⁹ It corresponded to a holistic view of nature, in which living and non-living elements would be interdependent and tending toward a relative equilibrium. Neo-romantics and rationalist romantics shared this holistic approach, despite their different arguments and methods, inferring an indivisibility between man and nature which would have vital implications for their vision of culture, social organization, and economic planning.

This holistic view of nature implies that natural resources are not independent elements that can be analytically separated and withdrawn from the whole without unintended consequences. To Kashkarov (1944), the practical importance of the concept of biocenosis lies in the fact that human intervention needs to acknowledge the dependency among the elements of a given ecological unit. “[E]ven if we are interested in a separate species of a natural complex, we are always confronted with the biocenosis, and often our inattention to the latter is fraught with undesirable consequences” (p. 215). Vernadskii shared this vision and expanded it, including the mineral realm into his understanding of a natural complex and proposing that the same interdependency among ecological elements is valid on a planetary level – the biosphere.

This view is not only in synch with the concept of ecosystem, but also with the economic notion of ecosystem services, which allude to the importance of the interconnections between different biogeochemical processes and the need for a holistic approach to understand their functioning. The term ecosystem, as proposed by George Tansley (1871–1955) in 1935, refers to “a holistic and integrative ecological concept that combine[s] living organisms and the physical environment into a system” (Golley, 1993, p.8). Major (1969, p. 15) compares the concepts of ecosystem and biogeocenosis, arguing that, although the

⁸ In this respect, Vernadskii’s concept of “natural productive forces” resembles the notion of natural capital discussed by DesRoches (2018, p.104) as nature’s “production processes that generate valuable goods and services in a manner that is relatively detached from human agency”.

⁹ Sukachev defined biogeocenosis as “a combination on a specific area of the earth’s surface of homogeneous natural phenomena (atmosphere, mineral strata, vegetable, animal, and microbiotic life, soil, and water conditions), possessing its own specific type of interaction of these components and a definite type of interchange of their matter and energy among themselves and with other natural phenomena, and representing an internally-contradictory dialectical unity, being in constant movement and development” (Sukachev & Dylis, 1968, p.26).

former is based on functions within the system and the latter more focused on descriptive relationships, both entail “the transformations and exchanges of matter and energy. (...) The biological concept common to both ecosystem and biogeocoenose [or biogeocenosis] is the important point”.

At least since the 1970s, the economic notion of ecosystem services refers to the “utilitarian framing of beneficial ecosystem functions as services (...) as a way to communicate societal dependence on ecological life support systems” (Gómez-Baggethun et al., 2010, p.1209). As shown for the concept of natural capital, which Åkerman (2003) divided into the “ecosystem” and “financial asset” approaches, the economic concept of ecosystem services, according to Gómez-Baggethun et al. (2010), also saw two different interpretations of its meaning in the 1980s: on the one hand, as use values in Classical economics, associated with nature's benefits; on the other hand, as exchange values in neo-classical economics, which is responsible for the mainstreaming of this concept in the 1990s and the accompanying trend of monetization and commodification of nature.

Kashkarov (1944), when discussing the ecological accounting of the pheasant, clearly links its economic use values – as inputs to a planned economy – to the role of other factors (e.g. the climate). These factors cannot be considered “in isolation, without their mutual connection and mediation”, which leads to the need to “study not only the statics of phenomena occurring in a complex, but to study their dynamics, to study the process” (p. 21) – i.e., to study ecosystem functions as services that yield well-being to humans.

Throughout the work of early Soviet ecologists, there is an explicit appreciation for the role which ecosystems play to the maintenance and improvement of the human condition, including material provisioning and the satisfaction of aesthetic or cultural needs (e.g. Kozhevnikov, 1960 [1909]). This is an appreciation of ecosystem services. However, instead of trying to assign monetary exchange value to an ecosystem and its services as “financial assets”, as common practice since the 1990s, they tried to conceive planning programmes based on use values, and how society could enjoy such capital and services without incurring in ruptures in the ecological balance of these ecosystems. They tried to assess the limits within which society could be provided for, and so plan economic activity accordingly. Their view of the role of ecosystems to social provisioning and cultural development can, therefore, be regarded as an early attempt to address the importance of ecosystem services as sources of livelihood, as well as to conserve them.

5. Final remarks

Early Soviet ecology was assessed as a scientific movement characterized by its combination of rationalist and romanticist views toward nature, and its agreement with the views of Soviet left-wing Marxists of the 1920s. Their attempt to apply ecological precepts to economic development was deemed as a condition for concurrently enabling material progress and the maintenance of healthy and productive biocoenoses. The integration of ecological accounting and economic planning would constitute an ideal path toward resource exploitation in the long run. The calculation of the productive capacity of a determined biocoenosis would allow for the conception and execution of an ecologically sound economic planning programme which did not prevent economic development, albeit it aimed, at the same time, to preserve large tracts of pristine nature.

The incursions of early Soviet ecologists into economic issues showcase a trailblazing interdisciplinary approach to understanding and acting upon the relationship between natural and social systems. They combined innovative research on community ecology with a conservationist ethos that translated into the idea that economic activity should be bounded by biophysical limits and planned so that natural processes are not irreversibly disrupted. These are the foundations for their ecosystemic, holistic approach to the notions of natural capital and ecosystem services.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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